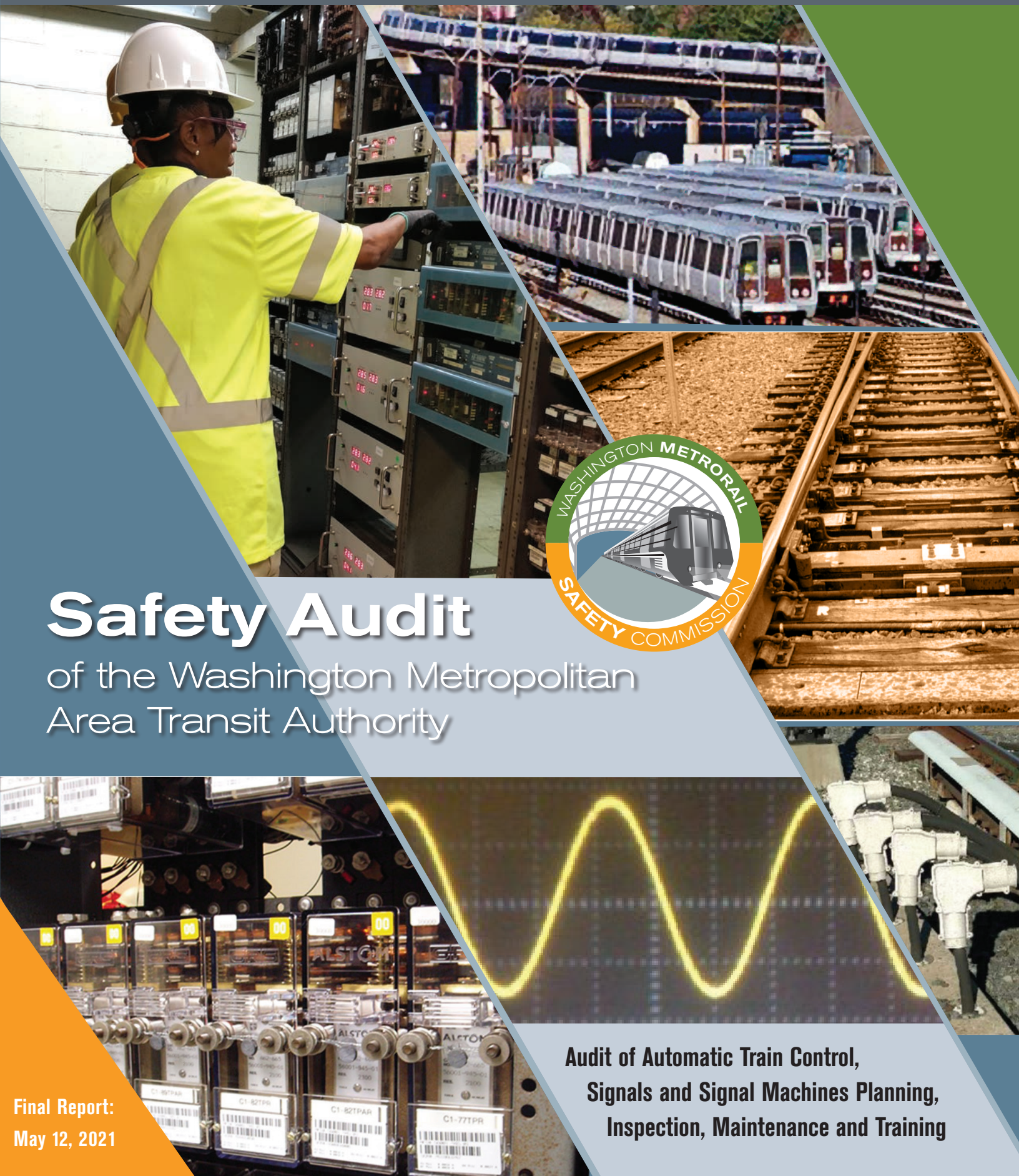


The Washington Metrorail Safety Commission



Safety Audit

of the Washington Metropolitan
Area Transit Authority

Final Report:
May 12, 2021

Audit of Automatic Train Control,
Signals and Signal Machines Planning,
Inspection, Maintenance and Training

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 the Washington Metropolitan Area Transit Authority (WMATA) Metrorail's Automatic Train Control (ATC) and signaling system inspection, maintenance, engineering and training practices based on in-depth interviews and document and data reviews conducted in late 2020 and early 2021. The scope of this audit included ATC system maintenance and inspection procedures and practices, engineering processes and manuals, management structures and staffing, planning and governance, and associated training.

The ATC system provides critical safety protections for train movement and roadway workers.

The WMSC identified several positive practices and a number of areas that require improvement. As a result, the WMSC is issuing 16 findings requiring Metrorail to develop corrective action plans (CAPs).

As described in the findings below, Metrorail has not adequately trained employees on safety procedures, and is not following several safety-related processes.

For example, Metrorail has continued work to return to Automatic Train Operation (ATO) in coming years without following its safety certification procedures. Metrorail is also not scheduling or completing all preventive maintenance as required by its own or manufacturer manuals, and Metrorail allows managers to bypass preventive maintenance work without any standardized way to determine whether bypassing the inspection or maintenance is safe.

Metrorail does not have documented ATC software standards.

For existing assets, Metrorail does not have adequate replacement parts or materials and has not planned for

the obsolescence of critical equipment even though many elements of the ATC system are decades old and beyond their useful life. This has contributed to rushed procurements, such as for the Grand Master 4000A switch machine, which was purchased and delivered without proper training or spare parts available for maintenance and inspection work.

ATC employees do not have minimum training course requirements or any requirement that they be trained on a specific system element prior to conducting maintenance work on it. Metrorail has not effectively managed turnover, vacancies and experience levels of ATC Maintenance

personnel to ensure that employees with crucial knowledge and experience are available to maintain, troubleshoot and repair the complex ATC system. When work is done, Metrorail allows employees to use tools that have not gone through any review or approval process to ensure that the tools are safe and effective for employees and for the infrastructure they are being used on.

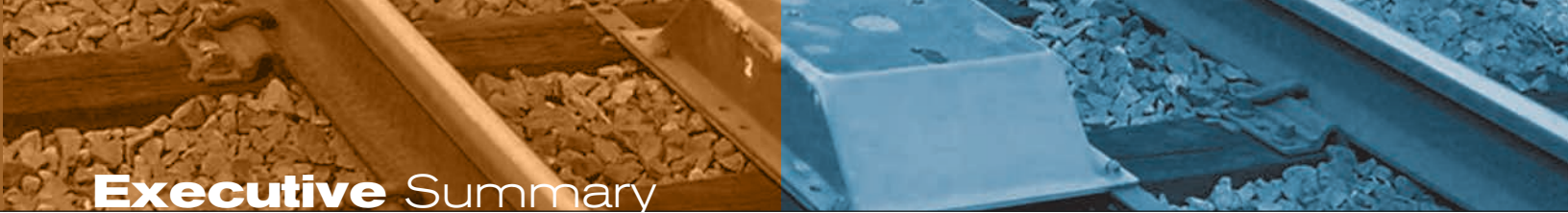
The departments directly involved in leading work on the ATC system – Automatic Train Control Maintenance (ATCM), Automatic Train Control Engineering (ATCE) and the Signal

System Renewal Program (SSRP) group – do not have clear, documented working relationships to ensure that required follow-up action is identified and taken, and do not have a clear process for the identification and prioritization of capital projects.

Some written procedures do not match current instruction to employees or do not include accurate information. Some test forms, work orders and data sheets are not properly completed with the required signatures or level of detail.

WMATA is required to propose CAPs for each finding no later than 45 days after the issuance of this report.





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Findings Summary

1 Metrorail has not adequately trained ATCM employees on safety procedures to ensure that all employees fully understand their roles with respect to safety. While several department managers acknowledged the dangers of ATCM's regular work on the roadway and the importance of safety procedures, multiple ATCM employees stated in interviews that there is too much safety, that safety rules have gone overboard so they do not comply, that Roadway Worker Protection (RWP) rule violations are common but acceptable, that Foul Time protections are not requested at all times required by the Metrorail Safety Rules and Procedures Handbook (MSRPH), and that rules do not factor in ATCM's unique situations on the tracks. Most individuals interviewed for this audit were not aware of the System Safety Program Plan (SSPP) or Public Transportation Agency Safety Plan (PTASP). In some cases, personnel were eager to rely only on a red signal as protection, even though that provides only one layer of protection. In addition, a complaint raised in fall 2020 about RWP protections in part of the area near the B03 interlocking was only addressed (marked as a hot spot) following a WMSC directive issued after the employee elevated their concern to the WMSC.

Minimum Corrective Action: Metrorail must implement safety promotion practices to build trust and a strong safety culture through positive and responsive safety communications and a collaborative process with employees to help identify safety issues and effective means to address those issues to ensure that work as performed comports with work as required. This could begin with safety stand downs and other training that emphasize not only rules and familiarization with any appropriate parts of the SSPP/PTASP, but also the safety reasons and risks behind those rules. Daily toolbox or other regular meetings or additional training must help ensure that employees understand safety risks and how safety measures such as personal protective equipment and RWP protocols help mitigate those risks.

The ATC system provides critical safety protections for train movement and roadway workers.

2 Metrorail has continued efforts to return to Automatic Train Operation without following its safety certification procedures. Under Metrorail's Safety and Security Certification Program Plan (SSCPP), Automatic Train Operation requires the highest level of safety certification including the use of a certifiable items list (CIL). However, WMATA is continuing to work on this project (with a target restoration date within a few years) without a CIL or a Certifiable Elements List (CEL). In various forms, Metrorail has been working toward restoring Automatic Train Operation in fits and starts since not long after Metrorail chose to deactivate the system following the fatal 2009 Red Line accident near Fort Totten, including several instances where the system was briefly activated. Yet the Department of Safety and Environmental Management (SAFE) told the WMSC that the safety certification process has not begun. WMATA has designated SAFE as responsible for the safety certification process, so SAFE must ensure that these processes are properly followed. Without a CIL, there is no documentation that hazards have been identified and mitigated. SSRP project managers are leading ATO restoration efforts without significant ongoing input from ATCE or ATCM.

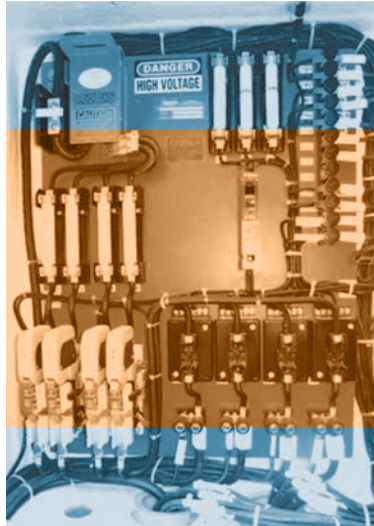
Minimum Corrective Action: Metrorail must comply with its safety certification procedures, which includes the development and use of a comprehensive CIL and CEL based on complete and updated hazard analyses, detailed review by safety working group(s) including all relevant departments, a final Safety and Security Certification Verification Report (SSCVR) and other aspects for projects that, like ATO, fall into Category 1 safety certification.

3 WMATA is not conducting all inspections and maintenance required by its ATC manuals and ATC manuals have incorrect or incomplete information and outdated references. During this audit, the WMSC reviewed Reliability Engineering Asset Management (REAM)

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records that showed that the AC Vane Relay Inspection and Testing Preventive Maintenance Instruction (PMI) was not completed (shown as not applicable) in 2019 or 2020, despite ATC manuals stating the work must be completed every 12 and 24 months on these vital relays. The WMSC reviewed additional records showing that these AC Vane Relay tests were also not all completed in 2018, but that there was some, limited testing, separate from the PMI tracked in the REAM document, conducted in the first half of 2020. After the WMSC raised this issue with WMATA, ATCM and ATCE also identified problems with relay testing procedures, ATC-1002A, in the ATC-1000 manual. The manual does not distinguish between different relay types in use: GRS/Alstom and Safetran, so the testing specification that employees are directed to use is not correct for Safetran relays. As this audit work was concluding in February 2021, ATCE developed an Engineering Information Bulletin (EIB) that provided new specifications and outlined new instructions for conducting testing such as energizing the relays for 15 to 60 minutes and slowly approaching required energy levels. The ATCE bulletin also appears to seek to place blame for these failures on ATCM, even though ATCM is obligated to follow the procedures in the manual. In another example of incorrect information in the ATC manuals, Transit Infrastructure and Engineering (TIES) is listed in the configuration plan. This department has not existed for several years. While ATCE employees stated they aim to update the manuals annually, the ATC-1000 and ATC-3000 manuals provided to the WMSC had not been updated since 2016.

Minimum Corrective Action: Metrorail must conduct its required inspections, preventive maintenance and testing, and must demonstrate that this work will continue to be conducted long-term. Metrorail must review and update manuals to ensure the manuals are up-to-date and accurate, must ensure that manual reviews are scheduled, must ensure that the manuals are reviewed and updated as scheduled, and must ensure that information about each update is clearly communicated to ATC personnel.



4 Metrorail allows employees to use tools that have not gone through any safety review or approval process. ATCM employees are provided with a 'personal tool' purchasing allowance, but Metrorail does not have a list of allowable or prohibited tools and does not provide employees with a description of what would make tools acceptable or unacceptable to use on WMATA property. Employees even stated that they are using their own rail grinders and impact wrenches. This creates multiple safety risks related to electrical, fire or other hazards, a lack of training and understanding of how to use the tools, the risk that these tools are not properly inspected or maintained, the risk that the tools may not be appropriate for the equipment or application on which they are being used, and the risk that work may not be done in the approved manner.

Minimum Corrective Action: Metrorail must develop, communicate, implement and monitor compliance with safety-based rules and procedures governing the use of non-WMATA tools on the roadway, including allowable and prohibited tool lists that are updated regularly and a sufficient approval or rejection process. For each tool, Metrorail must include specifications, process and timelines for tool inspection, calibration (if necessary) and certification. Metrorail must also ensure employees and contractors understand the dangers of using unapproved tools, and must institute regular compliance checks to ensure that only approved tools are in use and that tools are properly inspected daily.

5 Metrorail does not have a standardized determination of which preventive maintenance work must be prioritized as safety critical. ATCM supervision determines, based solely on their own judgement, which inspections or maintenance can be bypassed. There is no way to ensure that these decisions are made based on actual evidence, requirements, safety prioritization, or with any input from the equipment manufacturers to demonstrate that bypassing inspections or maintenance is safe. For example,

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power frequency track circuit tests and open-door spillover tests were listed as not performed as required in October and November 2020. Other preventive maintenance such as some interlocking inspection tests, train control room (TCR) inspection tests, TCR ground fault inspection and tests, interlocking inspection tests, switch obstruction tests, and shunt verification tests were listed as approved to be bypassed. Bypassed testing was not included as 'incomplete' in WMATA's internal calculations of percentages of compliance with preventive maintenance requirements.

Minimum Corrective Action: Metrorail must develop a safety-based procedure that specifies which, if any, PMIs may or may not be bypassed, the circumstances that must occur in order to safely bypass a PMI, how the justification for the bypass must be documented, the frequency with which a specific PMI may be bypassed, who is responsible for analyzing and reviewing those bypass logs, and what corrective action is required if a PMI is bypassed.

6 There is no formal process being used or communicated for ATCM, the department that performs the work in the field, to initiate or request an engineering modification or manual change from ATCE. Processes are documented for ATCE to initiate changes, but there is no such process for ATCM. This has led to the use of discussions or other communications without any formal tracking mechanism to ensure proper tracking, follow up and review from the departments involved or to ensure that other necessary approvals and reviews occur from departments such as SAFE. A previous ATCM leader even developed ATCM's own, unapproved version of the ATC-1000 and ATC-3000 manuals which created disagreements with ATCE. New revisions to the ATC-1000 and ATC-3000 manuals completed by ATCE were awaiting ATCM approval at the time of this audit due to additional training that will be required for ATCM personnel on the updates. These changes have also led to a level of confusion regarding which version

of the manual is actually in effect. Mechanics noted some errors in the manuals they are currently using such as steps that are out of order (e. g. put cover on and then check lights underneath rather than the other way around), which leads to mechanics developing work-arounds for procedures since the procedures cannot always be followed as written.

Minimum Corrective Action: Metrorail must develop, implement and document a formal process for engineering modifications or manual change requests initiated by departments other than ATCE. The process may be documented in a location such as the ATC-4000 manual.

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

certain interactions involving ATCM, ATCE and other departments are effective, such as daily meetings recapping the prior day's issues, in other areas there is little effective coordination. There are no formalized agendas, consistent follow up tracking of action items, or meeting minutes for several key meetings such as a weekly meeting between ATCE and ATCM leaders, which limits effective follow up on action items. The siloed nature of training and technical materials, capital planning and efforts such as a return to automatic door operations or automatic train operations create opportunities for safety issues to fall through the cracks. ATCE, which reports to ENGA, ATCM, which reports to RIME, SSRP,

which reports to Capital Delivery, and other departments such as SAFE do not appear to be on the same page or even aware of some actions being taken by other departments.

Minimum Corrective Action: Metrorail must provide specific expectations and requirements for the responsibilities of, and actual working relationships between, each department, and must document meetings with appropriate meeting agendas and with follow-up action items that are assigned

As described in the findings below, Metrorail has not adequately trained employees on safety procedures, and is not following several safety-related processes.

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to individuals or departments. Metrorail must also develop a method to share available training or technical reference materials among appropriate departments such as ATCE and ATCM, and could also include opportunities for ATCE to attend or observe ATCM training.

8 WMATA does not have a standardized process to prioritize and advance ATC capital projects. SSRP is making key ATC-related decisions without the full participation of ATCE and ATCM due to limited coordination and involvement with other departments. SSRP is not formalized with working groups or other specific coordination and planning including ATCE and ATCM personnel. There is no evidence of formal submissions of capital program requests from ATCM, and there is no specific plan to replace assets nearing or exceeding their useful life expectancy. SSRP stated that they plan to attempt to do this in the future, but SSRP, which got its first director about a year ago, was described by WMATA employees as in its infancy with some leaders of other departments unclear about SSRP's specific role. SSRP was described as having taken on or assumed substantial responsibilities, including long-term ATC capital planning and work coordination, even though it is not yet stood up and it has no standards or procedures. The only specific capital planning information provided during this audit was a generalized table described as the Safe Signals Program that identified projects that ATCE and ATCM rated high or low priority. ATCE stated that there is no capital program in place to renew the systems when components near the end of their useful life or to act based on the urgency of safety issues identified by the departments. ATCE described some locations "really in bad shape" that have been identified as urgent needs that have not yet been addressed. During this audit and following WMSC questions, an initial meeting was held related to SSRP capital planning.

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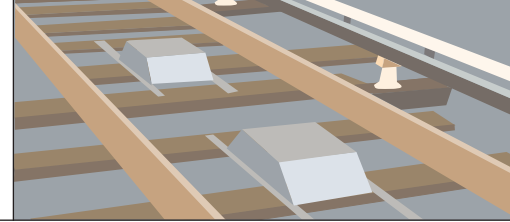
Minimum Corrective Action: Metrorail must develop and implement a formal, standardized process, including specific supporting documentation requirements, to request and justify the need for ATC capital renewal projects and that then evaluates and, as appropriate, leads to implementation of these projects. Metrorail must also create documented requirements for coordination among departments such as SSRP, ATCM and ATCE, and must document meetings involving SSRP, ATCM, ATCE and Strategy, Planning and Program Management (SPPM) with identified follow-up action items that are assigned to individuals or departments.

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

This leads to departments like ATCM scrambling to identify parts needed to cover any future repairs after new items like switch machines have been purchased, delivered and installed. Contracts for this equipment rarely include spare parts, which leaves ATCM starting from scratch rather than starting with the necessary items for regular maintenance already in stock. As the WMSC has identified in other audits, SAFE has not issued a Metrorail-wide procedure to ensure that safety certification or approval steps are followed, including as it relates to procuring spare parts for vital systems. There was no coordination with ATCM on the procurement of the Grand Master 4000A switch machine, which led to delivery without any notice or training to the department required to install and maintain the switch and to substandard training requirements in the contract that led to WMATA needing to revamp the training.

Minimum Corrective Action: WMATA must ensure that SAFE, departments responsible for procurement, and departments responsible for installation, maintenance, operations, engineering and training properly coordinate from the earliest stages of project development to provide for adequate review, approval, training and any parts or other features required to maintain the project and related systems in a state of good repair.

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10 Metrorail does not have adequate replacement parts or materials, and has not planned for the obsolescence of critical equipment. Many ATC system elements are decades old and a significant portion are already beyond their useful life, but WMATA has no coherent, unified plan to ensure that replacement parts are available to maintain the current system, to ensure that new parts are available for upgrades, or to comprehensively track the assets that require replacement based on life expectancy or average time to failure. ATC personnel described “major, major issues” in getting parts and a lack of knowledge at WMATA that parts have been or will be discontinued that prevents the agency from stocking up on items. The shortages are only identified when supplies run low, which delays safety-related projects. ATCM and Supply Chain Management also disagree at times on certain purchases given the frequency of use of some items that may sit on a shelf long-term, but that are crucial to have on hand if a repair is required.



Minimum Corrective Action: Metrorail must develop inventories of parts and materials and their availability and lead times or unavailability and identify those parts that require immediate or near-term action to procure in order to maintain a state of good repair. Metrorail departments must cooperatively develop and implement mid-term and long-term plans to replace equipment nearing or exceeding its useful life to maintain a state of good repair.

11 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. Multiple employees stated that ATCM personnel require more training in many areas. Training on specific equipment is not a requirement to work on the equipment in the field and is not documented in Metrorail’s Enterprise Learning Management (ELM) system. The lack of requirements, limited training and

lack of proper safety certification, along with a lack of long-term planning have created a number of safety concerns. For example, a lack of planning for the end of the useful life of Alstom 55E switch machines led to an expedited purchase (see finding 9) that resulted in Grand Master 4000A switches

being procured and arriving on Metrorail property without any training or notice for ATCM training and frontline personnel and without full manufacturer training or training materials. This led to initial training being conducted in a limited fashion using cords placed on the ground and without an ATCE EMI. An expedited process led to a limited written document for mechanics, developed among engineering, Technical Skills Maintenance Training (TSMT) and ATCM.

There are now several dozen of these switches in place, but despite some attempts to provide basic training on these to crews in areas with these switches, there is no requirement that crews have training and experience with these switches prior to working on them in the field. Instead, ATCM training stated it hopes that supervisors would only assign properly trained crews.

Minimum Corrective Action: Metrorail must specify, implement and document training requirements that must be met prior to work on specific equipment in the field, and must provide basic and ongoing higher-level training to ensure that employees have the required level of expertise for their positions. Metrorail must utilize its available or future technology, such as ELM and Maximo, to ensure that these requirements are followed. Metrorail must establish a process to set and document training requirements and obtain or create appropriate training for each new type of equipment.

12 Metrorail is not effectively managing turnover, vacancies and experience levels of ATC personnel. Increased retirements, promotions and vacancies have left ATC departments devoid of crucial knowledge, experience and technicians with appropriate technical backgrounds required to maintain, troubleshoot and repair the complex ATC

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systems. ATCM management stated that the hiring process has been frustrating, and that Metrorail has struggled to identify candidates with the required skills and background. ATCM and ATCE personnel also expressed concerns about needing additional personnel to fully take advantage of work windows or technology upgrades, and some ATCM personnel expressed concerns about the skills of some of their colleagues due to the complex nature of ATC work. There is now a limited number of experienced technicians that can teach and guide newer, less experienced employees. Any further reductions in staffing under current rules and requirements could put the completion of required work at risk, particularly given the upcoming Silver Line Phase 2 extension. ATCM stated that they are beginning to develop a new hiring process meant to fill vacancies, but had no timeline for when that new process may be implemented.

Minimum Corrective Action: Metrorail must identify technical skills and experience required, and must develop, finalize, implement and continuously improve an effective recruitment and hiring process. These actions must identify, attract and retain staff with the necessary background, technical knowledge, skills and experience (to do the job or to understand and succeed based on additional technical training that Metrorail may develop or obtain and provide). Metrorail must also identify and provide any training necessary for current employees to gain the higher level of knowledge and understanding necessary to fill the gaps left by those who have left the departments.

13 Some test forms, work orders, or data sheets are not completed or are not completed with the required level of detail. ATCM supervisors expressed concern about communication with other crews and supervisors, including due to a lack of detail in Maximo entries that can require repeating some troubleshooting work. Contrary to ATC-1000 manual requirements, ATC 1009 Switch Indication Locking Test Forms were not signed by supervisors, and some ATC compliance checklists and inspections were not signed or

were not legible. These documents are critical to understanding the state of the equipment and the accuracy of the work, particularly if any safety event were to occur.

Minimum Corrective Action: Metrorail must establish and communicate minimum standards for Maximo entries to ensure that crews do not need to restart troubleshooting from scratch, provide refresher training to employees on their required duties, and ensure that all tasks, reviews and supervisory oversight are properly completed and that forms are filled out legibly and completely to accurately reflect work that was conducted.

14 Metrorail's written procedures do not reflect changes that employees are being directed to implement. Rules and procedures including MSRP Rule 4.5.3.6.1 refer to the cranking and blocking of switches, however ATCM personnel are being instructed to and are even being certified to crank and clamp switches, and to no longer block and spike switches. ATCM stated that SOPs are hard to change, so they are simply training employees the way they want it to be done. While cranking and clamping switches is an acceptable method that presents an improvement over cranking and blocking, this improvement must be incorporated into written procedures.

Minimum Corrective Action: Metrorail must ensure that all written procedures, such as those governing cranking and clamping, match the direction given to ATC personnel and that the procedures go through the proper safety review and approval process.

15 The preventive maintenance instruction for snow melters (switch heaters) does not comply with other Metrorail rules. The snow melter is attached to the third rail, which, according to SOP 28, requires that power be de-energized during maintenance. However, if power were down under a red tag outage as required by SOP 28, it would not be possible to test the device and personnel stated it would also



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create challenges for revenue service. Other personnel stated that SOP 28 would technically require a red tag outage for clamping switches or triggering an Emergency Trip Station (ETS) box, but that SOP 28 does not factor in systems between the third rail and snow melters including fuses and switches. This safety concern has been raised to ATCM management and SAFE, and ATCM personnel stated they have developed their own work-arounds for the PMI procedure since following it as written is not reasonable. Written procedures that are not able to be followed (also see findings 3, 14) contribute to broader drifts away from following other critical procedures and reflect an ineffective safety culture.

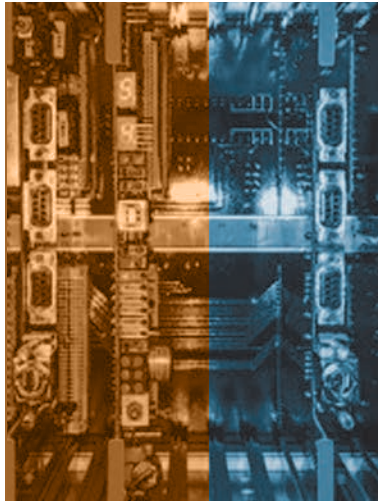
Minimum Corrective Action: ATCE, ATCM, SAFE and other relevant departments must identify the safest way to conduct this work, and what (if any) work can be done while connected to the energized third rail. Based on this review, Metrorail must update rules, procedures or SOPs to eliminate conflicts and provide training on the updated procedures.

16 Metrorail does not have documented ATC software standards. WMATA's ATC-4000 Manual Section 4006.4 states that "ATCS Software modifications are devel-

oped in accordance with ATC Engineering Design Standard ATC 5002, ATCS Software Design Process (future), which describes ATC Engineering standard for ATCS software development." The ATC-5000 Manual dated January 2015 that was provided by WMATA during this audit as the in-effect manual does not include any reference to an ATC 5002 process. A separate version of the ATC-5000 Manual, dated September 2020, was identified by an employee during audit interviews, which includes only an empty placeholder section 5002 for ATCS Software Standards.

Without any standards or processes, there is a risk that new software, software updates or other changes could be procured or implemented without proper reviews, software could fall short of actual safety and operational needs, or software updates could be missed by WMATA. ATC software is vital.

Minimum Corrective Action: Metrorail must develop and implement software standards that include all appropriate and required safety considerations, safety certifications, and approvals for each change, and the required processes to ensure that the reliability of the system is reviewed and that Metrorail identifies and considers each future update developed by system manufacturers.





Background and Scope

Background and Scope

The Automatic Train Control (ATC) and signaling system provides critical safety protections for train movement and roadway workers, including systems intended to prevent collisions and derailments.

The scope of this audit includes ATC and signaling maintenance and inspection, management structures, planning and governance, and associated training procedures, policies and practices.

Among other areas, the audit focuses on System Safety Program Plan (SSPP) Implementation, Maintenance and Inspections, and Training and Certification, which are elements 5, 15 and 16 of Metrorail's SSPP. During this audit work, as required by federal regulations, WMATA finalized its first Public Transit Agency Safety Plan (PTASP), titled the WMATA Transit Agency Safety Plan, which replaces the SSPP. Due to the timing of the PTASP's approval, the PTASP had not yet been implemented at the time of this audit.

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

Metrorail's ATC system uses fixed blocks based on track circuits. When a passenger train is in a particular section of track, the train changes the flow of the electric current that runs through the running rails, which de-energizes a relay, which then indicates that the block is occupied.

Information about occupied blocks, signal status and other factors runs through train control rooms to reach the Automated 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 in order to establish a work zone.

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

ATP refers to the system intended to protect against speeding and 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

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frequency track circuits, and are based on signals and track occupancy ahead of that train as detected by the automated systems.

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

ATO refers to the actual automated movement of the train under the supervision of the operator based on information provided by other parts of the ATC systems. 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.

The four-year gap without a major safety event that culminated with the Fort Totten collision demonstrates that a lack of high-profile events does not prove that the ATC system is fully functioning appropriately.

Since 2009, Metrorail has commissioned or developed a number of reports and plans to identify and carry out improvements, upgrades or future plans in line with NTSB, FTA and other findings or recommendations or based on internal planning and initiatives.

These reports include several related to Automatic Train Operation completed by consultants that identify steps required to return to ATO. Most recently, this includes four reports completed in 2019.

The current status of ATO restoration is further detailed later in this report.

Prior Reviews and Audits

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 (including 2 year AC Vane Relay tests – 5 of 35, or 14% were not completed; 5 year HF Track Circuit Cab Roadway Transmit Level Test – only 52% completed; 4 year DC Vital Relay Inspections and Tests – only 26% completed; 5 year open door command spillover test, Master – only 67% completed). 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, 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 below, 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. Additional basic training in development in 2018 that involved both classroom sessions and on-the-job training launched just prior to the March 2020 declaration of a public health emergency, which led to that training being paused. In 2018, ATCM was planning to institute Preventive Maintenance Instruction (PMI)-based certifications, however, as described below, this is still not in place.

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 (e.g. an inspection scheduled once every 5 years, would instead not be done for 10 years or, if missed twice, 15 years). Tests with the lowest completion percentages from 2014 to 2018 included the 4 year DC Vital Relay Test, 5 year HF Track Circuit Cab Roadway Transmit Level Test, 5 year Open Door Command Spillover Test and 1 year Snowmelter Inspections and Test. These tests relate to safe train movement and operations. 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 also identified by the WMSC during this audit as requiring ongoing coordination between ATC and track-related departments, some of which is underway.

The TOC also identified conflicts between ATC clearing procedures under Exclusive Track Occupancy protection and Metrorail's Roadway Worker Protection rules. As described below, ATC-related personnel are still not being properly trained on safety procedures to understand the importance of RWP and how it applies to their duties.

Several CAPs that were open at the time of the 2018 audit have been closed, including FTA-Rail-3-25-A related to track time and appropriate staffing for maintenance departments, TOC-ATC-15-011 related to requirements for ATC

The four-year gap without a major safety event that culminated with the Fort Totten collision demonstrates that a lack of high-profile events does not prove that the ATC system is fully functioning appropriately.



supervisor quality control or compliance checks, TOC-ATC-15-001 related to scheduling to prevent ATC maintenance from being routinely deferred, TOC-ATC-15-007 related to special tool calibration recording requirements for ATC personnel, FTA-Rail-2-16-A related to technical training for operations and maintenance departments, and FTA-Rail-8-43-C related to open corrective action plans from the 2009 Fort Totten collision including incomplete items from the System Implementation Gap Analysis Report requiring replacement of ATC cables with low insulation resistance.

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.

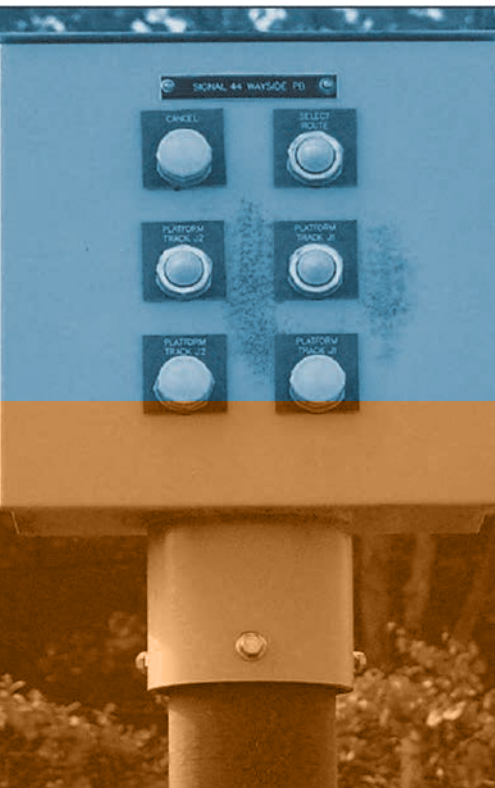
RTUs are a part of the Supervisory Control and Data Acquisition (SCADA) system that interface with wayside safety equipment and train control systems. These devices connect items in the field, such as those in a train control room or those like switches and signals that are linked to that train control room, to central data systems such as the AIM system that are used by the ROCC. 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, on February 9, 2021, an RTU failure led to the ROCC believing that third rail power was down near Braddock Road Station, however when an RTRA supervisor checked the area, power remained up.

Many of Metrorail's current RTUs are beyond their useful life or are no longer supported by a manufacturer. Manufacturers estimate that RTUs average an operational life cycle of five to ten years, but some RTUs can last longer. WMATA has RTUs in service that are more than 30 years old, some of which are the original RTUs placed into service as the system was built in the 1970s and 1980s. WMATA's 2019 Capital Needs Forecast estimated the useful life of RTUs as 40 years.

The OIG audit identified an ATCE train control room replacement effort including RTU replacement begun in 2018, an IT department RTU replacement effort focused on 97 RTUs begun in 2019, and an Office of Power Systems Engineering RTU replacement effort from 2012 to 2019 for traction power substations and tie breaker stations. The IT project was cut back as a result of this audit to focus on a longer-term solution.

The OIG audit also identified that WMATA had not conducted a risk assessment to ensure safety during the replacement of RTUs and that the competing projects and



technical requirements risked voiding ATC licenses and safety certifications if the RTUs did not meet industry specifications.

WMATA management committed to the OIG that the agency would, by the end of 2021, institute an enterprise-wide strategy and modernization plan for SCADA systems including the RTU replacement, integrate the RTU replacements with fiber optic communication installation, and improve coordination across the organization.

The revised plans are intended to eventually retire the current Data Transmission System (DTS), which includes the current RTUs, as part of a future migration to a more modern system architecture. Metro plans to finalize details of a long-term plan for that future architecture in late 2021.

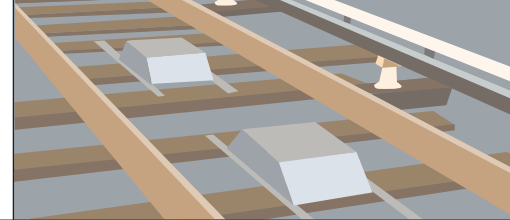
In late 2020, WMATA's Quality Assurance, Internal Compliance & Oversight (QICO) completed a separate review of Metrorail's switch machine power supply replacement program, which is replacing 166 power supplies throughout the rail system through January 2022. The review identified a lack of governing 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, being 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. The failures led to a more rigorous testing and simulation effort by ATCE that is intended to identify the causes of these failures.

Current Structure

Metrorail has assigned maintenance and inspection responsibilities for the ATC system to Automatic Train Control Maintenance (ATCM), which is led by a General Superintendent who reports to the WMATA Vice President in charge of Rail Infrastructure Maintenance and Engineering (RIME).

Metrorail has assigned a separate department, Automatic Train Control Engineering (ATCE) to establish or manage ATC system standards, designs, configuration management and software and to provide other engineering incident response and support. Standard practices are established by ATCE, with the concurrence of ATCM and the Department of Safety and Environmental Management (SAFE), in five main manuals: the ATC-1000 (Instructions for Testing and Inspection of ATC Apparatus and Systems), ATC-2000 (System Integrity Maintenance Practices), ATC-3000 (Preventative Maintenance Instructions and Technical Procedures Manual), ATC-4000 (Systems Configuration Management Plan Instructions and Procedures Manual)

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.





and ATC-5000 (ATC Engineering Design Standards). ATCE is led by the Chief of ATC Engineering, who reports to the Managing Director of Engineering and Architecture (ENGA).

As outlined below in the list of documents reviewed for this audit, WMATA provided versions of these manuals dated in 2014 (ATC-2000), 2015 (ATC-5000) and 2016 (ATC-1000, ATC-3000, ATC-4000), however an employee interviewed for this audit was aware of and provided later versions with revisions noted as late as 2020, suggesting confusion about the version of the manual that was in effect.

Based on the manuals and other requirements set by ATCE, ATCM schedules and enters preventive maintenance instruction (PMI) information into Maximo work orders. Maximo is the asset management software that Metrorail uses to manage its equipment, vehicles and other assets by capturing and recording details such as maintenance schedules and workflows. Maximo also contains corrective maintenance work orders that are created due to reported problems in the field. ATCM personnel enter information in Maximo regarding the work conducted in the field, and also submit other written forms for certain work. Metrorail is working toward an upgrade to a newer version of Maximo that would assist in a transition to all digital forms and the capability to enter information from a mobile or offline device. Some work also must be documented in other locations. For example, work done in a train control room (TCR) must be documented in that room's book of plans (BOP), which is essentially the blueprint for that room's equipment, wiring and power connection systems. The BOP in each TCR identifies track plans, schematics, cable plans, route charts, conduit plans, etc. It is critical that these plans are maintained with up-to-date circuit configurations to avoid negative impacts on train operations.

Signal System Renewal Program (SSRP) is a division within Capital Delivery (CAPD) that has been assigned by CAPD to oversee ATC-related capital projects. At times, Shops and Material Support (SAMS) helps to complete certain acceptance testing or other work.

Ongoing capital projects include the replacement of select train control rooms noted above and work at the Alexandria Rail Yard.

Longer-term projects identified by these groups include Metrorail's future (next generation) signaling system. ATCE has recommended communications-based train control (CBTC) as the ideal solution. Metrorail plans to conduct further safety and feasibility assessments before determining the path WMATA as a whole finds most appropriate and effective given current operational realities and potential future technological and operational developments.

Several CAPs that were open at the time of the 2018 audit have been closed.

Audit Work

The WMSC received initial documents related to this audit from WMATA in November 2020, conducted extensive interviews in December 2020 and January 2021, and received follow-up documents and conducted document reviews into February 2021.

An exit conference was held on January 15, 2021 with Metrorail staff to summarize the status of the audit to that point.

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

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

Personnel Interviewed

ATC Engineering (ATCE)

- Chief, ATC Engineering
- Manager, Engineering Configuration Management and Software
- ATC Engineer (2)
- Senior Train Control Engineer

Capital Delivery (CAPD)

- Signal System Renewal Program (SSRP)
 - Director

ATC Maintenance (ATCM)

- General Superintendent, ATCM
- Assistant General Superintendent (2)
- Superintendent, ATCM Production
- Assistant Superintendent
- Special Project Manager, ATC Training/OJT
- Shift Superintendent, ATC Training/OJT
- Special Project Manager, ATCM Materials
- Special Project Manager, ATCM Planning and Scheduling
- Manager, ATCM Compliance
- Shift Superintendent, ATC Compliance
- Shift Superintendent
- Mechanic AA
- Mechanic B (2)
- Mechanic D

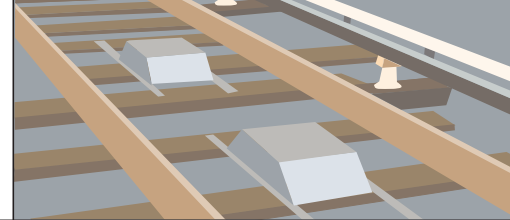
Safety and Environmental Management (SAFE)

- Deputy Chief, Safety Certification
- Performance Monitoring Manager

Documents Reviewed

1

- 2019 WMATA System Safety Program Plan (SSPP)
- 2020 WMATA Transit Agency Safety Plan (PTASP)
- 2020 Safety and Security Certification Program Plan (SSCPP)
- Metrorail Safety Rules and Procedures Handbook (MSRPH) (August 28, 2020)
- APTA RT-SC-RP-031-03 Recommended Practice for Signal Maintenance Personnel Hiring Qualifications, Training and Competencies (7/26/2004)
- WMATA Manual of Design Criteria, Section 25 (ATC)
- Hazard Management log
- ATCE and ATCM Organizational Charts
- ATCE and ATCM list of active employees and vacancy trends
- ATCM Enterprise Learning Management (ELM) training list
- ATC Reference Manual for Journeyman Training Program (version 5/8/2020)
- ATC journeyman training modules
- ATC Field operations training modules
- ATC Maintenance Department Phase One Course Reviews & Lab Worksheets Participant Guide (version 5/22/2020)
- Original Equipment Manufacturer (OEM) Maintenance Manuals
- ATC-1000 Instructions for Testing and Inspection of ATC Apparatus and Systems (1/21/2016)
- ATC-2000 System Integrity Maintenance Practices (9/19/2014) (Note: While this version was provided as WMATA's official response regarding the in-effect manual, one employee interviewed for this audit was aware of and provided a later version with revisions noted in 2017, 2019 and October 2020. The WMSC also reviewed that more recent version)
- ATC-3000 Preventative Maintenance Instructions and Technical Procedures Manual (1/21/2016)
- ATC-4000 Systems Configuration Management Plan Instructions and Procedures Manual (1/21/2016) (Note: While this version was provided as WMATA's official response regarding the in-effect manual, one employee interviewed for this audit was aware of and provided a later version with revisions noted in 2019 and August 2020. The WMSC also reviewed that more recent version)
- ATC-5000 ATC Engineering Design Standards (1/20/2015) (Note: While this version was provided as WMATA's official response regarding the in-effect manual, one employee interviewed for this audit was aware of and provided a later version with a revision made in September 2020. The WMSC also reviewed that more recent version)
- ATC Maintenance Control Policy (5/29/2020)
- Operations Administrative Procedure (OAP) 200-2 Maintenance Operations Center
- Engineering Action Bulletins (EABs):
 - 18-0001-A99
 - 18-0002-SYS
 - 19-0002-SYS



Documents Reviewed

2

- Engineering Information Bulletins (EIBs):
 - 17-0007-SYS
 - 17-0008-SYS
 - 17-0009-SYS
 - 18-0001-SYS
 - 18-0003-SYS
 - 19-0001-SYS
 - 19-0003-SYS
 - 19-0006-SYS
 - 19-0007-SYS
 - 19-0008-SYS
 - 20-0004-GEN3
 - 20-0005-SYS
 - 20-0006-SYS
 - 21-0001-SYS
- Safety Bulletin (SB) 17-09a Clamping of Switches (September 2017)
- Cable Insulation Resistance Test Data Sheets (i.e. meggering) from October 2017 to October 2020
- Ansaldo STS/US&S Track Circuit Tests Data Sheets from July 1, 2020 to September 2020
- Power Frequency (AC) Track Circuit Test Data Sheets from July 2020 to September 2020
- Ansaldo STS/US&S Track Circuit Tests Data Sheets (Track Circuit Shunt Verification Tests) from July 2020 to September 2020
- Code Rate Frequency Tests from January 2019 to October 2020
- Train Control Room Ground Fault Inspection and Test Data Sheets from July 2020 to August 2020
- Train Control Room Weekly Inspection Data Sheets from July 2020 to August 2020
- Weekly Interlocking Inspection Data Sheets for October 2020
- Switch Hand Cut-out, Restoration, CWP and Point Detector Tests Data Sheet from June 2020 to October 2020
- Switch Obstruction Tests Data Sheets from June 2020 to November 2020
- Audio Frequency Track Circuit Adjustments—Ansaldo STS/US&S, Alstom Gen. 3 & 4, US&S-GRS Split from October 2019 to October 2020
- Power Frequency (AC) Track Circuit Test Data Sheets from October 2019 to October 2020
- HF Track Circuit Cab Roadway Transmit Level Test from October 2017 to October 2020
- Vital Relay Test Data Sheets from October 2017 to October 2020
- Switch Machine Maintenance Inspections from October 2019 to October 2020
- Train Control Room Book of Plans Data Sheets from October 2018 to October 2020
- ATCM Supervisor Checklists July 2020
- Intrusion, Detection, and Warning System Inspection and Test Data Sheets from October 2017 to October 2020
- Highway Grade Crossing Test Data Sheets October 2017 to October 2020
- Open Door Command Spillover Tests Data Sheets from October 2018 to October 2020
- Switch Detector and Route Locking Tests from October 2018 to October 2020

Documents Reviewed

3

- Switch Indication Locking Tests from October 2018 to October 2020
- ATC Maintenance Corrective/Incident-Trouble Logs (2/10/2020, 3/10/2020, 8/10/2020, 10/10/2020)
- SCADA, AIM and other ATC-related alarm logs for February 10, March 10, August 10, and October 10, 2020
- List of RTU failures from January 2018 to October 2020
- List of bobbing track circuits from January 2018 to October 2020
- Work orders related to cable failures and bobbing track circuits
- List of ATCS (Automatic Train Control Systems) Equipment Repaired by SAMS (Shops and Material Support) in October and November 2020
- ATCE Tool Calibration List as of November 27, 2020
- SAMS ATC Test Equipment List and Calibration Dates
- List of ATC software in-use
- WMATA Red Line Return to ATO Safety Verification Report (April 2015)
- Mott MacDonald Return to ATO During Rush Hours Evaluation A: Hazard Analysis Report (June 1, 2019)
- Mott MacDonald Return to ATO During Rush Hour Periods Evaluation B: Test Plan (October 2019)
- Mott MacDonald Return to ATO During Rush Hours Periods Evaluation C: Document Review (June 2019)
- Mott MacDonald Return to ATO During Rush Hours Periods Evaluation D: Findings and Recommendations (February 4, 2019)
- List of contractors authorized to perform ATC repairs, inspections, or maintenance on Metrorail (from October 2017 to November 2020)
- ATCM PMI Compliance Report (2019)
- ATCM PMI Compliance Report (January to September 2020)
- WMATA OIG Report 21-01, Audit of the Replacement of WMATA's Remote Terminal Units (November 16, 2020)
- Hitachi Responses to WMATA inquiry on AF-800 track circuit subsystem at E08
- Presentation on Track Circuit E2-429 (November 11, 2019)
- Hitachi Analysis Results on AF-800 Receiver PCB Investigation (August 23, 2019)
- REAM Automatic Train Control Performance metrics (November 2020)
- Engineering Test Report (ETR): ATP Test Software for Auto Door Investigation (3/2/2020)
- Safety/Security Certification Review Committee Meeting Minutes (June, July 2020)
- RTRA Auto Door Certifications (December 2018 to July 2019)
- Service Bulletin B 606-01 Preparation for Auto Door Operation (January 30, 2018)
- Safety Acceptance Report, Return to Red Line Auto Doors Operation, 7000 Series Rail Cars and Red Line Stations (draft, November 30, 2020)



Documents Reviewed

4

- Sample ATC tests for married pairs: 7400-7401, 7746-7747
- RTRA Operations Personnel Notice, Automatic Doors Starting July 7, on Red Line Trains (June 25, 2019)
- RTRA Operations Personnel Notice, Return to Auto/Manual Doors on the Red Line (December 16, 2020)
- Temporary Order No. T-18-08: Modification to MSRPH Operating Rule 3.33 (December 3, 2018)
- Temporary Order No. T-18-10: Revision to SOP 40 (Door Operations/Station Servicing Procedures) (December 3, 2018)
- Auto Door Survey Results (October 2018)
- SOP #28 (Ver. 1.3, 7/6/2020)
- ATCM OJT Proficiency Evaluation form (ALSTOM GM400A: 1007E, 1008E & Adjustments)
- ATC Tool Inventory Sheet
- Sample (blank) ATCM Compliance Checklists (Level 1, 2, 3)
- Signal System Renewal Program (SSRP) Department Structural Plan presentation (January 12, 2021)
- RFP ATC Equipment Replacement, Solicitation No. FDECO211039/WJG (issued October 28, 2020)
- ATC Equipment Replacement Design-Build Services Specification Manual (FDECO211039/WG) (October 28, 2020)
- ATCM Monthly Preventive Maintenance Summary (PM scheduled November 2020, report date December 2020)
- Monthly Preventive Maintenance Summary Worksheet (November 2020)
- PMI Compliance Report (November 2020)
- Maximo report on ATC PMI status
- List of obsolete ATC assets
- EMI Prioritization Worksheet (draft Rev. L, August 12, 2020)
- EMI Status—ATC (updated 1/15/2021)
- ENGA-ATCM Discussion (1/15/2021)
- Mott MacDonald ATC Tasks Action Tracker (1/14/2021)
- Safe Signals Risk Assessment (3/15/2019)
- SSRP Capital Project Planning meeting notes (1/6/2021)
- EMI Implementation and Prioritization presentation (January 25, 2021)
- SSRP EMI Prioritization Worksheet (Final, January 25, 2021)
- ATC Capital Planning Agenda (meeting date: 2/1/2021)
- Draft Switch Replacement Schedule FY 21 and FY 22 (SSRP, 12/19/2020)
- List of compliance level reports (November and December 2020)
- ATCM PMI Compliance Report (October–December 2020)
- ATCE and ATCM Weekly Meeting Outlook Calendar Events (September–November 2020)



What the **WMSC** Found

What the **WMSC** Found

Positive Practices

The WMSC identified a number of positive practices related to Metrorail's ATC and signals programs while conducting this audit including:

- Presence of most required documentation and records, such as books of plans, and the regular use of tracking and documentation systems such as Maximo (although some work order entries could be more detailed to assist crews following up)
- Relationship between ATCE field engineering support and ATCM
- The pilot project to upgrade lines from copper cables to fiber optics between Rhode Island Ave-Brentwood and Takoma stations
- The use of document and approval tracking software for contractor submittals and books of plans, and the use and tracking of an electronic control log to be sure only one person is making changes at a time
- New effort to ensure books of plans in train control rooms are more up-to-date now that inspections have identified needs for updates and page replacements
- Initial improvements to ATCM training as required by past audits
- ATCM's attempt to triage training on new materials to provide it first to those most likely to work on the equipment in the field
- The use of systems such as Maximo to access current PMIs or work instructions
- WMATA's identification of cross bond construction errors on Silver Line Phase 2
- Efforts by ATCM to piggyback on service shutdowns to conduct work
- Efforts to improve the ATCM compliance group by expanding and providing more detail on required oversight
- New designated process for Engineering Modification Instructions (EMIs)
- Cooperation and collaboration with the WMSC audit team on this safety improvement process



The WMSC identified a number of positive practices.

Findings and Minimum Corrective Actions

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

While several department managers acknowledged the dangers of ATCM's regular work on the roadway and the importance of safety procedures, multiple ATCM employees stated that there is too much safety, stated that safety rules have gone overboard so they do not comply, stated that "it's overkill with this safety stuff", stated that Roadway Worker Protection rule violations are common but acceptable, stated that Foul Time protections are not requested at all times they are required by the MSRP, or stated that rules do not factor in ATCM's unique situations on the tracks, such as local signal control or the frequent movement during work from one track to another or with the direction of rail traffic, and therefore are not always followed.

These individuals were clear that they do not appreciate and have not been adequately trained to understand the value of safety rules and procedures to prevent damage, injury or their own death. Rules and procedures explicitly offered as examples that are regularly not followed included the use of eye protection or face shields, hard hats, and other RWP requirements.

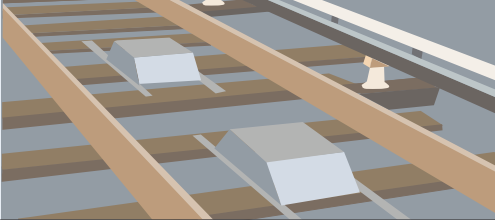
In some cases, personnel were eager to rely only on a red signal as protection, even though that provides only one layer of protection and not the multiple layers of protection that are required.

In another case in fall 2020, a complaint raised to the WMSC by an ATC employee about part of the area near the interlocking between Union Station and NoMa-Gallaudet U Station was only fully addressed (marked as a hot spot under RWP rules) following a WMSC directive issued after the employee elevated their concern to the WMSC.

Most individuals interviewed for this audit were not aware of the System Safety Program Plan (SSPP) or Public Transportation Agency Safety Plan (PTASP).

Minimum Corrective Action: Metrorail must implement safety promotion practices to build trust and a strong safety culture through positive and responsive safety communications and a collaborative process with employees to help identify safety issues and effective means to address those issues to ensure that work as performed comports with work as required. This could begin with safety stand downs and other training that emphasize not only rules and familiarization with any appropriate parts of the SSPP/PTASP, but also the safety reasons and risks behind those rules.

These individuals were clear that they do not appreciate and have not been adequately trained to understand the value of safety rules and procedures to prevent damage, injury or their own death.



2

Daily toolbox or other regular meetings or additional training must help ensure that employees understand safety risks and how safety measures such as personal protective equipment and RWP protocols help mitigate those risks.

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

Under Metrorail's Safety and Security Certification Program Plan (SSCPP), Automatic Train Operation requires the highest level of safety certification including the use of a Certifiable Items List (CIL). However, WMATA is continuing to work on this project (with a target restoration date within a few years) without a CIL or a Certifiable Elements List (CEL).

In various forms, Metrorail has been working toward restoring Automatic Train Operation in fits and starts since not long after Metrorail chose to deactivate the system following the fatal 2009 Red Line accident near Fort Totten, including several instances where the system was briefly activated. Yet SAFE told the WMSC that the safety certification process has not begun. In response to the draft of this report, WMATA added that it has not continued the safety certification process in a coordinated fashion, but instead has started over on the safety certification process each time.

Developing and properly identifying the Certifiable Elements List (CEL) and Certifiable Items List (CIL) as required along with a Preliminary Hazard Analysis (PHA) at the beginning of the process helps ensure that issues related to the safety and security of passengers, employees, contractors, emergency responders, or the general public are addressed. This work requires communications across departments (in this case including departments such as ATCE, ATCM, CMOR, SAFE and RTRA) to ensure proper integration and consideration of all identifiable hazards so that proper mitigations can be incorporated into the project. Without a CIL, there is no documentation that hazards have been identified and mitigated.

However, Metrorail told the WMSC that ATO was briefly trialed on the Red Line in April 2015, and that early stages of planning for a broader return also occurred later, leading up to a 2019 decision to pause those efforts due to the need to focus on other ATC safety and reliability projects. In response to this draft report, WMATA stated that each of these efforts was separate and uncoordinated and were managed by different groups. WMATA also stated that it stops safety certification work if a specific project stops, even if the agency plans to continue that project in another form in the near future.

Also in 2019, four consultant reports were completed that are intended to outline WMATA's path to some form of ATO restoration. These reports are described as a hazard analysis, test plan, document review and findings and recommendations.



Automatic Train Operation requires the highest level of safety certification including the use of a Certifiable Items List (CIL). However, WMATA is continuing to work on this project (with a target restoration date within a few years) without a CIL or a Certifiable Elements List (CEL).

WMATA has designated SAFE as responsible for the safety certification process, so SAFE must ensure that these processes are properly followed. After the WMSC transmitted a draft of this report to WMATA for technical review, WMATA took initial steps for this process, including internal meetings in March and April 2021.

SSRP project managers are leading ATO restoration efforts without significant ongoing input from ATCE or ATCM, without documentation of requirements, and without complete coordination of verification reports and validation of communications involving other systems and wayside-railcar communication.

For example, while ATCM stated that they have continued preventive maintenance on aspects of the system as if ATO was operational other than the needed improvements for marker coils and marker coil positions, this does not account for the fact that many assets that have not been used for more than a decade may be nearing the end of their useful lives, could have latent defects, may not be configured for current operational needs, or could have parts that Metrorail is unable to repair or replace (see finding 10). ATCE also had concerns about the fact that Metrorail had stopped spillover testing for an extended period and has identified other required changes to physical infrastructure such as marker coil positions. Metrorail will also need to address roadway worker protection and operator and supervisor training given that most current frontline workers have never worked under ATO.

SSRP described the latest ATO restoration plans as involving significant additional changes to other aspects of the ATC system including adjustments in train control rooms to govern train speeds using performance levels. Following the WMSC's audit work, WMATA held a return to ATO planning meeting that included invitations to all relevant departments.

Vehicle engineering (CENV) told the WMSC that it is running the return to automatic door operations with some project management assistance via SSRP and updates to RTRA but no involvement of the ATC teams. In response to a draft of this report, WMATA instead stated that SSRP had taken over management of the project from RAIL in early 2020.

Any changes, let alone such significant changes, to the ATC system are supposed to be done only with the direct involvement of ATCE and the safety certification process that would include SAFE review and coordination with other departments.

The WMSC obtained an initial, limited ATO restoration CIL from 2014 that appears not to have been kept up-to-date or revised as needed to reflect changing information or planning, and that now appears to have been discarded.

This is similar to Metrorail's action to stop following a CIL that had been created for the return to automatic door operations. A written response provided for this audit stated that no hazard analysis had been conducted for the automatic door operation restoration project. Current SSRP, CENV and SAFE personnel stated that automatic



door operation is a non-vital operation, and therefore WMATA concluded the current efforts did not require the highest level of safety certification. For both ATO and automatic door operations restoration, ATCE and ATCM personnel stated that, despite being relevant subject-matter experts, they are not directly involved in the process at this time.

ATCE already did substantial work to prepare the steps required for ATO restoration including developing EMIs, training and organization plans and a hazard analysis, test plan, procedural reviews and an explanation of what was otherwise required to return to ATO that were presented to other departments as a basis for continuing efforts, but were told by SSRP to stand down on any similar work for automatic door operations. ATCE leadership said they were not informed prior to the restoration of automatic door operations on the Red Line in January 2021, and documents demonstrate they were not included in preparatory meetings such as one held on July 24, 2020.

This audit identified one example of an ATC-related project that is currently fully involved in the safety certification process. According to the Safety Department, they were involved in the latest iteration of the train control room replacement project from the specification phase, which SAFE said had not been the usual practice.

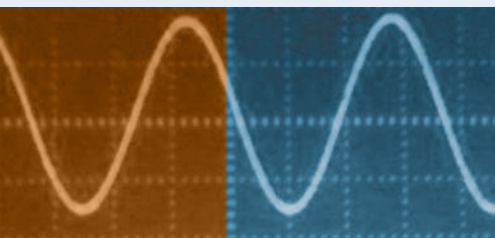
Minimum Corrective Action: Metrorail must comply with its safety certification procedures, which includes the development and use of a comprehensive CIL and CEL based on complete and updated hazard analyses, detailed review by safety working group(s) including all relevant departments, a final Safety and Security Verification Report (SSCVR) and other aspects for projects that, like ATO, fall into Category 1 safety certification.

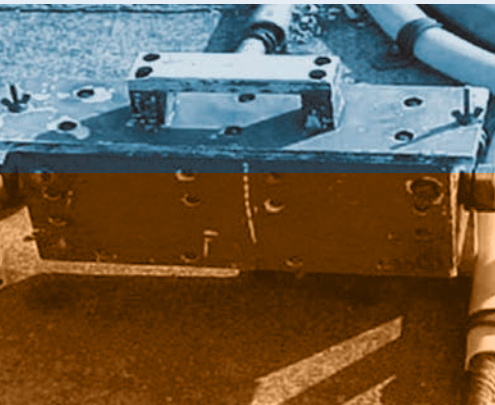
WMATA is not conducting all inspections and maintenance required by its ATC manuals and ATC manuals have incorrect or incomplete information and outdated references.

During this audit, the WMSC reviewed Reliability Engineering Asset Management (REAM) records that showed that the AC Vane Relay Inspection and Testing PMI was not completed (shown as not applicable) in 2019 or 2020, despite ATC and OEM manuals stating the work must be completed every 12 and 24 months on these vital relays.

Relays are critical to the safe operation of the Metrorail system because relay positions are what indicates when a section of track is occupied or unoccupied. If a relay incorrectly shows that a segment is unoccupied, there is a risk of collision. Relays are considered vital to safe train operation.

The WMSC reviewed additional records showing that these AC Vane Relay tests were also not all completed in 2018, but that some limited, different testing was conducted in the first half of 2020 that was separate from the PMI tracked in the





REAM document. The 2015 TOC ATC audit specifically noted that 14% of required 2 year AC Vane Relay tests were not completed in 2014, and that test was one of several tests with intervals of one year or more that had lower completion rates than more frequent testing. Given the long interval, and the fact that WMATA was not rescheduling tests that were not completed, the time between tests increased significantly for these tests, the 5 year HF Track Circuit Cab Roadway Transmit Level Test, the 4 year DC Vital Relay Inspections and Tests and the 5 year open door command spillover test, Master.

After the WMSC raised the issue of the AC Vane Relay testing with WMATA during this audit, ATCM and ATCE also identified problems with relay testing procedure, ATC-1002A, in the ATC-1000 manual. The manual does not distinguish between different relay types in use: GRS/Alstom and Safetran. The manual was initially written for GRS/Alstom relays, so the testing specification mechanics are directed to use is not correct for Safetran relays. As noted above, the manual that is in effect has not been reviewed and updated since 2016, and an update remains under review.

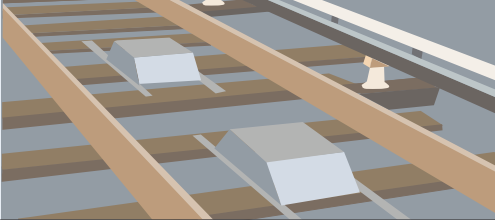
As this audit work was concluding in February 2021, after the WMSC requested further information related to these testing issues, ATCE developed an engineering information bulletin (EIB) that provided new specifications and outlined new instructions for conducting testing such as energizing the relays for 15 to 60 minutes and slowly approaching required energy levels. The ATCE bulletin also appears to seek to place blame for these failures on ATCM, even though ATCM is obligated to follow the procedures as they are written in the manual by ATCE.

In late February 2021, WMATA identified separate potential issues related to the Ansaldo relays.

In an example of some other issues in the manuals, the configuration plan (ATC-4000) refers to Transit Infrastructure and Engineering Services (TIES), a WMATA department that has not existed for several years. The ATC-4000 manual provided by WMATA as the in-effect version was dated January 2016, however one employee interviewed for this audit was aware of and provided a later signed and approved version with revisions noted in September 2019 and August 2020. Even that updated version contained this reference to TIES.

The ATC-2000 manual provided by WMATA as the in-effect version was dated September 2014, however that same employee interviewed for this audit was aware of and provided a later signed and approved version with revisions noted in 2017, 2019 and October 2020. The ATC-5000 Manual provided by WMATA as the in-effect version was dated January 2015, however the employee was aware of and provided a signed and approved version that was revised in September 2020.

ATCE employees stated they aim to update the manuals annually, however the ATC-1000 and ATC-3000 manuals provided to the WMSC by that employee and as part



Revisions to the ATC-1000 and ATC-3000 manuals were under review at the time of this audit.

of WMATA's official responses had not been updated since 2016. Revisions to the ATC-1000 and ATC-3000 manuals were under review at the time of this audit. Any changes were expected to require training for ATCM personnel so that they would be able to properly implement the revised procedures.

The existence of multiple versions of the manuals that WMATA personnel believed to be effective and information provided in interviews about prior ATCM leadership developing their own versions of the ATC-1000 and ATC-3000 manuals separate from those developed and approved by engineering suggest that there may be confusion about which version of the manuals apply. After ATCE discovered the alternative versions of the ATC-1000 and ATC-3000 created by ATCM and other similar revisions to documents, the ATC-4000 manual was updated to explicitly prohibit such a revision and specify the limited documents ATCM had the authority to revise.

Minimum Corrective Action: Metrorail must conduct its required inspections, preventive maintenance and testing, and must demonstrate that this work will continue to be conducted long-term. Metrorail must review and update manuals to ensure the manuals are up-to-date and accurate, must ensure that manual reviews are scheduled, must ensure that the manuals are reviewed and updated as scheduled, and must ensure that information about each update is clearly communicated to ATC personnel.

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

ATCM employees are provided with a 'personal tool' purchasing allowance, but Metrorail does not have a specific list of allowable or prohibited tools and does not provide employees with a description of what would make tools acceptable or unacceptable to use on WMATA property.

Employees even stated that they are using their own rail grinders and impact wrenches.

This creates multiple safety risks related to electrical, fire or other hazards, ergonomics, a lack of training and understanding of how to use the tools, the risk that these tools are not properly inspected or maintained, the risk that the tools may not be appropriate for the equipment or application on which they are being used, and the risk that work may not be done in the approved manner.

For example, grinders that do not meet safety requirements could throw sparks and trigger a fire or burn someone. An impact wrench that is too heavy could damage or reduce the useful life of infrastructure elements, or could lead to an employee or contractor injury.

The WMSC did see a 2015 general list of tools required to be purchased by employees, but that list was not restrictive and included only limited information regarding the safety requirements for those tools.

Without explicit rules regarding what tools may or may not be used, tools may not include proper guards or safety straps, not have sufficient strength to complete a job, may not be properly calibrated, or could be made of materials that increase the safety risks of working on or near electric wiring or the third rail.

Minimum Corrective Action: Metrorail must develop, communicate, implement and monitor compliance with safety-based rules and procedures governing the use of non-WMATA tools on the roadway, including allowable and prohibited tool lists that are updated regularly and a sufficient approval or rejection process. For each tool, Metrorail must include specifications, process and timelines for tool inspection, calibration (if necessary) and certification. Metrorail must also ensure employees and contractors understand the dangers of using unapproved tools, and must institute regular compliance checks to ensure that only approved tools are in use and that tools are properly inspected daily.

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

ATCM supervision determines, based solely on their own judgement, which inspections or maintenance can be bypassed. There is no way to ensure that these decisions are made based on actual evidence, requirements, safety prioritization, or with any input from equipment manufacturers to demonstrate that bypassing inspections or maintenance is safe.

For example, power frequency track circuit tests and open-door spillover tests were listed as not performed as required in October and November 2020, even as other WMATA departments were prepared to re-activate automatic door operations. Other preventive maintenance such as some interlocking inspection tests, train control room inspection tests, TCR ground fault inspection and tests, interlocking inspection tests, switch obstruction tests, and shunt verification tests were listed as approved to be bypassed.

Review of WMATA's records showed that the bypassed testing was not included as incomplete in WMATA's internal calculations of percentages of compliance with preventive maintenance requirements. Several PMIs showed that they were 100 percent complete even though there was work marked as bypassed for that period. WMATA only counted work as incomplete if it did not have a bypass approval entry in the Maximo system.

Minimum Corrective Action: Metrorail must develop a safety-based procedure that specifies which, if any, PMIs may or may not be bypassed, the circumstances that must occur in order to safely bypass a PMI, how the justification for the bypass must be documented, the frequency with which a specific PMI may be bypassed, who is





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WMATA only counted work as incomplete if it did not have a bypass approval entry in the Maximo system.

responsible for analyzing and reviewing those bypass logs, and what corrective action is required if a PMI is bypassed.

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

Processes are documented for ATCE to initiate changes, but there is no such process for ATCM. This has led to the use of discussions or other communications without any formal tracking mechanism to ensure proper tracking, follow up and review from the departments involved or to ensure that other necessary approvals and reviews occur from departments such as SAFE.

In response to the draft version of this report, WMATA noted the existence of blank comment forms related to the manuals. However, a log of suggestions contains only information from August 2014 through August 2015.

A previous ATCM leader even developed an unapproved version of the ATC-1000 and ATC-3000 manuals, creating disagreements with ATCE. New revisions to the ATC-1000 and ATC-3000 manuals completed by ATCE were awaiting ATCM approval at the time of this audit due to additional training that will be required for ATCM personnel on the updates. As noted above, these changes have also led to a level of confusion regarding which version of the manual is actually in effect. Mechanics noted some errors in the manuals they are currently using such as steps that are out of order (e.g. put cover on and then check lights underneath rather than the other way around), which leads to mechanics developing work-arounds for procedures since the mechanics stated that the procedures cannot always be followed as written.

In addition to helping to resolve these functional issues today, a formal tracking process for these requests would provide historical documentation for future Metrorail employees in these or related departments to understand what was done and why.

Minimum Corrective Action: Metrorail must develop, implement and document a formal process for engineering modifications or manual change requests initiated by departments other than ATCE. The process may be documented in a location such as the ATC-4000 manual.

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

While certain interactions involving ATCM, ATCE and other departments are effective, such as daily meetings recapping the prior day's issues with lower-level personnel, in other areas there is little effective coordination.

The siloed nature of training and technical materials, capital planning, and efforts such as a return to automatic door operations or automatic train operations also creates opportunities for safety issues to fall through the cracks.

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There are no formalized agendas, consistent follow up tracking of action items, or any meeting minutes for several key meetings such as a weekly meeting between ATCE and ATCM leaders, which limits effective follow up on action items. Without identifying owners of open action items, the items are not being acted upon in a timely and coordinated fashion.

This lack of clear action items and follow up leads to safety and maintenance issues not being addressed, and no specific accountability or methodical approach to what is failing, what is working, and what must be replaced to maintain a state of good repair. Based on the limited available notes related to these interactions, this lack of identification of areas requiring action has delayed progress on approval of updated ATC-1000 and ATC-3000 manuals, and likely contributed to the long delay in identifying and correcting the issues related to the AC Vane Relay testing noted above.

An improved and documented working relationship would also provide a basis to more thoroughly and appropriately address the significant portion of ATC assets that are beyond their useful life.

The siloed nature of training and technical materials, capital planning, and efforts such as a return to automatic door operations or automatic train operations also creates opportunities for safety issues to fall through the cracks. ATCE, which reports to ENGA, ATCM, which reports to RIME, SSRP, which reports to Capital Delivery, and other departments such as SAFE do not appear to be on the same page or even aware of some actions being taken by other departments.

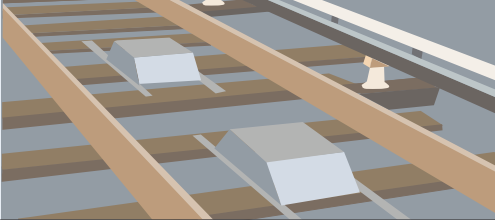
These departments also must work closely with others such as Communications, Traction Power, Track and Structures and the Rail Operations Control Center.

Minimum Corrective Action: Metrorail must provide specific expectations and requirements for the responsibilities of, and actual working relationships between, each department, and must document meetings with appropriate meeting agendas and with follow-up action items that are assigned to individuals or departments. Metrorail must also develop a method to share available training or technical reference materials among appropriate departments such as ATCE and ATCM, and could also include opportunities for ATCE to attend or observe ATCM training.

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

SSRP is making key ATC-related decisions without the full participation of ATCE and ATCM due to limited coordination and involvement with other departments.

ATCE and ATCM, for example, appear to have been sidelined from WMATA's planning to return to automatic door operation and automatic train operation in favor of, for ATO, SSRP and operations, which do not have technical expertise and in favor of car



maintenance for automatic door operations even though the railcar and ATC systems work closely together.

SSRP is also getting involved in scheduling of major ATCM production work, but it is not clear that these scheduling decisions are being coordinated with ATCE or that ATCE is providing input. SSRP is not formalized with working groups or other specific coordination and planning including ATCE and ATCM personnel. There is no evidence of formal submissions of capital program requests from ATCM, and there is no specific plan to replace assets nearing or exceeding their useful life expectancy. SSRP stated that they plan to attempt to do this in the future, but SSRP, which got its first director about a year ago, was described by WMATA employees as in its infancy with some leaders of other departments unclear about SSRP's specific role.

SSRP was described as having taken on or assumed substantial responsibilities, including long-term ATC capital planning and work coordination, even though it is not yet stood up and it has no standards or procedures. The only specific capital planning information provided during this audit was a generalized table described as the Safe Signals Program that identified projects that ATCE and ATCM rated high or low priority.

ATCE stated that there is no capital program in place to renew the systems when components near the end of their useful life or to act based on the urgency of safety issues identified by the departments. This information regarding the numbers of failures, types of failures, numbers of delays, the expected useful life of assets in the field, and other reliability data is available. However, in interviews, ATCM leadership only hesitantly recognized their responsibility for acting on this information.

WMATA has teams responsible for collecting, synthesizing and analyzing reliability data. To fully capitalize on the safety benefits of these efforts, there must be an integrated approach to using the information, including in project prioritization.

ATCE described some locations "really in bad shape" that have been identified as urgent needs that have not yet been addressed. During this audit, and following WMSC questions, an initial meeting was held related to SSRP capital planning.

Without specific accountability for capital and state of good repair needs and a methodical approach to what is failing, what is working, and what must be replaced to maintain a state of good repair, Metrorail risks a catastrophic accident as occurred in 2009 and 2015.

Minimum Corrective Action: Metrorail must develop and implement a formal, standardized process, including specific supporting documentation requirements, to request and justify the need for ATC capital renewal projects and that then evaluates and, as appropriate, leads to implementation of these projects. Metrorail must also create documented requirements for coordination among departments such as SSRP,



ATCM and ATCE, and must document meetings involving SSRP, ATCM, ATCE and Strategy, Planning and Program Management (SPPM) with identified follow-up action items that are assigned to individuals or departments.

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

Departments like ATCM scramble to identify parts needed to cover any future repairs after new items like switch machines have been purchased, delivered and installed. Contracts for this equipment rarely include spare parts, which leaves ATCM starting from scratch rather than starting with the necessary items for regular maintenance already in stock.

In addition to the specific parts required for each switch or other piece of equipment, some equipment also requires specific sets of tools for measurements, calibration or torquing. If these tools are not available, it can prevent maintenance work from being conducted or conducted properly and reduce the useful life of the equipment.

WMATA is creating parts issues for itself by not always including the initial required spare parts or adequate tool requirements in procurement contracts, and ensuring that those tools and parts are available to appropriate employees. ATC supply issues are a challenge at many transit properties today, but it is a challenge that can be overcome through proper planning and action.

For example, WMSC inspection and investigation work identified a cable connector at Silver Spring Station as a key cause of a bobbing track circuit and cable failures. ATC personnel did not have the proper torque wrench to adjust this connection, and at first used the wrong tool and did not coordinate with Traction Power Maintenance (TRPM). TRPM later was found to have the proper tool to make the adjustment.

As the WMSC has identified in other audits, SAFE has not issued a Metrorail-wide procedure to ensure that safety certification or approval steps are followed, including as it relates to procuring spare parts for vital systems. There was no coordination with ATCM on the procurement of the Grand Master 4000A switch machine, which led to delivery without any notice or training to the department required to install and maintain the switch and to substandard training requirements in the contract that led to WMATA needing to revamp the training.

The GM 4000A is an electric switch machine manufactured by Alstom that is designed for long life and low maintenance use on transit properties. It provides 4,000 pounds of force and, like all switch machines, controls the position of the rails, so improper actions during maintenance or installation or improper operations of the switch can cause serious damage or injuries, and switch damage could, in the most significant cases, lead to a derailment.





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Departments like ATCM scramble to identify parts needed to cover any future repairs after new items like switch machines have been purchased, delivered and installed.

As new assets or features are identified and integrated into the Metrorail system, the departments involved are supposed to be involved in setting required standards for associated training and other features that must come with any procurement, and any requirements for contractors involved.

Minimum Corrective Action: WMATA must ensure that SAFE, departments responsible for procurement, and departments responsible for installation, maintenance, operations, engineering and training properly coordinate from the earliest stages of project development to provide for and include adequate review, approval, training and any parts or other features required to maintain the project and related systems in a state of good repair.

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

Many ATC system elements are decades old and a significant portion are already beyond their useful life, but WMATA has no coherent, unified plan to ensure that replacement parts are available to maintain the current system, to ensure that new parts are available for upgrades, or to comprehensively track the assets that require replacement based on life expectancy or average time to failure.

ATC personnel described “major, major issues” in getting parts and a lack of knowledge at WMATA that parts have been or will be discontinued that prevents the agency from stocking up on items.

There is limited effective proactive focus on items reaching the end of their useful life, manufacturers that may be going out of business or parts that are no longer going to be made. Therefore, shortages are only identified when supplies run low, which delays safety-related projects. ATCM and Supply Chain Management also disagree at times on certain purchases given the frequency of use of some items that may sit on a shelf long-term, but that are crucial to have on hand if a repair is required.

While there are some areas, such as the project getting underway now to replace the equipment in 25 train control rooms, where Metrorail is doing larger upgrades, and Metrorail expects to institute a next generation signaling system at some point, the necessary parts to maintain the existing legacy elements are not on hand and are difficult to procure. This leads to long project lead times even for urgent repairs and to the need for special arrangements such as for extra receiver boards to replace those identified as problematic or for switch parts that are necessary just to keep the system functioning. Other parts have long lead times for purchases, such as WZ Bonds. SAMS also attempts to fix parts itself when possible, which helps to patch over the issue. These parts issues lead to

reactionary fixes like engineering modifications when a new timer cannot be found rather than proactive replacement planning.

Minimum Corrective Action: Metrorail must develop inventories of parts and materials and their availability and lead times or unavailability and identify those parts that require immediate or near-term action to procure in order to maintain a state of good repair. Metrorail departments must cooperatively develop and implement mid-term and long-term plans to replace equipment nearing or exceeding its useful life to maintain a state of good repair.

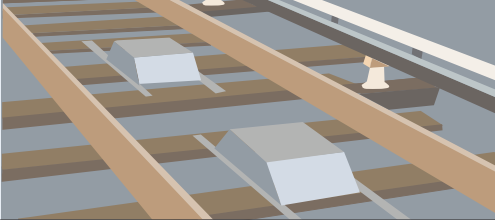
Metrorail has no specific minimum training course requirements, documented OJT requirements or equipment certifications for ATCM employees, or requirements that individuals be trained on a system element prior to conducting maintenance work on it.

Multiple employees stated that ATCM personnel require more training in many areas.

Training on specific equipment is not a requirement to work on the equipment in the field and is not documented in Metrorail's Enterprise Learning Management (ELM) system that WMATA has designated as the tracking system for training records. Current ATCM training is largely captured only in a spreadsheet maintained by and accessible to a small group of individuals. The lack of training requirements, limited training and lack of proper safety certification, along with a lack of long-term planning have created a number of safety concerns. For example, a lack of planning for the end of the useful life of Alstom 55E dual electrical and manual control switch machines led to an expedited purchase (see finding 9) that resulted in Grand Master 4000A switches being procured and arriving on Metrorail property without any training or notice for ATCM training and frontline personnel and without full manufacturer training or training materials.

This led to initial training being conducted in a limited fashion without an ATCE EMI using a rudimentary mock-up placed on the ground. An expedited process led to a limited written document for mechanics, developed among engineering, TSMT and ATCM. There are now several dozen of these switches in place, but despite some attempts to provide basic training on these to crews in areas with these switches, there is no requirement that crews have training and experience with these switches prior to working on them in the field. Instead, ATCM training stated it hopes that supervisors would only assign properly trained crews.

While Metrorail told the TOC in 2018 that ATCM was developing OJT documentation and tracking for PMI-based certifications that would enable ATCM to assign mechanics to perform specific PMIs based on their specific qualifications established through training and documented in ELM, this certification process does not exist today. WMATA had identified the same issue in a 2017 QICO review.



ATC personnel described “major, major issues” in getting parts and a lack of knowledge at WMATA that parts have been or will be discontinued that prevents the agency from stocking up on items.

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According to longer-tenured employees interviewed for this audit, detailed training on each PMI used to be conducted a few decades ago for each new mechanic hired. The journeyman program, which the 2018 TOC Audit found had not had a course provided at that time since 2015, provides an important general baseline understanding for new ATC employees, but this is separate from the specific and recurring training required for ATC personnel to fully and properly carry out each aspect of their work that they may be directed to do, particularly as it relates to the different types of equipment in use across the Metrorail system.

Metrorail has recently increased ATCM training plans to include basic baseline training and, for the first time recently, OJT classes on some equipment, which has shown ATCM personnel the type of training they need to get on other equipment across the system. This training was slowed soon after it began by COVID-19 safety precautions.

Metrorail is also working on training lab facility construction, but this was not available to employees at the time of this audit.

Minimum Corrective Action: Metrorail must specify, implement and document training requirements that must be met prior to work on specific equipment in the field, and must provide basic and ongoing higher-level training to ensure that employees have the required level of expertise for their positions. Metrorail must utilize its available or future technology, such as ELM and Maximo, to ensure that these requirements are followed. Metrorail must establish a process to set and document training requirements and obtain or create appropriate training for each new type of equipment.

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

Increased retirements, promotions and vacancies have left ATC departments devoid of crucial knowledge, experience and technicians with appropriate technical backgrounds required to maintain, troubleshoot and repair the complex ATC systems.

The proportion of mechanic positions at the A/AA level has declined from 24% in 2015 to 18% in 2018 (per prior TOC audits) to 15.9% of all mechanic positions when including vacancies (17.8% of filled positions) in fall 2020. The proportion of B/C mechanics has gone from 46% in 2015 to 48% in 2018 to 46.8% of all positions (52.2% of filled positions) in fall 2020. The proportion of D mechanics (formerly known as helpers) went from 29% in 2015 to 34% in 2018 to 37% of all positions (30% of filled positions) in fall 2020.

The more experienced mechanics will be stretched further when WMATA takes custody of Silver Line Phase 2 to Dulles International Airport and Loudoun County. Several employees interviewed for this audit stated that there is already a demand

on these individuals for overtime, and both managers and frontline employees acknowledged concerns about the overall experience level and expertise of ATCM personnel.

As senior mechanics retire and other normal turnover occurs, Metrorail must maintain an adequate number of staff and adequately trained staff through focused recruitment efforts. This could include outreach in areas such as trade schools and to former military servicemembers with electronics training. ATCM management stated that the hiring process has been frustrating, and that Metrorail has struggled to identify candidates with the required skills and background or has identified some of those candidates that do have the necessary background as “overqualified”. ATCM and ATCE personnel also expressed concerns about needing additional personnel to fully take advantage of work windows or technology upgrades, and some ATCM personnel expressed concerns about the skills of some of their colleagues due to the complex nature of ATC work.

There is now a limited number of experienced technicians that can teach and guide newer, less experienced employees to ensure continuous daily learning and growth. Any further reductions in staffing under current rules and requirements could put the completion of required work at risk, particularly given the upcoming Silver Line Phase 2 extension. ATCM stated that they are beginning to develop a new hiring process meant to fill vacancies, but had no timeline for when that new process may be implemented. Metrorail has not used technical, mechanical or practical aptitude tests for ATCM hires for a number of years.

Given the number of people required for many tasks, available staffing may also be contributing to the preventive maintenance completion concerns explained below and the decisions to administratively bypass some preventive maintenance work (which WMATA is not counting against the completion percentages in its internal reports).

Minimum Corrective Action: Metrorail must identify technical skills and experience required, and must develop, finalize, implement and continuously improve an effective recruitment and hiring process. These actions must identify, attract and retain staff with the necessary background, technical knowledge, skills and experience (to do the job or to understand and succeed based on additional technical training that Metrorail may develop or obtain and provide). Metrorail must also identify and provide any training necessary for current employees to gain the higher level of knowledge and understanding necessary to fill the gaps left by those who have left the departments.

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

ATCM supervisors expressed concern about communication with other crews and supervisors, including due to a lack of detail in Maximo entries that can require



Increased retirements, promotions and vacancies have left ATC departments devoid of crucial knowledge, experience and technicians with appropriate technical backgrounds.

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repeating some troubleshooting work, which extends the duration of time that corrective maintenance or other safety-related issues go unresolved.

This is similar to an issue identified by QICO in a June 2017 internal review related to inconsistent communication between successive shifts on corrective maintenance work orders in Maximo, which was leading to ineffective record keeping of work completed during each shift.

The ATC-1000 Manual requires datasheets to be signed by technicians and supervisors to certify readings are properly captured, however, ATC 1009 Switch Indication Locking Test Forms were not signed by supervisors, and some ATC compliance or other checklists and inspections were not signed or were not legible. These documents are critical to understanding the state of the equipment and the accuracy of the work, particularly if any safety event were to occur. Completing the work and documentation properly is critical to this important safety work, and clear signatures or other identifying information is critical to ensuring accountability.

Minimum Corrective Action: Metrorail must establish and communicate minimum standards for Maximo entries to ensure that crews do not need to restart troubleshooting from scratch, provide refresher training to employees on their required duties, and ensure that all tasks, reviews and supervisory oversight are properly completed and that forms are filled out legibly and completely to accurately reflect work that was conducted.

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

Rules and procedures including MSRP Rule 4.5.3.6.1 refer to the cranking and blocking of switches, however ATCM personnel are being instructed to and are even being certified to crank and clamp switches, and to no longer block and spike switches.

ATCM stated that SOPs are hard to change, so they are simply training employees the way they want it to be done. While cranking and clamping switches is an acceptable method that the rail industry has generally determined presents an improvement over cranking and blocking, this improvement must be incorporated into written procedures.

WMATA personnel stated that there would be recertification required on cranking and clamping, but that the recertification requirements have not yet been finalized.

Minimum Corrective Action: Metrorail must ensure that all written procedures, such as those governing cranking and clamping, match the direction given to ATC personnel and that the procedures go through the proper safety review and approval process.

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

The snow melter is attached to the third rail, which, according to Metrorail SOP 28, requires that power be de-energized during maintenance. However, if power were down as required by SOP 28, it would not be possible to test the device and personnel stated it would also create challenges for revenue service.

Other personnel stated that SOP 28 would technically require a red tag outage (which includes racking out circuit breakers to ensure power stays down) for clamping switches or triggering an Emergency Trip Station (ETS) box, but that SOP 28 does not factor in systems between the third rail and snow melters including fuses and switches. This safety concern has been raised to ATCM management and SAFE.

Concerningly, ATCM personnel stated they have developed their own work-arounds for the PMI procedure since following it as written is not reasonable. Written procedures that are not able to be followed (also see findings 3, 14) contribute to broader drifts away from following other critical procedures and reflect an ineffective safety culture.

Minimum Corrective Action: ATCE, ATCM, SAFE and other relevant departments must identify the safest way to conduct this work, and what (if any) work can be done while connected to the energized third rail. Based on this review, Metrorail must update rules, procedures or SOPs to eliminate conflicts and provide training on the updated procedures.

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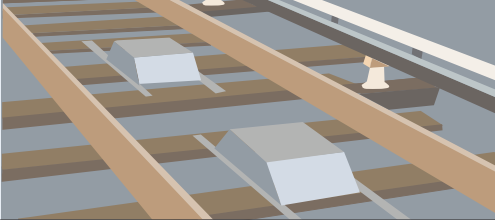
Metrorail does not have documented ATC software standards.

The ATC-4000 Manual Section 4006.4 states that "ATCS Software modifications are developed in accordance with ATC Engineering Design Standard ATC 5002, ATCS Software Design Process (future), which describes ATC Engineering standard for ATCS software development". However, the ATC-5000 Manual dated January 2015 that was provided by WMATA during this audit as the in-effect manual does not include any reference to an ATC 5002 process. A separate version of the ATC-5000 Manual, dated September 2020, was identified by an employee during audit interviews, which includes only an empty placeholder section 5002 for ATCS Software Standards.

Without any standards or processes, there is a risk that new software, software updates or other changes could be procured or implemented without proper reviews, that software could fall short of actual safety and operational needs, or that software updates could be missed by WMATA.

ATC software is vital, meaning that a failure can lead to system damage, injury or death.

ATCM supervisors expressed concern about communication with other crews and supervisors, including due to a lack of detail in Maximo entries that can require repeating some troubleshooting work.



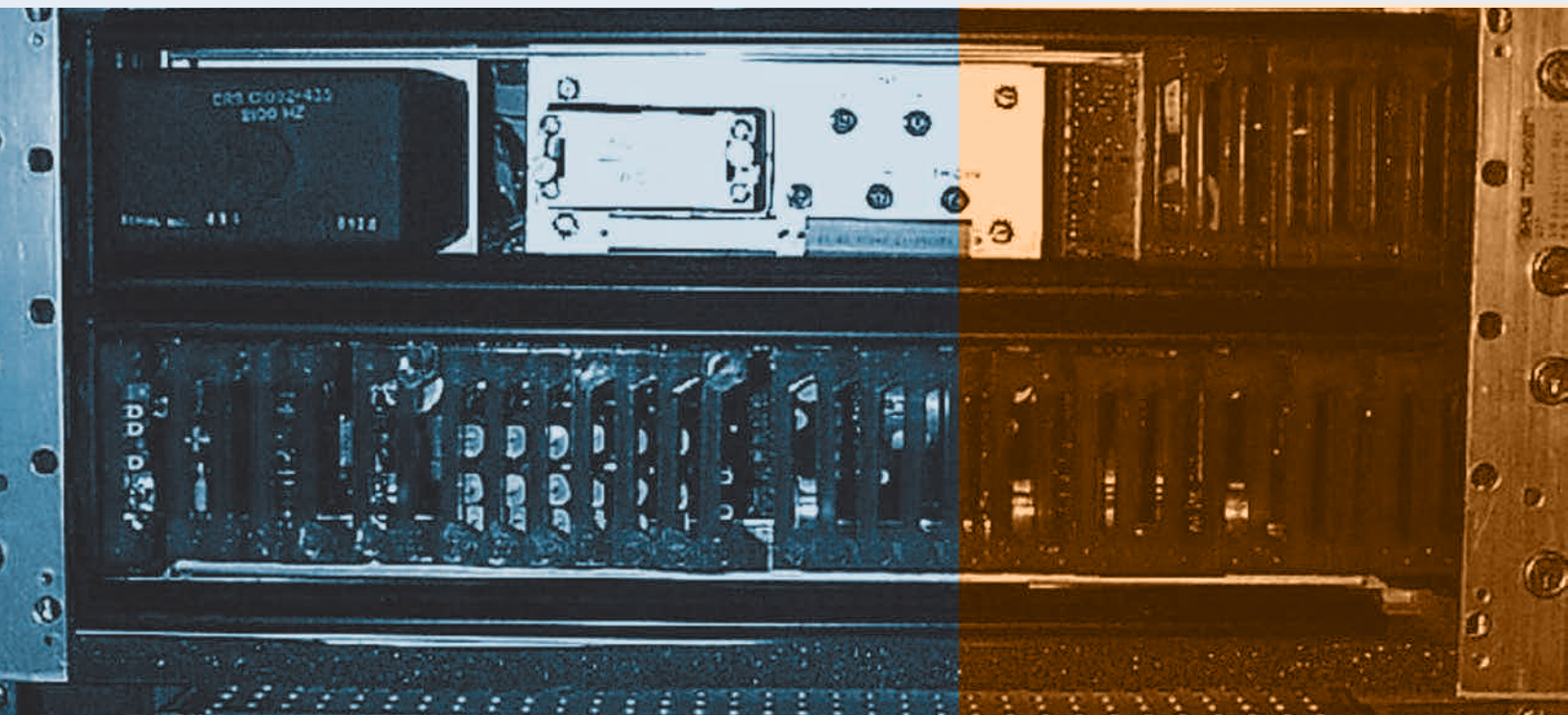
Metrorail's SSCPP requires that ATC projects go through the highest level of safety certification (see finding 2), however ensuring that process is appropriately completed is difficult if there are no standards to hold the software to, and the engineering design standards manual does not refer to the safety certification process.

ATCE said they have intended to create and implement these software standards, which would include WMATA standards as well as any relevant references to American Railway Engineering and Maintenance-of-Way Association (AREMA) and IEEE (Institute of Electrical and Electronics Engineers) specifications, but have not gotten to it yet.

In addition to operational requirements, software standards would also include requirements for implementation plans, updates, notifications to WMATA of updates and how to implement them, and requirements for software vendors to complete as part of a safety certification process.

Right now, WMATA has no standardized way to be notified of or otherwise ensure that it identifies important ATC software updates from manufacturers. No ATC software has gone through the safety certification process in several years, and the ATP software updates for the 7000 Series cars including those related to automatic door operations do not appear to have gone through safety certification.

Minimum Corrective Action: Metrorail must develop and implement software standards that include all appropriate and required safety considerations, safety certifications and approvals for each change, and the required processes to ensure



that the reliability of the system is reviewed and that Metrorail identifies and considers each future update developed by system manufacturers.

Other observations

This audit was conducted during the ongoing, long-term COVID-19 public health emergency.

As part of the initial response to the pandemic, new ATCM basic training classes that involved alternating classroom and hands-on instruction were disrupted soon after the program began.

In early 2021, ATCM was attempting to restart this training with smaller class sizes due to health precautions.

Smaller class sizes had also slowed training on new switch machines, which means fewer technicians are familiar with newer equipment that they may still be assigned to maintain (see finding 11).

During the initial months of the public health emergency, when revenue operations were reduced even more significantly than they are today and when maintenance employees were switched to alternate day (A/B day) schedules, ATC departments also determined that it was appropriate to temporarily revise certain preventive maintenance frequencies due to the reduced schedules and ridership. The scheduled frequencies have now returned to normal.

During the course of this audit, the WMSC identified some potential areas for efficiency or other improvements that did not at this time amount to findings or recommendations under the WMSC Program Standard. The WMSC specifically identified to WMATA's Office of Inspector General the areas of track access, non-revenue vehicle availability and use of employees' personal vehicles for WMATA purposes as areas that may warrant further review to determine whether changes to or the creation of administrative or other procedures would benefit the agency.

Next Steps

WMATA is required to propose CAPs for each finding no later than 45 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.



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