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W-0358 – Derailment – West Falls Church Rail Yard Lead – July 1, 2023

Document Purpose:

This WMSC written report on WMATA Metrorail's safety event investigations and review of Metrorail's findings in accordance with the WMSC Program Standard, in conjunction with the attached Metrorail investigation reports that have undergone WMSC staff review and, if necessary, feedback and revision, describes the investigation activities, identifies factors causing or contributing to the safety events, and sets forth ongoing, additional, or upcoming corrective actions and further oversight work (such as inspections and audits) as necessary or appropriate. The WMSC's ongoing oversight during the investigative process, including safety event reporting and verification, participation in investigative interviews, data review, consistent communication with the Metrorail investigations team, and feedback on Metrorail's reports leads to further improvements prior to consideration of the reports by WMSC Commissioners for adoption. The WMSC's safety event investigation oversight assures the sufficiency and thoroughness of Metrorail's investigations. The WMSC Commissioners are considering these documents (the WMSC review and Metrorail's investigation reports) as a unified item for adoption at the Washington Metrorail Safety Commission meeting on

WMSC staff recommend adoption of this investigation.

In 2024, Metrorail reported 3 derailments, a decrease from the 7 reported in 2023. All 2024 derailment events involved maintenance vehicles.

Roadway Maintenance Machines

The WMSC's audit of Metrorail's Maintenance Machine Program, issued on October 18, 2023, demonstrated that while Metrorail has made improvements to its RMM program, Metrorail is not effectively tracking and mitigating hazards related to RMM maintenance and operations, and Metrorail has not documented its practices regarding adjustments to its contractor RMM inspection procedures. Metrorail has developed and the WMSC has approved corrective action plans to address the audit's five findings and six recommendations. The WMSC continues to review deliverables for these corrective action plans, which have scheduled completion dates through December 2025 and will conduct oversight activities even after the CAPs are closed to ensure the improvements made continue.

Safety event summary:

A Hi-Rail Vehicle (a rubber-tired road vehicle that also has deployable rail wheels for operation on tracks) derailed in a curve on West Falls Church Yard Lead 2 near the tunnel portal at 3:10 a.m. on Saturday, July 1, 2023. The derailment was not reported to the Interlocking Operator until 4:02 a.m. and third rail power remained energized until that time. The derailment was not reported to the Rail Operations Control Center until 4:23 a.m. Metrorail requires safety events to be reported, in this case to the Interlocking Operator, immediately. This safety event demonstrated several deficiencies, including those related to roadway worker protection, communication, safe vehicle movement and track inspection.

WMSC Investigative Oversight Activities

- Participation in investigative interviews

- Review of documents and data (records, video, audio)
- Coordination with Metrorail investigations team and other Metrorail organizational units
- Review and feedback related to WMATA investigation reports, including corrective actions, to ensure sufficiency of investigation process and continuous safety improvement.

Event details

Hi-Rail Vehicle CR5971, a contractor-owned flatbed truck assigned to retrieve a spool of wire from the area of West Falls Church Station moved from the station toward the West Falls Church Rail Yard at approximately 3:05 a.m. The vehicle was returning to the rail yard because the crew was not granted permission to access Track 1 where the wire was located due to other work activities. The vehicle was operated by an Equipment Operator (contractor) with a Pilot (Metrorail employee).

Metrorail Closed-Circuit Television (CCTV) shows the vehicle moving in a curve, then shows the vehicle stop moving as it begins to exit the tunnel portal approaching the rail yard at 3:10 a.m.

In an investigative interview, the Equipment Operator estimated the vehicle was moving approximately 3 mph at the time they heard a loud noise, which was later determined to be the derailment. In a separate interview, the Pilot stated the vehicle was moving less than 5 mph. There is no vehicle data available to determine the specific speed the vehicle was travelling, but this approximate speed is consistent with what is visible on CCTV.

Response following derailment

The Metrorail employee onboard the vehicle as the Pilot informed the Interlocking Operator at 3:28 a.m. that there was a problem with the vehicle. The Pilot requested and received permission to exit the vehicle to investigate. The pilot identified that the rear right wheel had climbed the low-side running rail and derailed to the field side. The Pilot stated in an investigative interview that they notified their management of the derailment. The crew did not notify the Interlocking Operator or Control Center.

At 3:47 a.m., CCTV shows other personnel arrived in the rail yard and, by 3:48 a.m., began walking on the track toward the derailed vehicle without communicating with the Interlocking Operator responsible for rail vehicle movement and worker protection in this area.

At 3:58 a.m., a Track and Structures Supervisor reached the location, but informed the Interlocking Operator by phone that they were attempting to perform a track inspection between the third rail and running rail, and requested de-energization of third-rail power. The Interlocking Operator requested more information, however the Supervisor stated only that they “walked up on” an issue with the vehicle and they were investigating.

At 4:02 a.m., the Track and Structures Superintendent reported to the Interlocking Operator by phone that CR5971’s rear wheels had derailed within the West Falls Church Rail Yard, and that third rail power needed to be de-energized. The Superintendent told the Interlocking Operator to stand by, and that they would contact the Safety Department.

At 4:21 a.m., the Interlocking Operator requested an update from the Track and Structures Superintendent. The Superintendent stated the vehicle would likely need to be re-railed from behind.

At 4:23 a.m., an Office of Capital Delivery Construction Manager reported the derailment to the Buttons Rail Traffic Controller. When informed that the Control Center had not been informed of the derailment that occurred more than an hour earlier, the manager suggested the Controller contact the Safety Department for more information.

At 4:25 a.m., the Interlocking Operator reported the derailment to the Buttons Rail Traffic Controller. The Buttons Rail Traffic Controller stated that third-rail power should remain energized. The Interlocking Operator stated that trains could still be dispatched from the yard on Yard Lead 1 adjacent to the derailment.

By 4:34 a.m., additional Metrorail employees and contractors walked from the yard parking lot down Yard Lead 1 to the derailment location. No one in this group communicated with the Interlocking Operator.

At 4:47 a.m., the Mission Assurance Coordinator in the Control Center reported the derailment to the Metro Transit Police Department. The police dispatcher dispatched officers at 5:02 a.m.

At 5:10 a.m., Metrorail personnel moved another Roadway Maintenance Machine, SwingMaster (SM) 03 down the adjacent track that they planned to use to re-rail the derailed vehicle.

At 5:16 a.m., a Traction Power Maintenance employee, who reported that they were functioning as the Roadway Worker In Charge for the extended shutdown on the mainline tracks outside of the yard where this vehicle was coming from, contacted the Interlocking Operator to request permission to enter the roadway. The Interlocking Operator granted permission and stated that the worker should provide their own protection. No other personnel notified the Interlocking Operator before entering the roadway, as required by Metrorail policy.

A Safety Department representative and Automatic Train Control Maintenance personnel arrived.

At 5:28 a.m., the Traction Power Maintenance employee requested that third-rail power be de-energized. The Interlocking Operator initially denied this safety request, and stated power needed to remain energized so that service could be maintained by dispatching trains from the yard as the system prepared to open.

At 5:37 a.m., the Pilot of the derailed vehicle stated to the Interlocking Operator that switches had been clamped. The ATC Maintenance crew conducting the work had not reported completing clamping. The Interlocking Operator stated that if the track was clear, the vehicle had permission to pass Signal K99-56 after verifying the switches were in the normal position (straight through move). However, the vehicle was still derailed.

An MTPD Officer and Car Maintenance personnel arrived on scene. The Car Maintenance personnel requested and received permission from the Interlocking Operator to enter the roadway to re-rail CR5971. The Interlocking Operator stated that third-rail power was still energized.

At 5:59 a.m., third rail power was subsequently de-energized by the Interlocking Operator.

By 6:26 a.m., after two unsuccessful-railing attempts, Metrorail lifted the back wheels of CR5971 and began pushing it to the asphalt grade crossing in the rail yard. There was no phone or radio communication at this time with the Interlocking Operator about the movement of the vehicle. Metrorail's Safety Department Office of Emergency Preparedness personnel on scene recorded that the vehicle derailed a second time during a test movement after a first re-railing attempt. Throughout the event, Metrorail continued train movement on the adjacent track, Yard Lead 1.

At 6:50 a.m., a Car Maintenance Road Mechanic reported that the unit had been moved off of the tracks.

At 6:54 a.m., the new Interlocking Operator taking over at a shift change announced that third-rail power was being re-energized at the derailment site. Power was re-energized at approximately 7:03 a.m.

Post-derailment vehicle inspection

The vehicle was lifted from the rear so that it could be pushed and was moved into the rail yard. Metrorail utilized SwingMaster (SM) 03 to lift it, and did not use its typical rerailing equipment.

Post-derailment inspections identified multiple deficiencies on the vehicle. This included a bend in the hi-rail gear that would contribute to uneven loading of the vehicle. No defects had been identified during Metrorail's inspection of the vehicle on April 4, 2023 to certify it for operation in the Metrorail system.

As a result of the WMSC's 2021 finding that Metrorail did not have a procedure for the inspection of contractor hi-rail vehicles, Metrorail developed and implemented CAP C-0092. This CAP included the establishment of CMOR OAP 101-01, Contractor Rail Vehicle Inspection Program. The policy standardizes the inspection processes of all contractor Class 2 Vehicles used on WMATA Roadway and establishes guidelines for ensuring the vehicles are in satisfactory mechanical condition.

At the time of this event, Metrorail's contractor vehicle inspection process did not test movement through a curve with horizontal restraining rail. The cause of the bend in the vehicle frame present after the derailment could not be determined. The inspection also identified a shorn-off grease nipple to the rear right shock absorber. Metrorail's Safety Department released the investigation scene for movement of the vehicle prior to Metrorail's vehicle engineers conducting an inspection of the vehicle at the derailed location. The Safety Department documented the derailment scene.

Review of track conditions and data from prior inspections identified deficiencies such as loose chair and missing bolts. The deficiencies in the curve did not meet Metrorail's requirements for speed restriction or immediate repair. This vehicle had previously moved in and out of the yard on Yard Lead 1. This was the first time the vehicle traversed Yard Lead 2. Other hi-rail equipment being used for this shutdown had used Yard Lead 2 with no identified issues. A track inspection after the derailment identified missing third rail cover boards, corroded third rail, corroded restraining rail, missing restraining top bolts, the chair loose throughout the area, and multiple high bolts. The maximum recorded gauge was 57 7/16 inches, demonstrating lateral movement. The Metrorail inspection recorded the cross level as 13/16'.

During this safety event radio communication transmission quality issues resulted in personnel using cellphones to communicate. Similar issues with radio transmission quality have been identified in several safety event investigations, inspections and audits conducted by WMSC staff. Metrorail is currently undergoing an overhaul of its radio communications system to improve reliability throughout the system. The WMSC continues to closely monitor Metrorail progress on this project.

The causes and contributing factors include:

- Bend in the vehicle frame that resulted in uneven weight distribution and insufficient downforce that disrupted the wheel-rail interface.

As a result of this investigation, Metrorail implemented RCAs

- Metrorail reviewed the process and issued guidance to Safety Department on-call personnel regarding adequate time for subject-matter experts to conduct field assessments.
- Metrorail removed the Hi-Rail Vehicle from service on Metrorail property and required a new certification inspection by Metrorail's Car Track Equipment Maintenance prior to permitting further use at Metrorail.

Related Open CAPS

- CAP C-0241 addressed the finding that Metrorail is not effectively tracking and mitigating hazards related to RMM maintenance and operations in accordance with its PTASP (Scheduled completion date December 2025).
- CAP- C-0242 addresses the finding that Metrorail has not documented its practices regarding adjustments it its contractor RMM inspection procedures (Scheduled completion date June 2025).
- CAP C-0217 addresses the finding that Metrorail personnel are not effectively communicating, responding to and identifying issues related to trouble calls pertaining to communications systems. Metrorail closes communications-related "corrective maintenance" (repair) tickets without effectively identifying, documenting and addressing issues (Scheduled completion date October 2026).

Washington Metropolitan Area Transit Authority
Department of Safety (SAFE)
Office of Safety Investigations (OSI)

FINAL REPORT OF INVESTIGATION A&I E23445

Date of Event:	July 1, 2023
Type of Event:	Derailment
Incident Time:	03:10 hours
Location:	West Falls Church Yard (K99) Yard Lead (YL) 015+00
Time and How received by SAFE:	04:37 hours/MAC Call
WMSC Notification Time:	04:35 hours
Responding Safety Officers:	Office of Emergency Preparedness (OEP) Office of Safety Investigations (OSI)
Rail Vehicle:	Hi-Rail Vehicle Unit ID CR5971
Injuries:	None
Damage:	Minor infrastructure damage
Emergency Responders:	The Office of Track and Structures (TRST) Metro Transit Police (MTPD) The Office of Rail Transportation (RTRA) The Office of Capital Delivery (CAPD) The Office of Safety and Readiness (SAFE) The Office of Vehicle Program Services (CENV)
SMS I/A Number	20230701#109604

July 1, 2023
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Abbreviations and Acronyms

AOM	Assistant Operations Manager
CAPD	Office of Capital Delivery
CENV	Vehicle Program Services
CCTV	Closed-Circuit Television
CMOR	Office of the Chief Mechanical Officer
CTEM	Office of Car Track Equipment Maintenance
DOT	US Department of Transportation
MSRPH	Metrorail Safety Rules and Procedures Handbook
MTPD	Metro Transit Police Department
NOAA	National Oceanic and Atmospheric Administration
OEP	Office of Emergency Preparedness
RTRA	Office of Rail Transportation
ROCC	Rail Operations Control Center
SAFE	Department of Safety
SDOC	Safety Director On-Call
SME	Subject Matter Expert
SMS	Safety Measurement System
TRST	The Office of Track and Structures
WMATA	Washington Metropolitan Area Transit Authority
WMSC	Washington Metrorail Safety Commission

Executive Summary

**Note that all times listed are approximate and may contain minor variations due to differences between systems of record. **

On Saturday, July 1, 2023, at 03:10 hours, Hi-Rail Vehicle Unit CR5971 (a truck outfitted with deployable rail gear) derailed at the West Falls Church Yard portal, located at Yard Lead 2 (YL2) 015+00 while returning to the yard from West Falls Church Station. The derailment area is in a curve, which includes restraining rail. At 03:28 hours, the Pilot on board the unit advised the Interlocking Operator that there was a problem with the unit and requested permission to disembark and investigate. Multiple personnel responded to assist and assess. The Pilot onboard the unit discovered that that the rear right wheel had climbed the low-side running rail and derailed on the field side.

At 04:02 hours, a TRST Superintendent advised the Interlocking Operator that Unit CR5971's back wheels derailed within the West Falls Church Rail Yard halfway inside a portal. The TRST Superintendent advised that third-rail power needed to be removed.

At 04:23 hours, the Office of Capital Delivery (CAPD) Construction Manager advised the Buttons Rail Traffic Controller (RTC) that Unit CR5971 derailed at West Falls Church Rail Yard. The Buttons RTC advised the CAPD Construction Manager that the Rail Operations Control Center (ROCC) had not been previously advised of the incident. The CAPD Construction Manager advised the Buttons RTC to contact SAFE.

Additional personnel responded to the West Falls Church Yard to conduct the field investigation and rerail the equipment. The vehicle was removed from the roadway at 06:32 hours. There were no injuries or significant damage as a result of this event. Prior to the event, multiple rail vehicles successfully traversed the location without incident. This was the first time CR5971 traversed YL2.

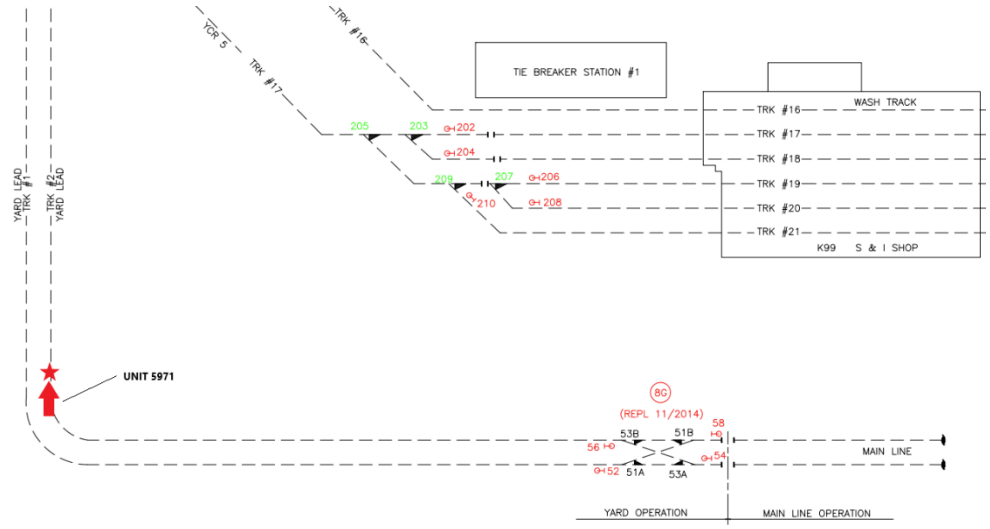
A post-incident inspection of the curve and restraining rail found minor deficiencies, which did not require immediate mitigation. WMATA Subject Matter Experts (SME) examined the vehicle after the event and noted a bend in the vehicle frame that would contribute to the uneven loading of the vehicle. The origin of the defect was not able to be identified but was not observed during the contractor vehicle's certification conducted on April 04, 2023.

The probable cause of the Derailment event on July 1, 2023, at West Falls Church Rail Yard was wheel climb at the point of derailment due to a bend in the vehicle frame that resulted in uneven weight distribution on the road wheels and a lack of rail wheel interface with the right (low) running rail.

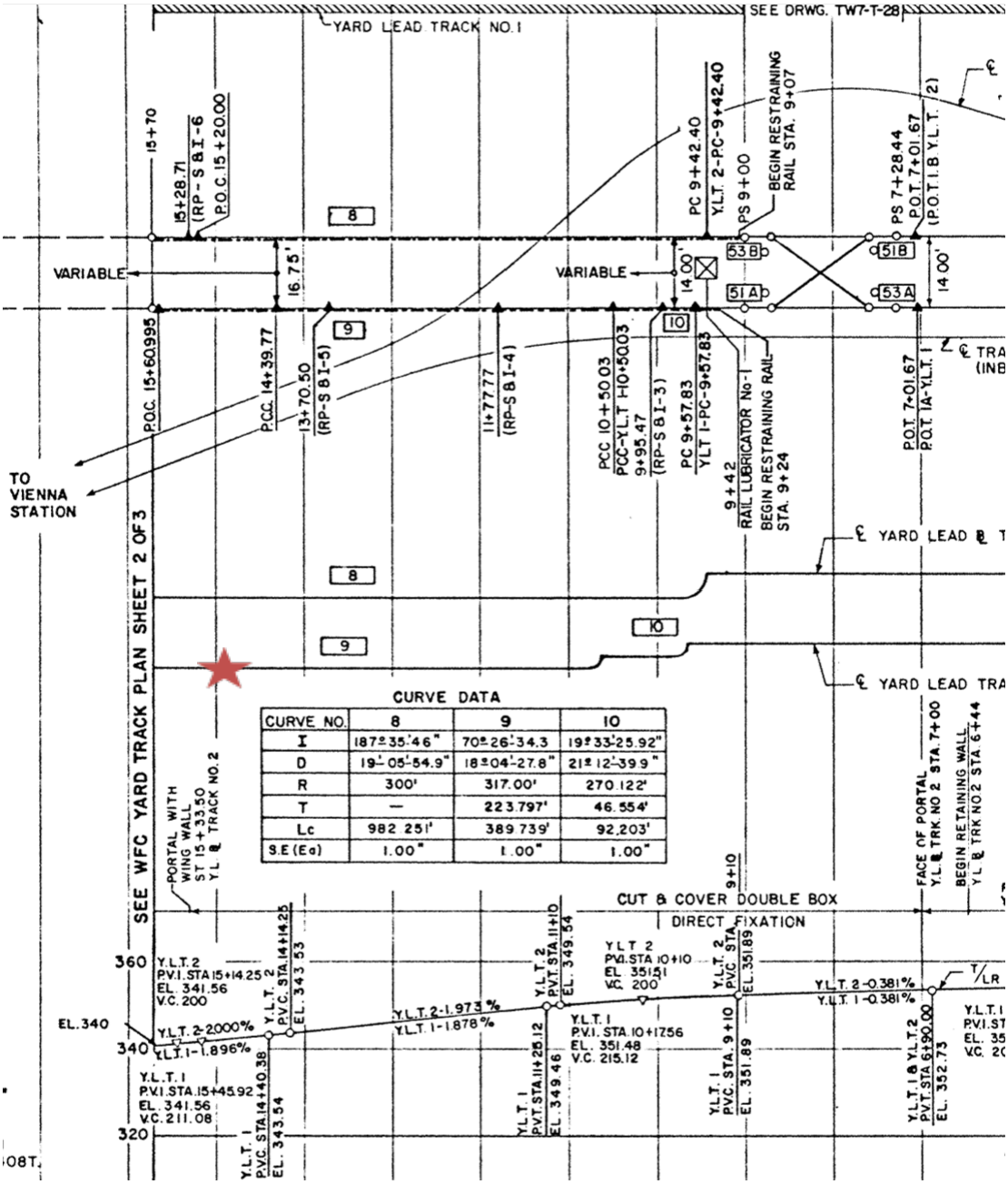
Incident Site

West Falls Church Yard (K99)
YL 2 015+00

Field Sketch/Schematics



Approximate incident site and location of derailment marked with a "red star." The above depiction is not to scale.



Approximate incident site and location of derailment marked with a "red star" on Track Drawing. Not to scale.

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

The investigative methodologies included the following:

- Physical Site Assessment

- Formal Interviews – SAFE interviewed three individuals as part of this investigation. 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:
    - The Equipment Operator (Hi-Rail Unit ID CR5971)
    - The Pilot (Hi-Rail Unit ID CR5971)
    - The Interlocking Operator

- Informal Interviews – Collected through conversations with individuals during the investigation to provide background and supporting information. Written statements were reviewed from personnel present during the event.

- Documentation Review – Collection of relevant work history information and process documentation contained in WMATA systems of record. These records include:
    - Metrorail Safety Rules and Procedures Handbook (MSRPH)
    - National Oceanic and Atmospheric Administration (NOAA)
    - Equipment Operator Training Records (Pending)
    - Equipment Operator Certifications (Pending)
    - Equipment Operator 30-Day work history review (Pending)
    - Pilot Training Records
    - Pilot Certifications
    - Pilot 30-Day work history review
    - Department of Transportation (DOT) Hi-Rail Vehicle Inspection Report
    - Vehicle Program Services (CENV) Inspection Report (Pending)
    - TRST Track Inspection

- System Data Recording Review – Collection of information contained in Metro Data Recording Systems. This data includes:
    - Audio Recording System (ARS) playback [Radio and Landline Communications]
    - Closed-Circuit Television (CCTV)

Investigation

On Saturday, July 1, 2023, at 03:10 hours, Hi-Rail Vehicle Unit CR5971 derailed at the West Falls Church Yard portal located at YL2 015+00. The event time was determined as when the vehicle was observed by Closed-Circuit Television (CCTV) exiting the portal and ceased to move. Video showed the unit traversing a curve at a slow speed and beginning to exit the portal on YL2 into West Falls Church Yard, when it came to a stop.

Figure 1 – Hi-Rail Vehicle CR5971 comes into view as it exited the portal on YL 2 and stops moving at 03:10 hours.

At 03:28 hours, the Pilot advised the Interlocking Operator that they were holding behind Signal K99-68 and were experiencing an unknown issue with Unit CR5971 and requested permission to disembark to investigate. At 03:58 hours, the Office of Track and Structures (TRST) Supervisor arrived on the scene and advised the Interlocking Operator that they had come upon Unit CR5971 and requested third-rail power de-energized. The Interlocking Operator requested further information, to which the TRST Supervisor advised there was an issue with Unit CR5971 and that the investigation was ongoing.

Figure 2 – Multiple WMATA personnel arrive on the scene at 03:47 hours.

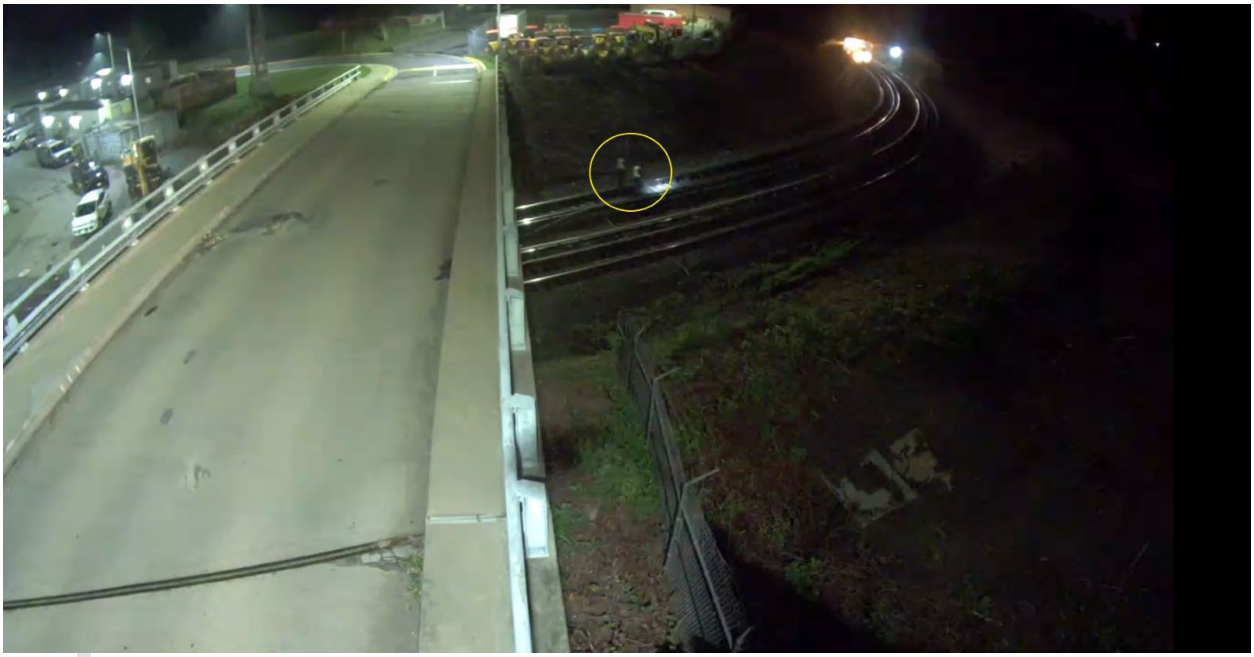


Figure 3 – Multiple WMATA personnel are observed walking the track to the derailment at 03:48 hours.

At 04:02 hours, the TRST Superintendent advised the Interlocking Operator that Unit CR5971's back wheels derailed within the West Falls Church Rail Yard halfway inside a portal. The TRST Superintendent advised that third-rail power would need to be taken down and that a derailment had occurred with the unit. The Interlocking Operator advised that they provided Unit CR5971 with Lunar Signals for movement between Signal K99-58 to Signal K99-78. The TRST Superintendent advised that the Department of Safety (SAFE) would need to be contacted and that they would do so.

At 04:21 hours, the Interlocking Operator contacted the TRST Superintendent for an update on the incident. The TRST Superintendent advised the Interlocking Operator that Unit CR5971 would need to be re-railed from behind. At 04:23 hours, the CAPD Construction Manager advised the Buttons RTC that Unit CR5971 had derailed at West Falls Church Rail Yard. The Buttons RTC advised the CAPD Construction Manager that the ROCC was unaware of the incident. The CAPD Construction Manager advised the Buttons RTC to contact SAFE.

At 04:25 hours, the Interlocking Operator contacted the Buttons RTC informing them of the derailment and provided a basic timeline of the incident. The Interlocking Operator requested third rail power to be de-energized. The Buttons RTC advised the Interlocking Operator that third-rail power would not need to be de-energized as a result of the event and requested from the Interlocking Operator whether trains would still be able to be dispatched from West Falls Church Rail Yard with the derailed vehicle in place. The Interlocking Operator advised the Buttons RTC that trains could still be dispatched.

The Buttons RTC further advised the Interlocking Operator to treat the incident as a derailment, apply clamps, keep the area clear, and await further instruction from personnel on the ground.

At 04:33 hours, the Interlocking Operator advised the Assistant Operations Manager (AOM) of the incident.

Figure 4 –WMATA and Contractor personnel are observed moving towards the derailment at 04:34 hours.

At 04:35 hours, the Mission Assurance Coordinator (MAC) advised the Washington Metrorail Safety Commission (WMSC) of the incident.

At 04:37 hours, the MAC advised the Safety Director On-Call (SDOC) of the incident.

At 04:47 hours, the MAC advised the Metro Transit Police Department (MTPD) of the incident. At 05:02 hours, the MTPD Dispatcher dispatched MTPD Officers to the scene.

Figure 5 –The WMATA re-railing equipment arrived on the scene at 05:10 hours on YL 1.

At 05:16 hours, an Office of Traction Power Maintenance (TRPM) Roadway Worker in Charge (RWIC) advised the Interlocking Operator that they were on scene and requested permission to

enter the roadway at the K99 Portal at Signal K99-66. The Interlocking Operator granted permission to enter the roadway.

At 05:19 hours, the SAFE representative arrived on the scene. At 05:20 hours, the Office of Automatic Train Control Maintenance (ATCM) RWIC advised the Interlocking Operator that they were on the scene. The Interlocking Operator requested if the ATCM team could clamp Switches 51 and 53 for a straight-through move. The ATCM RWIC acknowledged and requested permission to enter the roadway. The Interlocking Operator granted permission for the ATCM Team to enter the roadway.

At 05:28 hours, the TRPM Supervisor advised the Interlocking Operator that they were on the scene and requested third-rail power to be de-energized to the area. The Interlocking Operator advised the TRPM Supervisor that third-rail power would be needed for train dispatch and would need to remain energized.

Consultation with the Office of Emergency Preparedness (OEP) incident report and the Interlocking Operator's written statement indicated that third rail power was de-energized to the area at approximately 05:43 hours.

At 05:37 hours, the Pilot of Unit CR5971 advised the Interlocking Operator that all required Switches were clamped and inquired if ATCM had reached out yet. The Interlocking Operator advised the Pilot that if the track was clear, they had permission to pass Signal K99-56 after verifying that Switch 51 and 53B were in the normal position for a straight-through move.

At 05:41 hours, an MTPD Officer advised the MTPD Dispatcher that they had arrived on the scene. At 05:43 hours, the Road Mechanic advised the Interlocking Operator that they had arrived on the scene in order to re-rail Unit CR5971. The Interlocking Operator gave the Road Mechanic's team permission to enter the roadway and advised them that the third rail was still energized.

At 05:59 hours, third-rail power was confirmed as de-energized to YL-2.

Figure 6 –The WMATA re-railing equipment can be observed lifting Unit ID CR5971's rear wheels and pushing the Unit along YL2 into West Falls Church Yard at 06:26 hours.

Figure 7 –The WMATA re-railing equipment can be observed lifting Unit ID CR5971's rear wheels and pushing the Unit along YL2 into West Falls Church Yard at 06:28 hours. Note YL 1 was utilized to dispatch revenue trains during the event.

Figure 8 –Hi-Rail Unit ID CR5971 is observed engaging its road wheels and moving off YL2 at Signal K99-68 at 06:32 hours.

At 06:50 hours, the Road Mechanic advised the Interlocking Operator that they had re-railed Unit CR5971, and the unit was clear of the roadway.

At 06:54 hours, the oncoming Interlocking Operator announced to all personnel that third-rail power would be energized at the incident site.

Consultation with the OEP incident report, the Interlocking Operator's written statement and the ARS indicated that third rail power was re-energized to the area at approximately 07:03 hours.

A review of various systems was unable to determine the approximate speed of Unit CR5971. Further, track geometry data for the area was consulted but disregarded due to the inaccuracy of gauge measurements in special trackwork areas, such as those with restraining rails. The prior three months' visual inspection records indicated some deficiencies in the curve area, such as loose chair and missing bolts, but no defects requiring immediate repair were noted.

On July 12, 2023, TRST conducted a track inspection of the Yard Lead and determined that while multiple deficiencies were noted, all were within tolerance and no defects were identified.

Interviews with the involved personnel identified that they had previously used YL1 to enter and exit the Yard without issue. This was the first time they recalled entering the yard on YL2. Discussions with other operators determined that K99's YL2 had been used by other Hi-Rail equipment without incident.

A US Department of Transportation (DOT)-certified sub-contractor held Unit ID CR5971 for approximately 3 weeks post-incident in order to inspect the Unit for defects, damages or issues. Consultation of the report generated determined that no major issues were discovered during the inspection.

Following this, a joint inspection with the Office of Car Track Equipment (CTEM) and the Office of Vehicle Program Services (CENV) was conducted on August 8, 2023, at the Greenbelt Rail Yard to determine factors contributing to the derailment affiliated with Unit CR5971.

Figure 9 –Hi-Rail Unit during inspection at Greenbelt Yard had multiple defects including a shorn-off grease nipple to the rear right shock-absorber.

The report concluded the following:

“This incident is likely the result of insufficient down force on the right rear rail wheel. Without sufficient downforce, wheel climb can occur. Once on the ball of the rail, derailment was inevitable from the righthand lateral forces noted above. The insufficient down force appears to be due to a twisted vehicle frame. The reason for the frame twist is unknown but occurred sometime between the last inspection and the July 1 derailment."

In addition to this, CENV personnel advised that at the time of the derailment, they were unable to conduct as extensive fact-finding and investigation due to the moving of the Unit prior to their arrival on scene.

Figure 10 –Hi-Rail Unit during inspection at Greenbelt Yard can be observed with a visible lean to the left-hand side indicating uneven weight distribution.

Chronological Event Timeline

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

Time	Description
03:10:46 hours	*CCTV Camera observed Unit CR5971 appear within the Portal at YL2 015+00 at slow speed and come to a stop.*
03:28:42 hours	Pilot: Advised the Interlocking Operator that they were holding behind the 68 signal and were experiencing an unknown issue with their unit and needed to disembark to investigate. Interlocking Operator: Acknowledged. [Phone, K99 Tower]
03:47:00 hours	*CCTV Camera observed multiple WMATA responding personnel arrive on scene.*
03:48:00 hours	*CCTV Camera observed multiple WMATA responding personnel walk toward the derailment.*
03:58:51 hours	TRST Supervisor: Advised the Interlocking Operator that they were trying to perform a track inspection between the third rail and a running rail and inquired

Time	Description
	if the Interlocking Operator could bring down third rail power as there was an "issue" with a Hi-Rail vehicle. Interlocking Operator: Inquired what the issue with the unit was. TRST Supervisor: Advised the Interlocking Operator that they "walked up on," an issue with the vehicle and were still investigating. Interlocking Operator: Acknowledged. [Phone, K99 Tower]
04:02:40 hours	TRST Superintendent: Advised the Interlocking Operator that a Hi-Rail vehicle's back wheels derailed within West Falls Church yard halfway inside a portal. Requested power be taken down. Uncertain how the derailment occurred. Interlocking Operator: Advised that they had provided the Hi-Rail vehicle lunar for movement between Signal K99-58 to K99-78. TRST Superintendent: Advised the Interlocking Operator that SAFE would need to be contacted and the Equipment Operator's Supervision would need to be contacted. Interlocking Operator: Acknowledged. TRST Superintendent: Advised the Interlocking Operator to stand by and that they would contact SAFE. [Phone, K99 Tower]
04:21:51 hours	Interlocking Operator: Inquired from the TRST Supervisor if there was an update to the incident. TRST Supervisor: Advised the Interlocking Operator that Unit CR5971 had derailed. Further advised the Interlocking Operator that the unit would need to be re-railed from behind. Interlocking Operator: Acknowledged. Advised they would contact the ROCC. [Phone, K99 Tower]
04:23:13 hours	CAPD Construction Manager: Advised the Buttons RTC on OPS 4 that a Hi-Rail vehicle's back wheels derailed within West Falls Church yard while using a yard lead. Further advised that they were en route to the scene. Buttons RTC OPS 4: Advised that the ROCC was not aware of the incident. Construction Manager: Advised the Buttons RTC to contact SAFE. Buttons RTC: Acknowledged. [Phone, OPS 4]
04:25:39 hours	Interlocking Operator: Advised the Buttons RTC of the derailment and provided a basic timeline of the incident. Requested third rail power to be de-energized. Buttons RTC OPS 4: Acknowledged. Advised the Interlocking Operator that third rail power would not need to be de-energized. Requested from the Interlocking Operator if trains would be able to be dispatched from the location on time. Interlocking Operator: Acknowledged. Advised that the derailment would not impact train dispatch. Buttons RTC OPS 4: Acknowledged. Further advised the Interlocking Operator to treat the incident as a derailment, apply clamps, keep the area clear and await further instruction. [Phone, K99 Tower]
04:33:12 hours	Interlocking Operator: Advised the AOM of the incident. [Phone, K99 Tower]
04:34:00 hours	*CCTV Camera observed multiple WMATA and Contractor personnel commence evaluating the derailment.*
04:35:48 hours	MAC: Advised the WMSC of the incident.

Time	Description
	[Phone, MAC]
04:37:09 hours	MAC: Advised the SDOC of the incident. [Phone, MAC]
04:47:26 hours	MAC: Contacted MTPD and advised the location of the derailment was YL 2, within the vicinity of Signal K99-68. MTPD Dispatcher: Acknowledged. [Phone, MAC]
05:02:24 hours	MTPD Dispatcher: Advised MTPD Officer to respond to West Falls Church Yard in reference to a derailment. MTPD Officer: Acknowledged and en route. [Radio, MTPD-1X]
05:10:00 hours	*CCTV Camera observed the re-railing vehicle arrive on the scene by way of YL1.*
05:16:12 hours	TRPM RWIC: Advised the Interlocking Operator that they were on scene and requested permission to enter the roadway at K99 Portal at Signal K99- 66. Interlocking Operator: Permission granted, provide own protection and third rail is energized. TRPM RWIC: Acknowledged and repeated back. [Radio, FC-YD1]
05:19:33 hours	Safety Representative: Advised the MTPD Dispatcher that they had arrived on scene. MTPD Dispatcher: Acknowledged. [Radio, MTPD-1X]
05:20:50 hours	ATCM RWIC: Advised the Interlocking Operator that they were on scene Interlocking Operator: Acknowledged and advised them to clamp Switches 51 and 53 for a straight-through move ATCM RWIC: Acknowledged and requested permission to enter the roadway. Interlocking Operator: Permission granted, provide own protection and third rail is energized. ATCM RWIC: Acknowledged and repeated back. [Radio, FC-YD1]
05:28:41 hours	TRPM Supervisor: Advised the Interlocking Operator that they were on scene and requested if third rail power could be de-energized. Interlocking Operator: Acknowledged and advised that trains would need to be dispatched and third rail power would need to remain energized. [Phone, K99 Tower]
05:37:48 hours	Pilot: Advised the Interlocking Operator that the switches were clamped and inquired if ATCM had reached out. Interlocking Operator: ATCM should go direct with communications involving the switches. Further advised that if the track was clear, they had permission to pass Red Signal K99-56 after verifying that Switch 51 and 53B were in the normal position for a straight-through move. Pilot: Acknowledged. [Phone, K99 Tower]
05:41:59 hours	MTPD Officer: Advised the MTPD Dispatcher that they had arrived on the scene and requested the location of the derailment. MTPD Dispatcher: Acknowledged. Advised the MTPD Officer to seek out the tower for further information. [Radio, MTPD-1X]

Drafted By: SAFE 705 – 08/22/2023
Reviewed By: SAFE 707 – 08/26/2023
Approved By: SAFE 71 – 09/08/2023

Time	Description
05:43:59 hours	Roadway Mechanic: Advised the Interlocking Operator that they were on the scene in order to re-rail Unit CR5971 and requested permission to enter the roadway. Interlocking Operator: Acknowledged and granted permission and advised the Roadway Mechanic that the third rail is energized. [Phone, K99 Tower]
05:59:30 hours	Roadway Mechanic: Advised the Interlocking Operator that YL-2's third-rail power had been de-energized. Interlocking Operator: Acknowledged. [Phone, K99 Tower]
06:26:00 hours	*CCTV Camera observed the re-railing vehicle lift Unit ID CR5971's rear wheels and push the Unit along YL2 into Falls Church Rail Yard.*
06:32:00 hours	*CCTV Camera observed Unit ID CR5971 engage its road wheels and drive off YL2 where it intersects with Signal K99-68.*
06:50:12 hours	Roadway Mechanic: Advised the Interlocking Operator that Unit CR5971 was clear of the roadway. Interlocking Operator: Acknowledged. [Phone, K99 Tower]
06:54:22 hours	Interlocking Operator #2: Announced to all personnel that the third rail would be energized at the incident site. [Phone, K99 Tower]
07:03:15 hours	Roadway Mechanic: Advised the Interlocking Operator that YL-2's third-rail power had been re-energized. Interlocking Operator: Acknowledged. [Phone, K99 Tower]

Note: Times above may vary from other systems' timelines based on clock settings.

Advanced Information Management System (AIMS)

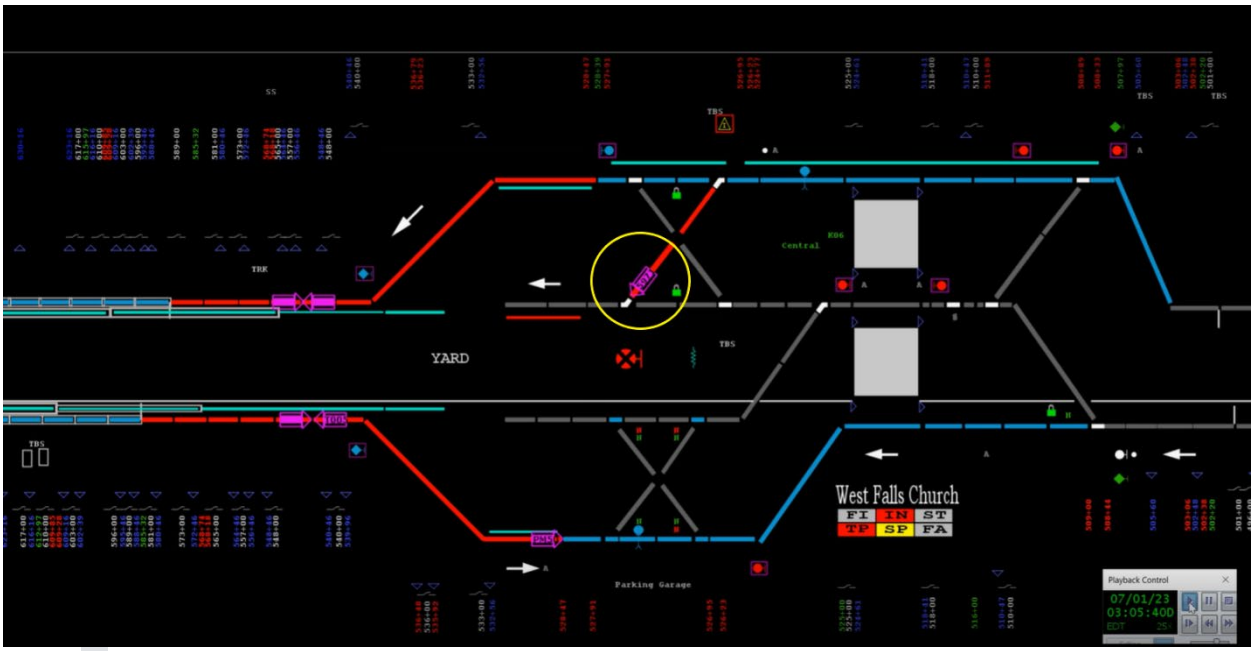


Figure 11 – AIMS depicting Unit CR5971 en route from West Falls Church Station to West Falls Church Yard at approximately 03:05 hours.

The Office of Track and Structures
Adopted from the TRST Track Inspection conducted on 07/12/2023

TRST conducted a Track Inspection of the Yard Lead and determined the following information:

- Six cover boards were missing
- Third rail was corroded at multiple points within the Yard Lead
- The Restraining Rail was corroded at multiple points within the Yard Lead
- Six restraining top bolts were missing throughout the Yard Lead
- The chair was loose throughout the lead
- Multiple bolts were considered high throughout the lead.

The following data was also recorded:

- Maximum Gauge: 57 7/16ths"
- Maximum Side Wear: None
- Maximum Flange Way Gauge: 2 ¾"
- Any evidence of Lateral Movement: Yes
- Any loose, missing, or broken clips or spikes: Yes
- All joint bar bolts tight: Yes
- Any surface alignment deviations: No
- Cross level: 13/16ths

The report did not yield any further clarifying information than what was described as above.

Interview Findings
As part of the investigation launched into the event, SAFE interviewed 3 people. The interviews identified the following key findings associated with this event. Findings detailed below include reported information from involved personnel and may conflict with other data sources contained in the report.

Interlocking Operator

- The Interlocking Operator stated at approximately 03:10 hours, they then received a call from the Pilot who stated that Unit CR5971 was experiencing an issue and that they would need to disembark.
- The Interlocking Operator stated they were then notified as personnel from TRST, SAFE, TRPM and ATCM arrived on scene. The Interlocking Operator stated that they were then requested to de-energize power to the outer loop between Red Signals 58 and 68 along YL 2. The Interlocking Operator stated the power was also hot-sticked and confirmed de-energized.
- From the Interlocking Operator's written statement, power was de-energized at 34, 84 and YL 2 at approximately 05:35 hours. The Interlocking Operator stated that power was re-energized to the same region at 07:03 hours.

Equipment Operator (Unit CR5971)

- The Equipment Operator stated they were unable to perform their desired work for the shift (retrieve a spool of wire) because they were not granted access to the track one side of the work zone and were sent, by the RWIC, back to West Falls Church Rail Yard.
- The Equipment Operator stated they then proceeded back towards West Falls Church Rail Yard via way of track 2 which led to YL 2 within the yard. The Equipment Operator stated they were traveling at approximately 3 MPH and were clearing the portal located near YL 015+00 when they heard a loud noise.
- The Equipment Operator stated they checked the vehicle and didn't notice any damage to the vehicle but observed the back rail wheels had come off the rail.

Drafted By: SAFE 705 – 08/22/2023
Reviewed By: SAFE 707 – 08/26/2023
Approved By: SAFE 71 – 09/08/2023

- The Equipment Operator stated they observed that an exposed restraining rail bolt had been damaged and surmised that the exposed bolt had contributed to the incident. The Equipment Operator stated they then contacted their hierarchy and advised them of the incident.
- The Equipment Operator stated that two re-railing attempts were unsuccessful.
- The Equipment Operator stated that for the third re-rail attempt, the re-railing equipment was used to lift Unit CR5971's back wheels off the rail and push it to Signal K99-68 in order to engage the road wheels and drive the vehicle off the track using the intersecting asphalt.
- Various personnel present for the interview of the Equipment Operator brought up concerns with the cross-level of the restraining rail being slightly raised above the running rail at the time of the incident.
- Personnel present during the interview of the Equipment Operator stated they base their inspection of the tire pressure on the required standard that is "posted on the vehicle."

The Pilot (Unit CR5971)

- The Pilot stated that at approximately 02:45 hours, their vehicle was not going to be utilized within the work zone established and was sent back toward West Falls Church Yard. The Pilot stated that they then commenced moving back towards West Falls Church Yard. Once clear of the mainline, they commenced movement along the Yard Lead.
- The Pilot stated they were traveling within the vicinity of YL 2 015+00 "less than 5 MPH" and heard a very loud, sudden noise. The Pilot stated the Equipment Operator reported not being able to move the vehicle forward. The Pilot stated they had never experienced a derailment before, however, were fairly certain prior to disembarking that the vehicle had derailed.
- The Pilot stated they then advised the Interlocking Operator that something had happened and that they needed to disembark to investigate. The Pilot stated they then observed that the rear wheels had derailed. The Pilot stated they then notified their hierarchy of the incident.
- The Pilot stated re-railing efforts then took place and after two failed attempted to re-rail the vehicle, the re-railing unit lifted the rear two rail wheels off the ground, allowing the two front rail wheels to keep contact with the rail, and the vehicle was carted to Signal K99-68 where the road tires were deployed, and the vehicle was driven from the roadway where the asphalt intersects immediately after Signal K99-68.
- The Pilot stated they believed the cause of the derailment was an exposed restraining rail bolt, coupled with rail wheels too small for the curvature of the roadway and interference from road tires being too large to allow adequate clearance between the rail and the vehicle when not in use.[1]

[1] This statement was not supported by other evidence found during post-incident inspection of the equipment and similar vehicles traversing the curve without incident.

Weather

On July 1, 2023, at the time of the incident, NOAA recorded the temperature as 67°F, with significant cloud cover, winds 5.9 mph, and 90% humidity. Weather was not a contributing factor in this incident (Weather source: NOAA) – Location: Dulles, VA.

Related Rules and Procedures

SOP 9.5.9 ROCC Procedures for Derailment in the Yard.

Human Factors

Fatigue

Signs and Symptoms of Fatigue

Conditions at the time of the incident were evaluated to distinguish whether evidence of fatigue was present. No video was available in order to observe fatigue factors. Both the Pilot and Equipment Operator reported feeling fully alert at the time of the incident and reported experiencing no symptoms of fatigue in the time leading up to the incident.

Fatigue Risk

The Pilot worked night shifts (22:00 – 06:00 hours) in the days leading up to the incident. The Pilot reported 10 hours of sleep in the last sleep period preceding the incident and was awake for 5.66 hours at the time of the incident. The Pilot was off duty for a calculated total of 17.16 hours, which provided the opportunity for 7-9 hours of sleep. The employee reported usual workday sleep durations of 8 hours and no issues with sleep.

The Equipment Operator worked night shifts (20:00 – 05:00 hours) in the days leading up to the incident. The Equipment Operator reported 9 hours of sleep in the last sleep period preceding the incident and was awake for 11.16 hours at the time of the incident. The Equipment Operator was off duty for a calculated total of 14 hours, which provided the opportunity for 7-9 hours of sleep. The employee reported usual workday sleep durations of 8 hours and no issues with sleep.

Incident data was evaluated for fatigue risk factors. There were no major risk factors for fatigue identified, however the incident time of day (03:10 hours) may suggest an increased risk of fatigue-related impairment.

Post-Incident Toxicology Testing

WMATA's Drug and Alcohol Program determined that the Equipment Operator and Pilot complied with the Drug and Alcohol Policy and Testing Program 7.7.3/6.

Findings

- Personnel reported successfully traversing the YL1 track to enter and exit the Yard on previous movements.
- Multiple attempts to re-rail Unit ID CR5971 with the available re-railing equipment failed when the rear wheels did not remain on the track.
- The Operator and Pilot estimated the speed of the unit to be 3-5 mph. The actual speed of the unit could not be verified through other systems of record.
- The Unit was moved from the track prior to inspection by CENV personnel.
- The Pre-Trip Inspection did not identify any deficiencies that would likely contribute to the derailment.
- The Post-Incident CENV Report determined that the derailment was a result of insufficient downforce on the right rear rail wheel generated by issues with vehicle tilt.
- Assessment of the YL 2 by TRST personnel determined that while minor issues with the track were observed, all were within tolerances and did not likely contribute to the derailment.
- While not contributory to the event, review of hard copy track inspection records found inconsistent levels of detail related to defects.

Immediate Mitigation to Prevent Recurrence

- The Equipment Operator and Pilot were both removed from service, post-incident.

Probable Cause Statement

The probable cause of the Derailment event on July 1, 2023, at West Falls Church Rail Yard was wheel climb at the point of derailment due to a bend in the vehicle frame that resulted in uneven weight distribution on the road wheels and a lack of rail wheel interface with the running rail on the right side.

Recommended Corrective Actions

Corrective Action Code	Description	Responsible Party	Estimated Completion Date
109604 _SAFECAPS_SAFE_001	Review process and issue guidance to SAFE On-Call personnel on scene release to ensure adequate time for SMEs to conduct field assessment.	SAFE SRC	Complete
109604 _SAFECAPS_CAPD_001	Ensure Hi-Rail vehicle is repaired, and equipment is recertified by CTEM prior to returning to service.	CAPD SRC	Ongoing

Appendices

Appendix A – Interview Summaries

The below narratives summarize the incident and represent the statements made by the involved individual. As such, times and details may present a conflict with the data contained in systems of record.

The Interlocking Operator

The Interlocking Operator is a WMATA Employee with 13 years of service, with 1 year of experience as an Interlocking Operator. The Interlocking Operator holds an RWP Level 2 that expires on 08/31/2023.

The Interlocking Operator stated prior to the incident, they had commenced preparations to deploy revenue-service trains from West Falls Church Yard. At the same time, the Interlocking Operator stated they had sent Unit CR5971 out toward an established work zone at West Falls Church Station between 02:30 and 02:45 hours.

The Interlocking Operator stated they then received a request by the same Unit to return to West Falls Church Yard via way of YL 2. The Interlocking Operator stated that was unusual, however, had issued them a block between Signal K99-58 and Signal K99-78 in order to leave the roadway at Signal K99-68.

The Interlocking Operator stated that at approximately 03:10 hours, they then received a call from the Pilot who stated that Unit CR5971 was experiencing an issue and that they would need to disembark.

The Interlocking Operator stated they were then notified as personnel from TRST, SAFE, TRPM and ATCM arrived on scene. The Interlocking Operator stated that they were then requested to de-energize power to the outer loop between Signals K9-58 and K99-68 along YL 2. The Interlocking Operator stated the power was also hot-sticked and confirmed de-energized.

From the Interlocking Operator's written statement, power was de-energized at 34, 84 and YL 2 at approximately 05:35 hours. The Interlocking Operator stated that power was re-energized to the same region at 07:03 hours.

The Equipment Operator (Unit CR5971)

The Equipment Operator has been with the contractor with Aldridge Group as part of a joint venture contracted to WMATA for approximately 1 year. The Equipment Operator has approximately 12 years working as an Equipment Operator and currently holds an RWP Level 1 that expires on 03/31/2024.

The Equipment Operator stated they were assigned to drive and operate Unit CR5971 as part of a two-person team. The Equipment Operator stated that during their pre-shift inspection, nothing appeared to be problematic or out of specification with Unit CR5971.

The Equipment Operator stated they were assigned to operate Unit CR5971 in order to retrieve empty wire reels out of a work zone located at West Falls Church Yard.

The Equipment Operator stated they were unable to retrieve the wire because they were not granted access to the track one side of the work zone and were sent, by the RWIC, back to West Falls Church Rail Yard.

The Equipment Operator stated they then proceeded back towards West Falls Church Rail Yard via way of track 2 that lead to YL 2 within the yard. The Equipment Operator stated they were traveling at approximately 3 MPH and were clearing the portal located near YL 015+00 when they heard a loud noise.

The Equipment Operator stated the Pilot then disembarked and relayed to them that the vehicle had derailed. The Equipment Operator stated they then checked the vehicle and didn't notice any damage to the vehicle but observed the back rail wheels had come off the rail.

The Equipment Operator stated they were uncertain how the derailment occurred, however, they noticed that an exposed restraining rail bolt had been damaged and surmised that the exposed bolt had contributed to the incident. The Equipment Operator stated they then contacted their hierarchy and advised them of the incident.

The Equipment Operator stated they then waited for additional personnel to assist in the re-railing efforts.

The Equipment Operator stated that when additional personnel arrived on the scene, the initial re-rail was unsuccessful. The second attempt at re-railing was also unsuccessful.

The Equipment Operator stated that for the third re-rail attempt, the re-railing equipment was used to lift Unit CR5971's back wheels off the rail and push it to Signal K99-68 in order to engage the road wheels and drive the vehicle off the track using the intersecting asphalt.
The Equipment Operator stated that the tire pressure for Unit CR5971 did not need to change based on load. The Equipment Operator stated they did not observe any issues with the tire pressure.

The Equipment Operator stated they were removed from service for post-incident testing.

Various personnel present for the interview of the Equipment Operator brought up concerns with the cross-level of the restraining rail being slightly raised above the running rail at the time of the incident.

These same personnel articulated that the tire pressure was "fixed" by WMATA, however, that it is a responsibility of the Contractor to ensure the tire pressure is at the required standard that is "posted on the vehicle."

<u>The Pilot (Unit CR5971)</u>

The Pilot is a WMATA Employee with 9.5 years of service, all of that as an Equipment Operator and as a Pilot. The Pilot holds an RWP Level 4 that expires on 08/31/2023.

The Pilot stated they were assigned to communicate with the ROCC and Interlocking Operator as part of a two-person team crewing Unit CR5971.

The Pilot stated that at approximately 02:45 hours, their vehicle was not going to be utilized within the work zone established and was sent back toward West Falls Church Yard. The Pilot stated

that they then commenced moving back towards West Falls Church Yard. Once clear of the mainline, they commenced movement along the Yard Lead.

The Pilot stated they were traveling within the vicinity of YL 2 015+00 “less than 5 MPH” and heard a very loud, sudden noise. The Pilot stated the Equipment Operator reported not being able to move the vehicle forward. The Pilot stated they had never experienced a derailment before, however, were fairly certain prior to disembarking that the vehicle had derailed.

The Pilot stated they then advised the Interlocking Operator that something had happened and that they needed to disembark to investigate. The Pilot stated they then observed that the back wheels had derailed. The Pilot stated they then notified their hierarchy of the incident.

The Pilot stated re-railing efforts then took place and after two failed attempted to re-rail the vehicle, the re-railing unit lifted the rear two rail wheels off the ground, allowing the two front rail wheels to keep contact with the rail, and the vehicle was carted to Signal K99-68 where the road tires were deployed and the vehicle was driven from the roadway where the asphalt intersects immediately after Signal K99-68.

The Pilot stated they believed the cause of the derailment was an exposed restraining rail bolt, coupled with rail wheels too small for the curvature of the roadway and interference from road wheels too large to allow adequate clearance between the rail and the vehicle when not in use.

The Pilot stated they were removed from service for post-incident testing.

Appendix B – OEP Report (Redacted)

Submitted by: [redacted]

metro OEP Office of Emergency Preparedness

SAFE OEP Incident Response Report

Overview

Incident Date/Time:
2023-07-01
0431

Incident Location:
West Falls Church Yard

Responder 1: [redacted]

MAC 1: [redacted]

MAC 2: N/A

Additional Responders: [redacted]

Incident Type:
Derailment

Incident Metrics

OPS Channel: OPS 1

MTPD Channels:
["MTPD 1x "]

Bus/Rail Yard Channel: N/A

Initial Incident Time: 0431

Dispatch Time: 0435

Response Time: 0500

On Scene Time: 0548

Disregard Time: N/A

Time of Recovery: N/A

In-Service Time: 0725

Command Est. Time: N/A

Transfer of Command Time: N/A

Incident Personnel

Metro IC: N/A

Jurisdictional IC: N/A

Fire Liaison ROCC: DCFD [redacted]

Forward Liaison (RTRA Supervisor):
N/A

Forward Liaison (MTPD): N/A

Maintenance Lead (ERT): [redacted] CTEM

Investigations Lead (MTPD):
N/A

Investigations Lead (Safety): [redacted]

Transportation Lead (Bus TFS): N/A

Document 1 – OEP Report Page 1 of 2

Submitted by: [redacted]

Incident Overview

Was Power removed: Yes - Supervisory **Red Tag (if applicable):**N/A

Incident Narrative:

A contractor vehicle derailed on West Falls Church Yard Lead 2 track. Third rail power was de-energized at 0543 by the tower. RWIC [redacted] performed a safety briefing and a work zone was set up. The vehicle was re-railed using Swing mover SM03. During a test movement of driving the vehicle forward, it derailed a second time. With the assistance of SM03, the vehicle was moved a short distance to the exit point and exited the track. C3M (contractor) notified their vehicle maintenance crew to pick up the vehicle and removed it from service for inspection. The tracks were inspected for damage and none was found. At 0655 third rail re-energization was requested and completed. No injuries were reported on the scene. Service was returned to normal at 0705.

Incident Successes:

All members on the scene communicated well and the work flowed smoothly.

Opportunities for Improvement:

N/A

Appendix C – Interlocking Operator's Report (Redacted)

Rail Transportation

Interlocking Operator's Report

Name [redacted] Time 5:00A Date 7/1/23

Subject High Rail Derailment # HR5TT1 / Operator [redacted]

To:

Comments HR#5TT1 contacted the tower @ 3:10A requested permission to disembark @ the westside roadway. @ 3:28A tower was contacted by HR5TT1 stated they were experiencing some trouble @ 68 signal. Upon further inspection ..... it was determined that the HR unit had derailed.

Power was De-Energized to Breakers 34, 84 and YR #2 affecting to inner-loop between 68 signal/58 signal @ 5:35A HSC by PU # [redacted] @ 5:37A

Power was Re-Engagized to Breakers 34/84 and YR #2 @ 7:03A HSC by PU # [redacted] @ 7:05A

Assisted by ATC personnel #[redacted]

10.541 11/95

Document 3 – Interlocking Operator's Report Page 1 of 1

Appendix D – TRST Post-incident Inspection (Redacted)

DAILY TRACK INSPECTION REPORT

NAME: [redacted] DATE: 7-12-23 PAGE: YARD: ✓ MAINLINE: ☐ SPECIAL: ☐ OTHER:
REPORTING LOCATION K99 INSPECTED FROM: Yard Lead 2 LINE: TRACK:
RING: [redacted] START: END: WEATHER:

ITEM	EXCEPTION CHAIN MARKER NO. FROM	TO	TRACK NO.	RAIL L/R/B/3	SWITCH NO.	CODES COMP	CODES DEFECT	STATUS G/Y/R/B	SIDE G/B/F	REPEAT DEFECT "X"	MAXIMO WO#
1	Six Cover boards off										
2											
3	3rd rail	Corroded in different				Sections	throughout				Lead
4											
5	Restraining	Corroded in different				Sections	throughout				Lead
6											
7	Six missing restraining	top bolts				throughout					Lead
8											
9	Loose chairs	throughout				lead need	to be	flushed	against	restraining	
10											
11	Some high screw	spikes				throughout					Lead
12											
13											
14											
15											

COMMENTS

1 Maximum Gauge: 57 7/16
2
3 Maximum Side Wear: None
4
5 Maximum Flange Way Gauge: 2 3/4
6
7 Any evidence of lateral Movement: Yes
8
9 Any loose, missing or broken Clips or Spikes: Yes
10
11 All joint bar bolts tight: Yes
12
13 Any surface or alignment deviations: No
14
15 Cross level 13/16

Note 1: Track has been inspected in accordance with WMATA's specifications for track Inspections as per the TRST-1000. WMATA Track Personnel are responsible for taking corrective action on observed conditions/defects and to notify operations of slow orders or other corrective measures that are required for the safe passage of trains based on RST-1000 Standards. Note 2: REPEAT DEFECT field is used to indicate the defect has been previously reported and the conditions have not progressed to where a change in status required. If defect has progressed and requires a status change, do not mark this box and downgrade status to appropriate new level, i.e. from a "G" to "Y" condition. NOTE 3: his form shall be used in lieu of MaxTrax in the event of technical failure of digital record systems

[redacted]
TRACK INSPECTOR (PRINT)

[redacted]
SUPERVISOR (PRINT)

[redacted]

SUPERINTENDENT / MAINTENANCE SUPERINTENDENT (PRINT)

SUPERINTENDENT / MAINTENANCE SUPERINTENDENT (SIGNATURE)

TRST-TMI-FRM-DTIR-REV-10.0 | 10192020

Document 3 – TRST Track Inspection Report Page 1 of 1

Appendix E – Contractor Rail Vehicle Inspection Checklist (Certification)

Contractor's Rail Vehicle Inspection Checklist

Contractor Information
Company Name: c3m- Aldridge, joint venture
Representative: [redacted]
Representative Phone: [redacted]
Contract ID: firpg211190
Estimated Date of Contract Completion: 7/2023
WMATAs Contracting Officers Technical Representative (COTR): [redacted]
COTR Phone: 2402477641
Project Scope and Vehicles Intended Use: transport materials-tools

Vehicle Information	
Vehicle # or designation: 100070	Year: 2014
Manufacture: freightliner	Model: m2 106
Vehicle Description: knuckle boom trk w/16' bed	Serial or VIN: 3alacxcy3fdgl5971
Mileage or Engine Hours: 17571	License Plate No.: 2616tx
Vehicle Length: 25'	Vehicle Width: 8'
Vehicle Height: 11'	Axle Spacing/wheelbase:
Gross Vehicle Weight (GVW): 55,000	Maximum payload (if any): 33000
Hi-Rail Gear Information (if applicable)	
Hi-Rail Gear Manufacturer: continental	Hi-Rail Gear model: g30
Date of last Hi-Rail inspection: 06-05-22	Hi-Rail Gear Serial #: 603206

Inspection Information		
WMATA designation: CR 5971	Date of initial inspection: 3/7/2023	
CTEM Inspector: [redacted]	Signature: [redacted]	
CENV Inspector: [redacted]	Signature: [redacted]	
SAFE Inspector: [redacted]	Signature: [redacted]	
ICS issue Date: 04/04/2023	ICS #: 330	ICS Expiration: 09/30/2023
Inspections are performed in accordance with OAP 101.01 and shall meet the requirements of Appendix A. The lead inspector must mark the appropriate column: P for pass, F for fail or N for not applicable. The contractor has thirty (30) days from the date of the initial inspection to have any failed items re-inspected. Re-inspected items that pass are marked in the R column.		
Authorized for use on WMATA's Roadway by: [redacted] WMATA [redacted]		
Notes: Repairs performed to Hi-Rail gear, unit passed re-inspection.		

CMOR Form 30.952, Rev. 2.0 **Page 1 of 3** **09/27/2021**

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Document 4 – Contractor Rail Vehicle Inspection Checklist Page 1 of 3

Contractor's Rail Vehicle Inspection Checklist

Records and Documentation		P/F/N	R	
1.a	Information sheet	P		Notes:
1.b-g	Required documentation	P		

Phase 1: In Shop Inspection

2	Lighting	P/F/N	R			P/F/N	R
2.a	Headlights	P		2.b	Brake lights	P	
2.c	Marker lights	P		2.d	Beacon light	P	
Notes:							

3	Visibility	P/F/N	R			P/F/N	R
3.a	Side visibility	P		3.b	Front and rear visibility	P	
Notes:							

4	Audible Warning Devices	P/F/N	R			P/F/N	R
4.a	Horn	P		4.b	Change of direction or Back-up Alarm	P	
Notes:							

5	Cab & Safety Appliances	P/F/N	R			P/F/N	R
5.a	First aid kit	P		5.a	Fire extinguisher	P	
5.b	Secure positions for pilot	P		5.c	Secure positions for personnel	P	
5.d	Windshields, wipers & overhead cover	P		5.e	Defoggers	P	
5.f	Securable turntables/working components	P		5.g	Condition and controls	P	
5.h	Hand holds	P		5.i	Decking	P	
5.j	Chocks	N		5.k	Documents box	P	
Notes:							

6	Labeling	P/F/N	R			P/F/N	R
6.a	Gross Vehicle Weight (GVW) and Speed	P		6.b	Max load	P	
Notes:							

7	Chassis & Structure	P/F/N	R			P/F/N	R
7.a	Clearance	P		7.b	Condition	P	
7.c	Derail guards	N				N	
Notes:							

8	Engine	P/F/N	R			P/F/N	R
8.a-b	Diesel condition	P		8.c-d	Exhaust	P	
8.e	Tank capacity	P					
Notes:							

9	Drive train & suspension	P/F/N	R			P/F/N	R
9.a	Drive train condition	P		9.b	Alignment	P	
9.c	Suspension condition	P		9.d	Wheel contour	P	
9.e-f	Configuration	P		9.g	Axle loading	P	

CMOR Form 30.952, Rev. 2.0 **Page 2 of 3** **09/27/2021**

Document 5 – Contractor Rail Vehicle Inspection Checklist Page 2 of 3

Contractor's Rail Vehicle Inspection Checklist

Notes:

10	Brakes	P/F/N	R			P/F/N	R
10.a	Parking brakes	P		10.b	Brake function	P	
10.c-h	Configuration	P		10.h-i	Testing	P	

Notes:

11	Subsystems	P/F/N	R			P/F/N	R
11.a	Hydraulic systems	P		11.b	Electrical systems	P	

Notes:

12	Emergency Recovery	P/F/N	R			P/F/N	R
12.a	Tow eyes front and rear	P		12.b-c	Configuration	P	
12.d	Towing procedure	P					

Notes:

13	Lifting Equipment	P/F/N	R			P/F/N	R
13.a-b	Condition and configuration	P		13.c	Certification	P	
13.d	Labeling	P					

Notes:

14	Other Requirements	P/F/N	R			P/F/N	R
14.a	Gas cylinders	N		14.b	Daily inspection forms	P	
14.c-d	Overall condition	P		14.e	Shunting test	P	

Notes:

15	Hi-rail equipment	P/F/N	R			P/F/N	R
15.a-d	Configuration	F	R	15.e	Steering lock	P	
15.f	Tire pressure label	P		15.g-i	Alignment	P	
15.j	Maintenance and records	P					

Notes:
The rear lock pin is broken. Repairs of rear lock pin complete to and passed re-inspection

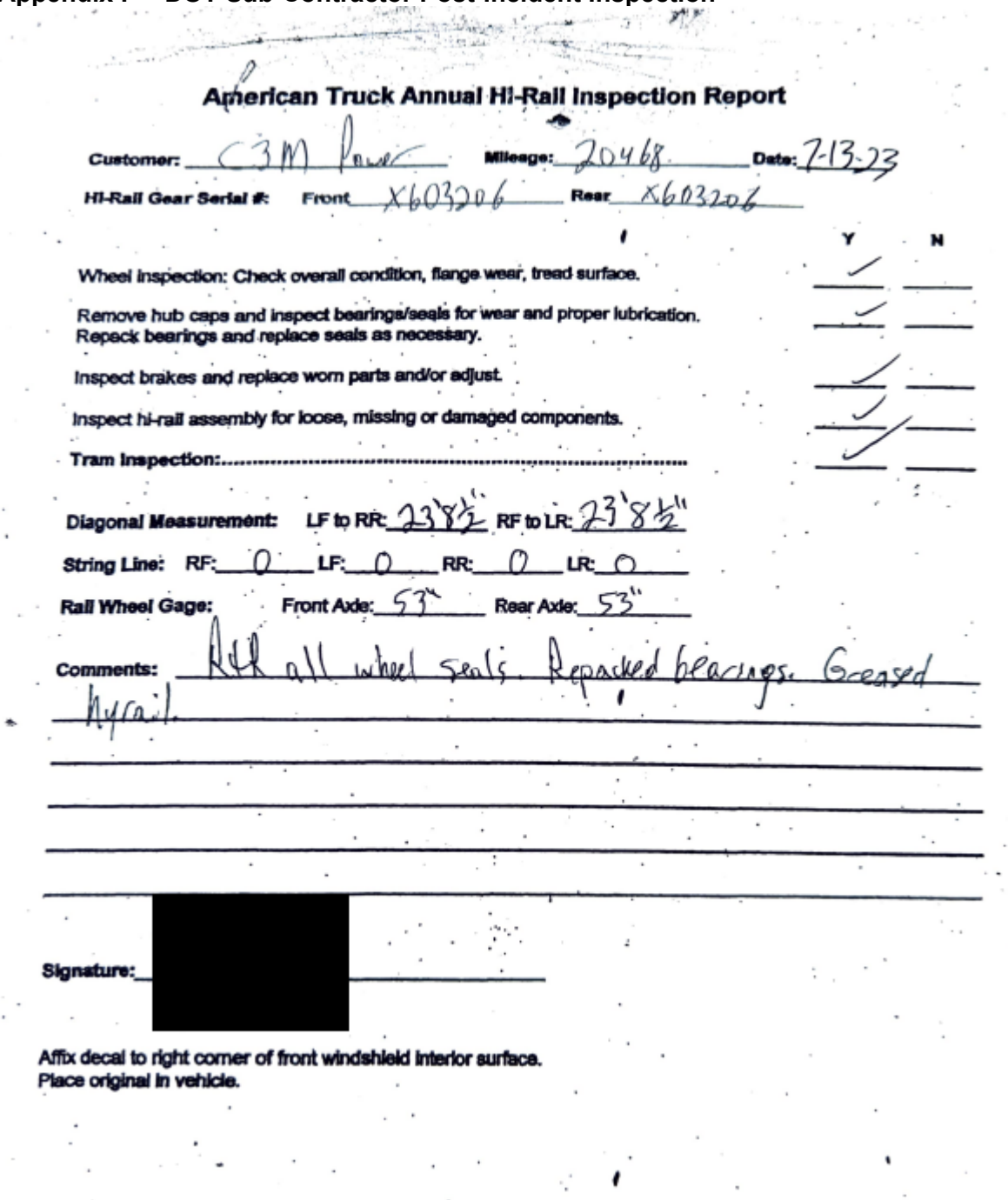
Phase 2: Local track test		P/F/N	R			P/F/N	R
16.a	Brakes	P		16.b	Shunting	P	
16.c	Switch negotiation	P		16.d	Track travel	P	
16.e	Track negotiation	P		16.f	Hi-rail tire contact and deflection	P	

Inspection area (embarkment point and start to finish signal numbers):
E99 TRST storage area and cleared E99-92

Notes:
Verification of repair to be established before ICS sticker shall be issued.

CMOR Form 30.952, Rev. 2.0 **Page 3 of 3** **09/27/2021**

Document 6 – Contractor Rail Vehicle Inspection Checklist Page 3 of 3



American Truck Annual Hi-Rail Inspection Report

Customer: C3M Power Mileage: 20468 Date: 7-13-23

Hi-Rail Gear Serial #: Front X603206 Rear X603206

	Y	N
Wheel inspection: Check overall condition, flange wear, tread surface.	✓	
Remove hub caps and inspect bearings/seals for wear and proper lubrication. Repack bearings and replace seals as necessary.	✓	
Inspect brakes and replace worn parts and/or adjust.	✓	
Inspect hi-rail assembly for loose, missing or damaged components.	✓	
Tram Inspection:	✓	

Diagonal Measurement: LF to RR: 23'8½" RF to LR: 23'8½"

String Line: RF: 0 LF: 0 RR: 0 LR: 0

Rail Wheel Gage: Front Axle: 53" Rear Axle: 53"

Comments: Rtk all wheel seals. Repacked bearings. Greased Hyrail.

Signature: [redacted]

Affix decal to right corner of front windshield interior surface.
Place original in vehicle.

Document 7 – DOT Sub-contractor Inspection Report Page 1 of 7

CARSON CRANE, INC.

85 Main Street, Suite 5A, Reisterstown, MD 21136 [redacted]

HYDRAULIC CRANE INSPECTION REPORT

CONSTRUCTION AND/OR INDUSTRY CERTIFICATION OF UNIT TEST AND/OR EXAMINATION OF CRANE, HOIST OR OTHER MATERIAL HANDLING DEVICE.

This documentation form is issued to record the survey herein noted, but does not substitute for any Federal or State certificates which may otherwise be required for the herein-listed equipment and which may be Recorded by another Carson Crane, Inc. certificate form for such Federal or State certification program.

Owner: C3M Power Systems
Contact:
Address:

Date: 7/18/2023
Certificate Number: 23253
Inspector: Tyler Clifton
Expiration Date: 7/18/2024

Equipment: Crane
Type: Hyd. Tele. Knuckle

Location Of Equipment: Remains at Work Site: Describe Location: American Truck
Changes Work Site: X

Manufacturer: Palfinger
Serial Number: 100725552
Unit Number: N/A
Model Number: PK12
Capacity: 12,300 lbs.

Service Status at Time of Survey: Lifting

Boom Status at Time of Survey: Length: 25'
Type: Hydraulic Telescopic

Test Loads Applied:	Radius	Proof Loads	Rated Loads
	N/A	N/A	N/A

Load Indicating or Limiting Device: N/A
Accuracy: N/A
Configuration at Time of Test: N/A
Application of Proof Loads: N/A
Basis for Assigned Load Ratings: Manufacturer's Specifications
Remarks and/or Limitations: Survey at owner's request and with his permission. ALL INFORMATION CORRECT AT TIME OF SURVEY.

Date of Last Inspection: 4/16/2022
Previous Certification Number: 22264

I certify that on the 18th day of July 2023, the above-described device was examined as arranged by or with permission of the owner and that the equipment was noted to HAVE MET all applicable OSHA 1926.1400 regulations and ANSI B30.5 Standards.

[redacted]

Date: 7/18/2023

[redacted]

Neither Carson Crane or its representatives shall be liable in any manner for any personal injury or property damage of any kind arising from or connected to this survey. All satisfactory items are valid at time of inspection.

Document 8 – DOT Sub-contractor Inspection Report Page 2 of 7

Carson Crane, Inc.
[redacted]

Company	C3M Power Systems				
Make/ Model#	Palfinger PK12				
Serial#	100725552				
Unit#	N/A	Capacity	12,300 lbs.	Certification #	23253

General Appearance	S	U	NA	Comments
1. Glass	✓			
2. Sheet Metal	✓			
3. Guard Covers	✓			
4. Components	✓			
5. General Lubrication	✓			
6. Housekeeping	✓			
7. Safety/ Warning Decals & Labels	✓			
8. Paint Condition	✓			

Lower Cab	S	U	NA	Comments
9. Grab Rails & Steps	✓			
10. Instrument & Gauges	✓			
11. Electrical Switches & Functions	✓			
12. Horns/ Lights	✓			
13. Back-up Alarm	✓			
14. Operational Controls	✓			
15. Mirrors	✓			
16. Fire Extinguishers	✓			

Lower Engine	S	U	N/A	Comments
17. Leaks	✓			
18. Belts & Hoses	✓			
19. Air Induction System	✓			
20. Exhaust Systems	✓			
21. Radiator & Cooler System	✓			
22. Electrical Harness	✓			
23. Engine Mounts	✓			
24. Air Compressor	✓			
25. Batteries	✓			
26. General Condition	✓			
27. Miles			✓	
28. Hours			✓	

Drive Train	S	U	NA	Comments
29. Transmission Mounts	✓			
30. Transmission	✓			
31. Differential, Planetary Fluid			✓	
32. Axle Mounting & Suspension	✓			
33. Steering Linkage & Components	✓			
34. Tires & Lugs	✓			
35. Brakes	✓			

Document 9 – DOT Sub-contractor Inspection Report Page 3 of 7

Carson Crane, Inc.
[redacted]

Company	C3M Power Systems				
Make/ Model#	Palfinger PK12				
Serial#	100725552				
Unit#	N/A	Capacity	12,300 lbs.	Certification #	23253

Lower Frame	S	U	NA	Comments
35. Frame Members: Where Visible	✓			
36. Hoses & Connections	✓			
37. Electrical Wiring	✓			

Outriggers	S	U	NA	Comments
38. Boxes & Beams	✓			
39. Extensions & Cylinders	✓			
40. Hoses & Fittings	✓			
41. Hold Valves/ Position Locks	✓			

Upper Cab	S	U	NA	Comments
42. Grab Rails & Steps	✓			
43. Instruments & Gauges	✓			
44. Electrical Switches	✓			
45. Signal Horn	✓			
46. Operational Controls	✓			
47. Capacity Charts	✓			
48. Control Labels	✓			
49. Warning Decals/ Signal Chart	✓			
50. Mirrors	✓			
51. Air/ Hydraulic Leakage	✓			
52. Crane Level Indicator	✓			
53. Anti-Two Block Device			✓	
54. Boom Angle Indicator			✓	
55. Load Weight Device			✓	
56. Fire Extinguisher	✓			
57. Operators Manual	✓			

Upper Engine	S	U	N/A	Comments
58. Leaks			✓	
59. Belts & Hoses			✓	
60. Air Induction System			✓	
61. Exhaust System			✓	
62. Radiator & Cooler System			✓	
63. Electrical Harness			✓	
64. Batteries			✓	
65. Air Compressor/Governor			✓	
66. Hours			✓	

Document 10 – DOT Sub-contractor Inspection Report Page 4 of 7

Carson Crane, Inc.

[redacted]

Company	C3M Power Systems				
Make/ Model#	Palfinger PK12				
Serial#	100725552				
Unit#	N/A	Capacity	12,300 lbs.	Certification #	23253

Rotating Upper Structure	S	U	NA	Comments
67. Frame Condition: Where Visible	✓			
68. Turntable: VISUAL	✓			
59. Electrical Collector Ring:	✓			
70. Hydraulic/ Air/ Electrical Leaks:	✓			
71. Gear Box:	✓			
72. Winch Mounting:			✓	
73. Winch Motor, Brake, Valve, Line:			✓	
74. Attachment Mounts, Pins, Keepers:			✓	
75. Counterweight Mount:			✓	

Main Boom	S	U	N/A	Comments
76. Lift Cylinder(s)	✓			
77. Telescoping Cylinder(s)	✓			
78. Hydraulic Hoses/Tubing Fittings	✓			
79. Holding Device	✓			
80. Boom Sections Alignment	✓			
81. Wear Pads	✓			
82. Sheaves	✓			
83. Hoist Line Dead End	✓			
84. Wire Rope Retainer	✓			
85. Boom Hinge Pin	✓			
86. Boom Head Section	✓			
87. Structure	✓			

Jib Extension	S	U	NA	Comments
88. Positive Stop(s)			✓	
89. Sheave(s)			✓	
90. Wire Rope Retainer(s)			✓	
91. Structure			✓	

Document 11 – DOT Sub-contractor Inspection Report Page 5 of 7

Carson Crane, Inc.
[redacted]

Deficiency Report

The following corrective action(s) (repairs, adjustments, replacement parts, etc) are to performed by a qualified person in accordance with all manufacturer's instructions, specifications, and requirements. OSHA requires that, *"any deficiency shall be repaired or defective parts replaced before continued use."*

Item#	Explanation
	No deficiencies noted at time of survey.

By signing this certificate, the inspector nor Carson Crane, Inc. makes any warranty, expressed or implied concerning the part described in this data report. Furthermore, neither the inspector nor Carson Crane, Inc. shall be liable in any manner for any personal injury, equipment, or property damage of any kind from or connected with this inspection. Further, this certificate is issued to subject to the conditions that it is understood and agreed that neither Carson Crane, Inc. nor any of its employees is under any circumstances whatever, to be held responsible for any inaccuracy of any report or certificate issued by Carson Crane, Inc. or its inspectors for any error of judgment, default or negligence of personnel.

Document 12 – DOT Sub-contractor Inspection Report Page 6 of 7

Carson Crane, Inc.
[redacted]

Recommendation Report

The following recommendation(s) should be considered for corrective action. The advisability of which depends on the facts in each situation. Any corrective action(s) are to be performed by a qualified person in accordance with all the manufacturer's instructions, specifications, and requirements.

Item#	Explanation	Immediate Action Required?
	No recommendations at this.	

Document 13 – DOT Sub-contractor Inspection Report Page 7 of 7

Washington Metropolitan Area Transit Authority

CENV

Incident Report

CR5971 K99 Yard Derailment

July 1, 2023

Document 14 – CENV Inspection Report Page 1 of 5

Table of Contents

LOCATION: K99 Yard Lead CM YL2 15+00
INCIDENT #: E23445
DATE: 07/01/2023
TIME: 0328 hours

Investigation Team Members

[redacted] Senior Vehicle Engineer – CENV
Assistant Manager – CENV

Report Prepared By: [redacted]

Report Approved By: [redacted]

[redacted] Digitally signed [redacted]
[redacted] WMATA Date: 2023.09.07 11:20:35 -04'00'

Executive Summary

On the morning of July 1, 2023, at approximately 0328 hours, contractor hi-rail unit CR5971 derailed on the K-line yard lead track 2 at chain marker 15+00 (Figure 1). ROCC was notified and CTEM mechanics were dispatched (see Attachment A). At 0700 hours, the unit cleared mainline to the road crossing for track dismount. No injuries were reported. Revenue service was not disrupted.

Figure 1. CR5971 derailment

Inspection of CR5971 on August 8, 2023, revealed an imbalance in the rear hi-rail gear causing insufficient loading on the right rear rail wheel and is the likely cause of this derailment. The truck frame height measured a one-inch difference between left and right from the ball-of-rail. The insufficient downforce would allow for wheel-climb leading to derailment in the direction of lateral forces.

Introduction

WMATA utilizes hi-rail vehicles to perform system maintenance. Hi-rail vehicles have the ability to traverse both over the road and on-rail. The most common application is standard DOT trucks outfitted with deployable rail gear. They are commonly used for short-term contracts that have unique requirements that do not warrant long-term investment through a WMATA vehicle purchase.

CR5971 is an M2 106 Freightliner with a 55,000 GVW. The hi-rail gear is Continental LS-35 series (Figure 2). CR5971 was inspected and approved for six-month use on 4 April 2023 (see Attachment B). WMATA requires contractor rail vehicles be inspected a minimum of every six months per CMOR OAP 101.01.

Figure 2. Continental hi-rail gear

Findings of Investigation

At approximately 0328 hours on the morning of July 1, 2023, at K99 (West Falls Church Yard), ROCC was notified of an Incident where the contractor hi-rail unit CR5971 derailed. CTEM arrived on the scene at approximately 0530 to assess the vehicle and found no major damage to the vehicle or surrounding structures. The vehicle's rear hi-rail gear derailed to the inside of the curve while driving cab-forward through a restrained curve. The vehicle was rerailed and attempted to traverse on rail to the disembarkment area (road crossing), however derailed again after only a few feet. A swing loader was used to suspend the rear of the vehicle to assist in the transport to the road crossing. CR5971 cleared the system by 0700.

Track conditions at the derailment location are as follows: cut and cover double box tunnel, 300 foot restrained radius, 2.0% decline, 1" super elevation. Restraining rail used at this location is 115 running rail turned on its side. Restraining rail of this type is not tested as part of the Contractor Vehicle Inspection program.

Upon CENV arrival, CR5971 had already been removed from the incident location and was located in a parking lot. Unless on-rail, the hi-rail cannot be properly deployed for inspection. The truck was released to the contractor to have the hi-rail inspected by a third party. Result of that inspection is in Attachment C. No deficiencies were noted by the third party and only routine maintenance was performed. The rear tires were inflated to 105 psi. The hi-rail gear installation does not state the recommended tire pressure for hi-rail use.

Reinspection of CR5971 on 8 August 2023 in Greenbelt yard, under the Contractor Vehicle Inspection program, noted the right rear of the truck was higher than the left side by one inch. Further inspection revealed the right rear rail gear was loaded much less than the left. This condition was not noted during the 4/4/2023 inspection. There are elastomeric springs on each side of the Continental gear to compensate for minor differences but does not allow for the present deviation.

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In this condition, the vehicle is not able to offer the necessary resistance to righthand lateral forces. At the incident location there were two sources of righthand lateral forces. One inch of super elevation is present in the radius and the rear tires were in contact the restraining rail (Figure 3). Both of these would cause a right bias in tracking and with less than the needed down force, the flange is able to climb the rail.

Figure 3. Lateral tire forces

Conclusion

This incident is likely the result of insufficient down force on the right rear rail wheel. Without sufficient downforce, wheel climb can occur. Once on the ball of the rail, derailment was inevitable from the righthand lateral forces noted above. The insufficient down force appears to be due to a twisted vehicle frame. The reason for the frame twist is unknown but occurred sometime between the last inspection and the July 1 derailment.

Recommendations

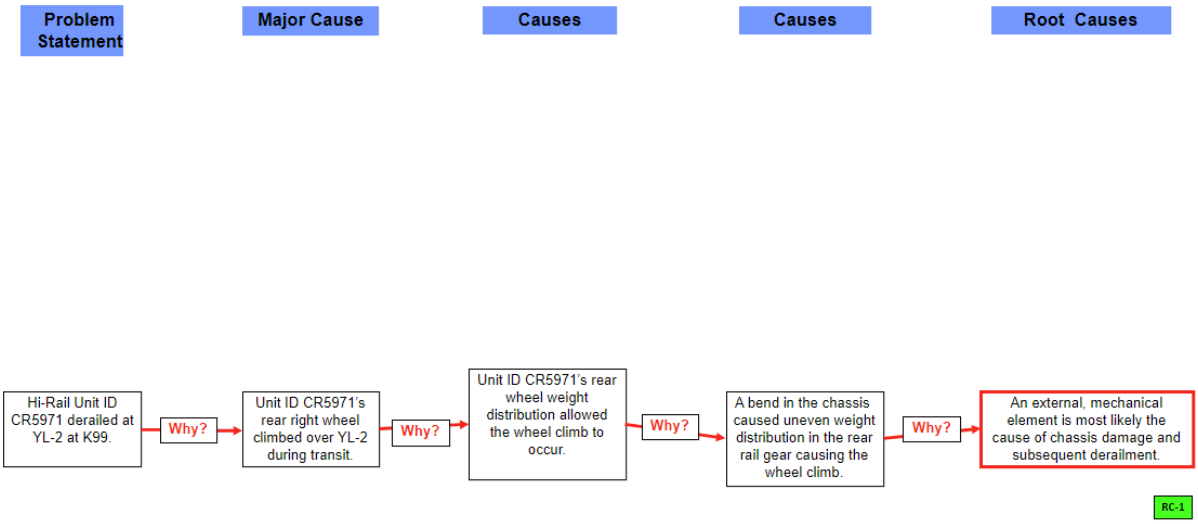
- CR5971 hi-rail gear should be reinspected by a certified third-party familiar with Continental hi-rail gear, correcting for any anomalies in the truck frame.
- Hi-rail gear installation should include the recommended rear tire pressure when rail-bound.
- Moving forward, preserve hi-rail incident scenes until hi-rail inspectors arrive.

Appendix H – Selected Photos


Jul 1, 2023 at 5:22:31 AM
7305 Idylwood Rd
Falls Church VA 22043
United States


Jul 1, 2023 at 5:24:41 AM
7305 Idylwood Rd
Falls Church VA 22043
United States

Appendix I – Why-Tree Analysis



Root Cause Analysis