

# The Washington Metrorail Safety Commission



## Safety Audit

of the Washington Metropolitan Area Transit Authority  
**Audit of Automatic Train Control (ATC) and Signals Program**



Final Report:  
January 18, 2024

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Prepared under the authority of the Washington Metrorail Safety Commission

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# Executive Summary

The Washington Metrorail Safety Commission (WMSC) performed this audit of Washington Metropolitan Area Transit Authority (WMATA) Metrorail's automatic train control and signals program through in-depth interviews, site visits, and document and data reviews conducted in March and April 2023, with additional follow up and document review in May and June 2023.

The ATC system provides critical safety protections for train movement and roadway workers. These include functions such as safe train separation, prevention of overspeed derailments, fail safe train detection, broken rail detection, interlocking rules enforcement, hazard response and work zone protection.

The scope of this audit includes the assessment of all associated automatic train control and signaling facilities, equipment, systems, and software on both mainline and in yards such as but not limited to remote terminal units (RTU); train control rooms (TCR) and constituent parts;

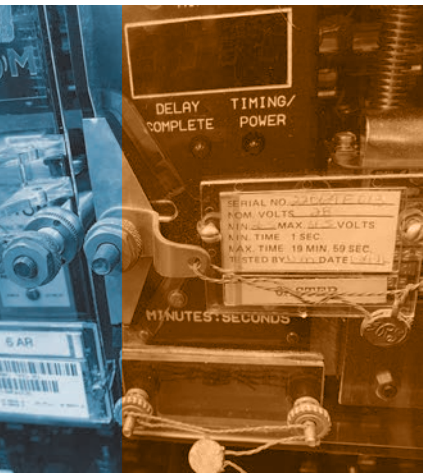
communication lines, devices, and any associated cabling; and the Advanced Information Management (AIM) system (but excluding how the Rail Operations Control Center uses the information typically provided by AIM).

The audit objectives include the assessment of inspection, maintenance, and engineering practices and procedures, and associated training for purposes of compliance with

applicable plans, policies, regulations, and industry best practices. This audit also focuses on closed corrective action plans that were issued as part of the WMSC's Automatic Train Control, Signals and Signal Machines Audit that was issued on May 12, 2021.

The audit demonstrates that Metrorail has implemented some improvements since the previous WMSC audit and the WMSC's August 4, 2022 Train Control Room maintenance and cleaning order, but the audit also demonstrates that Metrorail is not carrying out some key safety commitments.

**Metrorail has implemented some improvements since the previous WMSC audit and the WMSC's August 4, 2022 Train Control Room maintenance and cleaning order, but the audit also demonstrates that Metrorail is not carrying out some key safety commitments.**



**Metrorail ATC Maintenance personnel are not carrying out safety tasks as specified by Metrorail procedures.**

The audit includes five findings and three recommendations.

- ▶ **Finding 1: Metrorail ATC Maintenance personnel do not have a uniform understanding of Metrorail procedures, which leads to inadequate completion of safety tasks, such as inspections and handling of vital systems, that are required to ensure that track circuits and other elements of the ATC system function properly as required to prevent train collisions and to provide other designed safety protections.**

Field observations, interviews, and discussions with other personnel demonstrated that Metrorail ATC Maintenance personnel are not carrying out safety tasks as specified by Metrorail procedures. This creates the risk that vital systems will not function as required. This included maintenance personnel not understanding how to carry out AF-800W track circuit module preventive maintenance procedures, not following electrostatic discharge protection processes to protect circuit boards, not completing other work as required or with the in-effect procedures, not conducting required supervisory oversight, closing preventive maintenance work orders that are not complete, and not tracking deficiencies and required corrective maintenance to ensure that repairs are made.

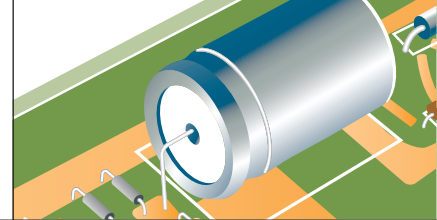
- ▶ **Finding 2: Metrorail does not review, analyze, and act upon available safety data about the health and functionality of the Automatic Train Control system and subsystems as required by Metrorail's Agency Safety Plan. Therefore, Metrorail's ATC Engineering cannot reliably or proactively determine whether or not the ATC system and subsystems are or will be functioning as designed to provide for the safety of riders and workers.**

Metrorail does not understand its data, its significance, what analysis is needed, or proper maintenance techniques. No one who understands the proper procedure is validating that the data comports with the PMI and its intended purpose or that the work is being carried out correctly, and there is no feedback that something is being done correctly or incorrectly. Metrorail's safety management system commitments, required by the WMSC Program Standard, in WMATA's Public Transportation Agency Safety Plan require data collection, review and analysis. However, ATC Engineering personnel are generally only reviewing preventive maintenance data following a failure that causes a passenger delay, and are utilizing reliability reports that are based only on the incomplete information in Metrorail's maintenance management system (Maximo).

- ▶ **Finding 3: Metrorail is putting its personnel at risk due to health hazards such as damaged and repositioned materials marked as containing asbestos that are not being identified and managed as required by its Agency Safety Plan.**

The WMSC observed disturbed floor tiles, some labeled with an asbestos warning, at Arlington Cemetery Station, and observed similar disturbed tiles and mastic (glue used to hold the tiles) at other locations. The WMSC reviewed these health hazards with Metrorail personnel on site and with Metrorail managers during audit interviews, followed up with





several document requests, discussed this with Metrorail management again during the exit conference for this audit, and additionally provided Metrorail with a more detailed written description following the exit conference. The WMSC then reviewed additional follow-up documents provided by Metrorail. Metrorail had not documented these or other health hazards in its inspections.

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► **Finding 4: Metrorail is not systematically identifying, tracking, and mitigating hazards related to automatic train control and signaling as required by its Agency Safety Plan.**

Following WMSC direction and an FTA safety advisory, Metrorail is making progress toward its initial safety risk management launch for train control and signals. This process has not yet been implemented. This audit demonstrates that Metrorail had not been systematically identifying, tracking, and mitigating hazards related to automatic train control and signals.

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► **Finding 5: Metrorail is not maintaining its books of plans in accordance with its requirements.**

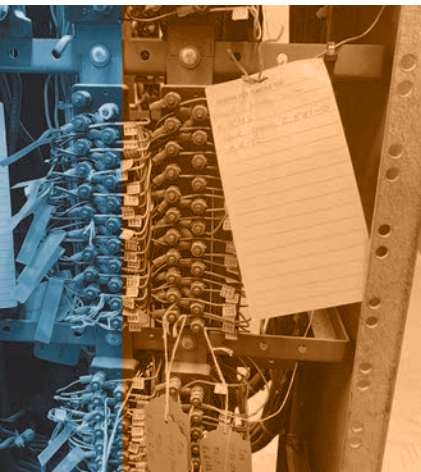
Books of plans in Train Control Rooms provide the basis for safe and effective work in the room, particularly work related to troubleshooting or repairs. In many rooms visited by the WMSC, these books providing the electrical drawings for personnel are improperly marked, have torn or missing pages, or are otherwise dirty or damaged. Such damaged, dirty, or missing pages can lead to incorrect or delayed troubleshooting and repairs which can create or exacerbate safety issues.

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**Metrorail is making progress toward its initial safety risk management launch for train control and signals. This process has not yet been implemented.**



The WMSC Audit team observed temporary hang tags on wires in many Train Control Rooms that had been in place since the 1970s, 1980s and 1990s.



► **Recommendation 1: Metrorail has not determined the required staffing for ATC and Signals.**

Metrorail personnel interviewed for this audit expressed concern about staffing and alignment within Metrorail's Communications and Signaling Department, and the desire to conduct a staffing and organizational assessment to determine the required staffing levels for specific tasks.

► **Recommendation 2: Metrorail does not ensure that lessons learned from prior projects are consistently shared with all relevant personnel responsible for ATC and Signals.**

Interviews for this audit demonstrated that lessons learned, particularly as part of capital projects, are developed but are not consistently shared and incorporated across ATC and Signals personnel. Proactively and consistently sharing lessons learned more broadly can help an organization like Metrorail avoid repeating similar issues and promote repeating of positive outcomes.

► **Recommendation 3: Metrorail does not have a procedure for the removal of hang tags in Train Control Rooms that indicate temporary modifications. This has led to many rooms having such “temporary” hang tags in place for decades.**

The WMSC Audit team observed temporary hang tags on wires in many Train Control Rooms that had been in place since the 1970s, 1980s and 1990s. As described on the tags and in interviews, Metrorail intends these blue or tan tags to indicate temporary modifications from the printed book of plans, such as the use of spare cables, that would then be replaced in the future or incorporated into permanent future updates to the books of plans used for troubleshooting and other work. However, Metrorail has no process to incorporate the information and remove these tags to provide for clearer access to wiring and provide assurance that the books of plans are accurate.

WMATA is required to propose CAPs to address each finding and respond to each recommendation no later than 30 days after the issuance of this report.







## **Background** and Scope



# Background and Scope

**Specific equipment and software relied upon by the ATC system is considered “vital” because its proper functioning is essential for the protection of human life.**

The scope of this audit is automatic train control and signaling. Specifically, this includes all associated automatic train control and signaling facilities, equipment, systems, and software on both mainline and in yards such as but not limited to remote terminal units (RTU); train control rooms (TCR) and constituent parts; communication lines, devices, and any associated cabling; and the Advanced Information Management (AIM) system (but excluding how the Rail Operations Control Center uses the information typically provided by AIM).

The audit objectives include the assessment of inspection, maintenance, and engineering practices and procedures, and associated training for purposes of compliance with applicable plans, policies, regulations, and industry best practices. This audit also focuses on closed corrective action plans that were issued as part of the WMSC’s Automatic Train Control, Signals and Signal Machines Audit that was issued on May 12, 2021.

The audit is based on the WMATA Public Transportation Agency Safety Plan (PTASP) effective December 31, 2022 (Rev. 3.0), Metrorail’s procedures and documentation, and other associated requirements. The specific elements of the Public Transportation Agency Safety Plan covered in this audit are listed in Appendix D. This includes the element of hazardous materials and environmental management, which was added during the audit process due to concerns identified during site visits for this audit that are described below.

## Metrorail’s ATC System

Metrorail’s ATC system design relies on fixed blocks based on track circuits. When a train (or a shunt placed by roadway workers) is in a particular section of track, it changes the flow of the electric current that runs through the running rails, which de-energizes a relay, which causes the block to indicate as occupied.

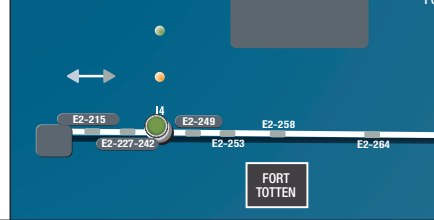
Information about occupied blocks, signal status and other factors flows through equipment in train control rooms including ATC modules and Remote Terminal Units, then through communications lines to reach the Advanced Information Management (AIM) system used by the Rail Operations Control Center (ROCC) to monitor and direct train and personnel movement. Using the AIM system, controllers can remotely change switch alignments, signal aspects and other features. ATC personnel can also take some of these actions locally from a train control room when directed by the ROCC due to system failures or to establish a work zone.

Metrorail’s Automatic Train Control (ATC) system includes physical components such as train control rooms (TCRs), cabling, impedance bonds, marker coils, wayside signals, switch mechanisms and relays, as well as software that is integral to the safe and proper operation of those components.

Specific equipment and software relied upon by the ATC system is considered “vital” because its proper functioning is essential for the protection of human life because it provides for safe train operations by, among other things, detecting track occupancy and preventing collisions.







The ATC system ensures key safety functions such as safe train separation, prevention of overspeed derailments, fail safe train detection, broken rail detection, interlocking rules enforcement, hazard response, and work zone protection.

Metrorail has more than 100 Train Control Rooms across the system. Each TCR contains, among other assets, equipment racks containing track circuit modules and other associated equipment that identify the location of trains and of fixed work zones. Metrorail currently has Ansaldo/Hitachi AF-800, Alstom Generation 3, Ansaldo/Hitachi AF-800W, and Alstom Generation 4 Audio/High Frequency Track Circuits on mainline track (track outside of rail yards). Metrorail also has vital single rail AC track circuits at some interlockings, and has series AC track circuits in rail yards on tracks other than yard leads.

Information is communicated to elements of the system through RTUs, a part of the Supervisory Control and Data Acquisition (SCADA) system that interfaces with wayside safety equipment and train control systems. These devices connect items in the field, such as those in a train control room or those like switches and signals that are linked to that train control room, to central data systems. They are crucial to the ongoing operation of the system from a centralized location since they enable certain actions to be taken remotely and allow important real-time information to be shared automatically with controllers and train operators. When RTUs fail, the actual conditions in the field do not correspond to what is displayed in the AIM system. For example, in multiple locations and instances in late 2022, information from RTUs was unavailable, leading to Rail Operations Control Center personnel seeing outdated and therefore incorrect information on their control screens, which creates a risk that they would provide a protective block to a train or foul time protection to roadway workers when, in fact, another train is moving through or positioned in that block. Metrorail also utilizes train-to-wayside communications systems with elements on the railcar, on and along the roadway, and in the train control room.

Metrorail procedures require that these train control rooms and equipment be maintained in a state of good repair and cleanliness to ensure that this vital train control equipment functions as intended.

Metrorail's ATC system includes Automatic Train Protection (ATP), Automatic Train Supervision (ATS), and Automatic Train Operation (ATO) subsystems.

ATP refers to the system intended to protect against collisions by keeping appropriate train separation. This system includes speed commands that are displayed on train operator consoles that are used by operators in manual mode or acted upon by the automated systems in ATO mode. The speed commands are automatically sent from the governing train control room (TCR) using the audio frequency track circuits, and are designed to be based on signals and track occupancy ahead of that train as detected by the automated systems.

ATS refers to the wayside system that is intended to be used to assist with train routing, speed, and train separation for headway or scheduling purposes.

ATO refers to the actual automated movement of the train under the supervision of the operator.

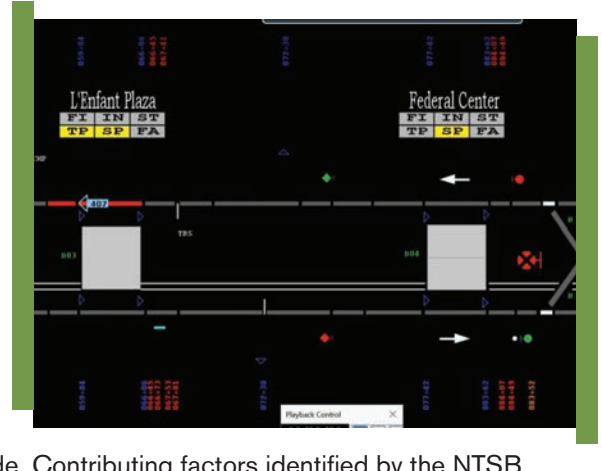
Metrorail records show there are additional interrelated elements that are part of each system.



**When RTUs fail, the actual conditions in the field do not correspond to what is displayed in the AIM system.**

**The 1996 report also identified safety issues related to Metrorail's use of systems that it had labelled non-vital, such as the ATS system, to perform vital functions such as reducing the speed of trains during inclement weather.**

Metrorail suspended the use of ATO in 2009 following the fatal Red Line crash near Fort Totten. The National Transportation Safety Board (NTSB) investigation into that crash concluded that the probable cause of the collision was a failure of track circuit modules that caused the overall ATC system to lose detection of the train that was struck and WMATA's failure to ensure that an enhanced track circuit verification test developed after safety events near Rosslyn Station in 2005 was institutionalized and used systemwide. Contributing factors identified by the NTSB included WMATA's lack of safety culture, and WMATA's failure to effectively maintain and monitor the performance of its automatic train control system.



Since 2009, Metrorail has commissioned or developed several studies, reviews, and plans to identify and carry out improvements, upgrades, or future plans in line with NTSB, FTA, WMSC, and other findings or recommendations or based on internal planning and initiatives.

In 2022 and 2023, Metrorail conducted a review of its progress on some of the items identified by these reports and plans, and determined that, although many items were complete, it could not provide any evidence that dozens of these safety improvements had been implemented (see Finding 4).

This review of certain previous findings and safety improvements that had been previously identified did not include those hazards identified as part of the NTSB's investigation into the fatal 1996 collision at Shady Grove Station. The 1996 investigation identified hazards related to the underlying design of the fixed block system and associated braking rates, similar to the type of overall hazard identified in the NTSB's 1970 report on failures in the original design of the Metrorail system to consider system safety principles. The 1996 report also identified safety issues related to Metrorail's use of systems that it had labelled non-vital, such as the ATS system, to perform vital functions such as reducing the speed of trains during inclement weather. The investigation further identified that station overruns (or trains bypassing stations) prevent trains from receiving the appropriate speed commands due to Metrorail relying on a train properly positioning within the platform to communicate with the train-to-wayside communication systems.

## **Prior Reviews and Audits**

### **WMSC Audit, Findings and Other Oversight**

Protecting vital systems from dust, water, and other contaminants has long been recognized as critical to life safety in rail operations. Maintaining assets in a state of good repair ensures that these assets are fit for purpose. This is a fundamental stewardship responsibility of an entity such as WMATA. This is especially true for assets that include vital train control equipment. The performance of vital systems is critical to ensuring safe Metrorail train operations. However, the WMSC identified in 2022 that Metrorail was not ensuring this state of good repair.



On August 4, 2022, the WMSC **issued an order** regarding Metrorail's ineffective and insufficient Automatic Train Control (ATC) Room inspection, maintenance, and cleaning program.

The order followed several months of engagement with Metrorail, initiated following a WMSC inspection of the Friendship Heights Station Train Control Room on March 28, 2022.

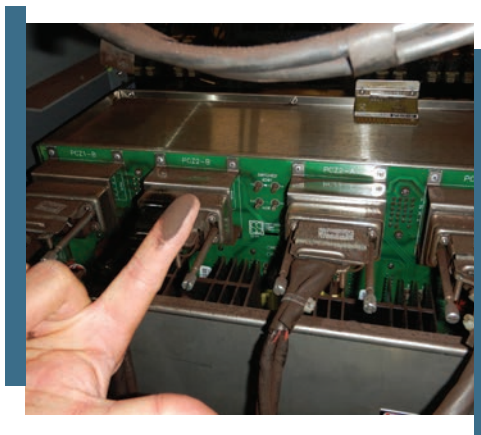
Although Metrorail procedures require weekly cleaning of each TCR, on March 28, 2022 the WMSC found the Friendship Heights Station TCR and its equipment covered in dust and other debris. The deteriorating ceiling in this room, including exposed rusting rebar and other materials, appeared to be at least one source of this debris. The TCR also had water leaks, some of which were being caught by buckets placed by Metrorail personnel, and other evidence of water intrusion. Metrorail had placed plastic over some equipment at some point in the past due to water leaks onto the equipment, but that plastic sheeting had deteriorated and was not an effective permanent mitigation. Air conditioning duct work was also deteriorated.

The water intrusion and debris were on, around and near vital automatic train control equipment. The equipment in this room had a layer of dust and debris, which could interfere with the equipment's safe operation and lead to a collision, loss of life, or other safety event.<sup>1</sup>

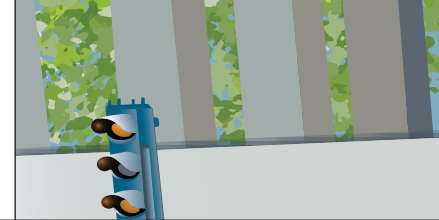
The WMSC communicated the urgent safety concern identified in that room to Metrorail on March 29, 2022 and required Metrorail to take immediate action to address those safety concerns.

The WMSC also initiated a broader review of Metrorail's TCR maintenance records and practices that included reviewing records and conducting additional field inspections.

The inspections demonstrated that the conditions at the Friendship Heights Station TCR were not isolated to that location. The WMSC communicated these conditions of accumulated dust on train control equipment, failing or inoperative heating, ventilation, and air conditioning (HVAC) units, and standing water in



<sup>1</sup> In comments on the draft of this report, Metrorail stated that the equipment is intended to be fail safe and is protected by the thin protective coating that is designed to allow for less spacing between circuits and that provides an additional layer of protection from low levels of contaminants. However, Section 5.2.2 of the original equipment manufacturer manual requires that the system equipment be clean, as this coating is a last layer of protection. The manual states that "cleaning is necessary to remove accumulated dirt and other substances from the equipment. While cleaning or servicing, exercise caution so as not to damage or dislodge any components or rack wiring, including connectors and back plane wiring." Further, industry practices as represented in the AREMA manual Part 11.5.1 Section C Classes of Environment, Class D: Wayside Control Room describe the need to clean the rooms and equipment to ensure it operates as intended. In addition, Metrorail's ATC 1000 Manual, Rev. 5, requires that Metrorail ensure in its weekly inspections that each track module is clean, dry, and clear of accumulated dust and foreign matter. Fail safe does not mean fail proof. Maintenance is needed to ensure proper operation. As noted in this section of the report, the WMSC has previously emphasized this to Metrorail, including during this audit and in the August 2022 Train Control Room order that is the focus of this section.



**The WMSC communicated the urgent safety concern identified in that room to Metrorail on March 29, 2022 and required Metrorail to take immediate action to address those safety concerns.**



underground conduit housing various electronic and electrical circuitry associated with the train control equipment to Metrorail.

The accumulation of dust and debris on equipment, the long-term water intrusion into rooms, the failing HVAC ductwork or nonexistent air filtration systems, and the collapsing or otherwise damaged structural elements showed that Metrorail allowed these conditions in TCRs to deteriorate over time.

Systemwide TCR inspection records for March 2022 showed that Metrorail personnel were not completing regular inspection reports and activities in each room as required by Metrorail's ATC 1000 manual, and that there was ineffective supervisory oversight to ensure that hazards are properly identified, mitigated, and addressed.

Metrorail as an organization did not effectively identify and mitigate these hazards.

WMSC follow up in July and August 2022 demonstrated that Metrorail did not follow through on all safety commitments made in April and May 2022, including not continuing and completing special safety inspections of all TCRs and not beginning similar special inspections of other similar rooms. Metrorail also stated on August 2, 2022 that it had not taken any additional action to ensure regularly scheduled inspections were conducted according to procedures and that safety issues are properly documented, communicated, and resolved.

The WMSC's **order** on August 4, 2022 included specific requirements, and a requirement that Metrorail develop and implement a corrective action plan. That CAP, C-0213, is open and Metrorail was in the process of implementing the CAP at the time of this audit.

### **Safety Certification**

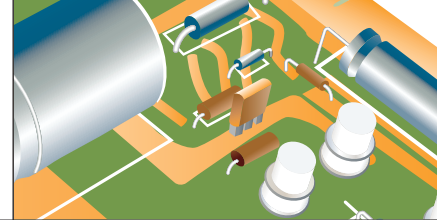
The WMSC **issued a finding** on August 13, 2021 regarding Metrorail not consistently following its safety certification process, which leads to project activation and use without proper hazard identification and mitigation, putting Metrorail customers, personnel and first responders at risk.

This finding was based on the WMSC's safety audits, other regular oversight activities, and additional investigation conducted in coordination with WMATA's Office of Inspector General. This included work related to the WMSC's ATC Audit issued in 2021 and related to updated ATC system design and installation in the Alexandria Rail Yard.

Metrorail reactivated the Alexandria Rail Yard (C99) ATC system over the safety-based objections of Metrorail's subject matter experts, the ATC Engineering Department. Metrorail's failure to follow its safety certification process contributed to not initially conducting an effective hazard analysis, not including reliability and maintenance requirements in the contract and planning, and Metrorail later activating areas of the yard without the required sign offs and approvals.

Metrorail's SSRP put the final portion of the yard back into service, and the Safety Department approved a TUN, in late May 2021 without ATC Engineering's required approval and despite ATC Engineering stating that there was insufficient safety review and





documentation. The Office of Engineering and Architecture (ENGA), which oversaw ATC Engineering at the time but does not have ATC subject matter expertise, signed off anyway.

Following the WMSC raising specific concerns related to the Alexandria Rail Yard, Metrorail acknowledged changes were required to ensure that subject matter experts, such as ATC Engineering, are not bypassed in the safety approval process for someone higher in the chain of command who is willing to sign off despite a lack of technical expertise in the relevant area. In addition, WMSC discussions with Metrorail's ATC Engineering experts identified safety concerns related to the process and requirements used and the safety steps required for the ATC system related to the Potomac Yard Station that was then under construction due to the contract not including, and Metrorail not initially following, all requirements to ensure that the track circuit design aligned with Metrorail's ATC design criteria. Metrorail subsequently acknowledged those safety certification deficiencies and adjusted the Potomac Yard Station project.

The corrective action plan Metrorail developed as required by the August 13, 2021 finding is CAP C-0118. Metrorail was in the process of implementing remaining parts of this CAP at the time of this audit.

### **WMSC ATC Audit issued in 2021**

The WMSC issued its **first audit of Metrorail's Automatic Train Control and Signals program** in May 2021. The report included 16 findings requiring Metrorail to develop corrective action plans (CAPs).

Metrorail had not adequately trained employees on safety procedures, and was not following several safety-related processes.

The list of findings and the evaluation of Metrorail's corrective action plans to address the 2021 findings is provided later in this report.

### **Oversight of Metrorail Safety Certification of Potential Use of Automatic Train Operation, Automatic Door Operation**

The WMSC has been conducting ongoing oversight of Metrorail's safety certification process for the potential use of Automatic Door Operation and Automatic Train Operation.

Although Metrorail had initiated safety certification steps as part of the corrective action plan to address the finding from the 2021 ATC audit described above, the WMSC's ongoing oversight demonstrated in summer 2023 that Metrorail was not following its process to ensure that hazards are identified and appropriately mitigated as Metrorail attempted to move forward with this project from fall 2022 through mid-summer 2023. The WMSC communicated these issues to Metrorail that would have prevented Metrorail from completing its safety certification process, and therefore would have prevented the WMSC from concurring that Metrorail had completed its safety certification process.

Metrorail initiated adjustments in summer and fall 2023 that began to align its work with its safety certification requirements and industry standard engineering practices. This led to Metrorail completing its safety certification steps required to begin utilizing Automatic Door



**The WMSC issued its first audit of Metrorail's Automatic Train Control and Signals program in May 2021.**

**The ATC work crew did not report this near miss and red signal overrun.**

Operations in passenger service on the Red Line in October 2023 as part of train operator certification, and to begin utilizing Automatic Door Operations on the Red Line on a regular basis in December 2023, with specified safety mitigations in a Temporary Use Notice. The WMSC continues to oversee Metrorail's process.

### Investigations

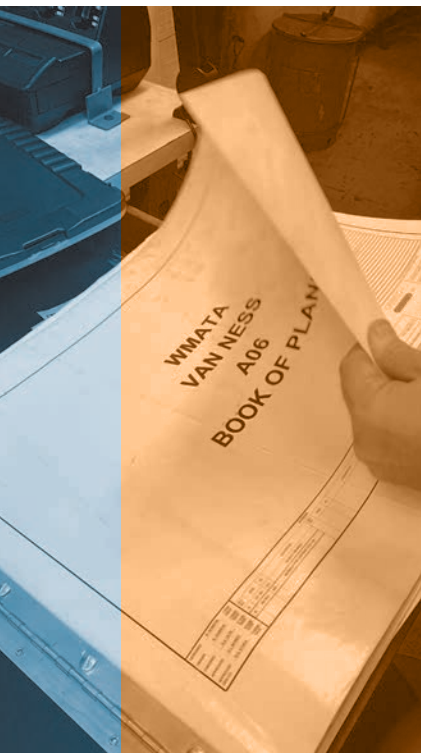
Metrorail has experienced safety events related to the ATC system and personnel. In addition to those described above, more recent events include a station overrun at Innovation Center Station on one of multiple trips a train operator operated in ATO without authorization, an action that was not reliably detected by Metrorail systems or noticed and acted upon by Metrorail personnel. Among other things, the investigation identified deficiencies related to Metrorail's train-to-wayside communications (TWC) systems that Metrorail had not identified or acted upon.

Safety events such as one on March 10, 2023 near McPherson Square and a December 6, 2022 red signal overrun near Smithsonian Station (W-0217) demonstrate ongoing roadway worker protection risks for signals personnel. In the December 6, 2022 event, there was a near-miss of a collision with an Automatic Train Control Maintenance crew with local control of an interlocking.

The ATC work crew did not report this near miss and red signal overrun. The work crew later stated that they had all reached a place of safety when the train passed, but were surprised by the train suddenly moving past the red signal without a route being set.

During the response to this event, there were several attempts by the Radio Rail Traffic Controller to contact the Roadway Worker In-Charge with no response.

Based on investigative interviews, ATC crew members were communicating among themselves on a "talk around" radio channel, rather than a Metrorail operational radio channel that is used by the Rail Operations Control Center and train operators (which leads to heavy communications traffic on that operational channel). The ATC crew reported regularly using a "talk around" channel for the Roadway Worker In-Charge to direct another member of the crew in the Train Control Room to set a lunar (proceed) signal once the work crew was clear of the roadway. Metrorail does not record "talk around" radio communications, so the use of such a channel reduces the opportunity for continuous safety improvement. The use of these "talk around" channels also means the Roadway Worker In-Charge (RWIC) may have their radio tuned to a channel other than the one being used to communicate operational, safety, and emergency information to and from train operators, other on-track personnel, and the Rail Operations Control Center. Metrorail developed a lessons learned communication for ATC Maintenance personnel regarding the need for effective communication among work crew members and proper Exclusive Track Occupancy – Local Signal Control procedures. Metrorail reviewed procedures for Exclusive Track Occupancy – Local Signal Control.





## Federal Transit Administration and Tri-State Oversight Committee Oversight

In 2015, a Tri-State Oversight Committee (TOC) audit of Metrorail's ATC and signals program identified inadequate completion of preventive maintenance that is scheduled on intervals of one year or longer.

The audit also identified concerns about tracking of tool status and calibration, pre-printed data sheets, data sheet completion and work order creation, work order closure processes, a lack of supervisor signatures on batches of data sheets, scheduling of all preventive maintenance procedures listed in the ATC-1000 and ATC-3000 manuals, tracking of past-due inspections, supervisor quality control or compliance assessments (see this audit's findings below), and a lack of structure with defined levels of training, knowledge and feedback for maintenance employees.

In 2018, a TOC audit of ATC and signals noted that prior findings remained open with corrective action plans that had not been implemented, but that WMATA had improved its tracking and calibration of tools. The audit included two findings: 1) that the introductory ATC Journeyman Course listed as required had not been offered since 2015, and 2) that the procedure and records for the 55E switch point detector test were not being followed or reported consistently. As explained in the WMSC's ATC Audit issued in 2021, Metrorail's later rush to replace 55E switches due to their poor condition and operations contributed to new machines arriving on Metrorail property without any coordination with or training for ATCM personnel.

In 2018, ATC Maintenance was planning to institute Preventive Maintenance Instruction (PMI)-based certifications. As described below, Metrorail has now created an ATC Maintenance on-the-job training program based on specific PMIs, but personnel in the field are not carrying out the procedures as required (see Finding 1).

In 2018, compliance rates for PMIs were lowest for those scheduled least often, which raised a concern that those important, less frequent inspections and maintenance work were not being completed for extended periods. These tests relate to safe train movement and operations. For example, spillover tests are designed to ensure that proper signals are sent so that trains operating with automatic door opening only open doors on the platform (not on the wrong side or with part of the train off the platform). At the time of the 2018 audit, 10-year cable meggering was not being done, but testing began in 2018 for cross bonds and identified a number of failures. The Two Year TCR and Ground Validation Test was not being scheduled or performed.

The TOC also noted areas of bobbing track circuits due to dissimilar rail sections within a track circuit, an issue that requires ongoing coordination between ATC and track-related departments.

The TOC also identified conflicts between ATC clearing procedures under Exclusive Track Occupancy protection and Metrorail's Roadway Worker Protection rules.



## Internal WMATA Reviews

In 2020, WMATA's Office of Inspector General (OIG) completed an audit of Metrorail's Remote Terminal Unit (RTU) replacement projects, after identifying that there were three uncoordinated projects moving forward separately due to inadequate internal controls, a lack of WMATA-wide planning, organizational fragmentation (silos), and not following the project lifecycle management process.

Metrorail subsequently adjusted these programs, including ATC, Power, and IT programs, and conducted further planning for these and associated projects.

In late 2020, WMATA's Quality Assurance, Internal Compliance & Oversight (QICO) completed a separate review of Metrorail's switch machine power supply replacement program, which was replacing 166 power supplies throughout the rail system through January 2022. The review identified a lack of governing documentation, a lack of training requirements, a lack of contractor oversight, and a lack of an established change management process. The review also identified opportunities to improve scheduling, to institute independent inspections for quality assurance, and to properly use track rights systems to schedule the work so that it did not conflict with the work of other departments. This replacement work, conducted by the Signal System Renewal Program (SSRP), had to be stopped by ATC Engineering (ATCE) in September 2020 due to failures of the newly installed equipment and the need for more rigorous testing and simulation.

In May 2021, Metrorail completed an Internal Review of its Switch Machine program that identified risks related to training; inspection, testing and status; process control; identification and traceability of assets and materials; document control; and corrective and preventive actions.

That review identified a lack of a comprehensive training plan to maintain new switch machines, a lack of proper and timely maintenance of snowmelter cabling, a lack of engineering oversight, approval and interdisciplinary coordination in the engineering and structural modification process to ensure safe and reliable train movement on aerial structures, a lack of a comprehensive plan for switch machine replacement, a lack of standardized review and revision process for preventive maintenance instructions leading to the use of outdated processes, and inadequate drainage around ATC components.

Regarding training, the internal reviewers noted that an ATC Maintenance crew had a printed copy of the approved maintenance procedure for new GM-4000A switch machines, but that they were unfamiliar with how to carry out this work due to differences from other Metrorail switches that they had not been trained on, differences in understanding of the procedure's requirements among members of the work crew, and none of the crew being familiar with the required measurement gauges. This is similar to issues identified below in Finding 1 of this audit, specifically the observed example of a crew working on AF-800W track circuit modules.

Regarding modifications, Metrorail conducted work to install switches without consulting structural engineers, which led to reducing the deck thickness of bridges such as near Huntington Station, Reagan National Airport Station, and east of Stadium-Armory Station that





also exposed supporting rebar, which accelerates degradation of the structure and risks rusting that cannot be detected during Metrorail's inspections. Metrorail conducted the work even after the plan was rejected by its structural engineering unit. As part of these high risk findings, Metrorail's internal review noted that the WMSC had identified related issues in Finding 6 of the audit report issued in 2021, and that actions would include stopping installation of GM-4000A switch machines on aerial structures and tunnel invert including floating slabs, developing a process to include concurrence of all applicable engineering departments during EMI development, specific approval before work on each bridge deck or tunnel track bed location, and remedial actions to protect the exposed concrete and reinforce structures and reinforce structures (see iCAPA below). The internal reviewers also recommended developing a plan for other switch machines that do not require structural modifications.

In 2022, Metrorail's internal review of Automatic Train Control Maintenance – Track Circuits identified that ATC Maintenance personnel did not have required testing equipment, ATC Maintenance personnel were not trained to use the equipment as required by preventive maintenance and other procedures, and that the ATC Maintenance Control Policy was not being followed for field repairable parts and unused materials. This included the identification that the digital multimeter being used by ATC Maintenance personnel was not capable of measuring the required range for shunt testing designed to test whether the track circuit properly displays as occupied in the worst-case scenario of a rail vehicle's wheels making poor contact with running rails. Metrorail's reviewers further identified in interviews that ATC Maintenance staff did not have the proper equipment capable of precision measurement to test/validate shunt straps used to simulate train presence. Metrorail's ATC-1000 manual requires the use of only validated shunt straps. Metrorail subsequently issued an Engineering Information Bulletin (EIB-22-0003-SYS) for the shunt validation procedure, and developed an iCAPA.

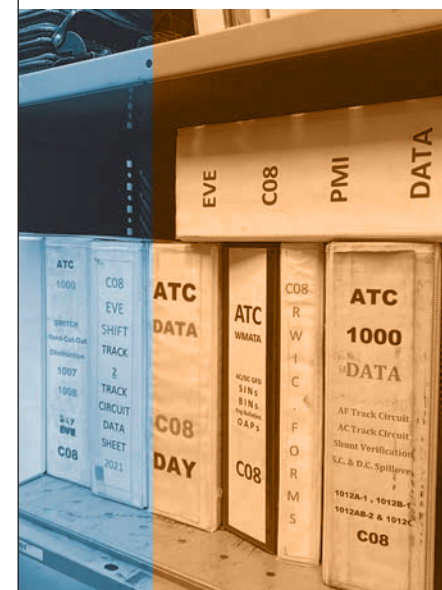
### iCAPA Status

At the time this audit began, Metrorail had several internal corrective action plans (iCAPAs) that were open related to Automatic Train Control and Signaling.

QICO-ATCM-20-01, updating the Automatic Train Control Branch Maintenance Control Policy, inclusive of departmental warranty claim process, was open and past due. This was originally expected to be completed in May 2021.

QICO-SM-21-03 was also open and past due, related to the need for a maintenance plan that incorporates best practices for drainage system maintenance that would protect WMATA's track-side assets. ATC Engineering and ATC maintenance had submitted relevant action items in 2022. Other parts of the Metrorail organization are responsible for the additional items.

Other open iCAPAs included QICO-SM-21-01 to update current EMI process to include concurrence and collaboration with all applicable engineering departments during execution of structural modifications, and conducting an inspection, evaluation and repair recommendations for those locations damaged by improper installation and planning. (See further information related to GM-4000 switch adjustments, and other EMIs).



**The digital multimeter being used by ATC Maintenance personnel was not capable of measuring the required range for shunt testing designed to test whether the track circuit properly displays as occupied in the worst-case scenario of a rail vehicle's wheels making poor contact with running rails.**



Open iCAPAs related to an ATC Maintenance – Track Circuits internal engineering and maintenance review included QICO-ATCM-22-01, to develop a standardized inspection process post rail replacement maintenance support and include ATCE in report distribution to provide for the identification and mitigation of track circuit disruptions due to dissimilar running rails, QICO-ATCM-22-02 to procure and distribute prescribed testing equipment, and train ATCM personnel on the use of testing equipment as stated in the prevailing PMI/EIB procedures, and QICO-ATCM-22-03 to enforce adherence to existing ATC Maintenance Control Policy on field repairable parts and unused materials, and to establish a process for the collection of materials.

## Organizational Structure

At the time of this audit, Metrorail had recently assigned responsibility for automatic train control and signals inspection, maintenance and engineering to the newly created Communications and Signaling Department, which Metrorail refers to as COSI. Metrorail created this department in December 2022 to oversee the existing Automatic Train Control Engineering (listed in some documents as Signal Engineering), Automatic Train Control Maintenance (listed in some documents as Signal Maintenance), and Signal Systems Renewal Program units that had previously each reported to separate departments. Within each of the three units, the organizational structure did not change.

ATC Engineering/Signal Engineering is responsible for ATC and signals engineering. ATC Engineering is led by a Senior Director, Assistant Chief Engineer, and 5 managers. This includes a new manager of engineering for software and a potential future transition to communications-based train control (CBTC).

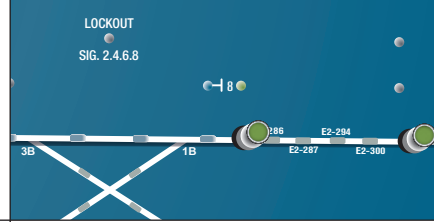
Metrorail stated that Signal Systems Renewal Program, which focuses primarily on capital projects, is responsible for inspection of ATC equipment. Metrorail's procedures specify that ATC Maintenance/Signal Maintenance is responsible for inspection and maintenance. ATC Maintenance includes on-the-job training personnel who provide classes on specific procedures. Metrorail utilizes Technical Skills Maintenance Training, which had been moved in December 2022 to report to the Safety and Readiness Department, to teach other classes.

Metrorail relies on other organizational units such as Shops and Materials Support to repair or calibrate certain ATC-related equipment.

Other departments are responsible for structural, power supply, or similar repairs and maintenance of ATC rooms such as Train Control Rooms and associated equipment. This includes Power Department responsibilities, Plant Maintenance responsibilities for flooring, air conditioning and similar items, Structures responsibilities for the integrity of the rooms, Communications responsibilities for information flow and in shared rooms other items, Information Technology responsibilities from Metrorail's main IT and Rail Operations Control Center IT groups, and Safety Department responsibilities for additional inspections and oversight.

Metrorail's realignment was not yet reflected in Metrorail's Public Transportation Agency Safety Plan that is the basis for this audit. Metrorail updated its Agency Safety Plan in late 2023 to reflect these changes.





## Audit Work

The WMSC received initial documents related to this audit from WMATA in February 2023, made subsequent document requests, and reviewed the documents provided by Metrorail throughout the course of this audit. The WMSC conducted an entrance conference in March 2023, and conducted site visits and extensive interviews with Metrorail personnel in March and April 2023. The WMSC held an exit conference with Metrorail in May 2023 and provided additional follow up to Metrorail.

As the WMSC does during each audit, the WMSC communicated safety issues to Metrorail personnel as those issues were identified and confirmed. During this audit, that included communication during site visits, during interviews, and during and after the exit conference. As described below, Metrorail took some initial action upon elements of this information discussed during interviews, such as the asbestos in train control rooms (see Finding 3). In response to the draft of this report, Metrorail indicated that it had not yet acted upon other safety information communicated by the WMSC, such as the improper performance of track circuit preventive maintenance (see Finding 1) that was discussed with supervisors during field observations and confirmed with signal engineering and signal maintenance managers during interviews, and that was subsequently reiterated during the presentation at the exit conference in May 2023 as among the examples supporting preliminary Finding 1 (which, following Metrorail's opportunity to provide additional documents and the WMSC's completion of document review, led to Finding 1 in the draft and final report).

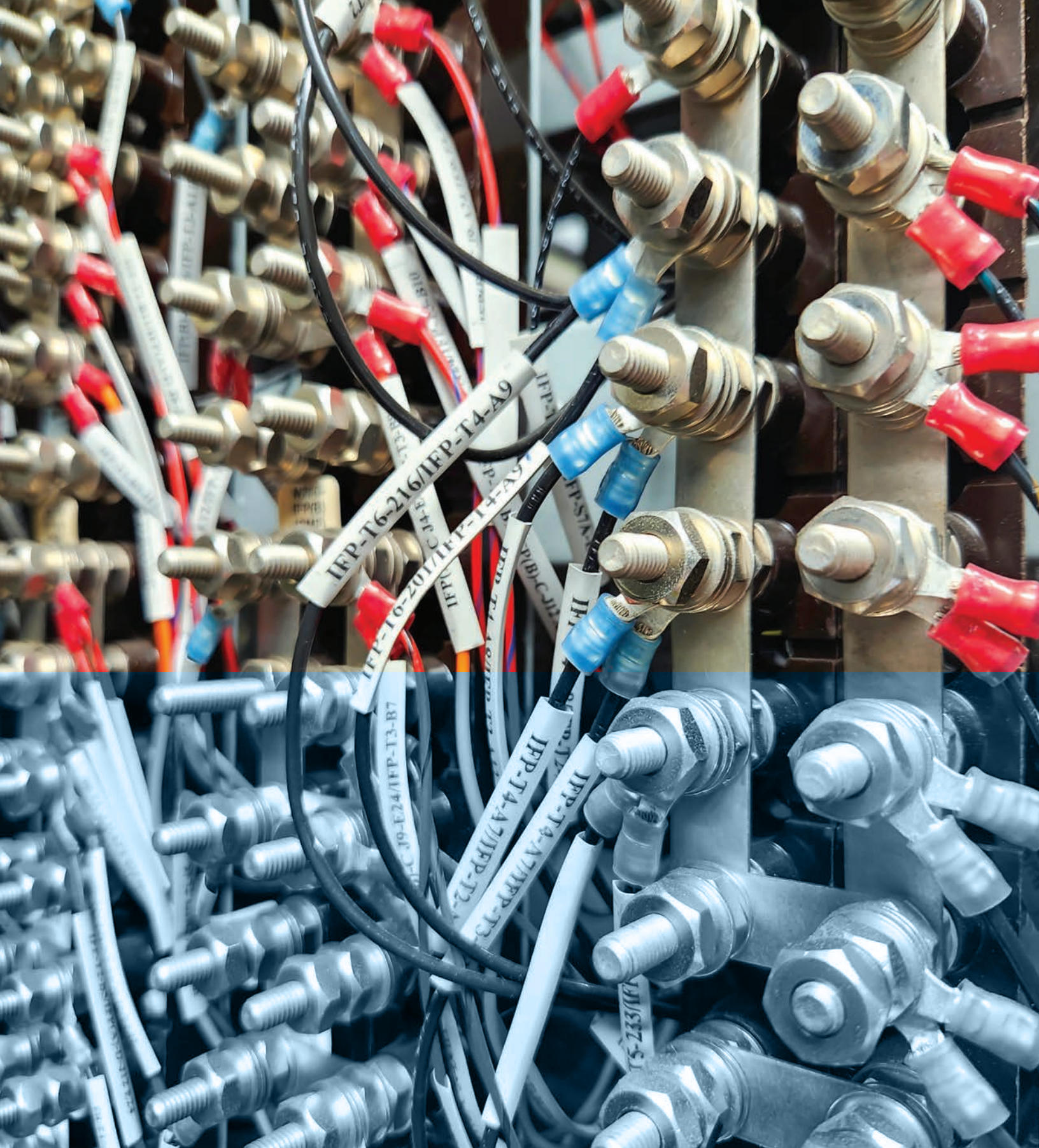
Lists of documents reviewed, site visit locations, and personnel interviewed for this audit are provided in the appendices.

The WMSC later provided a draft of this report to WMATA for technical review and incorporated any comments or technical corrections as appropriate.

**The WMSC communicated safety issues to Metrorail personnel as those issues were identified and confirmed.**

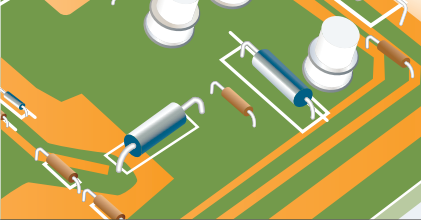






What the **WMSC** Found





# What the **WMSC** Found

**Metrorail has a training lab for ATC personnel, is planning a second facility at the Dulles Rail Yard that is to include Silver Line Phase 2 equipment, and has a switch training location at Telegraph Road.**

## Positive Practices

- Following the WMSC's August 2022 Train Control Room order and finding, Metrorail has improved conditions in some Train Control Rooms.
- Metrorail has developed and begun offering refresher training for AA, A, and B ATC mechanics.
- Metrorail has developed and is carrying out on-the-job training on specific switches and track circuits as committed to in CAP C-0112.
- Metrorail has a training lab for ATC personnel, is planning a second facility at the Dulles Rail Yard that is to include Silver Line Phase 2 equipment, and has a switch training location at Telegraph Road.
- Metrorail departmental leadership is tracking bobbing track circuits, and Metrorail documents addressing locations with regular issues.
- Metrorail is trialing monitoring devices on some switch machines.
- Metrorail is governing PMI deferral requests through a documented process that ensures PMIs are documented as completed as scheduled except in instances such as long-term shutdowns where access is not available and train movement will not occur, and that requires engineering approval for any deferral.
- At the time of this audit, Metrorail was testing an alternative microswitch in a Grand Master 4000 at the D&G Junction (where the Orange, Blue and Silver Lines diverge east of Stadium-Armory Station) to address some previous issues (see 2021 WMSC ATC Audit) and attempt to improve reliability. Metrorail had first tested the replacement microswitch at the Telegraph Road training facility, leading to additional adjustments before installation on mainline.





**Metrorail has made incremental progress.**

## Assessment of Corrective Action Plans from Previous WMSC Findings

### ► C-0102 (Closed)

*Metrorail has not adequately trained ATCM employees on safety procedures to ensure that all employees fully understand their roles with respect to safety.*

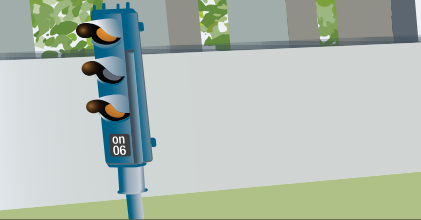
Metrorail has made incremental progress under this CAP to address basic safety promotion via training.

However, as further described below, including in Finding 1, this audit demonstrates that ATC personnel lack understanding of the direct safety implications of key elements of their work, are not following procedures, and have not been provided with an understanding of why elements of safety rules such as roadway worker protection are in place.

Finding 1 below describes specific examples of personnel not having a uniform understanding that ensures the proper completion of required safety tasks. Finding 4 below describes examples of Metrorail not systematically identifying, tracking, and mitigating hazards as required by its agency safety plan. During this audit, Metrorail completed compilation of its initial baseline safety risks for signals personnel under its safety risk management program. This included identifying challenges for the department's safety culture and the need to ensure Metrorail has adequate trained and knowledgeable staff, which is a positive start.

Many Metrorail personnel during this audit expressed ongoing confusion about Metrorail's local signal control protection policies, even after Metrorail made changes that management stated clarified the rules and procedures for exclusive track occupancy and a related safety stand down conducted in the months prior to this audit. Frontline personnel interviewed for this audit had relevant input to provide for consideration of such procedures and adjustments, but stated that they had not received feedback on concerns or suggestions made to their managers, such as requests for clearer information regarding whether a watchman/lookout and advance mobile flagger are required during interlocking inspections. Several people interviewed could not recall the fall 2022 safety stand down held several months prior to this audit. Multiple personnel this audit team spoke with complained about the presence of roadway worker protection "hot spots," those areas requiring Foul Time protection or greater, because there is space next to the tracks for personnel to clear in those areas and they believed it to be overkill for safety (See Finding 1). They did not understand, until explained to them by the WMSC at the conclusion of the interview or on-site interaction, the importance of Foul Time protection in restricted view curves to ensure that roadway workers have ample time and warning to safely clear the roadway.





**In August 2022, the WMSC selected Metrorail's Automatic Train Operation, Automatic Door Operation, Precision Station Stopping project for the WMSC's In-Depth Review of Metrorail's safety certification process in accordance with the WMSC Program Standard.**



► **C-0103 (Closed)**

*Metrorail has continued efforts to return to Automatic Train Operation without following its safety certification procedures.*

In accordance with the corrective action plan Metrorail developed, Metrorail developed some safety certification documentation, initiated meetings, and began associated steps following the issuance of this finding. This work led to the CAP's closure in 2022. The WMSC continued to oversee Metrorail's safety certification process, including for the Automatic Train Operation, Automatic Door Operation, Precision Station Stopping project, as part of other oversight work.

Subsequently in August 2022, the WMSC selected Metrorail's Automatic Train Operation, Automatic Door Operation, Precision Station Stopping project for the WMSC's In-Depth Review of Metrorail's safety certification process in accordance with the WMSC Program Standard.

During the In-Depth Review, the WMSC provided Metrorail with examples of continuing gaps in Metrorail's process that would prevent Metrorail from completing its safety certification process, and therefore prevent the WMSC's concurrence. This led to Metrorail initiating adjustments in summer and fall 2023 that began to align its work with its safety certification requirements and industry standard engineering practices. This subsequently allowed Metrorail to complete its safety certification steps required to begin utilizing Automatic Door Operations in passenger service on the Red Line in October 2023 with specified safety mitigations (restrictions) in a Temporary Use Notice. The WMSC continues to oversee Metrorail's process.

Personnel interviewed for this audit stated that they had recently resumed maintenance activities such as spillover testing for Automatic Door Operation signals that had not been consistently conducted during the time these systems have not been used.

Also related to this CAP, in August 2021, the WMSC issued a finding requiring Metrorail to develop a corrective action plan to address that Metrorail does not consistently follow its safety certification process, which leads to project activation and use without proper hazard identification and mitigation, putting Metrorail customers, personnel and first responders at risk.

Metrorail has implemented adjustments to its overall safety certification process as part of CAP C-0118 designed to address that finding. The corrective actions have included an update to Metrorail's Safety and Security Certification Program Plan made in accordance with the CAP, Metrorail's PTASP, and the WMSC Program Standard. Among the areas identified in the WMSC's August 2021 finding that led to Metrorail developing CAP C-0118 were findings from several safety audits and Metrorail's actions related to the Automatic Train Control project at the Alexandria Rail Yard (C99).



**Metrorail has implemented and sustained corrective action in this area for personal tools used by ATC Maintenance personnel.**

► **C-0104 (Closed)**

*WMATA is not conducting all inspections and maintenance required by its ATC manuals and ATC manuals have incorrect or incomplete information and outdated references.*

The audit issued in 2021 identified elements such as vane relays that were not being inspected, and manuals that were years beyond required review and update. This mirrored previous findings from the Tri-State Oversight Committee and Federal Transit Administration directives.

Metrorail's documentation provided as part of the current audit indicated that inspections are being completed (see Findings 1 and 2 for work orders being closed out despite pending corrective maintenance).

As further described in the findings below, this audit demonstrates that there is confusion for personnel surrounding which procedures and manuals are in effect. Metrorail provided Revision 5, for example, of the ATC-1000 Manual to the WMSC as the in-effect version, dated 2022 with stated approvals from ATC Engineering, ATC Maintenance and Safety Department personnel. However, multiple ATC engineering and maintenance personnel stated that they were relying on Revision 4 of the manual, which had meaningful differences from Revision 5. Other personnel stated that some Revision 5 procedures were in effect, but only those that had been sent out through an Engineering Information Bulletin.

These elements requiring correction are included in the findings below.

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► **C-0105 (Closed)**

*Metrorail allows employees to use tools that have not gone through any safety review or approval process.*

Metrorail documentation and interviews for this audit indicated that Metrorail has implemented and sustained corrective action in this area for personal tools used by ATC Maintenance personnel.

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► **C-0106 (Closed)**

*Metrorail does not have a standardized determination of which preventive maintenance work must be prioritized as safety critical.*

Records reviewed for this audit and interviews for this audit indicate that Metrorail has improved controls on deferring or bypassing preventive maintenance in Maximo. Preventive maintenance is now generally only recorded as bypassed or deferred in locations such as long-term shutdown areas where access or power is not available. ATC Engineering has a process to review and approve or reject requests to bypass or defer preventive maintenance work and has demonstrated that it rejects some such requests when appropriate.

ATC Maintenance management described checking for open preventive maintenance requirements that may be at risk of becoming past due, and reassigning those to different personnel to ensure they are completed.





► **C-0107 (Closed)**

*There is no formal process for ATCM, the department that performs the work in the field, to initiate or request an engineering modification or manual change from ATCE.*

Metrorail has developed this process and incorporated it into ATC manuals.

► **C-0108 (Closed)**

*Departments responsible for ATC do not have clear, documented, effective working relationships which contributes to communication and coordination challenges that limit safety improvements.*

Initially, Metrorail established meetings and other interactions among relevant departments.

In the months before this audit, Metrorail realigned high-level personnel to include assigning ATC Engineering, ATC Maintenance, and Signal System Renewal Program Personnel to report to the newly created position of Vice President, Communications and Signaling.

As described in Findings 1 and 2, there are areas where Metrorail can continue to improve, such as confusion about the in-effect procedures and a lack of review of data and work.

► **C-0109 (Closed)**

*WMATA does not have a standardized process to prioritize and advance ATC capital projects.*

Metrorail has developed this process.

As demonstrated by the WMSC's August 2022 Train Control Room order and the significant changes Metrorail has subsequently made to incorporate underlying safety issues into the previously planned Train Control Room systems renewal project, Metrorail can continue to improve by implementing corrective actions to address Findings 1, 2, 3, and 4 below and ensuring that hazards are identified, communicated, factored into planning, and addressed in a systematic way.

► **C-0110 (Closed)**

*Training and parts needed for maintenance appear to be an afterthought in WMATA procurements.*

Metrorail has made progress under this CAP on incorporating these items into ATC-related procurements.

► **C-0111 (Open)**

*Metrorail does not have adequate replacement parts or materials and has not planned for the obsolescence of critical equipment.*

Metrorail has conducted assessments of obsolete equipment and taken other steps as part of initial action items in this corrective action plan such as reviewing Maximo inventory and establishing minimum and maximum needs for each part. Additionally, Metrorail is doing related work as part of CAP C-0213.



Personnel interviewed for this audit expressed ongoing concerns about spare parts given the age of many key system elements. For example, Metrorail requires marker coil capacitors that are no longer manufactured, which has therefore required Metrorail to find a manufacturer willing to make some for a one-time order.

As described in Finding 4, personnel interviewed for this audit stated that they cannot rely on inventory information in Maximo, Metrorail's system of record, to reflect available parts. Metrorail's Shops and Materials Support (SAMS) personnel responsible for ATC-related assets rely on informal observation to notice when Metrorail is low on parts and should re-order, and does not consistently track what is available. Personnel indicated that they routinely receive material lists that do not reflect what is actually in the system. Personnel also explained that supplies had been removed from Metrorail systems because they had not been used recently, even though those supplies are replacement parts or parts needed to make repairs on items that fail and are necessary for the Metrorail system to continue service.



Personnel also indicated that supply chain inconsistencies have forced them to keep old replaced vital relays instead of returning them to SAMS when the units are replaced, which is a deviation from Metrorail procedures that Metrorail previously identified in an internal review. It was also expressed that personnel are running out of space with replaced relays being stored in work areas. Metrorail management explained efforts to improve purchase and refurbishments agreements, rather than allowing one-off purchases of recurring items. In comments on the draft of this audit report, Metrorail also noted its separate Supply Chain Management personnel have a lifecycle approach to inventory.

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► **C-0112 (Closed)**

*Metrorail has no specific minimum training course requirements, documented OJT requirements or equipment certifications for ATCM employees, or requirements that individuals be trained on a system element prior to conducting maintenance work on it.*

Metrorail has established training requirements and instituted on-the-job training courses for ATC Maintenance employees that focus on hands-on review of procedures. As described in Finding 1, personnel are not properly carrying out Metrorail procedures to maintain safety-critical equipment.

Personnel interviewed for this audit expressed a desire for more training, including on various switch types.

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► **C-0113 (Closed on Nov. 2, 2023)**

*Metrorail is not effectively managing turnover, vacancies and experience levels of ATC personnel.*



**The WMSC appreciates Metrorail's significant progress made in some areas between August 2022 and March 2023 due to the WMSC's August 2022 Train Control Room order.**



This CAP remained open at the time of this audit. See Recommendation 1 for additional opportunities for improvement related to recent Metrorail organizational adjustments.

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▶ **C-0114 (Closed)**

*Some test forms, work orders, or data sheets are not completed or are not completed with the required level of detail.*

Metrorail has improved in some areas since the last audit, however this audit continued to identify gaps in these forms, work orders, and data sheets (see findings below).

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▶ **C-0115 (Closed)**

*Metrorail's written procedures do not reflect changes that employees are being directed to implement.*

Metrorail has revised its procedures to reflect changes employees were directed to make related specifically to cranking and clamping of switches that were identified in the audit issued in 2021.

However, as described in Finding 1 below, Metrorail is now directing personnel to use different versions of other preventive maintenance instructions, procedures, and forms, rather than following Metrorail's approved versions.

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▶ **C-0116 (Closed)**

*The preventive maintenance instruction for snowmelters (switch heaters) does not comply with other Metrorail rules.*

Metrorail has updated this procedure to comply with its rules.

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▶ **C-0117 (Closed)**

*Metrorail does not have documented ATC software standards.*

Metrorail has added software standards to its ATC 4000 manual and made adjustments to its ATC 5000 manual.

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▶ **C-0213 (Open, finding issued August 4, 2022)**

*Metrorail has an ineffective and insufficient inspection, maintenance and cleaning program for Automatic Train Control equipment, particularly including a lack of required tools, procedural compliance, and supervisory oversight for care of vital equipment housed in train control rooms, and is not maintaining the structural integrity of these ancillary rooms.*

The WMSC appreciates Metrorail's significant progress made in some areas between August 2022 and March 2023 due to the WMSC's August 2022 Train Control Room order.

This audit demonstrated that Metrorail has made significant improvements in several locations, and some personnel stated they were getting electrostatic vacuums. However,



conditions in many other rooms remain poor. This includes rusted out power boxes, holes in ceilings, and dusty and unkempt conditions. These conditions raise concern that Metrorail still does not have effective processes to ensure that rooms and the vital equipment in them remain clean.

The audit also demonstrated that regular and special inspections and site surveys are not identifying all safety and maintenance issues (see Finding 3).

As part of the WMSC's oversight of Metrorail's implementation of this CAP and response to other elements of the August 4, 2022 Train Control Room order, the WMSC reviewed quarterly Train Control Room inspection reports. Metrorail could not provide evidence that areas identified for corrective action in those reports had been addressed. The WMSC conducted extensive follow-ups, and Metrorail later completed work and provided photographs showing certain work had been completed. In approximately December 2022, ATC Maintenance management directed personnel to begin uploading completed data sheets to Maximo, Metrorail's maintenance management system. Interviews for this audit further demonstrate that Metrorail does not have a consistent process for documenting corrective maintenance identified during preventive maintenance inspections. Some personnel indicated that they would make a repair and simply close the PMI work order, others indicated they would note the details of such a repair on the data sheet and open a separate work order.

Site visits and interviews for this audit demonstrate ongoing coordination challenges among departments with responsibilities for repair, and challenges with ensuring ATC Maintenance personnel assigned to inspect these rooms have the knowledge and understanding to identify and report items requiring repair (see findings below).

**Site visits and interviews for this audit demonstrate ongoing coordination challenges among departments.**







## **Findings** and **Minimum** Corrective Actions

# Findings and Minimum Corrective Actions



## Findings

- ▶ **Finding 1: Metrorail ATC Maintenance personnel do not have a uniform understanding of Metrorail procedures, which leads to inadequate completion of safety tasks, such as inspections and handling of vital systems, that are required to ensure that track circuits and other elements of the ATC system function properly as required to prevent train collisions and to provide other designed safety protections.**

Field observations, document review, and interviews for this audit demonstrated that Metrorail's Automatic Train Control Maintenance personnel do not have a uniform understanding of procedures, are utilizing varying versions of documents, are not recording information that is required for Metrorail to validate the health and functionality of the automatic train control system, and are closing out preventive maintenance work orders that are incomplete.

Metrorail uses different versions of ATC test instructions and data sheets, including test instructions and data sheets that are outdated according to Metrorail's approved manuals. This introduces inconsistencies that undermine the value of preventive maintenance and demonstrate disconnects between the organizational units responsible for ATC systems.

Collectively, there is not consistent inspection and maintenance practice and supervision.

Across the interviews for this audit, personnel regularly pointed to other departments or people or otherwise said that it was someone else's job to identify or address issues and carry out work. As documented in the WMSC's 2022 Train Control Room order, Metrorail must ensure that there is sufficient collaboration and responsibility to provide for the maintenance and health of all elements of the ATC system, including train control rooms and the system elements inside those rooms.

### **Vital systems not assessed against required values and are not handled by maintenance personnel as required, creating safety risks**

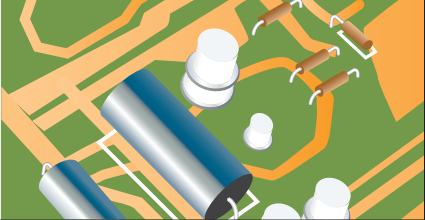
Field observations of maintenance practices, interviews for this audit, and discussions with other personnel during this audit demonstrated that Metrorail ATC Maintenance personnel are not carrying out safety tasks as specified by Metrorail procedures, such as the inspection and handling of vital systems. This creates the risk that these systems will not function as required.

### **Example A: AF-800W**

The audit activities demonstrate that multiple frontline personnel responsible for carrying out maintenance such as on AF-800W train control modules do not understand how to carry out their work on these vital safety systems. This includes not being provided with an understanding of what the measurements taken are required to be compared to in order to determine whether systems are providing the required safety protection, or what the required tolerances are for this work. Further, there are different versions of the procedure being relied upon by various personnel. The AF-800W is one of the types of track circuit modules that Metrorail relies upon to determine whether a section of track is occupied

**Metrorail ATC Maintenance personnel are not carrying out safety tasks as specified by Metrorail procedures, such as the inspection and handling of vital systems. This creates the risk that these systems will not function as required.**





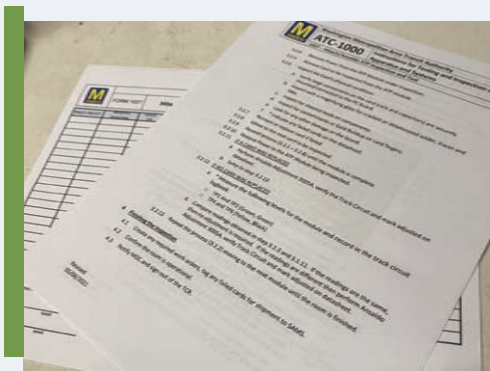
**The personnel took measurements, but marked those measurements as passing (meeting requirements) arbitrarily based on what they described as a rough comparison to other recent measurements.**

or unoccupied, and therefore is an element of the ATC system whose proper function Metrorail relies upon for its Automatic Train Protection (ATP) system to send the necessary speed commands to prevent train collisions.

The WMSC audit team scheduled and carried out an observation of Metrorail personnel in the field conducting regularly scheduled AF-800W preventive maintenance. The personnel took measurements, but marked those measurements as passing (meeting requirements) arbitrarily based on what they described as a rough comparison to other recent measurements. They stated they would only mark a vital circuit as failing if it was “grossly” off or a “major variation” from recent measurements. The copy of the procedure being relied upon during this field observation for this audit did not specify what tolerance was acceptable at those steps, or what to compare the measurements against in those steps of the procedure. The procedure being used stated the measurements had to be “the same” as initial measurements, with no tolerance given or other required comparisons. Review of Metrorail’s instructor guide and participant guide for the AF-800W Field



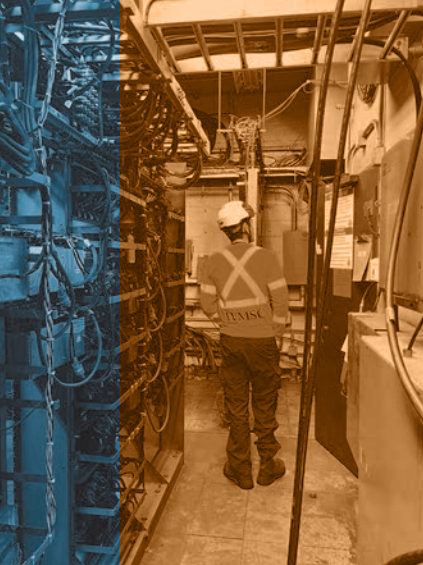
Operations and Maintenance class showed that those guides also do not reference the tolerance for this measurement for AF-800W maintenance, even if the measurements had been compared to the appropriate last adjusted value. The only referenced tolerance in the guide is an adjustment to the code rate tolerance from  $\pm 5\%$  to  $\pm 2\%$  compared to the older AF-800 requirements. In any case, the crew was incorrectly looking for such



a discrepancy between the readings taken on the same circuit during the procedure before and after card removal, rather than comparing the measurements being taken to the last adjusted value for each track circuit as required by the ATC-1000 manual to actually determine whether the system is functioning as intended to properly detect and communicate train movement or fixed work zone setup.

The WMSC followed up on these observations during audit interviews. Maintenance and engineering managers, as well as other personnel, confirmed in those interviews that the activities the WMSC observed in the field were improper. Engineering personnel confirmed that maintenance personnel should have been comparing measurements on the AF-800W to the last adjusted value, not the prior month or the reading taken earlier during the same PMI. Review of the procedure used for the work during an interview with maintenance management also confirmed that version of the procedure in use did not include the steps or tolerances necessary to ensure the inspection is properly carried out as intended. The procedure maintenance personnel were using and maintenance management referenced as in effect was from version 4.0 of the ATC-1000 manual, despite Metrorail having





provided the WMSC with version 5.0 as the current procedure that had been in effect for months at the time the audit began. The longstanding necessary comparison to the baseline (last adjusted) value required by Metrorail's manuals was not understood by frontline personnel, including those Metrorail assigned to carry out this work observed by the WMSC, despite this comparison serving as the basis for the significance and accuracy of the preventive maintenance data, and despite Metrorail reporting that it trains personnel on the procedure. Other ATC Maintenance personnel interviewed as part of the audit similarly – incorrectly – believed that the comparison is to the most recent past reading, rather than to the baseline (last adjusted) value as specified in Metrorail's current ATC manuals.

An adjusted value is the value recorded when changes are made to the track circuit, which may have occurred months or years earlier. Deviations from that adjusted value indicate an issue that needs to be addressed to ensure that the circuit properly indicates whether a section of track is occupied by a train or by a work crew using shunts as part of their roadway worker protection. As bonds go out of tune, there is lower resistance to the frequency it is supposed to be operating at.

When maintenance is not conducted properly, circuits can deviate such that they would not correctly indicate occupancy. If this occurred during train movement, it could lead to a false indication that the area is clear. A false indication that an area was clear led to the 2009 Red Line accident near Fort Totten.

A separate version of the track circuit adjustment procedure shown to the WMSC by other Metrorail personnel on a different field visit correctly specified that the comparison had to be made to the last adjusted value, not to the last measured values. That version also specified that the tolerance was 10% of the last adjusted value. However, the supervisory personnel who showed the updated procedure to the WMSC also did not know that data forms had been updated to remove the last adjusted value, that the last adjusted value was now supposed to be recorded on a different sheet at the front of a track circuit's records binder in the train control room, or that new sheet provided in the ATC-3000 Manual, Form 3005A, had to be referenced during the work. The ATC 3000 Manual requires adjustments to be recorded on a baseline data form, provided to the field office, and updated on form 3005A in the Train Control Room.

The personnel conducting the AF-800W testing were also unaware of the current procedure's requirement to refer to baseline (last adjusted) values that are meant to be recorded on that separate Form 3005A document at the front of the binder containing records for that track circuit. Prior Metrorail procedures had included a space for the last adjusted value at the top of the form used in the train control room to document specific readings from each track circuit preventive maintenance activity. Metrorail has changed forms for the AF-800W inspection and testing to no longer include a space to record the last adjusted value at the top of one of the forms used in the Train Control Room. The WMSC communicated about what was observed with Metrorail personnel during field observations in March 2023, communicated to and confirmed the deficiencies with management-level and other personnel within signal engineering and maintenance during audit interviews in March and April 2023 immediately following the field observations, and identified these maintenance deficiencies as a specific example supporting this



(then-preliminary) finding during the exit conference in May 2023. In addition to the improper maintenance, the WMSC noted to Metrorail in March, April, and May 2023 that personnel were not familiar with the documented procedures they were carrying out. Another example of safety information the WMSC shared during field observations, in interviews with responsible personnel, and in the exit conference relates to the asbestos hazard described in Finding 3. Metrorail subsequently conducted initial targeted asbestos testing, demonstrating the ability to take initial action based on the safety information shared by the WMSC.

Metrorail identified similar issues in a 2021 internal review regarding the use of outdated processes, and maintenance personnel being unfamiliar with approved procedures they were assigned to carry out (in that case as it related to switch maintenance). Maintenance personnel of various frontline levels interviewed for this audit expressed a desire for more training, including on track circuits and troubleshooting, the variety of different switch models in use in the system that they may be directed to work on, and other areas of responsibility. For example, frontline personnel explained they may be trained on and familiar with one type of switch, but are then sometimes assigned to work on another type of switch that they are not familiar with. Along with the observed field activities, this lack of familiarity with tasks they are assigned to complete is further evidence that, despite Metrorail's progress in beginning to offer training on specific procedures, personnel are not carrying those procedures out as designed.

Metrorail subsequently identified in a later internal review of Automatic Train Control Maintenance – Track Circuits in 2022 that it did not have required testing equipment, ATC Maintenance personnel were not trained to use the equipment as required by preventive maintenance and other procedures, and that the ATC Maintenance Control Policy was not being followed for field repairable parts and unused materials, and to establish a



process for the collection of materials. At the time of this audit, Metrorail had open internal corrective and preventive action plans (iCAPAs) including QICO-ATCM-22-02 to procure and distribute prescribed testing equipment, and train ATCM personnel on the use of testing equipment as stated in the prevailing PMI/EIB procedures. Metrorail's reviewers had identified that the digital multimeter being used by ATC Maintenance personnel was not capable of measuring the required range for shunt testing designed to test whether the track circuit properly displays as occupied in the worst-case scenario of a rail vehicle's wheels making poor contact with running rails, yet still marked preventive maintenance inspections as complete. Metrorail's reviewers further identified in interviews that ATC Maintenance staff did not have the proper equipment capable of precision measurement to test/validate shunt straps used to simulate train presence. Metrorail's ATC-1000 manual requires the use of only validated shunt straps. Metrorail subsequently issued an Engineering Information Bulletin (EIB-22-0003-SYS) for the shunt validation procedure, and developed the iCAPA. QICO-ATCM-22-03 was also open, with the work intended to enforce adherence to existing ATC Maintenance Control Policy on field repairable parts and



unused materials, and intended to establish a process for the collection of materials. Field assessments identified an out-of-service bond that was not properly tagged when removed from service, and interviews indicated that the handling of defective and unused (new or replaced) parts was inconsistent and that parts are stockpiled or kept in field offices and other locations rather than returned to Shops and Materials Support (SAMS) as specified in Metrorail's parts process.

In its comments on the draft of this report, Metrorail noted the system's vital design and intended fail-safe nature. However, without proper maintenance and inspections, Metrorail cannot assure itself that the system is functioning as intended and will fail safe.

This audit shows this safety issue of lack of uniform understanding to ensure the proper completion of safety tasks has not been effectively addressed.

### **| Example B: Electrostatic discharge protection not followed**

During field observations for this audit, the WMSC identified that Metrorail is not following standard anti-static practices to prevent electrostatic discharge. Such a discharge can damage electronic systems, including vital systems such as track circuit modules.

The American Railway Engineering and Maintenance-Of-Way Association (AREMA) Communications & Signals Manual, Part 11.4.5, documents the industry standard practice of applying anti-static protections for all components of the signal system.

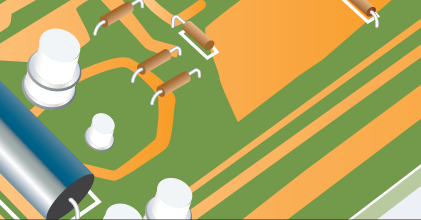
Electrostatic discharge protection may include protective mats, wrist straps, blowers, antistatic bags, and other procedural protections.

As part of CAP C-0213, developed to address the WMSC's August 4, 2022 order regarding Metrorail's ineffective and insufficient Automatic Train Control (ATC) Room inspection, maintenance, and cleaning program, Metrorail further committed that it would follow such anti-static procedures during cleaning activities.

Engineering Instruction Bulletin EIB-22-0007-SYS references the need for use of a ground strap from the personal tools of ATC maintenance personnel. The EIB "provides instruction on cleaning boards, modules, connectors and wiring during the performance of PMs, repairs, or testing." The EIB states that if the board is digital or microprocessor based, then anti-static precautions of using a ground strap and avoiding non-conductive materials such as Styrofoam, cellophane or plastic items in the work area is required, and an air duster should be used to remove dust and debris.

Metrorail acknowledged in its comments on the draft of this report the requirements of its EIB, and stated that not following electrostatic discharge protections would most likely lead to reduced circuit reliability. Metrorail also stated that it is relying on a protective coating meant to protect against environmental hazards. This protective coating is only meant to provide a last layer of protection. Industry practice codified by AREMA, which is referenced in Metrorail's ATC-1000 manual as a best practice, covers all components of the system. Metrorail has some additional references to electrostatic discharge (ESD) considerations in its ATC-2000 manual. Following electrostatic discharge protections protects silicon

**This audit shows this safety issue of lack of uniform understanding to ensure the proper completion of safety tasks has not been effectively addressed.**



**Despite direct relevance to the safety of passengers and personnel, multiple ATC Maintenance personnel who spoke to the WMSC during this audit described testing track circuits in accordance with Metrorail's procedures as being overkill or too much.**



devices, such as the AF-800W cards, as well as the circuitry that the devices are being connected to, which may include microprocessors.

Anti-static precautions such as use of a ground strap were not utilized during the activities observed by the WMSC audit team.

The observed activities done without electrostatic protection included removing printed circuit cards, handing the cards to another individual who then walked to the other side of the Train Control Room to reach the magnifying glass, then walking back to the original location, handing the card back for installation, and repeating the process for other cards.

### **Example C: Personnel describe proper testing of vital systems as overkill, do not complete as required**

Despite direct relevance to the safety of passengers and personnel, multiple ATC Maintenance personnel who spoke to the WMSC during this audit described testing track circuits in accordance with Metrorail's procedures as being overkill or too much. This is similar to sentiments shared by ATC personnel during the prior WMSC ATC Audit issued in 2021. Frontline workers must be provided with an understanding of the importance of their work and why it is being done to provide the greatest likelihood that they will carry out these safety-critical tasks properly. As noted above and further described below, Metrorail made incremental progress under CAP C-0102 to address basic safety promotion via training, but ATC personnel still lack understanding of the safety implications of their work for themselves and others.

Metrorail's failure to properly carry out testing of ATC equipment as required by its procedures led to the fatal 2009 Red Line accident near Fort Totten Station, as identified in the NTSB's determination of probable cause.<sup>2</sup> The National Transportation Safety Board determined that WMATA had developed and issued technical bulletins requiring the use of an enhanced circuit verification test procedure following two near-collisions in 2005 near the Rosslyn Station, which occurred due to parasitic oscillation. The NTSB's identified data demonstrating that the Rosslyn track circuit had this problem in 1988, the oldest data available at that time. However, none of the WMATA technicians interviewed as part of the National Transportation Safety Board investigation into the 2009 accident were familiar with the enhanced procedure, and the NTSB determined that "WMATA failed to institutionalize and employ systemwide the enhanced track circuit verification test procedure that was developed following the 2005 Rosslyn near-collisions. If the enhanced circuit verification test procedure had been used after recent track circuit work near the Fort Totten accident location, work crews would have been able to determine that the track circuit was failing to detect trains, and actions could have been taken to resolve the problem and prevent the accident."

The NTSB report also identified evidence of an ineffective safety culture, including "the low priority that Metrorail managers placed on addressing malfunctions in the train control system before the accident, which likely influenced the inadequate response to such malfunctions by automatic train control technicians, operations control center controllers, and train operators."

<sup>2</sup> See [NTSB RAR-10/02](#), probable cause and findings, including findings nos. 15, 16 and 20.



**Personnel interviewed for this audit, including those responsible for reviewing completed preventive maintenance inspection forms, said that “a change needs to be made” to ensure that Metrorail properly carries out and properly and reliably documents its ATC preventive maintenance.**

As examples during this audit, personnel the WASC audit team observed in the field expressed surprise when they conducted the work with a copy of a procedure and progressed through each step (as they understood it) at how long it took them to carry out the procedures as designed to provide for the comprehensive safety preventive maintenance work. They expressed this surprise even though they are assigned to carry out these tasks regularly and Metrorail relies on their records to state that these procedures are completed correctly. Preventive maintenance inspections are designed to provide for the safety of the system when fully carried out as designed. The surprise expressed by these personnel suggests to the WASC that they are not routinely carrying out these preventive maintenance inspections based on the written procedures that are designed to provide for the safety of the system when the procedures are fully carried out as designed.

Further, Engineering Instruction Bulletins related to switch inspections and other items included forms to complete and processes to carry out, yet records provided as part of this audit included other different forms being used after the bulletin took effect.

In another example of inconsistencies, Metrorail provided several records during this audit that were signed by an employee with a notation that the records were “signed under duress,” but that were still accepted as complete by Metrorail supervision.

The WASC identified and communicated related safety issues in 2022, including through the August 4, 2022 Train Control Room order which noted that systemwide TCR inspection records for March 2022 showed that Metrorail personnel were not completing regular inspection reports and activities in each room as required by Metrorail’s ATC 1000 manual, and that there was ineffective supervisory oversight to ensure that hazards are properly identified, mitigated, and addressed. Metrorail as an organization did not effectively mitigate these hazards.

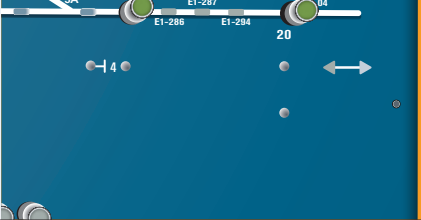
As noted above, Metrorail independently identified similar safety issues in a 2022 ATC Maintenance – Track Circuits, Engineering and Maintenance internal review dated July 2022, to include marking preventive maintenance inspections as complete despite not having equipment capable of completing the required measurements.

Personnel interviewed for this audit, including those responsible for reviewing completed preventive maintenance inspection forms, said that “a change needs to be made” to ensure that Metrorail properly carries out and properly and reliably documents its ATC preventive maintenance. These individuals expressed a belief that the current unreliable state is okay since no one has gotten hurt recently due to an ATC maintenance issue, but that more needs to be done to ensure people are following rules and procedures. As noted above and in the NTSB’s investigation into the 2009 collision, the lack of a recent safety event does not demonstrate the safety of the system.

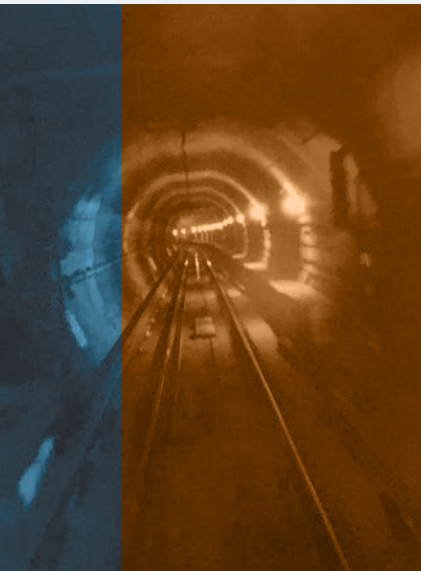
As described in Finding 2 below, inconsistencies in completing preventive maintenance inspections and associated documentation prevent Metrorail from making informed, data-driven decisions on repairs, engineering modifications, or other actions that may be needed to maintain the health and safety of the system.

During this audit, Metrorail completed compilation of its initial baseline safety risks for signals personnel under its safety risk management program. This included identifying challenges for the department’s safety culture and the need to ensure Metrorail has





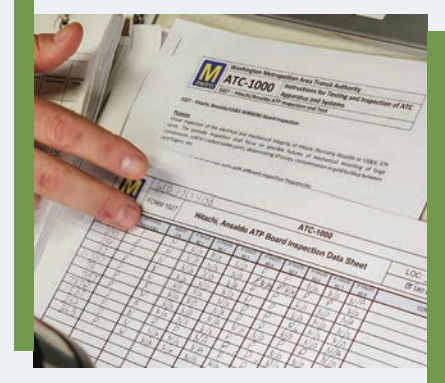
**Documents provided for this audit demonstrated that supervisors are signing forms that are not complete.**



adequate trained and knowledgeable staff. Acknowledging these previously identified risks is a positive start.

### **Example D: ATC Maintenance supervisory oversight**

Documents provided for this audit demonstrated that supervisors are signing forms that are not complete. For example, track circuit data inspection sheets (1012A-1) have a column to indicate that the data has been reviewed, but many sheets do not indicate that such a review occurred.



Completed data sheets provided to supervisors as field office copies also do not include all relevant data that is recorded in the train control room, meaning that supervisors would need to be in the field to determine whether some pass/fail determinations recorded on the field office form are correct.

Metrorail personnel also described that supervisors may not sign off on documents, but will still rely upon them as records of completed work. Metrorail has compliance personnel in the maintenance group assigned to audit some field office paperwork, a positive practice instituted under CAP TOC-ATC-15-005-A that Metrorail developed in response to FTA Safety Directive 16-2 issued in 2015 (CAP closed May 2020). These internal audits continue to identify deficiencies, which should provide Metrorail with an opportunity to more proactively implement corrective action. The same safety directive also identified missing supervisor signatures (TOC-ATC-15-006-A) and a lack of minimum requirements for supervisors' quality control or rule compliance checks of frontline personnel (TOC-ATC-15-011-A). Metrorail's Maintenance Control Policy also requires Superintendents, Assistant Superintendents, and Shift Supervisors to spend at least 50 percent of their duty day conducting facility inspections, safety observations, compliance audits, and other field observations or employee evaluation and retraining.

When the WMSC audit team asked Metrorail personnel in audit interviews and other interactions during the audit how ATC Maintenance personnel who do not have the required understanding would be identified and provided with guidance or training, supervisors were not certain.

Personnel such as supervisors and managers who spoke to the WMSC during this audit were also not aware of what indicators would be most important to quickly raise to higher levels of the organization or engineering personnel, which contributes to frontline personnel going through the motions of some inspection and maintenance procedures without understanding whether the data they are recording indicates a safety risk. This lack of understanding reduces the usefulness of ATC Maintenance supervisory field checks.

The WMSC observed that supervisors are not evaluated in on-the-job training classes, and are simply listed as attending. Without a performance evaluation, Metrorail cannot demonstrate that supervisors understand the procedures they are being trained on and are required to oversee. This prevents supervisors from identifying positive practices or areas for improvement and prevents supervisors from effectively coaching their personnel.

**A meaningful and effective feedback loop and collaboration among engineering, maintenance and training personnel and supervision is critical to ensuring that work is carried out as intended to provide for the safety of the train control system.**



**WMSC document review indicated that these procedures were not being consistently used.**

Although some supervisors with lengthy experience expressed confidence in their abilities and were praised by their crews, others the WMSC Audit team interacted with had been placed in positions without the direction necessary to effectively assign and oversee personnel. This includes supervisors reassigned to new roles, and supervisors who did not have the understanding necessary to effectively direct their crews.

Frontline personnel reported that communication with supervisors is not consistent, with some notifying their crews of events requiring corrective maintenance response via call or text, and others expecting their crews to notice information entered into Maximo on their own or to determine which other crew members to bring on their own.

Supervisory oversight and coaching in the field of ATC Maintenance personnel is necessary to ensure that these safety procedures are carried out as designed and that the data collected effectively reaches the necessary parties.

A meaningful and effective feedback loop and collaboration among engineering, maintenance and training personnel and supervision is critical to ensuring that work is carried out as intended to provide for the safety of the train control system.

### **Example E: Confusion over in-effect procedures, documents required in rooms**

In response to the initial document request for this audit, Metrorail provided the ATC-1000 Manual, Instructions for Testing and Inspection of ATC Apparatus and Systems, Revision 5, approved by the Design Control Board (ATC Engineering, ATC Maintenance, Safety Department) July 1, 2022, as the in-effect maintenance testing and inspection procedures.

However, WMSC document review indicated that these procedures were not being consistently used.

During field visits and interviews for this audit, a mix of Revision 4 and Revision 5 documentation was being relied upon. Some personnel indicated that only some Revision 5 procedures were being used, based on Engineering Information Bulletins stating that those specific updated procedures were to be in effect, despite Revision 5 already being approved.

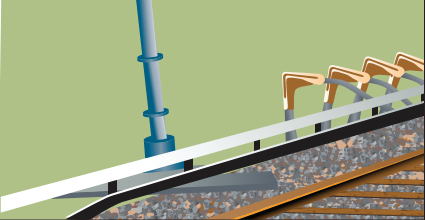


This is an example of maintenance and engineering personnel not being on the same page, and of inconsistencies among maintenance regions.

The confusion among maintenance and engineering personnel is similar to the confusion the WMSC identified during the previous ATC Audit issued in 2021.

Completed switch inspections, for example, were provided from after the listed approved date of Revision 5 that were conducted using the outdated Revision 4 procedures.

Some personnel interviewed by the WMSC stated that, for preventive maintenance, they rely on whatever version of the procedure is attached to the Maximo work order for that task. Other personnel stated that they relied on printed procedures in Train Control Rooms,



and still others stated that personnel are supposed to refer to an ATC Engineering intranet page or shared drive for the latest version. Engineering personnel said in interviews that the intranet page is intended to be up to date, and that personnel creating work orders for upcoming months attach the then-current procedure in Maximo. Printed procedures that are left in the field (as opposed to printed just before performing a specific task) may not be current.

The use of outdated forms was further confirmed during field visits for this audit.

In the Pentagon City Train Control Room, there were outdated ATC forms 1018, 1020, and 1021 used, and outdated Roadway Job Safety Briefing forms. The WMSC also observed other outdated Metrorail documents available to personnel, such as the 2011 Metrorail Safety Rules and Procedures Handbook from more than a decade before this audit that has been superseded multiple times.

Other work appeared to be done differently by different personnel in the field on their own based on their own understanding. For example, at the Arlington Cemetery Train Control Room, a room inspection on March 17, 2023 recorded reference material in the room as present, but an inspection on March 20, 2023 checked it off as missing. A few printed procedures were present, and no current manuals were present during the WMSC's on-site observation. The room inspection procedure requires checking the reference material. Some personnel indicated that they believed manuals had been removed from Train Control Rooms and others indicated that they believed all reference material should be present.

Other personnel in some parts of the system had printed and placed additional separate training materials in TCRs in their area as they said this reference information is necessary to understand various tasks. However, this was not present, placed, or tracked in other areas to provide the same benefits for all personnel.

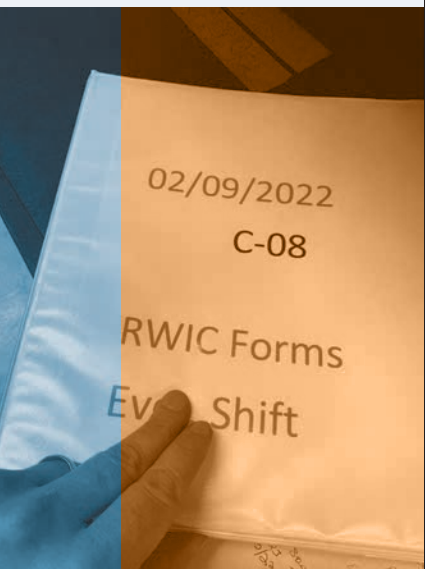
### **Example F: Information not being recorded as required to understand health of system**

In addition to the track circuit data issues described above, other forms and documentation are not being completed by ATC Maintenance personnel with information necessary to determine the health of the system and (see Finding 2) are not being shared and reviewed within Metrorail.

Completed documentation provided for testing that requires listing the calibrated tools used for a task does not include all the required tool information, such as the serial number and when the tool is due for calibration. Some completed forms include this information for some of the required tools for the task, but not for all tools that are needed to carry out the maintenance or inspection.

Without calibrated tool information on the inspection form, Metrorail cannot track if there is an issue. For example, if an oscilloscope is used for an inspection that is out of calibration, or if such a scope is used that is later determined to be problematic, Metrorail cannot identify what tests must be redone to assure itself that the system is operating as intended.

Other completed forms do not include clear indications as to whether a system has passed or failed a test, but may include checkmarks indicating that a test was done.





**These inspections showed that corrective actions were needed, but Metrorail did not have documentation that the necessary corrective actions had been taken.**

Records also indicated that required test, calibration, and installation stickers were not applied to all required relays. AC Vane Relay inspections require that after the inspection, the relay be tagged with information on the inspector and the date; however, completed 1002A forms demonstrate that the tags are not always available or applied, despite it being part of the process to provide assurance that the relays are current on required testing. Most of these two-year inspections were recorded as occurring within the required time period, but one was more than a year past due, having been last performed on January 8, 2019.

Interviews for this audit indicated a lack of consistent process for Maximo entries and ensuring that accurate and complete information is available (see further information in Finding 2).

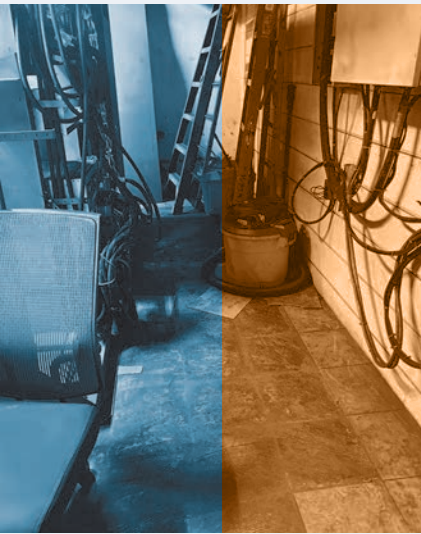
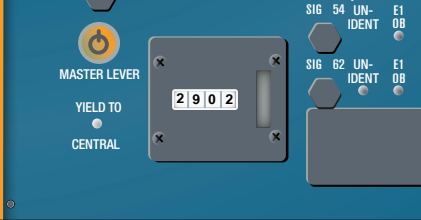
Further, records provided for this audit demonstrate that Metrorail ATC Maintenance teams are closing preventive maintenance work orders even when parts of the work have not yet been completed. For example, a daytime crew may do most of the preventive maintenance, then create a separate work order for the remaining items they are asking a night crew to finish after the system closes to riders, yet still close the preventive maintenance work order. This creates indications to upper management that preventive maintenance has been completed, even when there are outstanding items left to complete. A preventive maintenance work order is intended to remain open until the work is completed so that its closure reliably represents the completion of that preventive maintenance work. The existing work order can be reassigned in Maximo, Metrorail's maintenance management system. Frontline personnel said there are many PMI tasks that are regularly left to other shifts. This is not consistently noted on the PMI forms.

### **Example G: ATC Maintenance tracking of deficiencies and corrective maintenance, need for timely correction**

Records reviewed indicated that identified issues are not addressed in a timely fashion. For example, a ground detector alarm at Fort Totten with a work order created in June 2022 was yet to be addressed in April 2023, and an inoperative tower control panel at Branch Avenue Rail Yard requiring a reset reported in June 2022 was not addressed until June 2023.

As part of this audit and other oversight activities, the WMSC reviewed Train Control Room work orders including quarterly inspections reviewed as part of Metrorail's actions under CAP C-0213 in response to the WMSC's August 4, 2022 Train Control Room maintenance and cleaning order. These inspections showed that corrective actions were needed, but Metrorail did not have documentation that the necessary corrective actions had been taken. Metrorail stated the records of mitigations and repairs were in Maximo, however WMSC review of Maximo records demonstrated the records were not. Maintenance leadership later acknowledged that evidence of any completed work should have been in Maximo, but was not. The WMSC's site-visits for this audit further demonstrated conditions remain poor in multiple Train Control Rooms, which, as also described in Finding 3, had not been fully identified in prior inspections. Metrorail procedure provides for a corrective maintenance work order to be opened to document repairs to identified issues, but Metrorail did not have such work orders and could not





provide evidence from a Metrorail system of record that items were corrected according to Metrorail's processes. After extensive WMSC follow-up, Metrorail later corrected its identified conditions and provided photos of example locations highlighted by the WMSC. Field personnel during this audit provided varying responses regarding whether Maximo work orders are opened to address issues, who ensures such a work order is opened, and what is done with associated data sheets or other documentation. The varying practices contribute to the roadblocks to Metrorail engineers or managers knowing whether all required work has been properly completed.

Metrorail did not track these issues as required by its maintenance policies and procedures to ensure corrective action. Due to WMSC follow ups, Metrorail subsequently completed work in areas identified by the WMSC as examples of gaps in Metrorail's process. However, Metrorail's inability to demonstrate for itself that corrective actions have been taken to address identified issues demonstrates a lack of internal review and oversight.

Metrorail stated that it began directing personnel in December 2022, just before this audit began, to upload completed ATC maintenance records into Maximo starting in early 2023. During this audit, personnel stated that they were beginning to upload records of inspections into Maximo and are now beginning to carry out room cleaning requirements. The WMSC audit team observed many train control rooms where the years of not carrying out this work has created conditions that are more difficult to address.

Personnel interviewed for this audit provided differing responses regarding whether corrective maintenance that can be addressed immediately is documented and tracked in Maximo as specified in Metrorail's procedures.

For example, control panel lights were not functioning in the Pentagon City Train Control Room when the WMSC audit team visited the room for an observation. Some personnel indicated they would open a work order that would track such a repair, while others indicated they would replace the lights without necessarily opening a work order that would allow Metrorail to track the reliability of such systems and use of parts or materials.

In the Rosslyn Train Control Room, in addition to significant dust build up, damaged asbestos-containing flooring (see Finding 3), and a dirty filter on an air intake that Plant Maintenance later stated did not belong there, the room temperature on the thermostat read 85 degrees Fahrenheit during the visit the morning of March 23, 2023 and the room was not cooling. Yet despite the extensive dust, dirt, and grime in the room, multiple completed forms stated that the room was clean. Duct tape was being used to hold up a switch on a power supply in a train control room equipment rack, paperwork was in disarray, and rack covers meant to protect equipment were hanging down.



In the Ballston Train Control Room, an apparent heavy water leak onto the main power box had left the box, which provides power to the vital relays, rusted out. Work orders were noted in the log book as closed due to there being no visible active water leak, however the main power box was rusted out posing

**Metrorail stated that it began directing personnel in December 2022, just before this audit began, to upload completed ATC maintenance records into Maximo starting in early 2023.**



**At the Woodley Park Train Control Room, the room was hot and dirty, including dust and dirt in the card racks and cabling, there were old documents, and the floor was damaged in multiple locations.**

hazards including a potential loss of power. Although other parts of the room appeared clean, the room had broken conduit, corrosion and staining on the walls, inconsistent identification of these items, and missing weekly inspection records. Plastic sheeting had been placed on top of the equipment in an apparent temporary mitigation effort. There were no work orders addressing items which were immediately visible when entering the room.

Many other Train Control Rooms had floor tile damage, dirt on the floors, damaged pages in books of plans, delays in provision of updated books of plans, and other issues. Loose tiles were left in place, and dust was pervasive across equipment in multiple locations (see Findings 3, 4, 5).

At the Woodley Park Train Control Room, the room was hot and dirty, including dust and dirt in the card racks and cabling, there were old documents, and the floor was damaged in multiple locations. Personnel on site said work orders had been opened for the flooring, but it had not been addressed. Metrorail personnel at several locations expressed concern that the dust in the rooms is so bad it could impact their health (see Finding 3). The heat continued in the Woodley Park Train Control Room even with the door improperly propped open in an attempt to get airflow for the personnel and equipment in the room.

Based on the conditions in the rooms, and WMATA's planned cleaning of other equipment in train control rooms, the WMSC asked personnel about their practices for cleaning Remote Terminal Units in these rooms. The units provide communication between the Rail Operations Control Center and the systems in Train Control Rooms. Personnel said they do no such cleaning because it would dislodge the dust that has built up, which they are concerned would cause faults for the RTU or other equipment in the room.

In addition, personnel said they did not yet have electrostatic vacuums or cleaning equipment for card racks, and that these were still being procured following the WMSC's 2022 Train Control Room order.

At Friendship Heights Station, Metrorail had improved the conditions in the months after the WMSC's 2022 Train Control Room order. During site visits for this audit, the room was noticeably cleaner, and had a temporary cooling system, among other improvements. The hole in the ceiling remained. Nonetheless, the improvement demonstrates that despite the age of the facilities Metrorail can bring them into better condition.

Metrorail experiences further challenges due to its lack of understanding of its assets. As part of C-0111 to address a finding from the WMSC's previous ATC Audit issued in 2021 regarding Metrorail's lack of replacement parts or planning for system obsolescence, Metrorail was, at the time of the current audit, planning to procure a contract to assess gaps in ATC inventory and asset management practices. Metrorail planned for this contract to address gaps and required procedures, as well as deficiencies in ATC asset information in Maximo, Metrorail's system of record. Metrorail provided information for this audit regarding the specifics of its current assets based on a 2016-17 asset survey, plus information from the Potomac Yard Station construction project, Silver Line Phase 2 project, and Alexandria Rail Yard ATC renewal project.

Without knowing what parts and systems are in place, it is difficult for Metrorail to demonstrate that all systems and subsystems are being properly maintained in accordance with its procedures, and Metrorail cannot comply with its Transit Asset Management Plan.





The WMSC also identified some corrective maintenance work orders open for extended periods, such as a broken Wee-Z bond at E02 work order opened August 8, 2022 that had not been addressed as of January 2023 (WO 17248880), work orders listed as waiting support open since as long as October 2020 (WO 15954424, WO15959323) and October 2021 (WO166616559) related to a signal head, cable, and ground detector unit.

As described in Finding 2 below, these gaps in tracking and recording deficiencies and preventive maintenance contribute to reliability reports not providing an accurate profile of system performance, trends, health and repair or modernization needs.

### **Example H: Grade crossings**

Metrorail has grade crossings in rail yards where personnel walk or drive rubber-tired vehicles in and out of rail yards across yard tracks. At the crossings, Metrorail maintains flashing lights and/or gates that signal to people walking or driving across the tracks that a train is nearby and that they must stop away from the tracks.

WMSC review of documentation from the Greenbelt Rail Yard indicates Metrorail did not address issues with the batteries used to provide a backup in the event of a power outage in a timely manner to ensure that the safety features at the grade crossing activate and indicate to anyone who would otherwise attempt to cross the tracks that they must stop for train movement.

Inspections identified the need for replacement at least as early as June 17, 2022, a work order was not opened until October 3, 2022, and then Metrorail did not have replacement batteries available, which led to the issue not being addressed in a timely fashion. The ATC-1000 Manual requires batteries be replaced if voltage readings are not at an acceptable level.

The supervisory approval of the June 17, 2022 inspection without the creation of a corrective maintenance work order is another example of supervisors not completing required tasks, and, as further described below, is an example of Metrorail not tracking and addressing deficiencies and corrective maintenance work.

### **Conclusion**

In its comments on the draft of this report, Metrorail stated that it “considers the issues included in the draft ATC and Signals Program Safety Audit report rise to the level of an urgent hazard, particularly as described in the report narrative.”<sup>3</sup> Metrorail also acknowledged that “the instructions for preventive maintenance testing and inspection of ATC apparatus systems are designed to ensure that the ATC Systems, Subsystems & Equipment are in satisfactory condition. Additionally, these guidelines will be used to ensure the continued reliability of the ATC systems.” Further, Metrorail acknowledged that “regular inspections and tests play a crucial role in ensuring the reliability of the rail transit tracks, switches, signals, and other infrastructure components by identifying defects, wear, or damage.” The WMSC is concerned that Metrorail’s comments on the draft report referenced “vital design of the ATS and ATP systems,” when Metrorail’s ATS (automatic train supervision) system is non-vital. In fact, Metrorail’s reliance on that non-vital system for

<sup>3</sup> As described elsewhere in this report, the WMSC communicated issues to Metrorail, such as the improper maintenance of AF-800W cards, during site visits, interviews, and the exit conference.



vital safety operation contributed to the fatal 1996 collision at Shady Grove Station (NTSB RAR-96/04). This response and Metrorail's comments relying on a protective coating on vital track circuit modules referenced elsewhere in this final report are concerning to the WMSC as the approach appears to undermine the systems engineering approach of designing systems with multiple layers of protection, then maintaining and utilizing the systems only as intended. Viewing the deterioration or elimination of one of these layers of protection as inconsequential based on the assumption that other layers of protection are present, even when those other layers of protection may not be carried out properly, is contrary to the requirements of a high reliability organization. This is particularly concerning for safety critical systems.

◆ **Minimum Corrective Action (Finding 1 – CAP A)**

Metrorail must train ATC Maintenance personnel, and provide for and ensure supervision by trained personnel. Metrorail must conduct quality checks of training, maintenance, and records to ensure that ATC Maintenance personnel (including frontline employees, supervisors and managers) have a uniform understanding that ensures the proper completion of safety tasks. Metrorail must ensure that vital systems are assessed against required values and tolerances by including this information in its training and verifying this work in the field to ensure proper and complete inspections and handling of vital systems that are required for track circuits and other elements of the ATC system to function properly to prevent train collisions and to provide other designed safety protections.

This must also include assessing supervisors for their understanding of the procedures they are required to oversee.

Metrorail must clearly communicate the latest approved procedures when the changes are approved, in accordance with Metrorail's requirements, to review and (as needed) update the procedures and ensure that only current procedures are in use.

◆ **Minimum Corrective Action (Finding 1 – CAP B)**

Metrorail must ensure that all required information is recorded on ATC Maintenance PMI forms to allow for data review and analysis.

◆ **Minimum Corrective Action (Finding 1 – CAP C)**

Metrorail must identify and document deficiencies and their resolution as specified in Metrorail procedures and must act upon reported deficiencies or hazards in a timely fashion.

► **Finding 2: Metrorail does not review, analyze, and act upon available safety data about the health and functionality of the Automatic Train Control system and subsystems as required by Metrorail's Agency Safety Plan. Therefore, Metrorail's ATC Engineering cannot reliably or proactively determine whether or not the ATC system and subsystems are or will be functioning as designed to provide for the safety of riders and workers.**

ATC Engineering determines the necessary preventive and corrective maintenance procedures but does not review the data that is collected during this work that is intended



**Metrorail has no process for ATC engineers to look at and evaluate preventive maintenance and inspection data, or for anyone to evaluate data from inspections and testing in a systemic manner via sampling or broader analysis as the data is collected.**



to indicate whether each element of the system is functioning as designed. Engineering personnel expressed a reliance on maintenance groups, however, as described above, the maintenance personnel and supervisors do not have a uniform understanding and documentation necessary to ensure that proper processes and procedures have been carried out, or to ensure that any incorrect readings or readings that are cause for concern are identified and evaluated.

ATC Engineering has no insight into what the data collected during preventive maintenance inspections indicates about the performance of the train control system until after a problem has manifested in a significant train delay or a system failure that is recorded.

As also noted above, not all system failures and corrective action are being recorded. Personnel interviewed for this audit said that issues related to a train delay are reviewed quickly, regardless of the potential underlying safety risk.

Metrorail does not understand its preventive maintenance data, its significance, what analysis is needed, or proper maintenance techniques. No one who understands the proper procedure is validating that the data comports with the PMI and its intended purpose, and there is no feedback for anyone to identify that something is being done correctly or incorrectly.

Metrorail has no process for ATC engineers to look at and evaluate preventive maintenance and inspection data, or for anyone to evaluate data from inspections and testing in a systemic manner via sampling or broader analysis as the data is collected.

This deficiency creates confusion for Metrorail that makes it challenging for Metrorail personnel to answer basic questions about the health of the system.

Metrorail's safety management system commitments, required by the WMSC Program Standard, in WMATA's Public Transportation Agency Safety Plan require data collection, review and analysis.

As required by the WMSC, after an industry-wide FTA safety directive, Metrorail began a safety risk management process for Communications and Signals to identify and consolidate hazards as this audit was underway as an initial step toward safety management system implementation for Communications and Signals (See Finding 4).

### **ATC Engineering is not reviewing data, systems, or maintenance practices as required to validate its confidence in the reliability of this vital system**

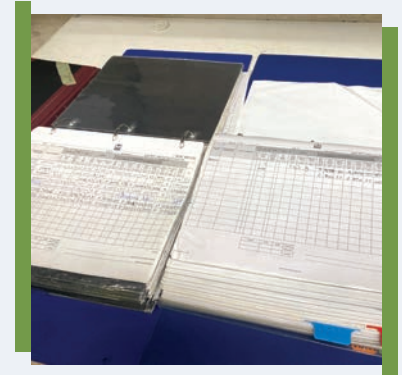
Interviews and document review demonstrate that ATC Engineering does not review results of preventive maintenance inspections on vital equipment such as track circuits, and there is no other review of this data on the basic health and functionality of the system. Contributing to this is the way that Metrorail is capturing this data, with significant portions of the data recorded solely on paper forms that are left in train control rooms, and other summary information recorded on paper forms that are stored in field offices. This makes data review and oversight challenging for managers and engineers. As noted above (Finding 1), field personnel do not have the understanding needed to identify readings or trends that could be cause for alarm, and the records are not structured to provide for such realization.



**ATC Engineering was unaware that ATC Maintenance personnel are not properly carrying out work such as track circuit preventive maintenance as described in Finding 1.**

Further, ATC Engineering was unaware that ATC Maintenance personnel are not properly carrying out work such as track circuit preventive maintenance as described in Finding 1. Engineering personnel expressed surprise and disappointment in interviews about what the WMSC observed and documented in the field.

The ATC Engineering personnel said they only review preventive maintenance records or individual procedures when an issue is raised to them by maintenance personnel, and that they do not check whether maintenance personnel are carrying out procedures correctly or review any sample of the actual readings taken during regular preventive maintenance.



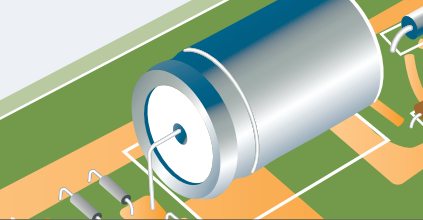
ATC Engineering personnel stated that engineers used to go to train control rooms and inspect data sheets, and would open work orders for issues identified in the test data or conduct of maintenance and inspection, but that this had not been done for many years.

Multiple engineers interviewed for this audit said this lack of presence in the field observing preventive and corrective maintenance activities is a problem. Metrorail's ATC manuals state that there are supposed to be compliance checks, but that Metrorail has not assigned personnel to carry that out consistently. These engineers believed carrying this out would require more staffing (See Recommendation 1).

It is positive that Metrorail added compliance checks to its ATC manuals, but these required checks by ATC Engineering (ATC-2000, 2005.16) are not being carried out. This is a basic requirement to understand whether maintenance, inspection and data collection is being done properly, correctly, and safely. Metrorail's ATC engineering compliance process requires verification of compliance with Metrorail rules and procedures. The ATC 2000 manual states the purpose of the compliance verification is to enhance configuration management, process compliance, and safety. However, the manual, in Appendix C, also states that Metrorail has not assigned a dedicated compliance officer(s), so senior engineers are supposed to perform periodic audits and file compliance reports. Metrorail provided blank forms for such checks and a handful of completed checks from 2020 and 2021 but stated that the process has only just begun. In its comments on the draft of this report, Metrorail stated that this requirement of its existing ATC manual, was only intended to be a trial. The WMSC appreciates continuous improvement, which would include carrying out those procedures specified in Metrorail's manuals that serve as a basis for the WMSC's audits.

For the AF-800W testing described above, engineering personnel indicated that maintenance personnel should look at a new separate form in the front of the binder for that track circuit in the Train Control Room to find the last adjusted value. As noted above, Maintenance personnel did not utilize this form when observed by the WMSC, and other Maintenance personnel interviewed by the WMSC were unaware of this form's existence or purpose. Engineering personnel confirmed that maintenance personnel should have been comparing measurements on the AF-800W to the last adjusted value, not the prior month or the reading taken earlier during the same PMI. The form with actual readings





**WMSC field observations and document reviews demonstrated the use of incorrect forms, inspections that were not completed, missing work order information, and missing information about calibrated equipment.**

is not provided to a maintenance supervisor, uploaded to Maximo, or made available to engineering unless engineering visits the Train Control Room or specifically requests it. Engineers stated they do not do regular checks of these forms. Form 1012A is the data sheet that provides the data over time in the Train Control Room. Form 1027 is a summary sheet that generally notes only pass or fail.

Managerial personnel interviewed for this audit suggested that ATC Engineering and ATC Maintenance need to more closely collaborate on PMI development and implementation to review the details of procedures and whether they will be carried out as designed in the field.

Inconsistencies in completing preventive maintenance inspections and associated documentation further prevents Metrorail from making informed, data-driven decisions on repairs, engineering modifications, or other actions that may be needed to maintain the health and safety of the system.

WMSC field observations and document reviews demonstrated the use of incorrect forms, inspections that were not completed, missing work order information, and missing information about calibrated equipment required to have been used to conduct an inspection properly, yet ATC Engineering is relying on this data to state that the system is in the required condition.

Engineering personnel expressed a hope that preventive maintenance and inspection data could be entered into a centralized database at some point in the future, such as digital entries of readings into Maximo, but there is not yet a plan in place to do this to provide for condition monitoring. Just prior to the start of this audit, Metrorail returned to scanning data sheets and uploading those images as attachments to Maximo work orders. Personnel indicated that they had not previously had scanners in every field office, and that IT personnel had expressed concerns about placing too much information in Maximo, despite Maximo being Metrorail's system of record. In its comments on the draft of this report, Metrorail provided records from the second half of 2023 – after completion of this audit and the WMSC raising these issues – that reflected initial steps toward potential digitization of some data collection in the future.

Today, there is no effective review, feedback, or quality control of the data collected during preventive maintenance by those responsible for the procedures and who are intended to be responsible for data analysis.

This leads to Metrorail personnel relying on subjective confidence in the safety and integrity of the ATC system, and, at the same time, not consistently identifying, reporting, and addressing issues that could indicate otherwise.

### **Other data not acted upon**

Beyond the gaps for engineering personnel related to data such as readings on vital track circuits collected by maintenance personnel and stored in the field, engineering personnel are not reviewing and acting upon specific other data that is available to them via electronic systems. For example, Metrorail had not identified or acted upon repeated failures of train-to-wayside communication systems in early 2023 that were indicated in real time through Metrorail's Advanced Information Management system, or to repeated





indications that trains were operating without authorization in Automatic Train Operation mode, until the WMSC identified and communicated these issues to Metrorail, including the importance of addressing indications that trains were not operating in Metrorail's required manual operating mode. Metrorail had not checked the indications of trains improperly being operated in automatic mode, contributing to a train operator who had been operating, unauthorized, in Automatic Train Operation over multiple trips continuing to operate in ATO until the train attempted to speed through a station platform and the train operator activated braking, stopping the front of the train beyond the station platform. After completion of the on-site activities for audit, but prior to the issuance of the draft report, Metrorail similarly did not act upon repeated indications of trains improperly moving without Automatic Train Protection at various locations across the Metrorail system until the WMSC identified and communicated these issues to Metrorail. For example, on April 15, 2023, these indications of a train moving with ATP cut out were accurate, but not acted upon by Metrorail, and the train was allowed to move along the Orange and Silver Line without this vital safety protection or any associated protective block.

After the WMSC raised these issues, Metrorail stated that the Automatic Train Supervision (ATS) system design and issues with Train-to-Wayside Communication (TWC) lead Metrorail's systems to default to indications of ATO use when there is a system problem. In the 1996 Shady Grove accident, Metrorail had relied on the ATS system, which Metrorail has designated as nonvital, to provide a safety-critical speed limitation (RAR-96/04). The train overran a platform, which meant it was not positioned to receive this indication, and instead defaulted to maximum speed commands prior to the fatal collision.

Also after the WMSC raised the issues related to ATO indications that Metrorail had not acted upon, Metrorail Communications and Signals leadership stated Metrorail would begin reviewing TWC data and Advanced Information Management (AIM) System data. Prior to the WMSC identifying TWC locations with extended periods of no communication, Metrorail had not identified or addressed these problems. When the WMSC raised these when the WMSC raised these safety issues during this audit to engineering experts within ATC Engineering, they were not aware of these improvements that Metrorail had committed to, and therefore stated of the issues with TWC that "this has been a well-kept secret." Departmental leadership stated during the audit they were now looking into ways to check TWC data after the WMSC informed them of the issues with their systems.

### **| Unreliable reliability reports**

Metrorail ATC Engineering and other personnel rely on Reliability Engineering Asset Management Reports to indicate safety and reliability trends that require adjustments to maintenance or engineering practices, however those reports are based on information in Maximo. Metrorail is not entering all deficiencies and corrective maintenance actions into Maximo work orders as required by Metrorail policy, has not consistently attached completed forms and other work records to Maximo work orders, and also does not enter the detailed measurements into Maximo during preventive or corrective maintenance that would allow for data analysis, assessment, and alerts. Further, as described above, not all corrective maintenance that is captured in Maximo is captured in sufficient detail to support such reporting. Personnel also stated that not all relevant information is entered into Maximo, even after some completed data sheets began to be uploaded as attachments

**Metrorail is not entering all deficiencies and corrective maintenance actions into Maximo work orders as required by Metrorail policy.**





PANEL LIGHTS



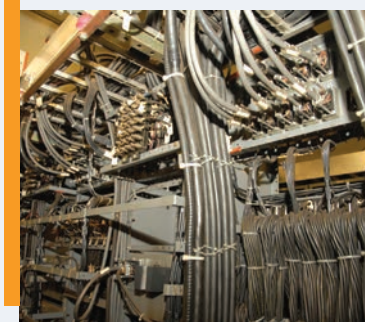
**It is positive that Metrorail is tracking and analyzing bobbing track circuits and regularly monitors and maintains its loss of shunt tool.**

to work orders as this audit was underway. In addition, preventive maintenance work orders are closed out prior to completion, which further undermines the accuracy of these reports. Therefore, these reports provide an inaccurate profile of emerging trends in equipment performance and therefore are an unreliable predictor of asset health, replacement, repair, or modernization needs.

Some engineering personnel stated in interviews that these reliability reports, relied upon by higher level management, are not meaningful.

Still, Communications and Signals Department leadership stated that these reliability reports or reports of problems requiring corrective maintenance represent the good health and definitive safety of the system as a whole. Engineering personnel stated they review the previous day's system failures daily, meaning those items such as track circuit or RTU failures that impact passenger service. Personnel interviewed for this audit explained that these reviews and the items that get classed as failures to be included and prioritized are based on the duration of delays for riders linked to the issue, and do not include or prioritize items that may separately indicate a safety hazard, increased risk, or existing latent risk. The focus of these daily failure reviews is on service impacts.

Further, Metrorail has not yet developed a complete inventory of ATC-related assets, including key equipment in each Train Control Room. Metrorail expected to begin work to assess gaps in ATC inventory and asset management practices in May 2023 as an element of CAP C-0111 to address deficiencies in procedures and incomplete asset information in Maximo, Metrorail's system of record. At the time of this audit, Metrorail could not provide complete, current lists of the equipment in each Train Control Room when the WMSC requested the age, type of system, specific model, and location of specific, key equipment.



It is positive that Metrorail is tracking and analyzing bobbing track circuits and regularly monitors and maintains its loss of shunt tool, but engineers stated that other data quality and collection is a maintenance responsibility (see issues noted in Finding 1), and engineers do not generally look at the data that is collected until and unless a failure is reported. Even for bobbing track circuits, personnel interviewed for this audit stated that a renewed focus was primarily due to a desire to initiate Automatic Train Operation. Metrorail records show that even as issues with certain circuits are addressed, some circuits remain consistent problems, such as A01 A2-3 that bobbed on a regular basis from January 1, 2021 through January 31, 2023, a total of 6,384 times, A14 A1-796 that bobbed extensively in 2021, then continued at a lower rate in 2022 (total for the period 3,137 times), A15 A1-905 that bobbed consistently over the period 4,548 times. D07 D2-183 bobbed 7,249 times between January 1, 2021 and January 31, 2023 on a consistent basis over the period, E03 E1-78 bobbed 9,299 times, E03 E1-92 6,004 times, E04 E2-97 4,734 times, G01 G2-337 and K04 K1-312 3,600 times, K04 K1-319 6,494 times, and K04 K2-319 8,382 times, the majority in 2021 demonstrating reduced frequency of the issue over time at that circuit (although the issue still recurs). Metrorail's collection and

regular analysis of this data by a small group, which should be followed by consistent and effective action to identify, address, and prevent underlying causes of these issues, is a positive example of the analysis of available data Metrorail could carry out on a broader basis. At the time of this audit, the follow-up actions had not yet been implemented. The WMSC understands that in some cases, such as where the bobbing is linked at least in part to dissimilar rail (the left rail and right rail having differing conductive qualities), replacement can take time.

◆ **Minimum Corrective Action:**

Metrorail must establish and implement a process for ATC Engineering and any other appropriate personnel to review, analyze, and act upon available safety data about the health and functionality of the Automatic Train Control system and subsystems. Metrorail must perform engineering spot checks and other reviews of preventive maintenance records and data, ensuring that all required information is recorded on PMI forms to allow for data review and analysis and meaningful reliability reports. This must include sampling or broader collection and review of data collected during preventive and corrective maintenance work, and engineering checks on the conduct of that work to provide insight into current system conditions. Metrorail must establish and implement a process to reliably and proactively determine the functionality of the ATC system and subsystems.

**The WMSC observed similar disturbed tiles and mastic in other Train Control Rooms such as the Woodley Park Train Control Room.**

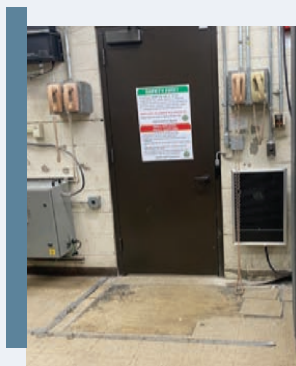
▶ **Finding 3: Metrorail is putting its personnel at risk due to health hazards such as damaged and repositioned materials marked as containing asbestos that are not being identified and managed as required by its Agency Safety Plan.**

During the WMSC's on-site visits to Train Control Rooms during this audit, the audit team observed disturbed and damaged floor tiles in the Arlington Cemetery Train Control Room that Metrorail had labeled as "DANGER ASBESTOS DO NOT DISTURB Vinyl Tile Floor or Mastic." The same apparent type of tiles and mastic were also disturbed elsewhere in the room (without such signage), and those



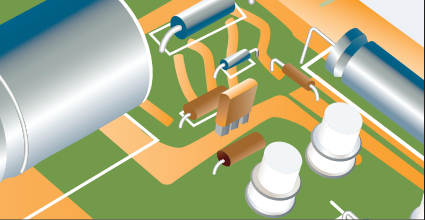
disturbed tiles slid under the feet of personnel entering or exiting the room. There were also locations where tiles had been dislodged but evidence of the mastic (glue used to hold the tiles in place) remained and was exposed with personnel placing their full body weight on this mastic as they walked in and out of the room. This included visible changes to the condition and amount of the remaining mastic in heavy foot traffic locations.

The WMSC observed similar disturbed tiles and mastic in other Train Control Rooms such as the Woodley Park Train Control Room.



The WMSC reviewed these health hazards with Metrorail personnel on site and with Metrorail managers during audit interviews, followed up with several document requests, discussed this with Metrorail again during the exit conference for this audit, and additionally





provided Metrorail with a more detailed written description as the WMSC continued to review the follow-up documents provided by Metrorail.

Metrorail provided records that demonstrate Metrorail's Plant Maintenance, Structures, and Power team did not identify the marked asbestos hazard in the Arlington Cemetery Train Control Room during a site survey that was conducted in March 2023, the same month as the WMSC's site visit for this audit. In addition, Safety Department Operational Safety Oversight inspections conducted as part of Metrorail's actions under CAP C-0213 to address the WMSC's August 4, 2022 Order recorded a missing cover on a wall-mounted fiber optic cable box as the only item that needed to be addressed in this Train Control Room, and did not identify the health hazard.

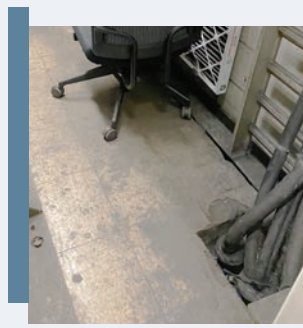
In another example, the WMSC also observed disturbed and damaged tiles in other Train Control Rooms such as the Rosslyn Train Control Room and Metro Center Red Line Train Control Room. Metrorail has previously confirmed for itself, including in a 2014 report provided by Metrorail, that the tiles and the associated mastic at Rosslyn contain asbestos. The damaged floor and dirty room at Rosslyn were not noted for correction in Metrorail inspections.

The 2014 report identified multiple assumed or confirmed asbestos-containing building materials in the sample of locations that were tested at that time due to those locations being scheduled for renovation. However, documents provided from Metrorail's 2021 physical assessment of asbestos-containing materials demonstrate that the 2021 assessment did not include even the Train Control Room locations previously identified by Metrorail in the limited 2014 sample as containing asbestos. Ongoing monitoring of known asbestos-containing materials is the basis for any determination that material has not been disturbed, that it remains in a condition where it is safe for people, and whether any replacement is required.

Further, even for several ATC locations in rail yards that were included in the areas to be inspected in the 2021 assessment report, Metrorail did not assess the condition of the materials to determine whether action was required. For example, Metrorail did not provide access for its contractors to the ATC Room and Train Control Room in the New Carrollton Rail Yard Administration or Yard Control Building. This includes the First Floor ATC Room where the material was already known to be damaged.

Plant Maintenance leadership, responsible for maintenance of items such as flooring, was not aware of any comprehensive list of locations where there are known asbestos containing materials. When the WMSC shared the conditions at Arlington Cemetery Station during an interview for this audit, they stated they had not been aware and would conduct testing.

Following the WMSC's communication of the asbestos hazard, Metrorail conducted samples of the Arlington Cemetery Station and Addison Road Station Train Control Rooms in April and May 2023 that Metrorail stated "are consistent with the results of previous





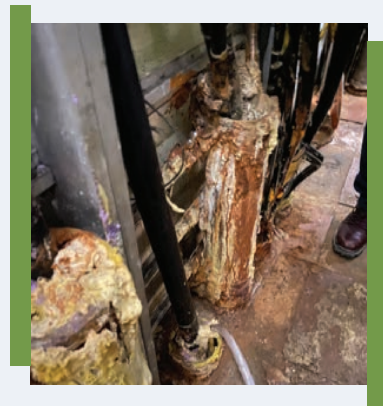
**There are still Train Control Rooms with heavy dust or other contaminants.**



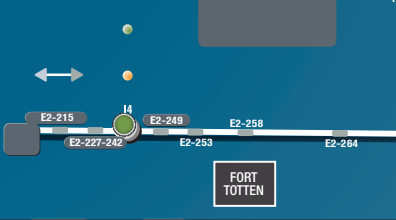
surveys in other TCRs.” This confirmed that both the disturbed floor tile and the disturbed black mastic used to stick the floor tiles in place are asbestos containing materials in the Arlington Cemetery Train Control Room. As described above, the WMSC observed that the mastic had been disturbed in the Arlington Cemetery Station Train Control Room. The highest asbestos risk occurs when the fibers are disturbed. In the Addison Road Train Control Room, the tiles contain asbestos, but an inspector rated them as being in good condition requiring periodic surveillance. In its comments on the draft of this report, Metrorail stated there had also been similar testing of these locations conducted in 2020. However, as noted above, the personnel responsible for working around these materials and maintaining the conditions of the room and flooring were not aware of this testing or its results. These hazards were not included in any systemic hazard tracking or mitigations provided by Metrorail for this audit for train control and signals personnel (see Finding 4). The conditions in the field demonstrated that the materials are not in their designed condition, and require enhanced monitoring or mitigation to ensure a safe workplace given the regular work Metrorail specifies is to be carried out in these rooms that involve personnel, tools, equipment, cleaning, and associated maintenance and repair activities. Personnel conducting this work and their managers informed the WMSC during this audit that they do not have training to identify or understand the hazard and to mitigate the likelihood of realization of the associated risks.

**| Other hazards**

Site visits for this audit show that Metrorail has improved conditions of some Train Control Rooms since the WMSC’s 2022 order. However, there are still Train Control Rooms with heavy dust or other contaminants, including significant dust that has moved through the air and built up on equipment such as significant buildup in the Rosslyn Train Control Room, and personnel expressed concerns about air quality hazards. These hazards and any associated mitigations are not included in Metrorail’s hazard log. Metrorail provided a 2017 tunnel dust assessment; however, this did not provide any information about air quality in Train Control Rooms. The 2017 assessment specifically tested locations on platforms, on mezzanines, and in station manager kiosks.

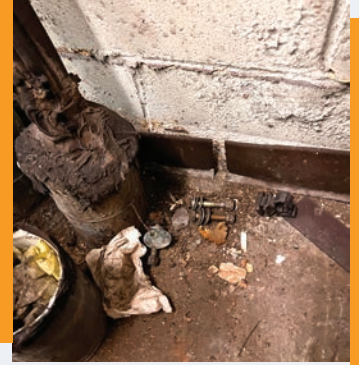


Further, Metrorail’s 2014 report identified locations with lead-containing surface coatings that were in poor or fair condition at that time that could pose risks if disturbed, damaged, or not properly disposed of. That report also noted that other layers of paint beneath the surface may be exposed after the assessment that could contain different levels of lead. The WMSC observed rooms with damage to walls or paint, with evidence of leaks, or with other deterioration. In the months following this audit, Metrorail identified in summer 2023, during work to implement a Corrective Action Plan unrelated to Communications and Signals, CAP C-0171 addressing expired and unclean equipment in emergency medical cabinets, that there were contaminants in the dust that had entered and built up in the emergency cabinets at the end of station platforms. Specifically, Metrorail identified levels of lead in this dust that require remediation and clearance testing.



**The WMSC's Train Control Room order noted that Metrorail had identified issues with HVAC systems, but had not generated work orders to address these issues.**

In addition, site visits demonstrated rusted out power boxes such as one in the Ballston Train Control Room that could pose an electrical hazard, holes in ceilings, dusty and unkempt conditions demonstrating that cleaning processes are not being effectively and consistently carried out across the system, and rooms such as those at Rosslyn and Woodley Park stations that are excessively hot for personnel and equipment. Personnel expressed similar concerns about other rooms, such as the Pentagon Train Control Room. At Rosslyn, an air filter was improperly mounted to the HVAC system. The filter was inside the Train Control Room, which Plant Maintenance mechanics do not have access to without an escort. Only some HVAC installations allow Plant Maintenance personnel to determine the temperature of the room from the location outside the room where they evaluate the HVAC system. Metrorail places primary inspection responsibilities on the ATC maintenance personnel for conditions of the room, including leaks, with other departments responding in the event a work order is opened.



The WMSC's Train Control Room order noted that Metrorail had identified issues with HVAC systems, but had not generated work orders to address these issues. Metrorail has the opportunity to improve safety by scheduling, conducting, and sustaining joint, interdepartmental inspections and maintenance activities, and by cross training personnel to identify basic hazards and clean all equipment in rooms they are authorized to access. CAP C-0213 remains open and Metrorail is in the process of implementing steps designed to address these items. The WMSC is not requiring a modification to this CAP for those cleaning and inspection issues at this time, and expects Metrorail to continue to implement this CAP in a timely manner.

### **| Lack of training to identify these health hazards**

Multiple personnel interviewed during this audit stated, as supported by the training records provided, that they do not have the training or understanding to identify these types of health hazards, including asbestos hazards, or the precautions that may be required for their safety or the safety of others. Managers reported that Metrorail would conduct asbestos testing as required prior to demolition work, but otherwise would not test for health hazards such as asbestos for maintenance or other work unless a specific concern is expressly raised by field personnel. As noted, field personnel do not have the training required to identify such a concern.

### **| Interim steps**

As part of interim cleaning steps for the Train Control Rooms, to address issues identified in the WMSC's August 4, 2022 Train Control Room Order, Metrorail had begun laying temporary rubber interlocking floor coverings prior to the on-site visits for this audit on top of existing tiles in some Train Control Rooms. In April and May 2023, Metrorail added this flooring in locations such as the Arlington Cemetery, Rosslyn, and Woodley Park Train Control Rooms where the WMSC observed and communicated concerns during this audit. These mats may provide some level of protection against new disturbance of the underlying materials and should make general cleaning of these areas easier. However, they do not on



their own address or mitigate the safety issues that relate to already-disturbed materials. Plant Maintenance personnel stated the matting is intended to help with cleanliness, ergonomics (non-slip), and make it easy to work on. Metrorail planned to install the matting in a total of 101 Train Control Rooms by mid-summer 2023 as an interim mitigation until a Train Control Room undergoes a capital replacement project.

Generally, the audit demonstrated that there are multiple Train Control Rooms in poor condition, even as other locations have been significantly improved by Metrorail since the WMSC's communications leading up to and including the August 4, 2022 Train Control Room Maintenance and cleaning order.

Metrorail stated on May 24, 2023 that its Office of Occupational Safety and Health was developing a corporate Asbestos Program, that was expected to be published in fall 2023. Following publication, the program would need to be implemented. Metrorail later stated the planned implementation of this program is in 2024.

◆ **Minimum Corrective Action:**

Metrorail must complete development of and implement its Asbestos Program, including implementation for employees and contractors in such departments as Communications and Signaling, Power, Track and Structures, Plant, Safety, Information Technology and Shops and Materials Support, who may access Train Control Rooms or other ATC and Signal locations with known or possible asbestos hazards. Metrorail must assess other health hazards, such as air quality/dust and lead, identify any necessary training, protective equipment, or other mitigations, and implement such mitigations.

**Generally, the audit demonstrated that there are multiple Train Control Rooms in poor condition, even as other locations have been significantly improved.**

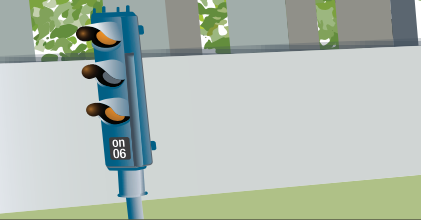
▶ **Finding 4: Metrorail is not systematically identifying, tracking, and mitigating hazards related to automatic train control and signaling as required by its Agency Safety Plan.**

Metrorail's safety management system commitments, required by the WMSC Program Standard, in WMATA's Public Transportation Agency Safety Plan, require data collection, review and analysis. In addition to the data described in Finding 2, Metrorail is not systematically collecting, reviewing, or mitigating hazards identified by its ATC and signals personnel.

Audit interviews and document review demonstrated that Metrorail was not maintaining hazard logs for Automatic Train Control and signals as required by its plans and procedures, that ATC personnel were not consistently aware of hazard management processes, and that there were not sufficient procedures in place to know that policies and processes – such as those designed to mitigate risk – were being implemented as designed and providing the intended benefits.

Metrorail took positive steps during the course of this audit, based on WMSC direction and an FTA safety advisory (22-2), to move toward implementing the safety management system approach required under the WMSC Program Standard and federal regulation that is specified in Metrorail's Agency Safety Plan. This approach has not yet been implemented.





**Metrorail is not meeting its safety promotion, safety assurance, or safety risk management requirements for ATC and signals personnel.**



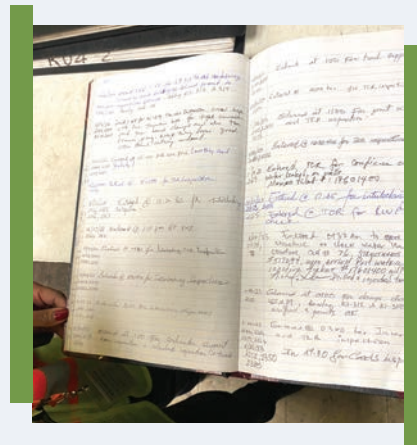
## Documents and Interviews

Metrorail made some progress from the WMSC's last ATC audit related to direct disregard for safety, but is not carrying out the hazard identification, hazard management and other SMS processes that are required. As described in Finding 1, maintenance personnel do not have the understanding necessary to identify and raise even hazards intended to be identified when carrying out documented procedures. Personnel the WMSC interacted with during this audit were not consistently aware of safety committees or hazard management processes, as required by Metrorail's Agency Safety Plan (including section 5.2.2). Those personnel that were aware of local safety committees at specific facilities described them as rarely relating to ATC, and stated that at the time of this audit there was no departmental safety committee that would identify and mitigate hazards that are occurring at multiple locations. Further, multiple personnel interviewed for this audit expressed concern about their ability to speak freely due to fear of retaliation.

Safety event investigations have also demonstrated hazards or near-misses that are not reported, such as a December 6, 2022 red signal overrun near Smithsonian Station (W-0217) near-miss of a collision with an Automatic Train Control Maintenance crew with local control of an interlocking. The ATC Maintenance crew did not report this near miss and red signal overrun. The work crew later stated that they were surprised by the train suddenly moving past the red signal without a route being set. The work crew reached a place of safety when the train passed.

Metrorail is not meeting its safety promotion, safety assurance, or safety risk management requirements for ATC and signals personnel. This deficiency makes it challenging for Metrorail to understand the hazards and risks facing Metrorail as an organization, its riders, and first responders.

Metrorail managers stated they do not maintain hazard logs as specified in Metrorail procedures, and Metrorail provided only project-specific hazards when asked for its hazard logs for areas associated with this audit. Metrorail noted that it was developing departmental hazards in accordance with the WMSC direction following the FTA safety advisory. The project-specific hazard information included a system hazard analysis for the Alexandria Rail Yard project. This is a project for which, as documented in the WMSC's August 13, 2021 finding, Metrorail did not initially follow its safety certification requirements.



Metrorail subsequently provided baseline risks for Communications and Signaling that were identified as an initial step in safety risk management implementation due to the WMSC's direction following the FTA safety directive, and stated that it was beginning to stand up a departmental safety committee as specified in its procedures (see below).

Interviews, field visits and document reviews as part of this audit and as part of corrective action plan oversight work demonstrate Metrorail lacks clear lines of responsibility and accountability, leading to complex processes and Metrorail collecting data without using that data or determining whether that data is right or wrong (See Findings 1, 2). Personnel

interviewed repeatedly passed off responsibility and accountability to others. As noted above, Metrorail's maintenance processes are inconsistent and are not monitored for conformance with PMI or other requirements. There are no meaningful checks of whether safety data indicates any issues. The reason to collect data is to feed into SMS. For example, data is collected because engineers need to know, but as explained in Finding 2, this data is not seen, analyzed, or addressed.

The SMS risks identified by Metrorail are a positive step, but they leave out other risks based on available data and are rated without consideration of the available data.

In its comments on the draft of this report, Metrorail acknowledged the requirements of its Agency Safety Plan for signals personnel.

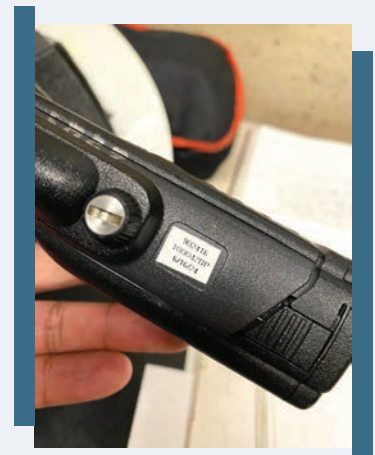
### | SMS Risks

As required by the WMSC, subsequent to an industry-wide FTA safety advisory, Metrorail began a safety risk management process for Communications and Signals to identify and consolidate hazards as this audit was underway as an initial step toward SMS implementation for Communications and Signals.

The preliminary risks identified related to deficiencies in the department's safety culture, unclear and improperly managed documentation, staffing levels, roadway worker protection, and ineffective management of tools and materials. After subsequent work, Metrorail identified seven baseline risks:

1. Shortage of knowledgeable and technically experienced staff jeopardizes our capacity to properly maintain the system
2. Deficiencies in preventive maintenance scheduling and inspection activities contributes to decreased system reliability
3. Inadequate procurement and management of critical tools and equipment compromise the ability to properly build and maintain the system
4. Radio dead zones compromise the safety of Communication and Signaling personnel working out in the system
5. Current procedures result in inadequate health and safety protections for Communications and Signaling personnel
6. Outdated and unavailable processes and procedures for conducting Communications and Signaling operations and maintenance result in deviations which impact safety to personnel and our capacity to properly maintain the system
7. Deficiencies in infrastructure, layout, and design increase the likelihood of incidents and safety events.

Metrorail identified 59 initial mitigations (including those mitigations already in place).





Metrorail focused these risks at the departmental level. The WMSC has previously found in multiple audits, and in the August 2022 Train Control Room order, that interdepartmental coordination is also an area for improvement.

Related to procurement and management of tools and equipment, Metrorail is implementing CAP C-0111. However, personnel interviewed for this audit stated that they cannot rely on current inventory information in Maximo, Metrorail's system of record, to reflect available parts. Metrorail's SAMS personnel responsible for ATC-related assets rely on informal observation to notice when Metrorail is low on parts and should re-order, and do not consistently track what is available.

Personnel interviewed for this audit explained that supplies have been removed from Metrorail because they had not been used recently, even though they may be necessary to make repairs or replace an item that fails.

In addition, several personnel interviewed said that records of the number of items available in storerooms is not reliable, and that those items are frequently not tracked until someone happens to see that there are only a few (or one, or none) on a shelf. One supervisor, for example, reported that if Metrorail's records show there are two of an item, there may in reality be only one or none.



Other elements of Metrorail's supply chain are similarly inconsistent, with descriptions of some people bringing vital relays to Shops and Materials Support (SAMS) for replacement, but then keeping the old part. In its comments on the draft of this audit report, Metrorail also noted its separate Supply Chain Management personnel have a lifecycle approach to inventory.

Metrorail has the opportunity to improve its supply and procurement process to ensure items necessary for safety and operations are available.

Related to deficiencies in design, in addition to those identified in the WMSC's safety certification order in August 2021 related to the Alexandria Rail Yard, the WMSC's Rail Operations Audit issued in 2022 identified that Metrorail does not effectively identify, track, communicate and address operational hazards as required by its Agency Safety Plan (CAP C-0182). Related to Automatic Train Control, this included Metrorail not identifying that new digital yard control boards were designed, then installed and activated at the Alexandria Rail Yard, without functions necessary to provide protection against routing trains into areas where work crews are present.

Metrorail's training requirements provided for this audit showed that safety certification training is not required for key personnel in the Signal System Renewal Program (SSRP) such as safety certification and project coordinators with responsibilities related to safety certification.



**There were not sufficient procedures or feedback loops in place to know that policies and processes are being followed.**

### **| Ongoing gaps**

At the time of this audit, departmental management acknowledged that there were not sufficient procedures or feedback loops in place to know that policies and processes are being followed.

Meetings that were occurring focused on issues that had caused service disruptions.

The department was not utilizing Metrorail's hazard management software, and leadership did not get meaningful information that reflected what is actually occurring in the field.

Items that were raised were recorded in disparate spreadsheets rather than a centralized system.

In addition, individuals interviewed for this audit passed off responsibility or accountability for work as basic as cleaning of shared Communications and ATC rooms.

### **| Previously identified hazards not considered**

Metrorail does not maintain hazard tracking systems that address previously identified hazards and ongoing mitigations related to train control and signals.

For example, personnel were not familiar with hazards identified in the National Transportation Safety Board investigation into the fatal 1996 accident at Shady Grove Station, even those hazards such as braking rates, block design, train-to-wayside (TWC) communication issues, and station overrun hazards that have direct relevance to current projects and day-to-day operations.

As part of Metrorail's efforts to understand and potentially activate Automatic Train Operation, a Metrorail consultant identified that Metrorail could not demonstrate that it had addressed all findings and recommendations/improvements from a selection of some of the ATC and ATO-related reports issued since 2009. Metrorail's review identified that 76 items from this selection of reports could not be verified as completed as of January 26, 2023.

For example, Metrorail's report showed that Metrorail does not have documentation that it has addressed previously identified hazards related to signal logic identified after the 2009 collision near Fort Totten that could lead to another train entering an occupied block if timers are not properly set and a bobbing track circuit occurs. Metrorail's recent review determined that it had no evidence to demonstrate that it had investigated, addressed, and corrected the locations across the system that were identified in a 2014 System Implementation Gap Analysis Report as having safety deficiencies in signal logic. Specifically, this relates to locations where logic designed to prevent a collision in an interlocking is not present. In its comments on the draft of this report, Metrorail confirmed that it did not have records regarding some of these suggested improvements to demonstrate whether those improvements were implemented. Metrorail also inaccurately claimed that it had provided records to the WMSC in December 2022 that demonstrated Metrorail had addressed the signal logic safety issue. The WMSC had requested such records in November 2022 as part of the WMSC's oversight of Metrorail's safety certification efforts related to the potential use of Automatic Train Operation and Automatic Door Operation. Through March 2023, Metrorail stated in its own tracking of its response to that request that it had not provided such documentation. In March 2023, Metrorail





**Books of plans in Train Control Rooms provide the basis for safe and effective work in the room, particularly work related to troubleshooting or repairs.**

stated it believed it had provided such information to the Federal Transit Administration prior to the creation of the WMSC. For the first time in this process, as part of its comments on this draft report, Metrorail provided records indicating the signal logic had been addressed at 13 locations previously identified by Metrorail contractors as requiring such corrections. As described above, Metrorail’s report that it was prepared to rely upon at the time of this audit to support progression of Automatic Train Operation indicated that Metrorail could not provide such documentation. The WMSC appreciates that Metrorail has now identified that these safety items have been addressed, and has now provided these records in December 2023.

**Field personnel believe safety reporting ineffective; safety-critical work overkill**

As described in Finding 1, multiple maintenance personnel diminished the importance of their maintenance of vital systems.

Other personnel described instances where they have reported hazards, malfunctioning or insufficient systems such as HVAC equipment, or heavy dust and debris in rooms with vital equipment, but work orders are closed out with no action taken, which has discouraged them from reporting safety concerns in the future. They also described an impression that “Metro knows about it,” so there is no reason to report issues.

In its comments on the draft of this report in December 2023, Metrorail stated that it had made further progress since the completion of this audit on the implementation of safety risk management processes related to automatic train control and signals. The WMSC looks forward to Metrorail implementing these practices as specified in its Agency Safety Plan as part of the corrective action plan to address this finding.

**Minimum Corrective Action:**

Metrorail must complete implementation of its safety management system for Communications and Signaling personnel. This must include systematically identifying, tracking, and mitigating hazards as required by the WMATA Agency Safety Plan. Metrorail must develop, institute, and carry out continuous safety promotion activities that ensure personnel understand the direct relevance of their work to the safety of themselves, passengers, and other personnel.

**Finding 5: Metrorail is not maintaining its books of plans in accordance with its requirements.**

Books of plans in Train Control Rooms provide the basis for safe and effective work in the room, particularly work related to troubleshooting or repairs. In many rooms visited by the WMSC, these books providing the electrical drawings for personnel are improperly marked, have torn or missing pages, or are otherwise dirty or damaged. Such damaged, dirty, or missing pages can lead to incorrect or delayed troubleshooting and repairs which can create or exacerbate safety issues.

**These issues are not consistently identified in Metrorail train control room inspection records.**

Metrorail's ATC-2000 Manual requires each Book of Plans to be kept up to date with correct circuit configurations, be legible, and be in serviceable condition. The manual states that ATC maintenance mechanics and supervisors are responsible for checking the condition of the Book of Plans.

In multiple locations, some pages with an Engineering Modification Instruction stamp were signed indicating work was complete, while other pages in the same room related to the same work were not. Metrorail personnel stated that signed pages (indicating that the modification work has been completed) should be replaced by a new permanent page showing the permanent configuration. In other cases, a stamp was present on the cover page, but not present on the related page elsewhere in the book. In the Green and Yellow Line Train Control Room at Fort Totten Station, wiring had been adjusted, but there was no signature showing the work was complete. Metrorail's requirements in the ATC 4000 Manual state that the signature confirms that all changes are as-in-service, and that drawing then remains in the book of plans until replaced with final as installed prints.

In the Red Line Metro Center Train Control Room, pages such as A01-G06 were damaged, and pages that the front of the book indicated should have an engineering modification instruction (EMI) recorded did not have a stamp or signature. At Branch Avenue Train Control Room, there were similar issues.

At Woodley Park Station, the book of plans had improper markings in black ink. Metrorail policy requires any markings to be made with red ink to demonstrate items added and with yellow ink to demonstrate items removed. When the WMSC pointed this out to Metrorail personnel on site, they acknowledged the deficiency.

These issues, including the torn and damaged pages, are not consistently identified in Metrorail's train control room inspection records, and are therefore not being consistently documented and addressed.

Metrorail is not carrying out a process to ensure books of plans are current. Current, accurate, and appropriately approved books of plans are necessary for personnel to address identified issues safely. If personnel are looking at the wrong circuitry, there can be negative outcomes for safety and system functionality. These are key pieces of information for maintenance staff to properly troubleshoot and maintain the health of the system.

As noted in Findings 1 and 2, ATC engineers are not regularly checking field work, including the conditions and accuracy of books of plans.

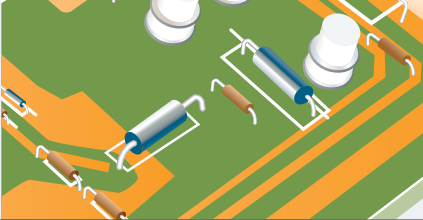
In its comments on the draft of this report, Metrorail acknowledged the need to keep books of plans current, complete, and legible, and stated that it has begun work to ensure each room has such plans.

**◆ Minimum Corrective Action:**

Metrorail must review each ATC book of plans and ensure that each is in good condition with current content in accordance with Metrorail procedures. Metrorail must ensure that this review is conducted on a recurring basis as specified by Metrorail procedure.







## Recommendations

### ► Recommendation 1: Metrorail has not determined the required staffing for ATC and Signals.

Metrorail personnel interviewed for this audit expressed concern about staffing and alignment within Metrorail's Communications and Signaling Department, and the desire to conduct a staffing and organizational assessment to determine the required staffing levels for specific tasks.

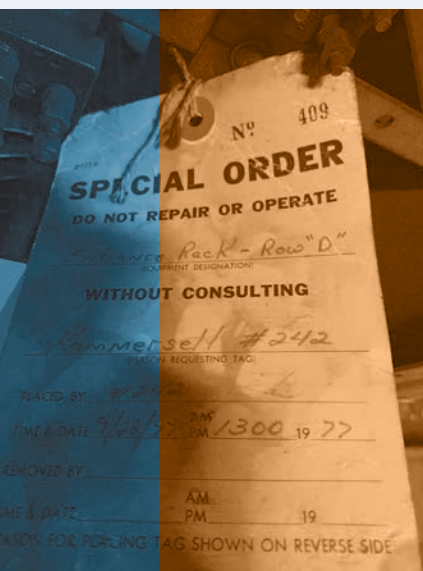
CAP C-0113 addressing the 2021 ATC Audit finding that Metrorail is not effectively managing turnover, vacancies, and experience levels of ATC personnel, remained open at the time of this audit. The WMSC closed this CAP on November 2, 2023 after Metrorail began implementing an apprenticeship program, recruitment strategies, and updated minimum training requirements for ATC maintenance personnel. Determining the overall required staffing for ATC and signals personnel in accordance with this recommendation would build on the actions taken under CAP C-0113.

In December 2022, Metrorail created the new Communications and Signaling Department by placing ATC Maintenance, ATC Engineering and the capital project group Signal Systems Renewal Program under the new department, along with the Communications Department.

The organizational structure for Communications and Signaling was in flux at the time of this audit due to Metrorail's recent reorganization of its executive management structure, and the expectation that further changes might be made at lower levels in the future. Incorporating a staffing and workload assessment, particularly for maintenance and engineering personnel who have the largest day-to-day roles in inspecting, maintaining, and ensuring the safe condition of the ATC and signals systems across the Metrorail system, would provide Metrorail with an opportunity to improve safety by ensuring that its personnel and organizational structure are appropriately scaled to the size and complexity of the Metrorail system.

At the time of this audit, ATC Engineering expressed a need for additional staffing. As described above, several engineers interviewed for this audit (and Metrorail's documentation) also expressed a gap related to presence in the field observing maintenance activities, and the need to be with maintenance personnel doing preventive maintenance. These engineers believed this would also require more staffing. Metrorail needs to determine whether staffing is the cause of this lack of engineering presence in the field as stated in its ATC manuals (see Finding 2), and address the cause of this issue.

ATC Maintenance personnel expressed a desire for consideration of support for activities on the roadway so that trained technicians could be assigned to ATC tasks rather than roadway safety tasks, and other personnel without ATC expertise could serve in roadway worker protection functions. Maintenance leadership stated they do not believe they have enough personnel to do their work and expressed challenges in recruiting and retaining personnel to fill available positions. This has led to individuals being hired who require more training. Maintenance leadership expressed concern about the amount of overtime currently required.



**Metrorail subsequently identified staffing as a risk requiring mitigation.**

Personnel interviewed for this audit expressed challenges in filling certain existing vacant positions based on promotion requirements, applicant skills, or differential benefits such as the benefit of union representation for some engineering positions that does not extend to more senior positions.

Metrorail subsequently identified staffing as a risk requiring mitigation as it initiated a safety risk management process for Communications and Signaling.

Interviews with multiple personnel also identified the opportunity to review maintenance and inspection assignments so that they are scheduled in the most efficient manner to achieve the best results and most efficient use of limited maintenance person hours on a regular basis. For example, personnel interviewed for this audit reported a variety of preventive maintenance inspections are assigned to the day or evening shifts, yet are rarely or never permitted to be completed by those shifts due to required track time that Metrorail does not authorize while the system is open due to possible delays for riders, such as work involving checking shunts in some areas with roadway worker protection hot spots requiring foul time protection. Competing priorities of maintenance and service regularly lead to direction to put off work until nighttime, which then requires ATC personnel to submit a track rights request. Metrorail could consider planning that work in advance on a regular schedule, which could be coordinated with other maintenance and inspection activities.

Maintenance personnel interviewed for this audit also stated that they expected additional work such as marker coil maintenance may be required if Metrorail begins utilizing Automatic Train Operation.

**◆ Recommended Corrective Action:**

Metrorail may conduct and act upon a staffing assessment for ATC and Signals including the necessary hiring, training, and retention programs.

**▶ Recommendation 2: Metrorail does not ensure that lessons learned from prior projects are consistently shared with all relevant personnel responsible for ATC and Signals.**

Interviews for this audit demonstrated that lessons learned, particularly as part of capital projects, are developed but not consistently shared and incorporated across ATC and Signals personnel.

Proactively and consistently sharing lessons learned more broadly can help an organization like Metrorail avoid repeating similar issues and promote repeating of positive outcomes.

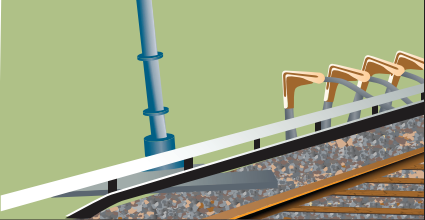
Interviews showed that individual capital project teams may develop lessons learned, but these do not reach other ATC and Signals personnel in a timely manner.

Metrorail would benefit from sharing these safety and project lessons early in project lifecycles, and by ensuring that these lessons reach all relevant project managers, engineers, and similar personnel.

**◆ Recommended Corrective Action:**

Metrorail may establish a process to place lessons learned in a centralized location and ensure that this information is shared through regular meetings, training, or other means.

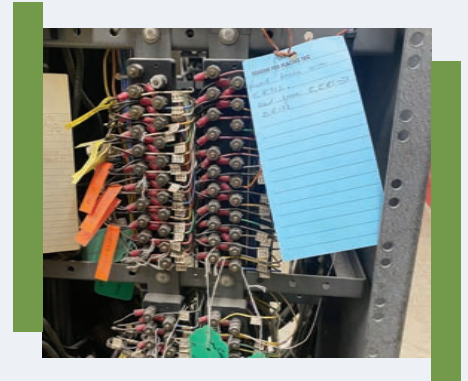




The WMSC Audit team observed temporary hang tags on wires in many Train Control Rooms that had been in place since the 1970s, 1980s and 1990s.

► **Recommendation 3: Metrorail does not have a procedure for the removal of hang tags in Train Control Rooms that indicate temporary modifications. This has led to many rooms having such “temporary” hang tags in place for decades.**

The WMSC Audit team observed temporary hang tags on wires in many Train Control Rooms that had been in place since the 1970s, 1980s and 1990s. As described on the tags and in interviews, Metrorail intends these blue or tan tags to indicate temporary modifications from the printed book of plans, such as the use of spare cables, that would then be replaced in the future or incorporated into permanent future updates to the books of plans used for troubleshooting and other work. However, Metrorail has no process to incorporate the information and remove these tags to provide clearer access to wiring and provide assurance that the books of plans are accurate.



Metrorail's ATC-2000 Manual requires blue tags to be placed at each location where equipment or a circuit has been interrupted or disarranged from its configuration as drawn in the book of plans, but does not specify a process to ensure these adjustments are documented in the book of plans and removed from the room. When placing a tag, the manual states that a log book entry must explain in detail the circumstances and reasons for the changes as well as the other information required on the tag, and a work order must be opened. Log book entries and work orders from decades ago are no longer accessible for maintenance or engineering personnel, and Metrorail did not have open work orders for tags placed decades ago.

It is positive that Metrorail has documented these wiring adjustments somewhere with these tags, but developing and implementing a procedure to update books of plans and remove these hang tags containing handwritten information within a specific time period would help Metrorail maintain awareness of current configurations, better support field personnel in carrying out their work, and demonstrate a commitment to the cleanliness and maintenance of Train Control Rooms.

During this audit, Metrorail personnel acknowledged this is an opportunity to close out these tags, incorporate any changes into the book of plans, and document current conditions and changes over time, and that the tags should not be permanent fixtures of these rooms. Other personnel were not sure whether hang tags ever got removed.

Examples included tags with listed dates from as early as 1977 and 1979 at Metro Center Station, 1982 at Rosslyn Station, 1989 at Woodley Park Station, 1993 at Arlington Cemetery Station, 1997 at Fort Totten Station, and 1998 at Pentagon City Station.

The decades-old hang tags are related to Finding 5 regarding Metrorail not maintaining its books of plans in accordance with its requirements, but the institution of a process for removal of the hang tags is provided as a separate recommendation in accordance with the WMSC Program Standard as an opportunity for a further safety improvement.



**Metrorail is beginning to consider a future communications-based train control system.**

Metrorail updating the book of plans, marking the wires on the back board, and removing the hang tags would provide for more effective maintenance and troubleshooting and demonstrate to employees the importance of maintaining books of plans and other records.

**♦ Recommended Corrective Action:**

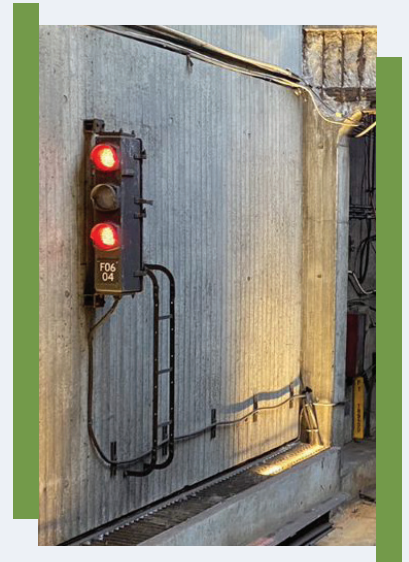
Metrorail may develop and implement a procedure for the removal of hang tags in train control rooms that indicate temporary modifications and ensure that such modifications are reflected in the book of plans within a specified timeframe.

### Other Observations

Metrorail is beginning to consider a future communications-based train control system. This includes creating engineering positions, considering high level strategy including any possible automation, bringing suppliers on, and coming up with proposal plans and possible segmented phasing for future work over coming decades. Some Metrorail personnel interviewed for this audit expressed concern about the long-term maintainability of the current train control system given limited parts availability, reliance on original wiring, and the reliance on 1960s and 1970s technology designed without incorporating system safety or safety management system principles.

### Recurring RTU, related issues

The WMSC observed repeated RTU communications failures in the months leading up to this audit that led to personnel in the Rail Operations Control Center not having real-time information about train movement. This outdated information on controller's screens introduced the risk that a Rail Traffic Controller could provide a protective block for a Train Operator or Foul Time for roadway workers when a train was in fact in or moving through that area that the controller believed they were protecting. Further, following the conclusion of this audit, during the WMSC's oversight of Metrorail's safety certification efforts related to the potential use of Automatic Train Operation, Metrorail stated that an RTU failure can lead to trains receiving speed commands that are higher than intended.



In the WMSC's prior ATC Audit issued in 2021, the WMSC noted that many RTUs were beyond their useful life, and Metrorail stated they were going to have a new long-term plan.

As part of CAP C-0111, Metrorail identified that the MERCS boxes used to send signals between the RTU and Metrorail's SCADA system are one of the highest points of failures for ATC assets, and stated that new MERCS boxes would be designed and built systemwide as part of the future Train Control Room Renewal project. Records provided for this audit showed some MERCS with last updates in 2003, suggesting they did not get updates specified in a 2010 EMI. Metrorail also identified as part of C-0111 that it has obsolete RTU models from 5 suppliers at various locations in the system. Metrorail stated that it planned to replace RTUs at

**ATC Engineering now has a committee related to RTUs.**

14 locations to generate spare parts for other existing TRW and Ferranti models, which had the highest number of failures. Metrorail also identified concerns about modem software. Metrorail now has an RTU replacement plan.

In response to the concerns identified by the WMSC regarding the potential consequences of the multiple RTU failures that occurred in late 2022, Metrorail represented that the failures that prevent Rail Operations Control Center personnel from knowing where trains are located or from remotely operating safety and operational equipment did not pose a safety risk.

During this audit, the WMSC audit team asked Metrorail personnel whether RTUs are cleaned in Train Control Rooms. Personnel said that cleaning would be problematic because it could dislodge the heavy dust that Metrorail has allowed to build up and cause another fault, or that components themselves could dislodge given the dirt and age of the equipment.

ATC Engineering now has a committee related to RTUs, the RTU Working Group, that includes multiple departments. It also includes discussion of protocol changes, current fiber optic cable installations to connect system elements to the RTU, and AIM build updates. At the time of this audit, Metrorail planned to adjust to use this group to review more specific details of the plans. The existing RTUs include communications related to multiple disciplines and require coordination to ensure that proper information is communicated and received and displayed by the Advanced Information Management (AIM) system. Metrorail plans to split power functions to separate RTUs over time. RTU configuration for those locations that are part of the Train Control Room Renewal Project is under review as part of Metrorail's design process, which includes renewal of some elements and modifications of others.

## Next Steps

WMATA is required to propose CAPs to address each finding and to respond to each recommendation no later than 30 days after the issuance of this report. Each proposed CAP must include specific and achievable planned actions to remediate the deficiency, the person responsible for implementation, and the estimated date of completion. Each proposed CAP must be approved by the WMSC prior to WMATA implementation. For each recommendation, WMATA must either propose a CAP or submit a hazard analysis and associated documentation as required by the WMSC Program Standard.





## Appendices



# Appendices A, B, C and D

## Appendix A: Personnel Interviewed

- ◆ Communications & Signaling
  - Sr. Vice President
- ◆ Communications & Signaling/Automatic Train Control Engineering
  - Automatic Train Control Engineer
  - Assistant Chief Engineer
  - 4 Managers (CBTC/Software, Field Engineering and Support, Design Engineering and Change, Configuration Management and Compliance)
  - Software Engineer
  - Sr. Director Train Control Engineering
  - 3 Sr. Train Control Engineers
- ◆ Communications & Signaling/Automatic Train Control Maintenance
  - 2 Assistant General Superintendents
  - Assistant Superintendent
  - 6 Mechanics
  - 2 Special Project Managers
  - Superintendent
  - 3 Supervisors
  - Manager Corrective Action Plan Compliance
- ◆ Communications & Signaling/Signaling System Renewal Program
  - Construction Engineer ATC
- Project Engineer
- 2 Project Managers
- Sr. Portfolio Director
- Sr. Program Manager
- Supervisory Construction Inspector
- ◆ Communications & Signaling/Communications Field Maintenance
  - Superintendent
  - Supervisor
  - Safety & Readiness
  - Sr. Director, Safety Risk Management
  - Sr. Vice President & Assistant Chief Safety Officer
- ◆ Safety & Readiness/Technical Skills Maintenance Training
  - Supervisor
  - Office of Facilities, Systems, and Vertical Transportation Maintenance/Shops and Material Support
  - Supervisor
- ◆ Office of Facilities, Systems, and Vertical Transportation Maintenance/Plant Maintenance
  - Director
  - Assistant Director

## Appendix B: Site Visits

- ◆ Woodley Park RTU Inspection and Test (March 20, 2023)
- ◆ Training Class and Training Lab at the Carmen Turner Facility (March 21, 2023)
- ◆ Ft. Totten Station Train Control Rooms, including AF-800W preventive maintenance in Red Line Train Control Room (March 22, 2023)
- ◆ Various Train Control Rooms (March 23, 2023)
- Arlington Cemetery
- Pentagon City
- Rosslyn
- Ballston
- Metro Center (2)
- Branch Avenue
- Friendship Heights
- Van Ness

## Appendix C: Documents Reviewed

### ORGANIZATIONAL CHARTS AND DEPARTMENT RESPONSIBILITIES:

- Descriptions of Automatic Train Controls & Signals Departments (no date)
- Communications Field Maintenance Organizational Chart (11/20/2022)
- SMNT/SAMS Organization Chart (2/2023)
- Comms & Signaling – Automatic Train Control Engineering (ATCE) Organizational Chart (1/27/2023)
- Office of PLNT Maintenance HVAC Organizational Chart (2/10/2023)
- Team Power Organizational Chart (1/23/2023)
- Signaling System Renewal Program Organizational Chart (2/14/2023)
- Automatic Train Control Maintenance Organizational Chart (no date)
- TSMT Organizational Chart (1/3/2023)
- SAMS Organizational Chart (2/14/2023)
- Department of Safety Organizational Chart (2/10/2023)
- Track and Structures Division 3 Organizational Chart (2/1/2023)
- ATC-Signaling Staff (2/9/2023)
- Training and Development Staff – Signals (no date)
- Office of Power – Master Roster (2/7/2023)
- PLNT HVAC Personnel and Budgeted Positions (no date)
- TRST – Structure Personnel and Positions (no date)

### ROLES/RESPONSIBILITIES/JOB DESCRIPTIONS:

- Assistant Office Engineer, Project Planning (4/5/2021)
- Assistant Project Manager (12/4/2014)
- Commissioning Manager (4/14/2021)
- Construction Inspection (Train Control/Signals) (8/31/2018)
- Director Capital Programs (2/15/2012)
- Mechanic, Automated Train Control (ATC) (no date)
- Performance Analyst (6/24/2022)



- Project Coordinator (12/4/2014)
- Project Manager, Capital Funded Programs (12/4/2014)
- Senior Capital Program Manager (1/16/2022)
- Senior Director, Capital Program Delivery (8/29/2014)
- Senior Vice President, Communications & Signaling (Engineering, Maintenance, and Capital Delivery) (2/3/2023)
- Signaling Roles and Responsibilities (2/10/2023)
- Supervisor, Construction Inspection (3/22/2021)
- Systems Training Instructor (4/17/2015)
- Supervisor, Craft Crew-HVAC Refrigeration Equipment (no date)
- Assistant Superintendent, Plant Maintenance (4/29/1992)
- Assistant Director, Plant Maintenance (3/9/2000)
- Superintendent, Plant Maintenance (7/3/2018)
- Director, Plant Maintenance (3/20/2019)
- Plant Boiler/Chiller Operator (5/15/2019)
- HVAC Plant Technician Lead (5/17/2019)
- HVAC Refrigeration Equipment Mechanic (5/17/2019)
- Supervisor, Technical Skills Training (6/15/2016)
- Technical Skills Maintenance Training Instructor (2/8/2019)
- Signal Engineering (COMM & SIGNALS) – Groups and Roles (2/1/2023)

## ROLES/RESPONSIBILITIES/JOB DESCRIPTIONS: (CONTINUED)



- SSRP Divisions Descriptions and Outline (no date)
- Division 3 Responsibilities Description (no date)

### INTERNAL REVIEWS:

- Internal Review: Engineering & Maintenance, (10) Automatic Train Control Maintenance-Track Circuits (7/7/2022)

### PROCEDURES/POLICIES/MANUALS/FORMS:

- 1-3K Change Request Log and Action Tracker (04/07/2023)
- 2-4-5K Change Request Log and Action Tracker (04/08/2023)
- ATC Signals Program List of Maintenance Requirements (no date)
- ATC-1000 & 3000 (PMIs) Memorandum (08/06/2021)
- ATC-1000, Instructions for Testing and Inspection of ATC Apparatus and Systems (05/06/2021)
- ATC-2000, System Integrity Maintenance Practices (12/14/2022)
- ATC-3000, Instructions for Adjusting ATC Apparatus and Systems (05/13/2021)
- ATC-4000, Systems Configuration Management Plan Instructions and Procedures Manual (04/21/2022)
- ATC-5000, ATC Engineering Design Standards (04/21/2022)
- Automatic Train Control – Maintenance Control Policy (05/29/2020)
- CAPD-SSRP-CBTC\_PIP Rev 0, WMATA NextGen Signaling Program Implementation Plan (December 2022)
- CAPD-SSRP-SOP-5.03 Rev. 0, ATC Capital Project Selection Process SOP (10/03/2022)
- COSI-SSRP-SOP-10.01 Rev. 0, Nonconformance/ Corrective & Preventive Action (01/13/2023)
- COSI-SSRP-SOP-13.01 Rev. 0, Compliance Audits & Internal Assessments (01/13/2023)
- COSI-SSRP-SOP-14.01 Rev.0, Training (01/13/2023)
- FQ 18134, Lessons Learned, C99 Alexandria Yard ATC Replacement Project (03/03/2023)
- Infrastructure Office of Signaling-520-01, On the Job Training (OJT) Team, Course Tracking Instructions (02/13/2023)
- Master Comment Response Table ENGA-002 (no date)
- Memorandum, Rosslyn Train Control Room Heating Ventilation and Air Conditioning Filter (04/10/2023)
- Metrorail Safety Rules and Procedures Handbook – Operating Procedures (01/01/2023)
- Project Implementation Manual, Volume II (08/2020)
- SOP 2, Third Rail Power Energization and De-energization Procedures (11/01/2022)
- SOP-204-01, Equipment Calibration (01/24/2020)
- WMATA Manual of Design Criteria (no date)
- WMATA SSRP Contractor Quarterly Audit Checklist (08/08/2022)
- Work Instruction, ATCM-I01-00, Switch Machine Hand Cranking & Switch Point Clamping Instruction (07/12/2022)



## TRAINING:

- AC Power Distribution Field Maintenance Presentation (4/9/2020)
- AC Power Distribution Presentation (4/14/2020)
- AF-800W Field Operations and Maintenance Participant Guide (07/2020)
- AF-800W Field Operations and Maintenance Instructor Guide (no date)
- AF-800W Field Operations and Maintenance Presentation (July 2020)
- All ATC Training List (01/01/2022 to 04/03/2023)
- Alstom Gen 4 Track Circuit (Silver Line Phase 1) Participant Guide worksheet (08/2020)
- Alstom Gen 4 Track Circuits (Silver Line Phase 1) Instructor Guide (no date)
- Alstom Gen 4 Track Circuits (Silver Line Phase 1) Presentation (08/2020)
- Alstom Gen 4 Track Circuits (Silver Line) (no date)
- Alstom VPI 1 System Operation and Maintenance Instructor Guide (no date)
- Alstom VPI 1 System Operation and Maintenance Participant Guide (no date)
- Alstom VPI 1 System Operation and Maintenance Presentation (no date)
- ATC Course Reference Book (5/8/2020)
- ATC Maintenance Department Phase One Course Reviews & Lab Worksheets (2019)
- ATC Mandatory Class List (no date)
- ATC Overview – Journeyman Training Program Presentation (4/7/2020)
- ATC Tools & Test Equipment Syllabus (no date)
- ATC Tools Presentation (02/2023)
- ATC Traction Power Presentation (3/11/2019)
- Book of Plans – ATC Journeyman Training Program (4/16/2020)
- COMM Training Transcripts (no date)
- DC Power Distribution – ATC Journeyman Training Program Presentation (4/21/2020)
- Genisys Hardware and Troubleshooting (02/2023)
- Introduction to ATC Safety presentation (05/08/2020)
- Intrusion Detection and Warning (IDW) System Instructor Guide (no date)
- Intrusion Detection and Warning Systems (IDW) Participant Guide (no date)
- Intrusion Detection and Warning Systems (IDW) Presentation (no date)
- IT Training Transcripts (no date)
- Journeyman Phase 1 Test and Answers (no date)
- Metro Safety Trumps Service Hand-out (no date)
- MicroLok II Maintenance Presentation (02/2023)
- OJT Training Records/Courses (2021-2022)
- Phase 1 ATC Journeyman Syllabus (no date)
- Phase 2 ATC Track Circuits Syllabus (no date)
- PLNT List of Required Trainings (no date)
- PLNT Training Transcripts (no date)
- Power Training Transcripts (no date)
- Relay and Locking OJT Records List and Evaluation Forms (no date)
- SAFE Training Transcripts (no date)



## TRAINING: (CONTINUED)



- SAMS Training Transcripts (no date)
- SSRP Required training by roles (no date)
- SSRP Training Transcripts (no date)
- Standard Operating Procedure, Infrastructure-Office of Signaling-520-01, On the Job Training (OJT) Team, Course Tracking Instructions (02/13/2023)
- Switches and Grade Crossing OJT Records and Evaluation Forms (no date)
- Tools Videos (no date)
- Track Circuits OJT Records List and Evaluation Forms (no date)
- Train Control Room Equipment Presentation (3/11/2019)
- Training Lab – Track 1 – ATP Module Arrangement Chart (6/7/2019)
- Training Lab – Track 1 – Bridging Receiver Arrangement Chart (6/7/2019)
- Training Matrix – ATC Worksheet (no date)
- Training Transcripts ATCM (no date)
- TRL BOP Package (12/30/2019)
- TRST Training Transcripts (no date)
- WMATA Laboratory Safety Rules (no date)
- WMATA Safety Bulletin SB #16-05a (5/11/2016)
- WMATA Training Room TRL Book of Plans (7/3/2002)

## INSPECTION AND MAINTENANCE:

- 1 Year Grade Crossing Work Order List (12/2020 to 9/2022)
- 2 Year AC Vane Relay Work Order List (2/2021 to 2/2023)
- 4 Year DC Vital Relay Work Order List (no date)
- AC Track Unit Circuit Work Order List (1/1/2020 to 12/31/2022)
- AC Vane Relay Locations List (no date)
- AC Vane Relay PMI Schedule and Last Tested Dates List (no date)
- AC Vane Relay Test Data Sheets, (12/03/2022 to 04/10/2023)
- Alstom Solid State AC Vane Relay Test and Installation Data Sheet, Location A11 (04/07/2023)
- ATC HVAC Report (04/11/2023)
- ATC Signals Program List of Maintenance Requirements (no date)
- ATC Wayside Inspection Work Order List (no date)
- ATC-1000 1003, Switch Detector and Route Locking Test, Location A15 (4/11/2023)
- ATC-1000 1003, Switch Detector and Route Locking Test, Location C07 to C08 (4/1/2022)
- ATC-1000 1010, Traffic Locking Test, Location A15 (04/04/2023)
- ATC-1000 1010, Traffic Locking Test, Location C07 (04/09/2022)
- ATC-1000 1011A TCR Ground Fault Inspection Forms (January 2022 to January 2023)
- ATC-1000 1012A/B-5 PF Track Circuit Test Data Location Forms (February 2022 to February 2023)
- ATC-1000 1012A-1 TCR Ground Fault Inspection Location Forms (December 2022 to February 2023)
- ATC-1000 1012A-1, AF Track Circuit Test Datasheets (February 2022 to March 2023)
- ATC-1000 1012B-1, AF Track Circuit Test Datasheets (March 2022 to December 2022)
- ATC-1000 1014A, Grade Crossing Monthly Operation Test, Location E94 (02/10/2023)

## INSPECTION AND MAINTENANCE: (CONTINUED)

- ATC-1000 1014A, Grade Crossing Monthly Operation Test, Location E99 (01/17/2023)
- ATC-1000 1014A, Grade Crossing Monthly Operation Test, Location E99 (12/13/2022)
- ATC-1000, 1021, ATC TCR Qtr. Inspection Forms (June 2021 to March 2023)
- ATC-2000 Appendix C, Field Compliance Report (01/12/2023)
- ATC-2000 Appendix C, Field Compliance Report (04/30/2022)
- ATC-2000 Appendix C, Field Compliance Report (05/01/2021)
- ATC-2000 Appendix C, Field Compliance Report (10/03/2020)
- ATC-2000 Appendix C, Field Compliance Report (10/29/2021)
- ATC-2000 Appendix C, Form 2004, Software Compliance Report (02/24/2023)
- ATC-2000 Appendix C, Form 2004, Software Compliance Report (02/26/2023)
- ATC-CM Work Orders List (2020, 2021, 2022)
- ATCM Failure Analysis Report (07/2022)
- ATCM Failure Analysis Report (08/2022)
- ATCM Failure Analysis Report (09/2022)
- ATCM Failure Analysis Report (10/2022)
- ATCM Failure Analysis Report (11/2022)
- ATO PSS EMI Sheet (No Date)
- Bobbing Track Circuit Adjustment Detailed Reports January 2020 to January 2023 (02/07/2023)
- Bobbing Track Circuits reported January 2020 to January 2023 (02/07/2023)
- CM Failed Cable Test Work Order Log (no date)
- Code Rate Frequency Work Order List (no date)
- D13 UPS Maintenance Excel file (no date)
- Deferral Request Forms (May 2022 to December 2022)
- Deferred Maintenance Work Order List, May 2022 to December 2022 (02/01/2023)
- EAB 22-003-SYS, Mechanical Vane Relay to Solid State Relay (10/10/2022)
- EAB-22-0003-SYS, AC Vane Relay Replacement, Mechanical Vane Relay-to-Solid State Vane Relay Forms (October 2022 to November 22)
- EIB 22-0009-MUL (08/19/2022)
- EIB-20-0005-SYS Engineering Information Bulletin AS800 and AF800W PCB Cross Reference and Keying (10/13/2020)
- EIB-21-0007-SYS (08/05/2021)
- EIB-21-0008-SYS, GM4000 Point Detector Switch Module, Rotary Cam Inspection Data Sheets (January 2022 to March 2023)
- EIB-21-0018-SYS Engineering Bulletin (12/17/2021)
- EIB-22-0001-SYS (07/01/2022)
- EIB-22-0006-E99 Engineering Bulletin (06/21/2022)
- EIB-22-0011-SYS Engineering Bulletin (09/26/2022)
- EIB-22-0012-SY Engineering Bulletin (09/09/2022)
- EIB-22-0012-SYS Engineering Bulletin (09/12/2022)
- EIB-22-0016-SYS (10/04/2022)EAB-22-0003-SYS, AC Vane Relay Replacement, Mechanical Vane Relay-to-Solid State Vane Relay F99 SSVR (11/08/2022)
- EIB-22-0018-SYS (10/24/2022)
- EMI 210566-A Line (11/15/2019)
- Engineering Change Log – ATC Drawings – A-Line (04/27/2015)





## INSPECTION AND MAINTENANCE: (CONTINUED)



- Engineering Change Log – ATC Drawings – B-Line (04/27/2015)
- Engineering Change Log – ATC Drawings – C-Line (04/27/2015)
- Engineering Change Log – ATC Drawings – D-Line (04/27/2015)
- Engineering Change Log – ATC Drawings – F-Line (04/27/2015)
- Engineering Change Log – ATC Drawings – G-Line (04/27/2015)
- Engineering Change Log – ATC Drawings – J-Line (04/27/2015)
- Engineering Change Log – ATC Drawings – K-Line (04/27/2015)
- Engineering Change Log – ATC Drawings – N-Line (04/27/2015)
- Form 1014, Highway Grade Crossing Test Data Sheets (January 2021 to November 2022) Ground Fault Inspection Work Order List (no date)
- Interlocking Inspection Work Order List (no date)
- Level 1 Compliance Check List (January 2023)
- Level 2 Compliance Check List (November 2022 to January 2023)
- Limited Asbestos Containing Materials (ACM Survey (05/19/2023)
- List of ATC Software Updates (01/23/2023)
- Memorandum on Maximo Work Orders Documentation and Retention Process (02/14/2023)
- Number bobbing track circuits reported, (01/01/2020 to 01/22/2023)
- Physical Assessment of Asbestos-Containing Materials Reports (2021)
- PMPASS Word Orders Scheduled (January 2021 – December 2022)
- PMPASS Work Order List (May 2022 to December 2022)
- RTU Failures through December (2022)
- RTU Inspection Work Order List (no date)
- SAMS ATCM WO (05/05/2023)
- Shunt Strap Validation Date on the Datasheet and the Task Tab in Maximo (04/01/2023)
- Signals Failure Analysis Report (December 2022)
- Signals Failure Analysis Report (January 2023)
- Switch PM 1007A List (November 2022 to January 2023)
- Switch PM 1007ABCE List (November 2022 to January 2023)
- Switch PM 1007ACD List (November 2022 to January 2023)
- Switch PM 1007ACF (November 2022 to January 2023)
- Switch PM 1007BCE (November 2022 to January 2023)
- Train Control Room Site Survey Findings, Location A08, A09 and C06 (no date)
- Tunnel Dust Assessment Final Report (11/03/2017)
- WMATA Quality Audit Report for Mass Electric Construction Co. (03/30/2023)
- WMATA Slippery Rail Prevention Program Final Report (06/28/2013)
- Work Order 15848530 Work Description (04/10/2023)
- Work Order 15954424 Work Description (03/07/2022)
- Work Order 15959323 Work Description (03/07/2022)
- Work Order 16067405 Work Description (07/19/2022)
- Work Order 16661659 Work Description (10/26/2021)
- Work Order 16717826 Work Description (11/22/2021)

**EQUIPMENT:**

- 2018 Asset Inventory Lists (no date)
- Assets from Maximo Database (02/06/2023)
- ATC Asset Hierarchy List (09/22/22)
- ATC Asset Hierarchy Potomac Yard List (09/22/22)
- ATC Trend Analysis SAMS (05/08/2023)
- Automatic Train Control Maintenance Control Policy (05/29/2020)
- CAP 111 Task Order on Asset and Inventory Management Memorandum (02/07/2023)
- Engineering Control Log – ATC Software (01/29/2015)
- FQ150000 – WMATA 700 Mhz Radio System – Daily Report (04/19/2022)
- FQ150000 – WMATA 700 Mhz Radio System A04 Woodley Park Station Site, Issued for Construction (05/26/2020)
- Lifecycle Decision Metrics (01/02/2017)
- List of AC Room Batteries (12/2022)
- List of AC Room UPS Information (no date)
- List of Alexandria Yard Assets from Database (no date)
- List of ATC & Signals Program HVAC & Ventilation Equipment (no date)
- List of DC Room Batteries (no date)
- Memorandum on ATCM Mechanic Tool List (June 30, 2020)
- MERCS Information List (02/09/2023)
- Radio Calibration Report (02/09/2023)
- Silver Line Phase II ATCS Assets from Maximo (02/09/2023)
- SOP 204-01, Calibration, Overdue Calibration and Non-Calibrated Equipment (01/24/2020)
- Test Equipment Report (02/09/2023)

**SAFETY CERTIFICATION:**

- ATC System Reliability, Availability and maintainability and Safety Program – ATC Hazard Log (1/10/2023)
- ATO/8 car PSS/Auto Doors Hazard Tracking List (no date)

- Dulles Corridor Metrorail Project Phase 2 ATC System Preliminary Hazard Analysis (3/2/2017)
- Dulles Corridor Metrorail Project Phase 2 Hazard Log (no date)
- Dulles Corridor Metrorail Project, Phase 2, Pkg A (5/13/2022)
- Heavy Repair and Overhaul Facility – SAFETY AND SECURITY CERTIFICATION PROGRAM – Preliminary Hazard Analysis (PHA) (no date)
- NextGen SSRP Risk Register (04/10/2023)
- Safety Risk Management Process Implementation Update for Communications and Signaling (2/10/2023)
- WMATA Alexandria Yard ATC System Replacement System Hazard Analysis (4/14/2022)

**MEETINGS MINUTES/AGENDAS:**

- ATCE LSC Agenda and Meeting Minutes (January 2022 to November 2022)
- ENGA Safety Meeting Minutes (January 2022 to November 2022)
- Local Safety Committee Meeting Minutes (02/28/2022)
- Return to ATO-Dissimilar Rail Agenda, Schedule and Minutes (03/29/2023)
- Return to ATO-Dissimilar Rail Agenda, Schedule and Minutes (04/05/2023)
- RIME/SMNT Joint Departmental Safety Committee Meeting Presentations (January 2022 to November 2022)

**CAPITAL PLANNING:**

- List of ATC Capital Projects (no date)



## Appendix D: Public Transportation Agency Safety Plan (PTASP) Elements Reviewed

### 1. Safety Management Policy

- a. Safety performance targets
- c. Organizational SMS Accountabilities and Responsibilities
- d. SMS documentation

### 2. Safety Risk Management

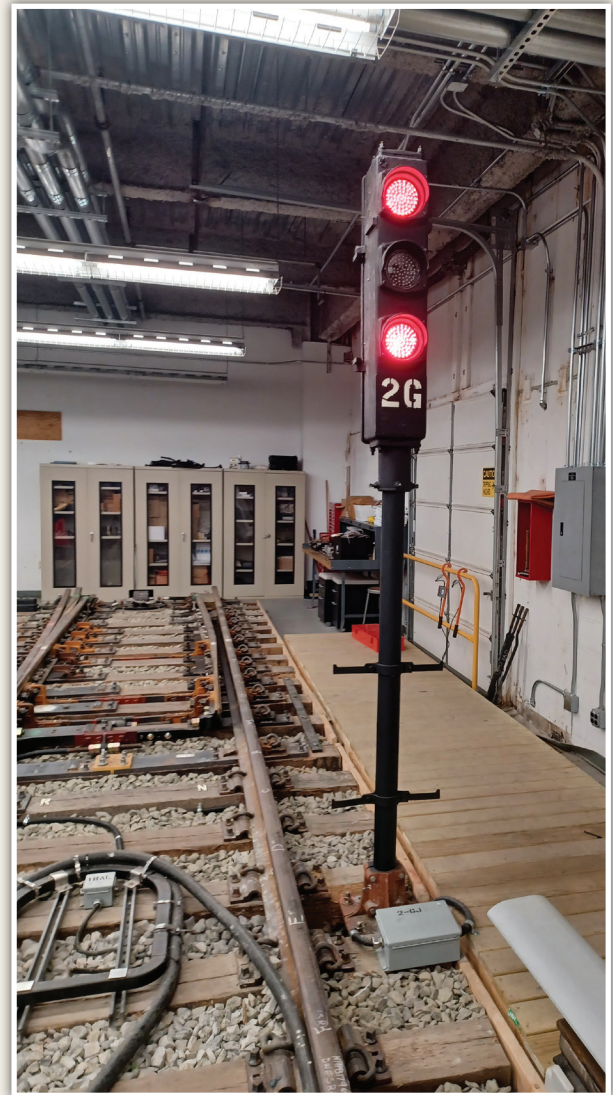
- a. Safety Risk Management (SRM) process
- b. Risk Assessment Process
- c. Risk assessment methodology
- d. Hazard identification
- e. Hazard investigation
- f. Hazard analysis and evaluation of safety risk
- g. Hazard resolution (mitigation, elimination)
- h. Hazard tracking

### 3. Safety Assurance

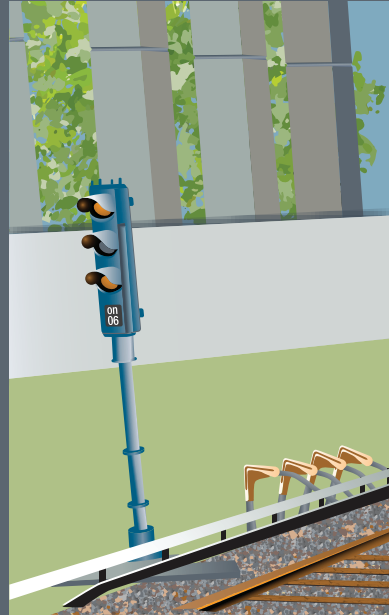
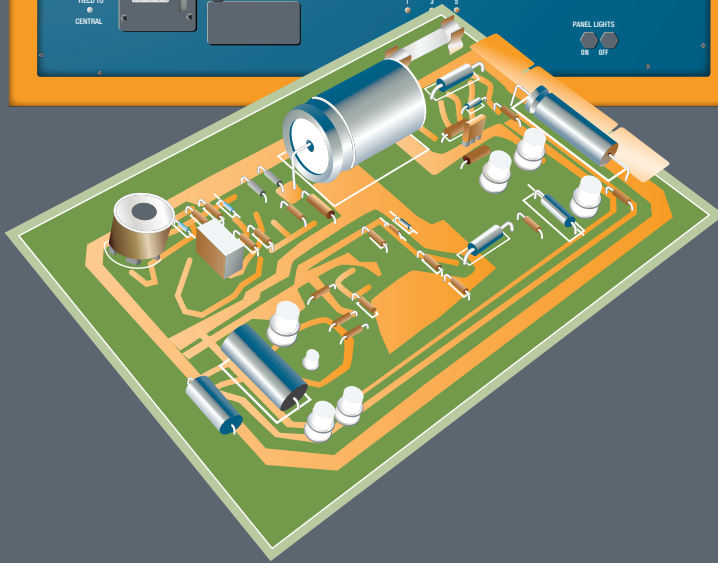
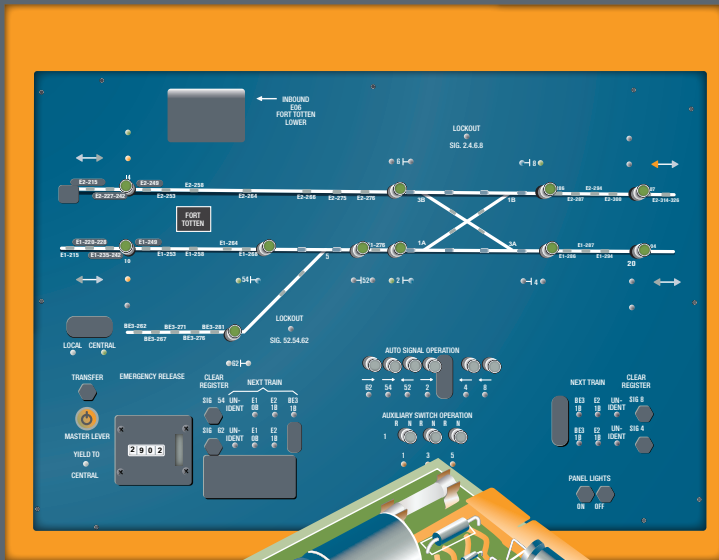
- a. Systematic, integrated data monitoring and recording of safety performance
- b. Real-time assessment with timely information
- d. Departmental controls
- e. Compliance and sufficiency monitoring (i.e. quality management system plan (QMSP))
- f. Document assurance activities
- g. Preventive, Predictive, and Corrective Maintenance
- h. Event reporting/investigations
- i. Change management
- j. Safety and Security Certification
- k. Corrective action plans

### 4. Safety Promotion

- a. Training
- b. Contractor Safety
- c. Safety Communications
- d. Hazard and safety risk information
- e. Safety committees
- f. Hazardous materials and environmental management
- g. Drug and Alcohol Compliance







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