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WMSC Commissioner Brief: W-0151 – Improper Movement, Red Signal Overrun – Alexandria Rail Yard – October 19, 2021

Prepared for Washington Metrorail Safety Commission meeting on March 8, 2022

Safety event summary:

A Train Operator moved a train out of the car wash at the Alexandria Rail Yard in the opposite direction that they had been told to travel, and continued moving the train beyond a red signal without authorization.

The Train Operator had reported to the yard on October 19, 2021 for a 2 a.m. to 7 a.m. shift following a separate assignment in the same work day from 4:08 p.m. October 18 to 1:17 a.m. October 19. The Train Operator had not been required to move any trains as part of the yard operator assignment until this move just after 5 a.m.

The Interlocking Operator attempted to contact the train operator twice over the radio starting at 5:02 a.m. The operator did not respond over the radio. The Train Operator then called the Interlocking Operator via telephone at 5:03 a.m. The Interlocking Operator told the Train Operator to move a four-car train from the car wash in the Service and Inspection Shop to the 2 West lead. This movement is opposite the informal normal direction of travel for trains departing the car wash (this movement is allowed, however it was an unusual move for the operator).

The Train Operator reported over the radio at 5:08 a.m. that they were ready to exit the car wash. The Interlocking Operator instructed the Train Operator to verify that signal C99-208 was lunar (proceed indication), and to proceed to within 10 feet of the next signal, C99-204, which was red (stop indication), then to reverse ends (move to the operating cab at the trailing end of the train) for further instructions. The Train Operator repeated back the correct first signal, C99-208, but incorrectly stated that the red signal would be at C99-144. C99-144 is in the direction that the train later improperly travelled, but is not in a location where the move as described in the repeat back is possible. C99-144 is on an adjacent track. The Interlocking Operator did not identify the incorrect repeat back.

In an investigative interview, the Train Operator stated that after this communication, they needed to walk through the train to close some of the train's doors.

The Train Operator began to move the train at 5:14 am. The Train Operator moved the train eastbound, rather than moving westbound as instructed. At 5:17 a.m., the train operator stopped for approximately five seconds at red signal C99-222. The Train Operator then, without any additional communication, continued on past the red signal, and over switch 211, which was not properly aligned for this move. Post-event tests of the switch did not identify any damage.

At approximately 5:18 a.m., the Train Operator reported that they had stopped at the next signal C99-236, which was red. The Interlocking Operator then identified that the Train Operator had moved the train in the opposite direction from the Interlocking Operator's instructions. The train had been moved to the east out of the car wash, rather than to the west as the Interlocking Operator had instructed. The Interlocking Operator also identified that the Train Operator had, without authorization, passed red signal C99-222 to reach that location.

Probable Cause:

The probable causes of this event were Metrorail's inconsistent compliance with and inconsistent supervisory oversight of compliance with radio communication protocols, and Metrorail's lack of effective physical characteristics training for operations personnel.

Corrective Actions:

Metrorail provided additional training to the train operator and interlocking operator, and informed other operations personnel of the event.

WMSC staff observations:

Metrorail's Rail Transportation 'lessons learned' document states that the operator should have contacted the interlocking operator after boarding the train to establish positive communication regarding which the end of the train the operator was positioned in. This is not a documented Metrorail rule. Metrorail may consider instituting such a rule.

The WMSC has transmitted a draft Rail Operations Audit report to Metrorail for technical review. This audit included an assessment of the adequacy of Metrorail training for operations personnel, including on physical characteristics of the rail system.

The WMSC's Fitness for Duty Audit issued in August 2021 identified and required Metrorail corrective action plans (CAPs) to address safety issues such as Metrorail's lack of implementation of its fatigue management policy and inadequate collection of fitness for duty data required to fully implement a safety management system (SMS) approach that would effectively allocate resources to address safety hazards and mitigate risks. Metrorail is in the process of implementing its corrective action plans.

Staff recommendation: Adopt final report.

Washington Metro Area Transit Authority
Department of Safety and Environmental Management (SAFE)

FINAL REPORT OF INVESTIGATION A&I E21510

Date of Event:	10/19/2021
Type of Event:	Red Signal Overrun
Incident Time:	05:17 Hours
Location:	Alexandria Rail Yard
Time and How received by SAFE:	05:44 Hours; SAFE/IMO
WMSC Notification Time:	06:10 Hours
Responding Safety Officers:	WMATA: Yes WMSC: N/A Other: N/A
Rail Vehicle:	L7684/85x7337/36T
Injuries:	None
Damage:	None
SMS I/A Incident Number:	20211019#96234MX

Alexandria Rail Yard – Red Signal Overrun

October 19, 2021
Table of Contents

Abbreviations and Acronyms

ARS	Audio Recording System
ATCM	Automatic Train Control Maintenance
CAP	Corrective Action Plan
CCTV	Closed-Circuit Television
CMNT	Office of Car Maintenance
CMOR	Office of Chief Mechanical Officer
COMR	Office of Radio Communications
MSRPH	Metrorail Safety Rules and Procedures Handbook
NOAA	National Oceanic and Atmospheric Administration
RTRA	Office of Rail Transportation
ROCC	Rail Operations Control Center
SAFE	Department of Safety and Environmental Management
S&I	Service and Inspection
SMS	Safety Measurement System
VMDS	Vehicle Monitoring and Diagnostic System
WMATA	Washington Metropolitan Area Transit Authority
WMSC	Washington Metrorail Safety Commission

Executive Summary

On Tuesday, October 19, 2021, at approximately 05:23 hours, an Interlocking Operator at Alexandria Rail Yard reported a red signal overrun to the Rail Operations Control Center (ROCC). An Alexandria Division Train Operator was operating a four car consist (L7684/85x7337/36T), exiting the Service & Inspection (S&I) Shop car wash traveling eastbound when the train passed signal C99-222, displaying a red aspect, and trailed switch 211. There were no injuries or damage as a result of this incident.

The Audio Recording System (ARS) playback reveled that at approximately 05:02 hours, the Interlocking Operator attempted to contact the Train Operator via radio two times. The Train Operator then contacted the Interlocking Operator via telephone from the Train Operator's lounge at approximately 05:03 hours. The Interlocking Operator instructed the Train Operator to report to the S&I Shop car wash to move a four-car consist from the car wash to the 2 West (2W) lead for storage.

At approximately 05:08 hours, the Train Operator contacted the Interlocking Operator and reported that they were ready to exit the car wash. The Interlocking Operator instructed the Train Operator to verify C99-208 signal was lunar, with an absolute block within 10 feet of the next governing signal, C99-204 red, and reverse ends. The Train Operator's transmission back to the Interlocking Operator was to verify that C99-208 was lunar, and to go around to C99-144 and reverse.

At approximately 05:19 hours, the Train Operator reported to the Interlocking Operator that they were standing by at C99-236 signal red. The Interlocking Operator instructed the Train Operator to standby. The Interlocking Operator contacted an Office of Rail Transportation (RTRA) Supervisor and notified them of the red signal overrun. The RTRA Supervisor instructed the Interlocking Operator to report the red signal overrun incident to the Automatic Train Control Maintenance (ATCM) team and ROCC.

The Train Operator and Interlocking Operator were removed from service for post incident testing.

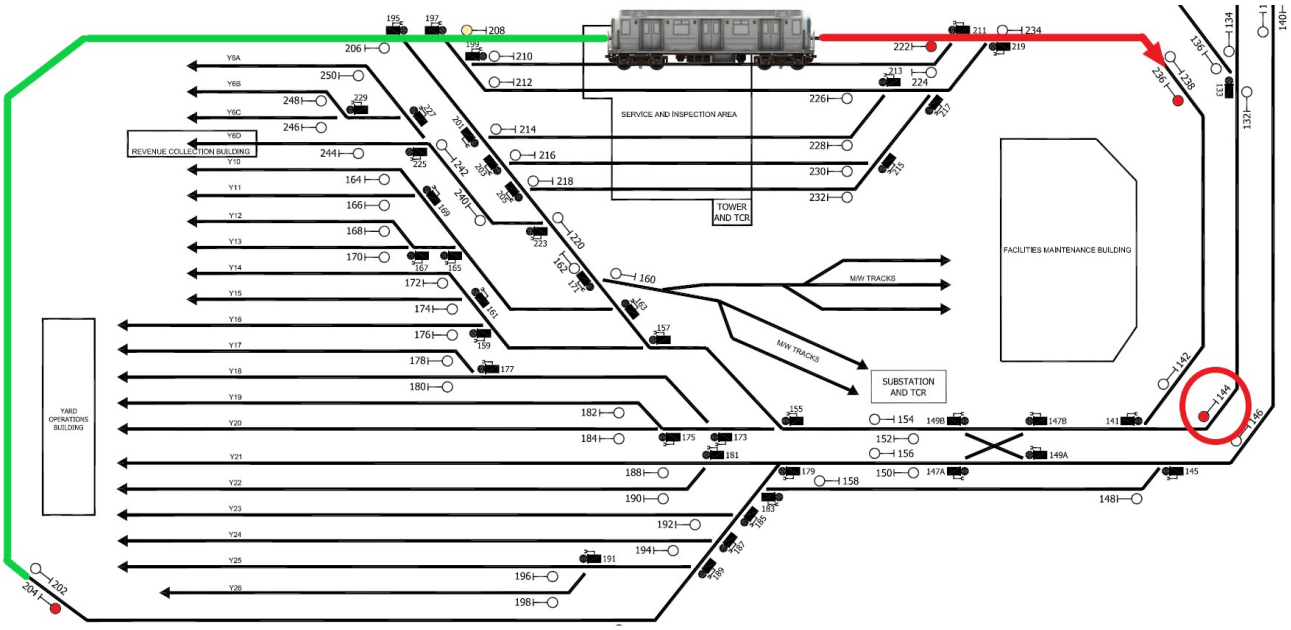
The probable cause of the Red Signal Overrun incident was a failure to adhere to established rules and procedures when in approach of a red signal, as identified in the Metro Rail Safety Rules and Procedures Handbook (MSRPH) – Sec. 3 OR 3.67, which states, "*Rail vehicles shall not be operated past or closer than a point 10 feet in approach of an interlocking signal or lamp displaying a red aspect, a red flag, or a dark interlocking signal, except at a bump post or entering a pocket track, or unless authorized by ROCC or the Interlocking Operator and the move is consistent with customer safety as specified in Rule 3.1*." The Train Operator appears to have lost situational awareness, as they reported receiving a ride to the shop area and possibly due to having to normalize the train doors prior to moving, leading to their failure to observe and report the red signal to the Interlocking Operator before passing. A contributing factor to the event was a missed repeat-back by the Interlocking Operator after the Train Operator transmitted the incorrect instruction before exiting the car wash.

Another potential contributing factor to the incident was possible fatigue on the part of the Train Operator. The Train Operator worked evening shifts in the week leading up to the incident. The Train Operator also worked a regular shift and overtime, totaling 14 hours (16:08 – 01:17 hours and 02:00 – 07:00 hours) the day preceding the incident. However, fatigue modeling could not be applied due to lack of data indicating the bed and wake times for the Train Operator. *Note: The Train Operator was not in violation of the fatigue policy.*

Incident Site

Alexandria Rail Yard, Signal C99-222

Field Sketch/Schematics



Purpose and Scope

The purpose of this accident investigation and candid self-evaluation is to collect and analyze available facts, determine the probable cause(s) of the incident, identify contributing factors, and make recommendations to prevent a recurrence.

Investigative Methods

Upon receiving the notification of the Red Signal Overrun at Alexandria Rail Yard on October 19, 2021, SAFE dispatched a cross-functional team to assess the scene and conduct the subsequent investigation. SAFE team members worked with relevant Washington Metropolitan Area Transit Authority (WMATA) subject matter experts to review the incident's facts and data.

The investigative methodologies included the following:

- Physical Site Assessment

- Formal Interviews – SAFE interviewed two (2) individuals as part of this investigation. The interviews included persons present at, during, and after the incident, those directly involved in the response process, and representatives from the Washington Metrorail Safety Commission (WMSC). SAFE interviewed the following individuals:
    - Train Operator
    - Interlocking Operator

- Informal Interviews – Collected through conversations with individuals during the investigation to provide background and supporting information.

- Documentation Review – Collection of relevant work history information and process documentation contained in WMATA systems of record. These records include:
    - Train Operator & Interlocking Operator Training Records
    - Train Operator & Interlocking Operator Certifications
    - Train Operator & Interlocking Operator 30-Day work history review
    - Metrorail Safety Rules and Procedures Handbook (MSRPH)
    - Interlocking Operator Yard Procedure Manual
    - National Oceanic and Atmospheric Administration (NOAA)
    - Rail Operations Control Center (ROCC) Incident Report
    - Maximo Data

- System Data Recording Review – Collection of information contained in Metro Data Recording Systems. This data includes:
    - ARS (Audio Recording System) playback [Radio and Landline Communications]
    - The Office of Chief Mechanical Officer (CMOR) Incident Investigation Team (IIT) Vehicle Monitoring and Diagnostic System (VMDS)
    - Closed-Circuit Television (CCTV)

Investigation

On Tuesday, October 19, 2021, at approximately 05:23 hours, an Interlocking Operator at Alexandria Rail Yard reported a red signal overrun to the ROCC. An Alexandria Division Train Operator was operating a four car consist (L7684/85x7337/36T), exiting the S&I Shop car wash traveling eastbound when the train passed red signal C99-222. There were no injuries or damage as a result of this incident.

On Monday, October 18, 2021 at approximately 16:21 hours, the Train Operator of this incident reported on duty and worked until their off-duty time of 00:38 hours on Tuesday, October 19, 2021. The Train Operator's workday was not complete, and at approximately 02:00 hours, the Train Operator reported on duty to the Alexandria Rail Yard Tower to work until 07:00 hours.

At approximately 05:02 hours, the Interlocking Operator attempted to contact the Train Operator via radio without a response. At approximately 05:03 hours, the Train Operator contacted the Tower via landline telephone from the Train Operator's lounge. According to the statement of the Train Operator, they were waiting around when the Interlocking Operator contacted them to make a move at the S&I shop. According to the Interlocking Operator's statement, this move was the first request that the Interlocking Operator had instructed the Train Operator to do during their shift. The Interlocking Operator instructed the Train Operator to report to the S&I Shop car wash and move four rail cars from the car wash to 2W Lead. This instruction required the consist to exit from the car wash westbound. The Train Operator repeated the instructions and disconnected the phone call.

At approximately 05:08 hours, the Train Operator contacted the Interlocking Operator from rail car 7684 and reported that they were ready to exit the car wash. The Interlocking Operator

instructed the Train Operator to verify C99-208 was lunar[1], with an absolute block within 10 feet of the next governing signal C99-204 red and reverse ends. The Train Operator's transmission back to the Interlocking Operator was to verify that C99-208 was lunar, and to go around to C99-144 and reverse.

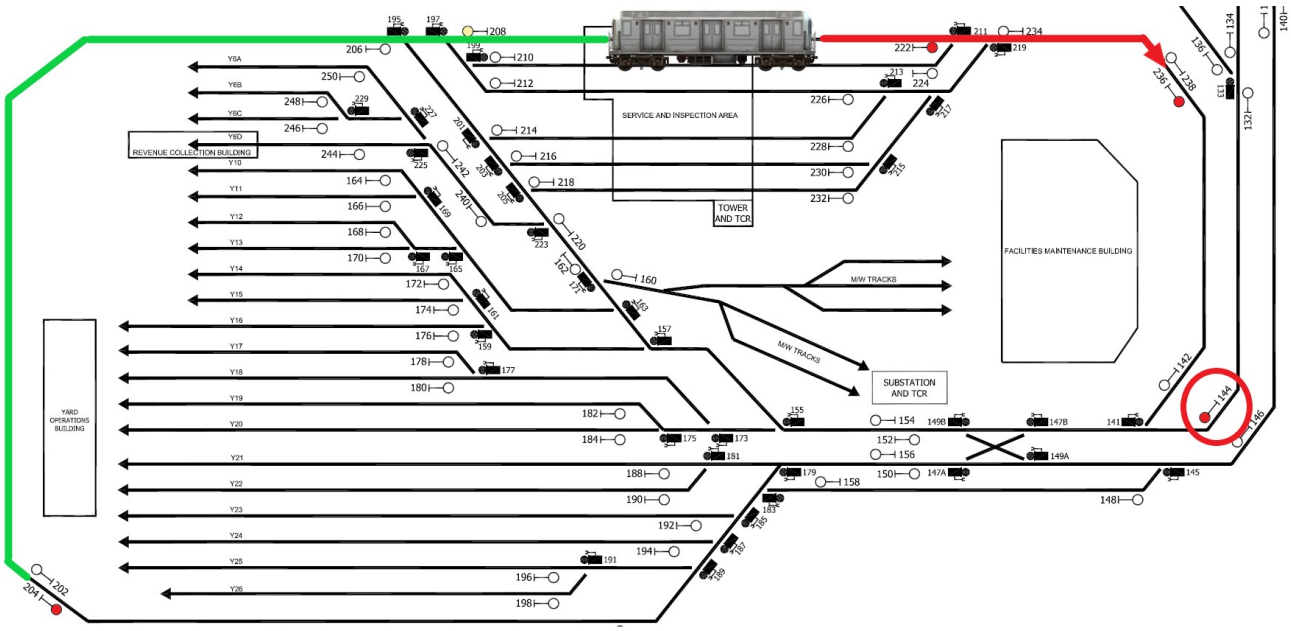


Image 1 – Map of Alexandria Rail Yard depicting the incident route, the instructed route from the Interlocking Operator from C99-208, and the location of C99-144 signal.

The Train Operator did not accurately repeat the instructions and moved the train, without verifying they fully understood the radio transmission of the Interlocking Operator. Additionally, the Interlocking Operator failed to correct the Train Operator's incorrect transmission, missing an opportunity to determine whether the Train Operator fully understood the transmission and instructions. These actions on the parts of both the Interlocking Operator and Train Operator were a violation of the Metro Rail Safety Rules and Procedures Handbook (MSRPH) – Sec. 1 GR 1.79, which states "*Personnel shall not take any action until they are positive that all radio transmissions or receptions are heard, fully understood, and acknowledged. Individual radio transmissions shall, at all times, be repeated by the receiver so the transmitter can confirm the message was received completely and by the intended receiver. Whenever the transmitter has completed their transmission and is turning the airtime over to the receiving party for acknowledgment or reply, they are to end their communication with the word "over.""*

At approximately 05:14 hours, the Train Operator began to exit the car wash moving the train eastbound, in approach of C99-222 signal red. At approximately 05:17 hours, the train stopped approximately 11 feet ahead of C99-222 signal red for approximately 5 seconds. The train then continued, passing C99-222 signal red, trailing switch 211, before coming to a stop at the C99-236 signal. This action is a violation of the Metro Rail Safety Rules and Procedures Handbook (MSRPH) – Sec. 3 OR 3.67, which states "*Rail vehicles shall not be operated past or closer than*

[1] The Train Operator was not able to verify a lunar signal at C99-208 because they were positioned on opposite end of the consist, not facing the proper signal.

a point 10 feet in approach of an interlocking signal or lamp displaying a red aspect, a red flag, or a dark interlocking signal, except at a bump post or entering a pocket track, or unless authorized by ROCC or the Interlocking Operator and the move is consistent with customer safety as specified in Rule 3.1."

At approximately 05:18 hours the Train Operator reported to the Interlocking Operator that they were standing by at C99-236 signal red. The Interlocking Operator instructed the Train Operator to stand by while they reported the red signal overrun to a Rail Operations Supervisor. The Interlocking Operator was instructed to notify ROCC and ATCM. ATCM was dispatched to inspect and test the trailed switches. The incident track was returned to service after testing was completed.

Chronological Event Timeline

The Audio Recording System (ARS) playback revealed that at approximately 05:03 hours the Interlocking Operator instructed the Train Operator to report to the S&I Shop car wash to move a four-car consist from the car wash to the 2 West (2W) lead. At approximately 05:08 hours, the Train Operator contacted the Interlocking Operator and reported that they were ready to exit the car wash. The Interlocking Operator instructed the Train Operator to verify C99-208 was lunar, with an absolute block within 10 feet of the next governing signal, C99-204 red, and reverse ends. The Train Operator's transmission back to the Interlocking Operator was not at 100% repeat back. At approximately 05:19 hours, the Train Operator reported to the Interlocking Operator that they were standing by at C99-236 signal red. The Interlocking Operator instructed the Train Operator to standby.

A review of ARS playback, i.e., phone and radio communications, revealed the following timeline:

Time	Description
05:02:20 hours	Interlocking Operator: Attempts to contact the train operator. [Radio]
05:03:05 hours	Interlocking Operator: Attempts to contact the train operator. [Radio]
05:03:15 hours	Interlocking Operator: "Alex Tower." Train Operator: "It's [Train Operator.]" Interlocking Operator: "When you come over to the car wash, car maintenance already put the cars in the shop. Get the four cars that's in the car wash. We're going to put those on 2 west lead and then we should be done." Train Operator: "Okay, the four cars in the car wash to 2 west lead?" Interlocking Operator: "Uh, huh." Train Operator: "Ok, bye." [Phone]
05:08:56 hours	Train Operator: "Tower, train operator getting ready to exit the car wash with four cars." Interlocking Operator: "Verify C99-208 lunar, absolute block, 10 feet of C99-204 red and reverse ends, over." Train Operator: "Verifying C99-208 lunar, go around to C99-144 reverse." [Radio] *Note: Interlocking Operator does not respond.*
05:18:32 hours	Train Operator: "Tower standing by C99-236 red." [Radio]
05:19:00 hours	Interlocking Operator: "You were supposed to come out on the west side." [Ambient]
05:19:47 hours	Train Operator: "Tower you copy C99-236 red." Interlocking Operator: "Standby." [Radio]
05:20:12 hours	Interlocking Operator: "I think the train operator just ran a signal." RTRA Supervisor: "Where?" Interlocking Operator: "Over by the car wash. I told them to come out C99-208 on the west side. They came out on the east side, they're standing by 236 and the whole thing is lit up." RTRA Supervisor: "Say what?" Interlocking Operator: "They was supposed to come out with 4 cars out of the car wash and come out the west side. I got a lunar set for them to come out at 208 and clear 206 to go to 2 west lead. They went out the east side, the signal over there was red. They're holding at C99-236, like they're coming back to the yard and the whole side is lit up." RTRA Supervisor: "They forced it open?" Interlocking Operator: "Right." RTRA Supervisor: "Did they say east or west?" Interlocking Operator: "I told them over the radio to take the 4 cars out of the car wash and you're going to put them on 2 west lead. Now they're holding at 236. I'm about to send you the map, but when I looked 211 is flashing and the whole east side, the whole route is lit up because he ran that signal." RTRA Supervisor: "Okay, call ATC and report it to Central." [Phone]

Time	Description
05:23:12 hours	ROCC Asst. Operations Manager: “ROCC.” Interlocking Operator: “A train operator overran 222 in Alexandria Yard.” ROCC Asst. Operations Manager: “222?” Interlocking Operator: “Yes, it’s near the car wash. They were supposed to come out at C99-208. They came out C99-222; switch 211 is flashing out of correspondence in reverse.” [Phone]
05:26:29 hours	Interlocking Operator: “ATC, over.” ATCM: “This is ATC.” Interlocking Operator: “Give the tower a landline.” [Radio]
05:28:09 hours	Interlocking Operator: “Can you go over to switch 211, it looks like the train operator ran the signal? Can you go standby? We need you to check out the switches.” ATCM: “Where?” Interlocking Operator: “Over near the car wash, the east side signal 222.” ATCM: “Okay, I’ll be over there.” [Phone]

**Note: Times above may vary from other system's timelines based on clock settings.

Rail Car Video Recordings

Figure 1 – 4-Car Consist leaving the car wash eastbound, approx. 05:14 hours.

Figure 2 – 4-Car Consist stopped at C99-222 signal red, approx. 05:17 hours.

Figure 3 – 4-Car Consist approaching C99-236 signal red, approx. 05:18 hours.

The Office of Chief Mechanical Officer (CMOR) / Vehicle Monitoring and Diagnostic System (VMDS) Timeline

Event Recorder (ER) Data Graph/Sequence of Events

Based on CMOR/IIT analysis of the downloaded VMDS and ER, details from the data analysis are as follows:

IIT has completed the data downloads and analyzed the data retrieved from the cars in question. Per the Network Video Recording (NVR) and ER data, R7684 was parked inside C99 wash track #1. At 05:14:28 the train keyed up and began to move east towards interlocking signal C99-222. The train stopped 11 feet from C99-222 red signal for 5 seconds and continued to move passing C99-222 red signal and trailed switch 211. The train came to a complete stop at C99-236.

Based on the ER data and VMDS logs, there were no faults with the train during the reported incident time that contributed to the cause of this incident. The train performed as designed.

Time	Description
05:14:28 hours	Rail Car 7684 keyed up.
05:14:45 hours	Train entered the Stop and Proceed mode.
05:14:46 hours	Master Controller placed in a “P1-P4” Power Mode.
05:14:49 hours	Train began to move in east direction towards C99-222.
05:17:07 hours	Train came to a complete stop 11 feet of C99-222 signal.
05:17:12 hours	Train began to move passing C99-222 signal red. Master Controller was placed in a “P1-P4” Power Mode.
05:18:14 hours	Train came to a complete stop at C99-236.

Note: Times above may vary from other system’s timelines based on clock settings.

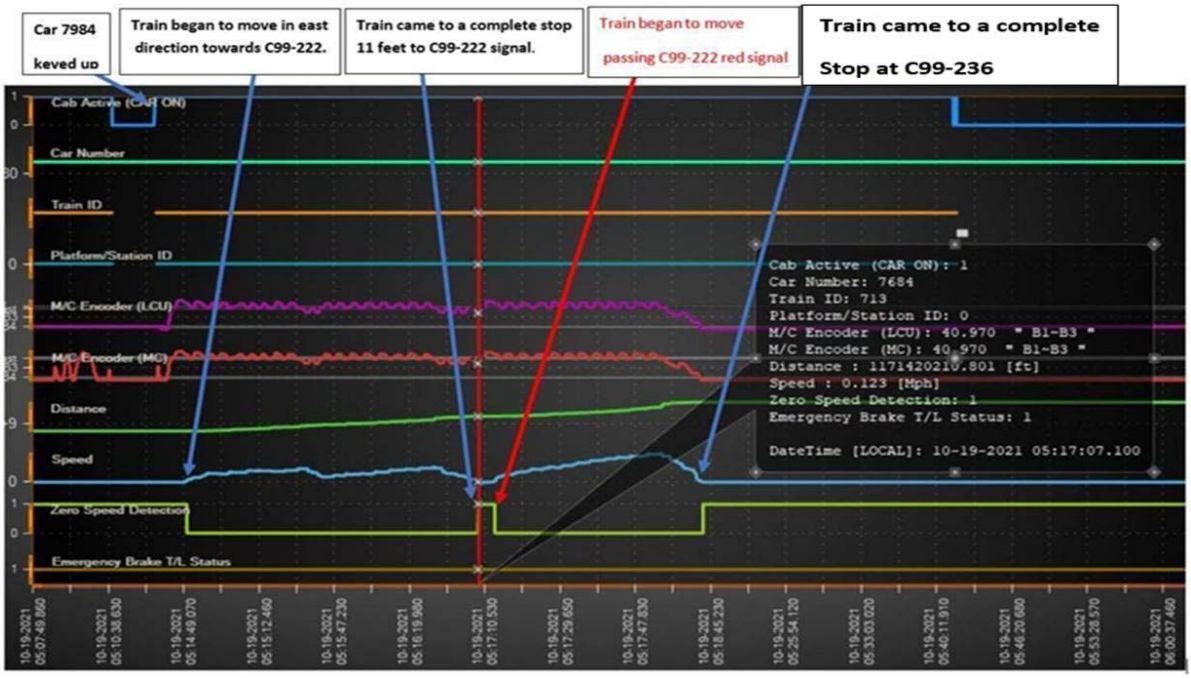


Figure 4 – Event Recorder Graphical Analysis

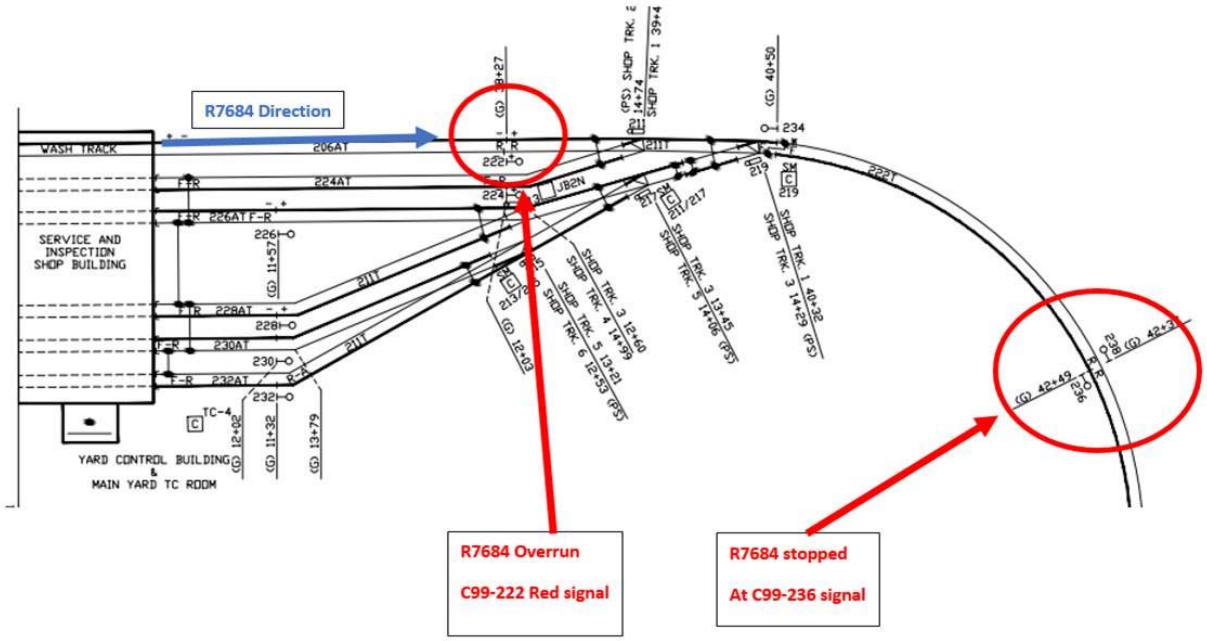


Figure 5 – C99 Track Map

Automatic Train Control Maintenance (ATCM)

ATCM performed a Switch Obstruction Test on switches 119 and 211, details from the results are as follows:

"Switch 211 was trailed, exercised and in correspondence both Normal and Reverse positions. Both switches passed the obstruction test."

Office of Radio Communications (COMR)

After reviewing the Audio Recording System (ARS) playback there did not appear to be any communication deficiencies over the radio.

Office of Car Maintenance (CMNT)

CMNT performed an exterior and interior inspection of the affected car and found no equipment related issues. Additionally, CMNT performed a post-incident inspection on the master controller, brake system, and propulsion system. CMNT found these subsystems worked as designed. CMNT did not identify any anomalous conditions that contributed to the red signal overrun incident.

Interview Findings

Based on the investigation launched in the Alexandria Rail Yard Red Signal Overrun incident, SAFE conducted the following two virtual interviews via Microsoft Teams, which included members of the SAFE investigation team and the Washington Metrorail Safety Commission (WMSC):

The Interlocking Operator stated that the day was going normal, the pipe to the bathroom was backed up, and they had to deal with that throughout the night. The night was moving steady and they called the Train Operator to make moves in the shop. The Train Operator reported on duty during their shift and that was the first move that they had instructed the Train Operator to do. They called the Train Operator over the radio, and the Train Operator did not answer, then they called the Clerk to see if the Train Operator was at work. The Train Operator called the Tower by phone and the Interlocking Operator informed the Train Operator that there were 4 rail cars in the shop that needed to be moved to 2W lead. The Interlocking Operator instructed the Train Operator to go over to the shop, where 4 rail cars were left in the car wash. The Interlocking Operator instructed the Train Operator to move the 4 rail cars from the car wash to 2W lead so that when car maintenance was finished inspecting the cars on 2W and 2E, those cars could move out of the shop by way of the east side and the 4 cars on 2W lead could move into the shop. The Interlocking Operator set a lunar at C99-208 signal and began printing paperwork from the RPM since it was the close of the shift. When they heard from the Train Operator again, they were at C99-236 signal red. When they looked at the board, that's when the Interlocking Operator realized that the Train Operator ran the signal.

The Train Operator stated that they began the day as directed at Huntington Station to assist with the derailment work until 01:00 hours. They reported to Alexandria Yard to work at 02:00 hours. They were waiting around and then were called by the Tower to make a move. The Interlocking Operator instructed them to move 4 rail cars from the shop to 2W lead. The Train Operator repeated the instructions to move 4 rail cars to 2W lead. The Train Operator received a ride over to the shop and the Interlocking Operator informed them that the 4 rail cars were in the car wash and they repeated inside the car wash. The Train Operator got to the car wash and keyed up the train, then realized that the train did not move because the doors were open. The Train Operator closed the doors, looked out the window and noticed the outside switch at doors 3 and 4 was open. They keyed down and went to normalize the train doors. After all the doors were closed, the Train Operator keyed up from a different cab and received an all doors closed. They continued to the front of the train, then keyed up and reported to the Tower that the train was moving. The Train Operator then proceeded out of the car wash thinking that they were going to C99-144 to reverse ends.

Weather

On October 19, 2021, at the time of the incident, NOAA recorded the temperature as 48° F, with clear skies. SAFE has concluded that weather was not a contributing factor in this incident (Weather source: NOAA – Location: Alexandria, VA)

Human Factors

Fatigue

Signs and Symptoms of Fatigue

Train Operator
The conditions of at the time of the incident were evaluated to distinguish whether evidence of fatigue was present. Video of the incident was reviewed for behaviors suggesting fatigue. No indications of fatigue were evident from the video. The Train Operator reported feeling moderately

alert at the time of the incident. The Train Operator reported symptoms of fatigue including feeling sluggish.

Interlocking Operator

Conditions of at the time of the incident were evaluated to distinguish whether evidence of fatigue was present. Video of the involved person was not available to ascertain whether evidence of fatigue was present. The Interlocking Operator reported feeling fully alert at the time of the incident. The Interlocking Operator reported experiencing no symptoms of fatigue in the time leading up to the incident.

Fatigue Risk

Train Operator
Incident data was evaluated for fatigue risk factors. Risk factors for fatigue were identified. The incident time of day (5:44 hours) suggests an increased risk of fatigue-related impairment. The employee worked evening shifts in the week leading up to the incident, including an overtime shift of 14 hours (16:08 – 1:17 and 2:00 – 7:00) the day preceding the incident. The employee's bed and wake times on the day preceding the incident could not be confirmed; therefore, the employee's total number of sleep hours in the sleep period preceding the incident and hours awake at the time of the incident could not be determined. The employee reported some variation in sleep schedule in the days leading up to the incident and habitual workday sleep durations of 6 hours. The off-duty period preceding the incident was 9.35 hours long, which provided the opportunity for 7-9 hours of sleep. The employee reported no issues with sleep.

Because of unreliable bed and wake time information, the presence of fatigue risk factors contributing to the incident could not be thoroughly evaluated with a modeling analysis.

Interlocking Operator

Incident data was evaluated for fatigue risk factors. Risk factors for fatigue were identified. The incident time of day (5:44 hours) suggests an increased risk of fatigue-related impairment. The employee worked overnight shifts (22:00 – 6:00) in the week leading up to the incident. Based on the employee's reported bed and wake times the day before the incident, the employee slept a total of 8.5 hours in the sleep period preceding the incident and was wake for 9.3 hours at the time of the incident. The off-duty period preceding the incident was 15.9 hours long, which provided the opportunity for 7-9 hours of sleep. The employee reported usual workday sleep durations of 7.5 hours and no issues with sleep.

A biomathematical fatigue modelling application (SAFTE-FAST WebSFC) was used to further evaluate fatigue risk factors that may have been present in the Interlocking Operator's schedule. The analysis was based on the Interlocking Operator's work schedule, bed, and wake times from the day before the incident and reported habitual sleep durations. Estimated performance effectiveness at the time of the incident was 77.2%. Specifically, the analysis identified the circadian effects of night work as a factor contributing to an increased risk of fatigue at the time of the incident.

Modeling analysis output shows estimated performance effectiveness during the incident work shift and for the week leading up to the work shift, based on the employee work and reported sleep schedule. Estimates were based on the Interlocking Operator's work schedule, bed, and wake times from the day before the incident and reported habitual sleep durations (7.5 hours a day). Bold portions of the modeled curve show work (in black) and sleep times (in blue). Effectiveness is shown on the vertical axis, with colored fields in the chart background signifying ranges of effectiveness scores including high effectiveness (>90%) in green, and low effectiveness (<65%) in red. Time is shown on the horizontal axis. Markers for work and sleep times are shown in the lanes above the time of day on the horizontal axis.

Post-Incident Toxicology Testing

After reviewing the Train Operator's post-incident testing results, SAFE determined the employee complied with the Drug and Alcohol Policy and Testing Program 7.7.3/6.

After reviewing the Interlocking Operator's post-incident testing results, SAFE determined the employee complied with the Drug and Alcohol Policy and Testing Program 7.7.3/6.

Findings

- The Train Operator did not transmit 100% repeat back of instructions, and the Interlocking Operator did not correct the Train Operator when they did not repeat the correct instructions.
- The Train Operator failed to verify a lunar and correct rail alignment and did not have permission to pass C99-222 signal red before moving the train.
- CMOR/IIT analysis on the affected consist showed the consist stopped 11 feet from C99-222 signal red for 5 seconds, then continued to move, passing C99-222 red signal
- A possible fatigue factor was present on the part of the Train Operator due to the Train Operator working evening shifts in the week leading up to the incident, and working a

regular shift to include overtime totaling 14 hours (16:08 – 01:17 hours and 02:00 – 07:00 hours) the day preceding the incident.

Immediate Mitigation to Prevent Recurrence

- RTRA removed the Train Operator and Interlocking Operator from service for post-incident toxicology testing.
- RTRA removed the incident consist from service for CMNT inspection and CENV analysis.

Probable Cause Statement

The probable cause of the Red Signal Overrun incident was a failure to adhere to established rules and procedures when in approach of a red signal, as identified in the Metro Rail Safety Rules and Procedures Handbook (MSRPH) – Sec. 3 OR 3.67, which states, "*Rail vehicles shall not be operated past or closer than a point 10 feet in approach of an interlocking signal or lamp displaying a red aspect, a red flag, or a dark interlocking signal, except at a bump post or entering a pocket track, or unless authorized by ROCC or the Interlocking Operator and the move is consistent with customer safety as specified in Rule 3.1*." The Train Operator appears to have lost their situational awareness, as they reported receiving a ride to the shop area and possibly due to having to normalize the train doors prior to moving, leading to their failure to observe and report the red signal to the Interlocking Operator before passing. Additionally, the inadequate oversight of the Interlocking Operator when they failed to establish 100% repeat back after the Train Operator transmitted the incorrect instruction before exiting the car wash was a contributing factor to the incident.

Another potential contributing factor to the incident was possible fatigue on the part of the Train Operator. The Train Operator worked evening shifts in the week leading up to the incident, and worked a regular shift to include overtime totaling 14 hours (16:08 – 01:17 hours and 02:00 – 07:00 hours) the day preceding the incident.

SAFE Recommendations/Corrective Actions

Corrective Action Code	Description	Responsible Party	Due Date
96234_SAFE CAPS_RTRA _001	Schedule and ensure the Train Operator and Interlocking Operator complete refresher training on General Rule 1.79 and other relevant radio communication training.	RTRA	Completed
96234_SAFE CAPS_RTRA _002	Schedule and ensure the Train Operator completes refresher training to include Operating Rule 3.67.2, Passing a Red Signal.	RTRA	Completed
96234_SAFE CAPS_RTRA _003	RTRA Management to produce a Lessons Learned and distribute throughout department.	RTRA	Completed

Appendices

Appendix A – Interview Summary

RTRA

Interlocking Operator
The Interlocking Operator is a WMATA employee with 14.5 years of service and five (5) years of experience as an Interlocking Operator. The Interlocking Operator holds a Roadway Worker Protection (RWP) Level 2 certification that expires in February 2022.

During the virtual interview, the Interlocking Operator stated that the day was going normal, the pipe to the bathroom was backed up, and they had to deal with that throughout the night. The Interlocking Operator stated that the night was moving steady and they called the Train Operator to make moves in the shop. The Interlocking Operator stated that the Train Operator reported on duty during their shift. The Interlocking Operator stated that that was the first move that they had instructed the Train Operator to do. The Interlocking Operator stated that they called the Train Operator over the radio and the Train Operator did not answer, then they called the Clerk to see if the Train Operator was at work. The Interlocking Operator stated that the Train Operator called the Tower by phone and that they informed the Train Operator that there were 4 rail cars in the shop that needed to be moved to 2W lead. The Interlocking Operator stated that they instructed the Train Operator to go over to the shop, where 4 rail cars were left in the car wash. The Interlocking Operator stated that they instructed the Train Operator to move the 4 rail cars from the car wash to 2W lead so that when car maintenance was finished inspecting the cars on 2W and 2E, those cars could move out of the shop by way of the east side and the 4 cars on 2W lead could move into the shop. The Interlocking Operator stated that they set a lunar at C99-208 signal, and they began printing paperwork from the RPM since it was the close of the shift. The Interlocking Operator stated that when they heard from the Train Operator again, they were at C99-236 signal red. The Interlocking Operator stated that when they looked at the board, that's when they realized that the Train Operator ran the signal.

Train Operator
The Train Operator is a WMATA employee with 9.5 years of service and four and a half (4.5) years of experience as a Train Operator. The Train Operator holds a Roadway Worker Protection (RWP) Level 2 certification that expires in August 2021.

During the virtual interview, the Train Operator stated they began the day As Directed at Huntington Station to assist with the derailment work until 01:00 hours. The Train Operator stated that they reported to Alexandria Yard to work at 02:00 hours. The Train Operator stated that they were waiting around and then were called by the Tower to make a move. The Train Operator stated that the Interlocking Operator instructed them to move 4 rail cars from the shop to 2W lead. The Train Operator stated that they repeated the instructions to move 4 rail cars to 2W lead. The Train Operator stated that they received a ride over to the shop, and the Interlocking Operator informed them that the 4 rail cars were in the car wash, and they repeated inside the car wash. The Train Operator stated that they got to the car wash, keyed up the train, then realized that the train did not move because the doors were open. The Train Operator stated that they closed the doors, looked out the window and noticed the outside switch at doors 3 and 4 was open. The Train Operator stated that they keyed down and went to normalize the train doors. The Train Operator stated that after all the doors were closed, they keyed up from a different cab and

received an all doors closed. The Train Operator stated that they continued to the front of the train, then keyed up and reported to the Tower that the train was moving. The Train Operator stated that they proceeded out of the car wash thinking that they were going to C99-144 and reverse ends. The Train Operator stated that they haven't worked in the yard too much. The Train Operator stated that they feel familiar with the yard and yard procedures.

Appendix B – Incident Photos

Image 2 - 4-Car Consist stopped C99-236 signal after passing C99-222 signal red and trailing switch 211.

Image 3 – Switch 211, trailed when the 4-car consist passed C99-222 signal red.

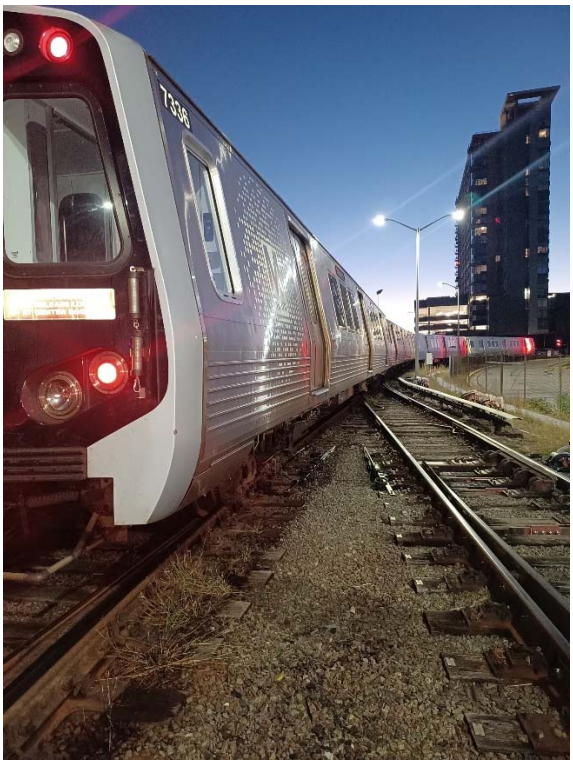


Image 4 - 4-Car Consist stopped C99-236 signal red, after passing C99-222.

Appendix C – Maximo Data

Washington Metropolitan Area Transit Authority
Maintenance and Material Management System
Work Order Details

Work Order #: 16647112
Type: CM

Status: CLOSE
10/24/2021 20:17

Work Description: TRAIN RAN RED SIGNAL C99 - 222.
Job Plan Description:

Work Information

Asset:	R7684 7684, RAIL CAR, KAWASAKI, 7000 AC, A CAR	**Owning Office:**	CMNT-CMNT-CMNT	**Parent:**	
Asset Tag:	R7684	**Maintenance Office:**	CMNT-BRWD-INSP	**Create Date:**	10/19/2021 07:42
Asset S/N:	7684	**Labor Group:**	CMNT	**Actual Start:**	10/19/2021 07:48
Location:	1151 B99, BRENTWOOD YARD	**Crew:**		**Actual Comp:**	10/24/2021 15:01
Work Location:	1213 C99, ALEXANDRIA YARD	**Lead:**		**Item:**	K18050001
Failure Class:	CMNT001 RAIL CAR	**GL Account:**	WMATA-02-33330-50499160-041-**********-*****-OPR**		
Problem Code:	1025 ACCIDENT/COLLISION/DERAIL	**Supervisor:**	E002287	**Target Start:**	
Requested By:		**Requestor Phone:**	703-667-2858	**Target Comp:**	
Chain Mark Start:		**Chain Mark End:**		**Scheduled Start:**	
Create-Mileage:	396023.0	**Complete-Mileage:**	146661.0		

Task IDs

Task ID							
10	TRAIN IN THE YARD. COMPLIED WITH ENGINEERING RECOMENDATIONS. VISUAL INSPECTION OF WHEELS REVEALED NO FLATS. SEE DETAILS... PERFORMED MC OPERATIONAL CHECK OK. RECORDED MC ENCODER VALUES CST-B5, AND P1-P5: CST=49.60, B1=40.82, B2=31.20, B3=23.97, B4=15.08, AND B5=9.91 COMPLIED WITH BRAKE RATES CHECK. VALUES WITHIN SPEC. FRONT: CST=0, B1=9, B2=17, B3=24, B4=34, B5=44 AND EMERGENCY=46 REAR: CST=0, B1=9, B2=17, B3=24, B4=35, B5=44 AND EMERGENCY=44 CHECKED DEADMAN OPS OK. RUN DI-OK.						
Component:	000-300-D01 PROPULSION: MASTER CONTROLLER; MP; 2K/3K/6K/7K	**Work Accomp:** CHECKED	**Reason:** INCIDENT//ACCIDENT	**Status:** CLOSE	**Position:**	**Warranty?:** Y	
20	INSPECTED AND MEASURED WHEELS. INSPECTED UNDERCAR IN SHOP, NO FLATS OR SPALLING ALL FLANGE SIZE ARE GOOD.						
Component:	000-300-K03 TRUCK&SUSPENSION: WHEEL & AXLE ASSY; TRUCK; 2K/3K/6K/7K	**Work Accomp:** INSPECTED	**Reason:** INCIDENT//ACCIDENT	**Status:** CLOSE	**Position:** 213	**Warranty?:** Y	

Actual Labor

Task ID	Labor	Start Date	End Date	Start Time	End Time	Approved?	Regular Hours	Premium Hours	Line Cost
10	[redacted]	10/20/2021	10/20/2021	02:00	04:00	Y	02:00	00:00	$85.59
20	[redacted]	10/23/2021	10/23/2021	18:00	19:00	Y	01:00	00:00	$38.85
20	[redacted]	10/23/2021	10/23/2021	18:00	19:00	Y	01:00	00:00	$41.97

Document 1 – CMNT Maximo Work Order #16647112 detailing inspections conducted. (Page 1 of 2)

Washington Metropolitan Area Transit Authority
Maintenance and Material Management System
Work Order Details

Work Order #: 16647112
Type: CM

Status: CLOSE
10/24/2021 20:17

Work Description: TRAIN RAN RED SIGNAL C99 - 222.
Job Plan Description:

Actual Labor

Task ID	Labor	Start Date	End Date	Start Time	End Time	Approved?	Regular Hours	Premium Hours	Line Cost
						Total Actual Hour/Labor:	04:00	00:00	$166.41

Related Incidents

Ticket	Description	Class	Status	Relationship
8566022	A RED SIGNAL OVER RUN ON SIGNAL C99-222 IN CAR WASH SWITCH 211 OUT OF CORRESPONDENCE IN REVERSE	SR	CLOSED	ORIGINATOR

Failure Reporting

Cause		Remedy		Supervisor	Remark Date
2090	IMPROPER EQUIPMENT USAGE CAUSING FAILURE	3192	TESTED / INSPECTED	[redacted]	10/24/2021
Remarks:	GOOD MASTER CONTROLLER OPS CHECK, BRAKE RATES, NO FLATS/WHEEL FLANGE DEFECTS FLANGES, ALL GOOD. COMPLIED WITH CMOR SI 3G# RED SIGNAL OVERRUN FOR CLASS 1 VEHICHLES.				

Document 2 - CMNT Maximo Work Order #16647112 detailing inspections conducted. (Page 2 of 2)

Appendix D – RTRA Lessons Learned

Office of Rail Transportation

Lessons Learned

RTRA OFFICE OF RAIL TRANSPORTATION

metro

Looking back, to effectively move forward

November 24, 2021
Number: 303-02-00

Red Signal Overrun Alexandria Yard (C99)

INCIDENT SUMMARY

On Tuesday, October 19, 2021, at approximately 5:17am, there was a red signal overrun at Alexandria Yard (C99). The train involved overran C99-222 signal, red and trailed switch 211. All appropriate notifications were made (ROCC, ATC, Division Management and SAFE) and the operator was removed from service and transported for post incident testing and interviewed with SAFE Department and Division Management personnel. There were no injuries reported because of this incident.

ROOT CAUSES

The Interlocking Operator is heard providing specific instructions over the radio to the operator requiring the operator to board a 4-car consist for a **westbound** move. Although the operator repeated back the transmission, the operator boarded the 4-car consist (from the wrong end) and made an **eastbound** move. In doing so, the operator overran C99-222 signal, which was red. The operator's inattentiveness contributed to this incident.

MSRPH RULES VIOLATED

OR 3.67 Rail vehicles shall not be operated past or closer than a point of 10 feet in approach of an interlocking signal or lamp displaying a red aspect, a red flag, or a dark interlocking signal unless authorized by ROCC or the Interlocking Operator and the move is consistent with customer safety as specified in Rule 3.1. ROCC or Interlocking Operator shall give permission to pass a red signal or dark aspect after the switches have been blocked or clamped for the required move in accordance with SOP #35. Once this has been verified the train or track unit will be given permission to pass the red signal or dark aspect at a speed not greater than 5 mph.

OR 3.77 If a rail vehicle runs through an improperly aligned track switch, the operator shall stop the vehicle immediately, and report the occurrence to ROCC or the Interlocking Operator. All parties shall treat the situation as if the vehicle has derailed (SOP #9), and the vehicle shall not be undertaken until investigated and determined to be safe, by authorized personnel.

GR 1.79 Personnel shall not take any action until they are positive that all radio transmissions or receptions are heard, fully understood, and acknowledged. Individual radio transmissions shall, at all times, be repeated by the receiver so the transmitter can confirm the message was received completely and by the intended receiver. Whenever the transmitter has completed their transmission and is turning the airtime over to the receiving party for acknowledgment or reply, they are to end their communication with the word "over."

LESSONS LEARNED

What happened…	*What should have happened…*
The interlocking operator's (IO) original instructions to the operator were to move four cars to 2 west lead (west bound move). The Train operator boarded the train and began moving east bound passing C99-222 signal red and trailing switch 211. The operator never contacted the Tower before moving.	The operator should have contacted the interlocking operator (IO) once he boarded the train to establish positive communication before moving. Therefore, the IO would have known the operator was keyed up on the wrong end of the train and would have instructed the operator to reverse ends.
The train operator moved eastbound (wrong direction) passing C99-222 signal red trailing switch 211. The train operator stopped the train at C99-236 red.	The train operator should have verified a lunar signal and correct rail alignment before moving. When the operator observed C99-222 signal red, he should have stopped the train and contacted the IO. Instead he continued moving past the red signal.

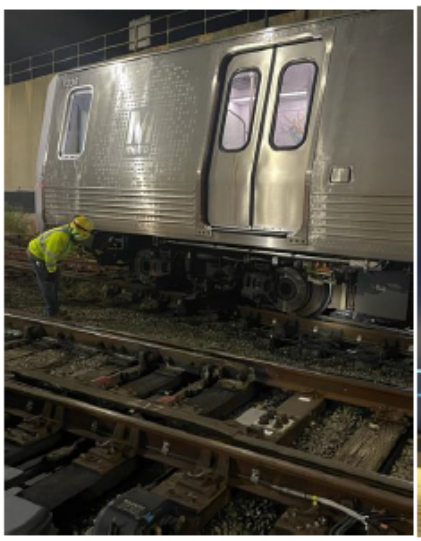
Document 3 – RTRA Lessons Learned (Page 1 of 2)

RTRA Lessons *Learned*

Looking back, to effectively move forward

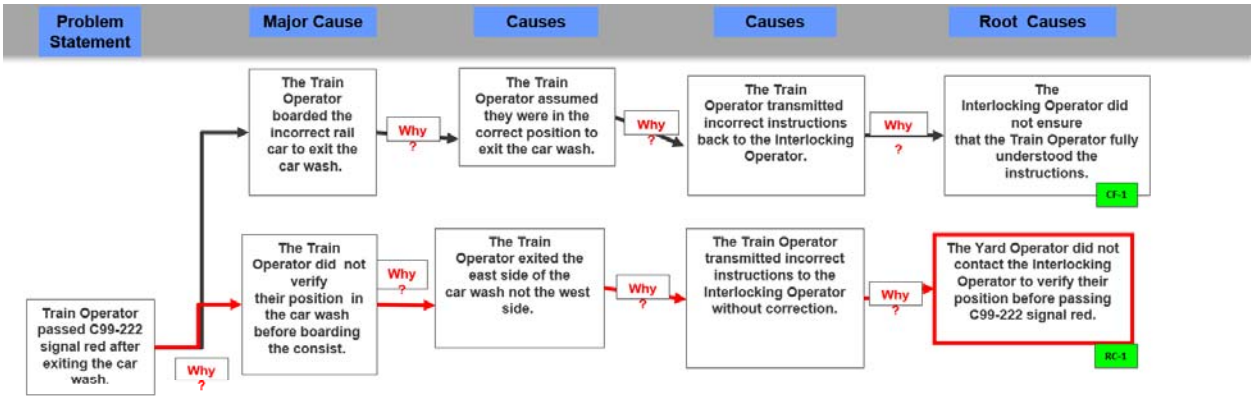
RECOMMENDATIONS

- ✓ Emphasize that all operations personnel abide by all SOP's when operating trains.
- ✓ Emphasize the importance of operators being attentive to instructions from Interlocking Operators, Supervisors and ROCC, as well as confirming these instructions before moving their train.
- ✓ Stress the importance of operators establishing proper radio communications and repeat-backs to ensure the message is understood before moving a train.
- ✓ Stress the importance of verifying all lunar signals and rail alignment while operating trains and to move no closer than 10 feet of a red signal



Document 4 – RTRA Lessons Learned (Page 2 of 2)

Appendix E - Root Cause Analysis



Root Cause Analysis WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY