



**WMSC Commissioner Brief: W-0210 – Derailment – Greenbelt Rail Yard – September 10, 2022**

*Prepared for Washington Metrorail Safety Commission meeting on April 11, 2023*

**Safety event summary:**

A hi-rail vehicle owned and being operated by a Metrorail contractor derailed at an asphalt grade crossing in the Greenbelt Rail Yard at approximately 2:28 a.m. on Saturday, September 10, 2022. The vehicle continued onto the area of ballasted track where the vehicle came to rest leaning toward the energized third rail. The contractor and the Metrorail employee assigned as a pilot on the vehicle did not report the derailment to the Interlocking Operator responsible for control of the rail yard and did not respond to radio calls. Approximately 11 minutes after the derailment, a Kiewit contractor reported the derailment to the Rail Operations Control Center (ROCC). Third rail power remained energized until approximately 40 minutes after the derailment when a ROCC Assistant Operations Manager directed the Interlocking Operator to de-energize power.

The investigation determined that the condition of the grade crossing (improper flangeway depth and width, bulging and unevenly worn asphalt above the rail) and the inflation of the vehicle's left rear tires above the maximum pressure for safe movement on the rails via the hi-rail gear contributed to the derailment. The grade crossing is in an approximately 383-foot radius curve.

The asphalt was bulging at the grade crossing where the left rear tires would have been when the vehicle derailed. Metrorail's road crossing pavement height specification considered only rail wheel flange and not the additional width of a rubber tire on a hi rail vehicle. At the point of derailment, the asphalt was approximately 0.4 inches above the top of the rail on the right side of the rear wheel set and 0.6 inches above the top of the rail on the left side of the forward wheel set.

The flangeway did not meet the minimum depth of 2 inches. The flangeway was filled with debris and grease that interfered with wheel clearance and could cause wheel climbing.

The tires were inflated to the pressure for over-the-road movement, 125 psi, rather than the 90 psi specified for hi rail operation. The operator had not identified this prior to operating the vehicle. Tire pressure checks were required as part of the pre-trip inspection, however Kiewit's procedures specified that a different person, a mechanic, was responsible for loading the vehicle onto the rails, including placing the hi rail gear in its operating position, checking lights and brakes, and moving the vehicle forward and backward to verify. There was no evidence that Metrorail's pilot observed a pre-trip walkaround inspection as required by Metrorail procedure.

In addition to the tire pressure issues, the rear rail gear had insufficient downforce even after tire pressure was adjusted. Axle weight distribution appeared to be within the acceptable range.

Metrorail had certified the vehicle for use in the Metrorail system in August 2022 (this approval was rescinded for this specific vehicle following the derailment and subsequent observations that the hi-rail gear lightened during a post-derailment test at the grade crossing even with correct tire pressure and no issues identified with hi-rail gear adjustment).



This was the first time the Metrorail contractor was moving this vehicle. They had been certified on September 9, 2022, just before this derailment, as a vehicle operator through the contractor's training program for the Yellow Line bridge and tunnel project. They did not typically operate hi-rail vehicles. Kiewit assigned the individual to operate the vehicle due to what the operator described as a shortage of equipment operators. The operator had worked approximately 18 hours the day before the derailment.

Two other similar Kiewit hi-rail vehicles also operated by Kiewit personnel with a Metrorail pilot moved through the grade crossing to leave the rail yard without any issues. This third vehicle derailed. The vehicle operator did not identify that they had derailed and that the rubber tires had engaged with the pavement and that the hi rail gear was being dragged on the asphalt until after they exited the grade crossing and the vehicle dropped to the ground (to the left, toward the third rail). The vehicles were being moved to the long-term Yellow Line shutdown work location between L'Enfant Plaza and Pentagon stations.

#### **Probable Cause:**

The probable cause of this event was Metrorail's insufficient maintenance and inspection of, and requirements for grade crossings, combined with operation of a vehicle with hi-rail gear deficiencies and overinflated tires that were not identified by Metrorail or contractor personnel prior to operation through the grade crossing in a tight radius curve.

#### **Corrective Actions:**

As interim mitigations, Metrorail directed personnel moving hi rail vehicles through the area to reduce rear tire pressure to 60 psi to increase downward force until corrections could be made to the grade crossing. Metrorail also assigned spotters for moves through this crossing and reduced speed through the crossing.

As a long-term mitigation, Metrorail resurfaced the asphalt around the grade crossing and cleaned the flangeways.

Metrorail is evaluating adjustments to its track specifications for grade crossings.

Examples of other related open CAPs

- C-0131 addressing that Metrorail is not providing medical oversight of contractors and does not include any requirements in contracts that contractors meet WMATA medical, fatigue or hours of service standards. (Last deliverable due for completion in 2025)
- C-0100 addressing that Metrorail is not maintaining a fully functioning radio communications system in all rail yards and shops. (Last deliverable due for completion in October 2026)

#### **WMSC staff observations:**

Metrorail is responsible for the safety of its system and personnel, whether employees or contractors. This includes ensuring proper fitness for duty through meaningful and effective fatigue risk management.

Metrorail is responsible for ensuring all personnel adhere to all WMATA policies and procedures, including those related to timely reporting of safety events. In this case, the delayed reporting prevented third rail power from being de-energized in a timely manner for the safety of personnel.



750 First St. NE • Ste. 900 • Washington, D.C. 20002

Office: 202-384-1520 • Website: [www.wmsc.gov](http://www.wmsc.gov)

Review of audio recordings as part of this investigation demonstrated ongoing deficiencies related to radio communication in the Greenbelt Rail Yard, which were reported as a total radio communications outage. Metrorail is addressing issues related to yard communication through CAP C-0100.

Metrorail inspects contractor vehicles every six months.



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

**FINAL REPORT OF INVESTIGATION A&I E22585**

<b>Date of Event:</b>	09/10/2022
<b>Type of Event:</b>	A-5: Derailment
<b>Incident Time:</b>	02:30 hours
<b>Location:</b>	Greenbelt Yard – Outer Loop at the grade crossing
<b>Time and How received by SAFE:</b>	02:41 hours Mission Assurance Coordinator (MAC)
<b>WMSC Notification Time:</b>	03:22 hours
<b>Responding Safety Officers:</b>	WMATA SAFE: Yes WMSC: No Other: RTRA, ATCM, TRPM, TRST
<b>Rail Vehicle:</b>	CR 7972
<b>Injuries:</b>	None
<b>Damage:</b>	None
<b>Emergency Responders:</b>	MTPD, ERT
<b>SMS I/A Number</b>	20220910#102773

# Greenbelt Yard – Derailment

September 10, 2022

## Table of Contents

Abbreviations and Acronyms-----	3
Executive Summary -----	4
Incident Site -----	5
Field Sketch/Schematics -----	5
Purpose and Scope -----	5
Investigative Methods-----	5
Investigation -----	6
Chronological Event Timeline-----	10
Office of Vehicle Program Services (CENV) Inspection Report-----	11
Office of System Maintenance, Office of Radio Communication (COMR) -----	11
Office of Tracks and Structures (TRST)-----	11
Maintenance of Way Engineering (MOWE) -----	12
Interview Findings-----	12
Findings -----	13
Weather -----	13
Human Factors -----	14
Fatigue-----	14
Signs and Symptoms of Fatigue -----	14
Fatigue Risk -----	14
Post-Incident Toxicology Testing -----	14
Immediate Mitigation to Prevent Recurrence -----	14
Probable Cause Statement-----	15
Recommended Corrective Actions -----	15
Appendix A – Interview Summary -----	16
Hi Rail Operator -----	16
On-Scene Commander -----	16
Pilot-----	16
Appendix B – Hi Rail Vehicle, CR 7972 -----	18
Appendix C – Mass Electric Designated Operator Program Evaluation and Certification-----	19
Appendix D – CENV Incident Report -----	25
Appendix E – CR7972 Hi – Rail Inspection -----	31
Appendix F – Photos of Grade Crossing after Resurfacing -----	32
Appendix G – Switch Order -----	36
Appendix H – Root Cause Tree -----	38

## **Abbreviations and Acronyms**

<b>AIMS</b>	Advanced Information Management System
<b>AMF</b>	Advance Mobile Flagger
<b>ARS</b>	Audio Recording System
<b>CAP</b>	Corrective Action Plan
<b>CCTV</b>	Closed-Circuit Television
<b>CENV</b>	Office of Vehicle Program Services
<b>CMOR</b>	Office of Chief Mechanical Officer
<b>MAC</b>	Mission Assurance Coordinator
<b>MSRPH</b>	Metrorail Safety Rules and Procedures Handbook
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>RTC</b>	Rail Traffic Controller
<b>RTRA</b>	Office of Rail Transportation
<b>ROCC</b>	Rail Operations Control Center
<b>RWIC</b>	Roadway Worker in Charge
<b>SAFE</b>	Department of Safety
<b>SMS</b>	Safety Measurement System
<b>TRST</b>	Office of Tracks and Structures
<b>VMS</b>	Vehicle Monitoring System
<b>WMATA</b>	Washington Metropolitan Area Transit Authority
<b>WMSC</b>	Washington Metrorail Safety Commission

**Washington Metropolitan Area Transit Authority**  
**Department of Safety – Office of Safety Investigations**

---

**Executive Summary**

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

On Saturday, September 10, 2022, three (3) Kiewit Hi Rail vehicles operated by Kiewit Equipment Operators traversed the outer loop of Greenbelt Yard in preparation to enter the mainline and travel to the National Park Service Yard as part of a shutdown on the L-Line Bridge. The first two Hi Rail vehicles successfully traversed the yard tracks and left Greenbelt Yard without issue. However, at 02:28 hours, Hi Rail vehicle CR 7972 derailed as it entered the eastern side of the grade crossing and came to rest on the western side of the crossing. At 02:36 hours, the Interlocking Operator attempted several times to contact the pilot of CR 7972 via radio to instruct them to proceed to signal E99-68 and hold their location. The pilot of CR 7972 did not respond to the Interlocking Operator.

At 02:39 hours, the Rail Operations Control Center (ROCC) Buttons Rail Traffic Controller (RTC) received a call from a Contractor informing them that Hi Rail vehicle, CR 7972, derailed while attempting to leave the yard and was leaning towards the third rail. ROCC personnel and the Mission Assurance Coordinator (MAC) made initial notifications and dispatched personnel to the scene.

An investigation revealed that as CR 7972 attempted to traverse the grade crossing, the tires on the Hi Rail vehicle came in contact with the asphalt of the crossing, causing the rear rail gear to lift and derail. The Hi Rail Operator was unaware that the unit derailed initially due to the tires riding along the paved crossing. Once the vehicle exited the crossing, the hi rail wheels came in contact with the ground/ballast and the vehicle came to rest. A visual inspection of the grade crossing showed uneven wear and some bulging at the perimeter of the asphalt crossing.

The operator involved in this event was recently retrained on hi rail operations and received their hi rail vehicle operations certification the previous day on September 9, 2022. This was their first movement with the vehicle and had not previously mounted the hi rail vehicle onto the rail because the mechanics load the hi rail vehicles on the rail. They reported being unfamiliar with the exact process for transitioning the vehicle from road operations to rail operations. During a post-incident inspection from Car Track Equipment Maintenance (CTEM), it was observed that the left rear tires were overinflated and set at an over-the-road air pressure level. In addition, the post-event inspection found that the rear rail gear had insufficient downforce. Inspection of the grade crossing also identified that the flangeway depth was too shallow.

The probable cause for the derailment that occurred on September 10, 2022, was a combination of human and mechanical factors. The combination of limited flangeway depth, width, and uneven asphalt at the entrance of the grade crossing were the root cause of the derailment. A contributing factor to the event was the Hi Rail Operator's failure to observe the left rear tires were over-inflated for hi rail operations during their pre-trip inspection. The overinflation contributed to the wheels lifting when they contacted the asphalt. Following remediation of the flangeway depth and smoothing the asphalt around the grade crossing, the hi rail wheels continued to climb during further attempts to recertify the vehicle. Based on identical vehicles' ability to traverse the crossing before and after the flangeway depth was addressed, an unidentified mechanical deficiency with the vehicle's hi-rail gear is also a suspected contributing factor. The vehicle was removed from the property because Greenbelt Yard was no longer the storage location for its assigned task and was not used on the mainline.



## Incident Site

Greenbelt Yard – Yard Lead Grade Crossing

## Field Sketch/Schematics



Figure 1: Shows an aerial view of the derailment (circled) location.

## 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 two (2) individuals as part of this investigation including
  - Hi Rail Operator
  - Pilot
- Informal Interviews – Collected through conversations with individuals during the investigation to provide background and supporting information.
  - ERT Unit (On-Scene Commander)
- Documentation Review – A collection of relevant work history information and process documentation contained in Metro systems of record. These records include:
  - Hi Rail Operator Training Procedures & Records



- Metrorail Safety Rules and Procedures Handbook (MSRPH)
  - National Oceanic and Atmospheric Administration (NOAA) data
  - Kiewit Grade Crossing Event Summary
  - CENV Inspection Report
- System Data Recording Review – A collection of information contained in Metro Data Recording Systems. This data includes:
    - Audio Recording System (ARS) playback include OPS 3 Radio, Telephone

## **Investigation**

On September 10, 2022, at 02:28 hours, a contractor operating Hi Rail vehicle, CR 7972, approached the grade crossing in the westbound direction, with a route to leave Greenbelt Yard and enter the mainline on Track 2.



*Figure 2: Shows a view of the grade crossing CR 7972 traversed when it derailed.*

Prior to the Hi Rail Operator arriving at the grade crossing, two other contractors operating similar Kiewit Hi Rail vehicles were given lunar signals and absolute blocks to the L-Line Bridge shutdown. The first two Kiewit Hi Rail vehicles traversed this grade crossing without any issues. CR 7972 came to a complete stop at the grade crossing and then proceeded at the required speed. When the Hi Rail Operator began to traverse the grade crossing at slow speed, the tires engaged with the paved area and the hi rail wheels disengaged from the running rails. The Hi Rail Operator was unaware they were off the rail until they crossed the grade crossing and the hi rail wheels dropped to ground, derailing to the left side near the third rail.



Figure 3: Shows the view looking at the beginning of the grade crossing where the point of derailment occurred.

The point of derailment shows that the Hi Rail vehicle derailed as soon as it started to traverse the grade crossing. As CR 7972 traversed the grade crossing, the rear rail gear was dragged along the asphalt.



Figure 4: Shows a center view that captures the left and right rail rear gear markings.

The Hi Rail Operator had a pilot with them at the time of the derailment but they were unaware of the pilot's role and responsibilities. During the post-event inspection of CR 7972, it was identified that the rear tires were overinflated at the time of the derailment. The left rear tires were at 125 pounds per square inch (psi), which is used for over the road operations. The tire psi should have been set to 90 psi for hi rail operation. The Hi Rail Operator stated they conducted a pre trip inspection of CR 7972 before leaving the railyard. A portion of the pre-trip inspection is conducted before the unit is mounted on the rail and the other is completed once the unit is mounted on the rail. As part of the pre trip inspection, the Kiewitt operator is to inspect the vehicle rims and tires because under or over inflation will change the effective traction and guidance of the Hi Rail gear. Kiewit's Hi Rail Operators are not responsible for transitioning the Hi Rail units from on the road operations to on rail operations but are responsible for inspecting the units prior to usage. A Kiewit mechanic checks to make sure the hi rail vehicle is properly aligned with the rail. The Mechanic lifts the front gear and pull the front rail gear carry pins and store them in their storage holes. Then they put the front gear down and knuckle the gear all the way back to the operation position. The Mechanic then lift the rear rail gear pulling the locking pins. Once that's completed, they put the rear rail gear down to full extension position and install locking pins in the lower holes to prevent hydraulic bleed off. Then check all lights and brakes to insure they are working. The Mechanic then moves the truck forward and backwards to insure free movement.

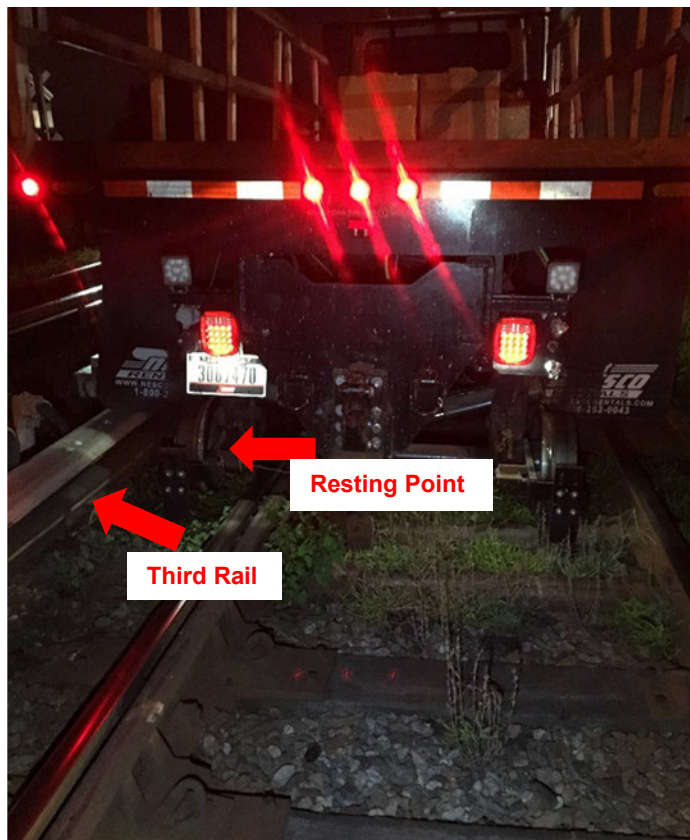


Figure 5: Shows a view from the rear of landing point of CR 7972 after derailment.

The resting point of CR 7972 was the western side of the grade crossing, with the hi rail gear in close proximity to the third rail. There was no damage to the third rail nor the Hi Rail vehicle. During the investigation, both Kiewit and CENV reported concerns about the asphalt at the grade crossing. When CENV conducted their preliminary inspection, they identified there was a bulge in the asphalt where the left rear tires would have been at the point of derailment.





Figure 6: Shows the asphalt at the beginning of the grade crossing that is uneven, with some ridges and bulging.

Hi Rail vehicle CR 7972 was inspected in August 2022 and certified for mainline operation. As a result of the derailment, the sticker on CR 7972 was removed and the unit was placed out of service. The inspection sticker was only removed from CR 7972. Kiewit was asked to review the mounting of the hi-rail gear because it lightened during the test through the Greenbelt Yard grade crossing even with the correct tire pressure. Prior to returning for use on WMATA property, the vehicle must be reinspected and certified by CTEM.

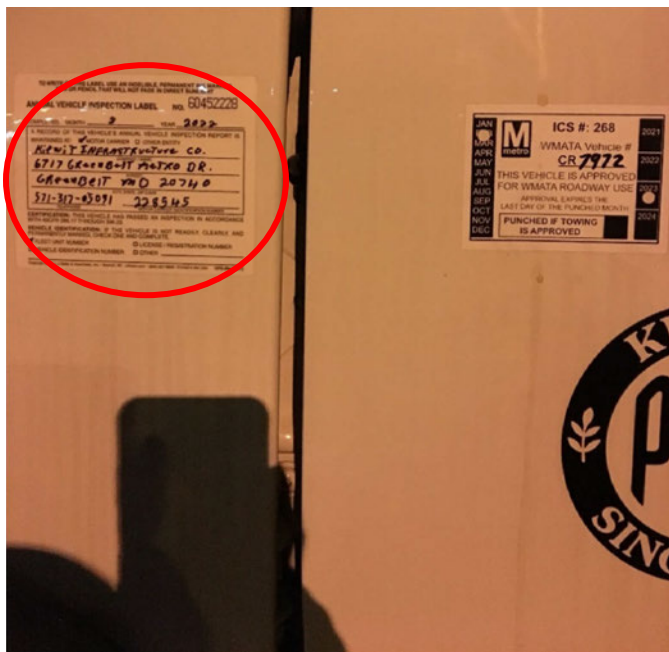


Figure 7: Shows the sticker that confirms CR 7972 recently passed inspection.

## Chronological Event Timeline

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

Time	Description
02:11 hours	<u>Greenbelt Tower</u> : Instructed CR4436 to E99-182 signal and an absolute block to signal E99-68 red and hold.
02:18 hours	<u>CR7975</u> : Contacted the RTC to inform them they were holding on Track 2 at E10-08 signal and was requesting permission to the L-Line Shutdown. [Radio]
02:19 hours	<u>RTC</u> : Gave a 100% repeat back and asked if there were more units coming. [Radio]
02:19 hours	<u>CR7975</u> : Affirmed there were more units as soon as they could get out of the yard due to terrible radio connection. [Radio]
02:19 hours	<u>RTC</u> : Gave CR7975 a lunar signal to PG Plaza Station. [Radio]
02:20 hours	<u>CR7975</u> : Gave a 100% repeat back. [Radio]
02:27 hours	<u>RTC</u> : Gave CR4436 permission to move on absolute block to E10-08 38 lunar, correct rail alignment and the block was to clear E10-36. [Radio]
02:27 hours	<u>CR4436</u> : Gave a 100% repeat back. [Radio]
02:30 hours	<u>CR7975</u> : Informed RTC they were clearing College Park Station. [Radio]
02:31 hours	<u>RTC</u> : Informed CR4436 their absolute block changed to College Park Station, Track 2. [Radio]
02:36 hours	<u>Greenbelt Tower</u> : Attempted to contact CR 7972 to inform them they had a lunar at 182 and to hold at 68 red. [Radio]
02:36 hours	<u>CR7975</u> : Informed RTC they were holding at PG Plaza Station, track 2. [Radio]
02:39 hours	<u>CR4436</u> : Informed the RTC they cleared College Park. [Radio]
02:39 hours	<u>Buttons RTC</u> : Received a call from a Contractor informing them that one of the Hi Rail Vehicles leaving Greenbelt Yard derailed and was leaning next to the third rail. [Phone]
02:45 hours	MOC advised of Greenbelt Yard derailment.
02:54 hours	<u>TRST Assistant Superintendent</u> : Contacted the MOC about the derailment.
02:57 hours	<u>ROCC Assistant Operations Manager</u> : Contacted TRST personnel because they could not reach Power (TRPM). They needed someone to hot stick and confirm third rail power was down. [Phone]
03:05 hours	<u>ERT Unit</u> arrived on scene and was assigned as On Scene Commander. [ROCC Report]
03:06 hours	Power is still energized at YCR130.
03:06 hours	<u>TRPM Unit</u> : Contacted Rail 1 to make sure breaker E99-31 was tripped. [Phone]
03:07 hours	<u>CMNT Assistant General Superintendent</u> : Contacted CMNT Supervisor to get details about the derailment. [Phone]
03:07 hours	<u>ROCC Assistant Operations Manager</u> : Contacted Greenbelt Tower to inform them power was energized, and they needed to trip breakers. [Phone]
03:10 hours	<u>ERT Unit</u> hot stuck and confirmed third rail power was de-energized. [ROCC Report]
03:16 hours	<u>Power Desk Assistant Superintendent</u> : Contacted the On-Scene Commander to get the YCR number. On-Scene Commander informed them the power was deenergized at 03:10 hours. [Phone]
03:20 hours	<u>Radio Shop</u> : Contacted the MOC about radio issue at Greenbelt Yard. They were informed it was a complete outage at Greenbelt Yard. [Phone]
03:46 hours	<u>ROCC Assistant Operations Manager</u> : Contacted the Greenbelt Tower about the estimated time to have the unit CR 7972 rerailed. [Phone]
03:48 hours	Radio Communication restored.

Time	Description
03:49 hours	<u>ROCC Assistant Operations Manager:</u> Contacted the On-Scene Commander to ask if it was possible to move trains on the opposite track. The On-Scene Commander advised they should not run trains on the opposite track until the unit was re-railed. [Phone]
04:14 hours	<u>Greenbelt Tower:</u> Informed the last High Rail Vehicle Operator to park their unit because they were not going out for the night. [Radio]
04:24 hours	<u>Red Tag issued.</u> [Switch Order]
04:36 hours	<u>On-Scene Commander:</u> Informed the ROCC that all personnel were clear, CR 7972 was rerailed, and third rail power could be restored. [Radio]
04:42 hours	<u>Power Desk Controller:</u> Contacted PDAS to advise that tag 2022253527-A for E99 was returned by the On-Scene Commander, permission from Tower, they were ready for step 8. [Phone]
04:59 hours	Third rail power re-energized. [Switch Order]

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

### **Office of Vehicle Program Services (CENV) Inspection Report**

1. The left-side rear tires were over inflated. They were set to over-the-road pressure and not reduced for hi-rail use. 125 psi vs 90 psi.
2. The road crossing tarmac has a bulge where the left rear tires would have been at the POD. The road crossing height specification only considers rail wheel flange and does not take into consideration the additional width of a truck tire.
3. At the point of derailment, the asphalt was approximately 0.4 inches above the top of rail on the right side of the rear wheel set and 0.6 inches above the top of rail on the left side of the forward wheel set.
4. Kiewit was instructed to have the rear hi-rail gear readjusted. Returning to the incident location and with the proper hi-rail tire pressure, the rear rail gear had insufficient downforce.
5. All axles were within 10% of each other indicating an acceptable weight distribution.

### **Office of System Maintenance, Office of Radio Communication (COMR)**

COMR personnel responded and performed a comprehensive radio operational test at Greenbelt Yard. The test was successful, and the signal was at an optimal level.

After reviewing the Audio Recording System (ARS) playback, there appeared to be some communication deficiencies over the radio (e.g., static and distortion), but no issues were discovered during the radio operational test.

### **Office of Tracks and Structures (TRST)**

TRST personnel responded to the derailment scene, inspected the condition of the tracks and collected track measurements of the derailment area. The measurements were taken 50 feet in front and behind the road crossing.

- Chair# 460 Gauge 57 1/8" Cross-Level 3/8"
- Chair# 470 Gauge 57" Cross-Level 3/8"
- Chair# 480 Gauge 57" Cross-Level 1/2"
- Chair# 490 Gauge 57" Cross-Level 3/8"
- Chair# 500 Gauge 57" Cross-Level 3/8"



### **Road Crossing**

- Chair# 520 Gauge 57" Cross-Level 7/16"
- Chair# 530 Gauge 57" Cross-Level 5/16
- Chair# 540 Gauge 57" Cross-Level 3/8"
- Chair# 550 Gauge 57 1/8" Cross-Level 1/2"
- Chair# 560 Gauge 57" Cross-Level 7/16"

### **Maintenance of Way Engineering (MOWE)**

MOWE personnel inspected the asphalt embedded track at the grade crossing where the derailment occurred. The flangeway width was in compliance with TRST 1000 volume 1 & 3, however the flangeway depth was not in compliance to the standard in some locations. The minimum depth should be 2" deep but when it was inspected it measured at 1 1/2". It was observed that the flangeway was full of debris and grease which might interfere with wheel clearance and cause wheel climbing to the surface. The gauge and lateral movement of rails were compliant.



*Figure 8: This image shows debris that was observed in the flangeway.*

### **Interview Findings**

During the interview, the Hi Rail Operator stated the day of the incident was not a normal workday for them. They were filling in because the crew was short on equipment operators that night. The Hi Rail Operator had not driven the Hi Rail vehicle during a shift prior to the incident. The Hi Rail Operator was recently certified by Kiewit to operate the unit. The night of the derailment was their first day operating on live track. The Hi Rail Operator was unaware of the process of transitioning from driving on the road to driving on rail because the mechanics always mount the units on the rail. The Hi Rail Operator did not experience any mechanical issues prior to the derailment. The Hi Rail Operator was unaware the rear wheels were off the rail as they crossed the grade crossing because of the tires. As soon as they crossed the grade crossing, the rear wheels dropped to the left side near the third rail and that is when the Hi Rail Operator knew they derailed.



## **Findings**

- Unit CR 7972 was inspected and certified to operate on the mainline in August 2022.
- Two Hi Rail Vehicles traversed the grade crossing without any issues prior to CR 7972 derailling.
- The Hi Rail Operator does not typically operate Hi Rail vehicles and was filling in for someone the day of the derailment.
- The Hi Rail Operator completed their Hi Rail vehicle training on September 9, 2022.
- The Hi Rail operator did not transition the Hi rail vehicle from on the road to rail operations. A Kiewit mechanic placed the Hi Rail vehicle on the rail. There were no issues traversing the yard tracks leading up to the point of derailment.
- The Hi Rail Operator had a WMATA pilot in the Hi Rail vehicle that was communicating with Yard Tower. The Hi Rail Operator was unaware of the exact responsibility of the pilot because they do not typically operate Hi Rail vehicles.
- The Hi Rail Operator worked approximately 18 hours the day before the derailment.
- CR 7972's rear gear was fully extended and pinned in place to prevent movement/collapse of the rear gear.
- The left-side rear tires were over inflated. The left side tires were set to over-the-road pressure and not reduced for hi-rail use. 125 psi vs 90 psi.
- The road crossing tarmac has a bulge where the left rear tires would have been at the POD. The road crossing height specification only considers rail wheel flange and does not take into consideration the additional width of a truck tire.
- The running rail gauge measurements were within tolerance.
- The flangeway depth was not in compliance at the grade crossing, 1 ½ inch.
- With the proper hi-rail tire pressure, the rear rail gear had insufficient downforce to maintain the proper height.
- At the point of derailment, the asphalt was approximately 0.4 inches above the top of rail on the right side of the rear wheel set and 0.6 inches above the top of rail on the left side of the forward wheel set.
- All axles were within 10% of each other indicating an acceptable weight distribution.

## **Weather**

On September 10, 2022, at the time of the incident, NOAA recorded the temperature as 63 ° F, with clear skies throughout the afternoon. Weather was not a contributing factor in this incident (Weather source: NOAA) – Location: Greenbelt, MD.)

## **Human Factors**

### **Fatigue**

#### **Signs and Symptoms of Fatigue**

We evaluated conditions at the time of the incident to distinguish whether evidence of fatigue was present. No video of the involved person was available to ascertain whether evidence of fatigue was present. The Hi Rail Operator reported feeling fully alert at the time of the incident. The Hi Rail Operator reported experiencing no symptoms of fatigue in the time leading up to the incident.

#### **Fatigue Risk**

We evaluated incident data for fatigue risk factors. Risk factors for fatigue were present. The incident occurred at a time of low circadian alertness. The Hi Rail Operator reported keeping a regular sleep schedule in the days leading up to the incident. The Hi Rail Operator performed day and night work in the days leading up to the incident. The employee was awake for 8.91 hours at the time of the incident. The Hi Rail Operator reported 8.5 hours of sleep in the 24 hours preceding the incident. The off-duty period preceding incident was less than 8 hours long, 5 hours, which reduces the opportunity for sufficient sleep. This was a comparable amount of sleep as the employee's usual workday sleep durations. The employee reported no issues with sleep.

#### **Post-Incident Toxicology Testing**

WMATA's Drug and Alcohol Program determined that the Hi Rail Operator was not in violation of the Drug and Alcohol Policy and Testing Program 7.7.3/6.

#### **Immediate Mitigation to Prevent Recurrence**

- The Hi Rail Operator was removed from service for post-incident testing.
- CR 7972 was removed from service and certification sticker was removed.
- The derailment area was inspected by TRST personnel and cleared for train movement.
- Prior to moves across the grade crossing involving similar Hi Rail Vehicles, all rear tire pressures were lowered to 60 psi to give more pressure on the rear rail gear.
- Prior to moves, two contractor spotters and WMATA personnel were assigned on each side while Trucks traversed the crossing.
- Crossing speed at the grade crossing was reduced.

### **Probable Cause Statement**

The probable cause for the derailment that occurred on September 10, 2022, was a combination of human and mechanical factors. The combination of limited flangeway depth, width, and uneven asphalt at the entrance of the grade crossing were the root cause of the derailment. A contributing factor to the event was the Hi Rail Operator's failure to observe the left rear tires were over-inflated for hi rail operations during their pre-trip inspection. The overinflation contributed to the wheels lifting when they contacted the asphalt. Following remediation of the flangeway depth and smoothing the asphalt around the grade crossing, the hi rail wheels continued to climb during further attempts to recertify the vehicle. Based on identical vehicles' ability to traverse the crossing before and after the flangeway depth was addressed, an unidentified mechanical deficiency with the vehicle's hi-rail gear is also a suspected contributing factor. The vehicle was removed from the property because Greenbelt Yard was no longer the storage location for its assigned task and was not used on the mainline.

### **Recommended Corrective Actions**

<b>Corrective Action Code</b>	<b>Description</b>	<b>Responsible Party</b>	<b>Estimated Completion</b>
102773_SAFECAPS_PLNT_001	The asphalt across the grade crossing was resurfaced.	PLNT	Completed
102773_SAFECAPS_TRST_002	Flangeways were cleaned and remeasured as compliant.	TRST	Completed
102773_SAFECAPS_MOWE_001	Evaluate and respond to CENV recommendation to "Ensure the roadway, at any road crossing, is kept at or below the Top of Rail for at least 12 inches to each side of the running rails, both field and gauge side."	MOWE	8/30/2023

## **Appendices**

### **Appendix A – Interview Summary**

*\*The below transcript is a summary of the SAFE interview conducted with the Hi Rail Operator. It reflects statements made by them and may conflict with other systems of record.*

#### **Hi Rail Operator**

The Hi Rail Operator is a Kiewit employee with twelve (12) years of service as an Operator Engineer and has been with the local branch of Kiewit for the last 3 months. The Hi Rail Operator is RWP Level 2 certified and must recertify in July 2023. The Hi Rail Operator mentioned feeling fully alert right before the event. The Hi Rail Operator stated the day of the event was not a normal workday because they were filling in due to a shortage of equipment operators. The Hi Rail Operator said their work assignment for the night was to drive a Hi Rail vehicle from Greenbelt Yard to the NPS Yard. The Hi Rail Operator stated they completed a Roadway Job Safety Briefing (RJSB) before leaving the yard. The Hi Rail Operator had not driven the Hi Rail vehicle during a shift prior to the incident. The Hi Rail Operator was certified the day prior to the event to operate the unit and the night of the event was their first day operating on live track. The Hi Rail Operator completed a pre-trip inspection of the unit and did not identify any mechanical issues. The Hi Rail Operator said WMATA had radio issues while they were trying to leave the yard. The Hi Rail Operator was asked to explain the process from driving on the road to driving on the rail. The Hi Rail Operator stated they do not have their CDL so they could only drive the Hi Rail unit on rail. The Hi Rail Operator stated the Kiewit mechanic is the person that transitions the Hi Rail vehicles from on the road to on the rail. The Hi Rail Operator was asked to explain what happened on the night of the derailment. They stated, "The first two trucks left and then we got caught at a red signal, so they stopped us. After that we got the green light, so we went ahead and pulled up and it was the first road crossing there. We stopped at the stop sign and then honk the horn and then started pulling forward. I couldn't have been going maybe three or five miles per hour at tops because I was just at a stop. I went to go over the road and I didn't know I derailed. I didn't know the asphalt was high. As soon as we came up on top of the road, the truck was derailed. But I was on tires, so I didn't feel it. Then as soon as I pulled off the other side of the road, it dropped down and dropped on the track, which was derailed. I waited for the pilot to get out and go check everything. We got out of the truck and then called safety and my boss and went through the steps of that." The Hi Rail Operator did not know the purpose of the pilot and instructed us to ask their manager.

#### **On-Scene Commander**

The On-Scene Commander was the ERT Unit that arrived on scene. A Kiewit contractors High Rail vehicle (CR 7972) was being transported to the L-line bridge shutdown and derailed at 02:37 hours at E99 yard road crossing. Personnel were contacted by the Superintendent and MOC responded to the derailment at 02:55 hours. TRST personnel, Track Supervisor, was assigned as the On-Scene Commander and conducted a brief assessment of the derailment area. The On-Scene Commander took pictures of the incident scene and conducted a visual inspection of the derailment area. The On-Scene Commander determined that no physical or structural damage was caused by the derailment. TRST and Kiewit personnel re-railed the high rail vehicle at 04:17 hours and removed it from the rail at the grade crossing. Power was re-energized at 04:53 hours. On-site Mechanics Supervisor deemed the high rail unit CR 7972 out of service until inspected.

#### **Pilot**

The Pilot is a WMATA employee with four (4) years of service as an Equipment Operator A. The Pilot is RWP Level 2 certified and must recertify in November 2022. The Pilot mentioned feeling

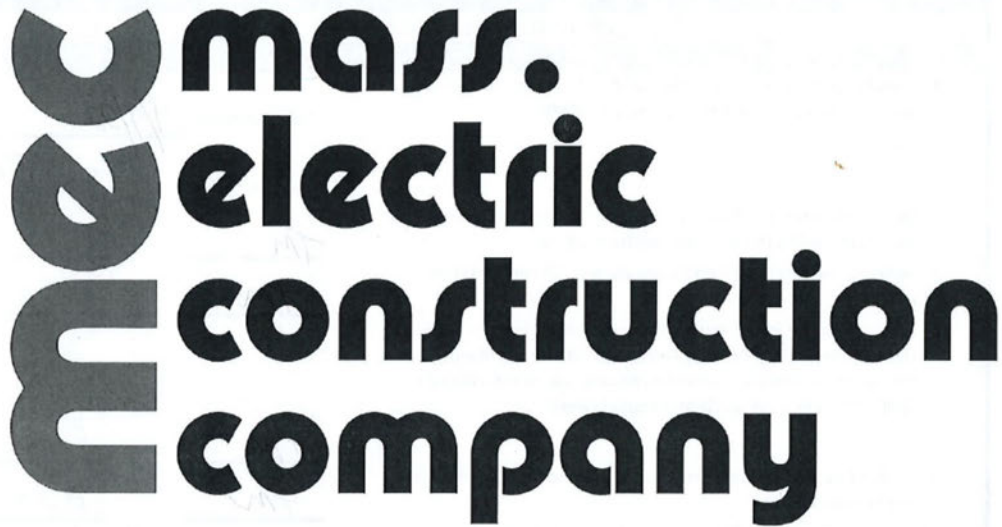
fully alert right before the event. The Pilot stated they serve as a Pilot frequently but not so much for hi rail vehicles. They stated they pilot other class 2 vehicles such as the rail grinder at least 3 to 4 times a month. The Pilot mentioned never having any issues while serving as a pilot. On the night of the derailment, the Pilot's responsibilities were to communicate with tower to request where they were working on mainline and to instruct the driver when to go and when to stop. The Pilot was inside the hi rail vehicle when they reached the grade crossing. The Pilot stated pilots are typically inside the vehicle at grade crossings. The Pilot stated they did not have any mechanical issues prior to leaving the yard. The Pilot described the event as follows, "We got a block out of the yard from the Tower, and I gave the operator permission to proceed. I told him speeds no greater than 5 miles per hour over switches and curves due to the nature of the vehicle and we got to the road crossing stops. He blew the horn then started to proceed. As we were proceeding, we crossed the first road crossing, got about halfway to the second road crossing and we felt the back of a truck drop. So, I told him to stop right there, put it in park, and I'm going to get out and inspect. I saw the truck was sitting on the ground. I called the RWIC and let him know. Then I proceeded to get on my radio and tell the tower what was going on." The Pilot stated they experienced radio communication issues while they were in the yard. The Pilot mentioned the driver and themselves did everything correct and believed the asphalt at the grade crossing caused the unit to derailment.

## Appendix B – Hi Rail Vehicle, CR 7972



Figure 9: Shows the Hi Rail vehicle, CR 7972, involved in the derailment.





**DESIGNATED OPERATOR PROGRAM**

**OPERATOR EVALUATION FORM**

REVISED 2020

Page 14 of 337

Attachment 1: Designated Operator Program Evaluation Form Page 1 of 6.



## MECT- DESIGNATED OPERATOR PROGRAM

### OPERATOR EVALUATION FORM

*Trainer write the date and location next to each of the types of equipment Operator has been certified on*

Date	Abbreviation	Description	Location
9-9-2022	GO	General Overview	680-118015
9-9-2022	DVI	Daily Visual Inspection	680-118015
9-9-2022	LDHR	Light Duty HiRail	680-118015
	PAL	PaLift Hook Loader	
	TT	Trailer Towing	
	HRBKT_ALB	HiRail Bucket Truck- Altec ALB	
	HRBKT_AT41M	HiRail Bucket Truck- Altec AT41M	
	BKT_AT41M	Bucket Truck- Altec AT41M	
	BKT_THRLT	Bucket Truck- Terex HI Ranger LT Series	
	BKT_THRTL	Bucket Truck-Terex HI Ranger TL50	
	BKT_ETI	Bucket Truck-ETCMH-37-IH	
9-9-2022	HRPLF_MEC2400	HiRail Platform Truck- MEC2400	680-118015
	HRPLF_LAL	HiRail Platform Truck- Lift-a-Loft	
	SVCL2K	Service Crane < 2000lb Capacity	
	WPTKRTSE	Wire Pulling Truck TSE UP85	
	UTV	Utility Vehicle	
	HRUTV	HiRail Utility Vehicle	
	HR3RTT	HiRail 3 Reel Turret Trailer	
	QS	Qualified Signal Person	
	QR	Qualified Rigger	

### ACKNOWLEDGEMENT

*I understand that I (Operator) am responsible for the proper and safe operation of equipment per MECT's Designated Operator Program and SOPs. I will not operate any equipment that I have not been designated to operate by a MECT Certified Trainer.*

Operator's Name: \_\_\_\_\_

PRNER \_\_\_\_\_

Location: Greenbelt

*The Operator noted above has demonstrated the understanding, knowledge and ability to operate the equipment listed above safely and in accordance with MECT's Designated Operator Program.*

Company Representative: \_\_\_\_\_

# **mass. electric construction company**

## **DESIGNATED OPERATOR PROGRAM**

**LIGHT DUTY HI RAIL**



REVISED 2020

Page 52 of 337

Attachment 1: Light Duty Hi Rail Guidelines Page 3 of 6.

## DISTRICT GUIDELINES FOR OPERATION OF HIRAIL EQUIPMENT

7. Rail gear that is locked into position with pins must not be used unless rail gear is properly pinned off.
  8. Rail gear that is locked in place by hydraulic cylinders rotating the gear over center must not be used unless the rail gear has been over-centered and is up against the stops.
    - ii. Dis-engage rail gear in the reverse order as engaging. When removing vehicle from the rail the HiRail gear must be fully raised and pinned off in the stowed position before driving on the road.
3. Operation On Rail
- a. Operation on rail requires a different driving technique than on highway due to the reduced traction through reduction of the tire area contact.
  - b. Before moving HiRail vehicles along a rail, turn on the head lights and rotating beacon or strobe light.
  - c. The vehicles backup alarm must be operational to work on rail.
  - d. Prior to moving the vehicle honk twice to signal forward movement and three times to signal reverse movement.
  - e. Operators must familiarize themselves with the equipment by making several practice stops and starts each day before actual rail operation.
  - f. Operators must consider track conditions, visibility, grade, weather and all other conditions that may affect safe operation of the vehicle.
  - g. Operator must get out and check all movement through all switches in any direction of travel. Use a spotter when available.
  - h. Operators must observe and follow all railroad safety rules and regulations. Railroad rules governing speed must be observed at all times.
  - i. HiRail vehicles must operate in a forward direction whenever possible. The following speeds must not be exceeded:
    - i. 10 MPH in the forward direction
    - ii. 10 MPH in the reverse direction
    - iii. 5 MPH when traveling on unfinished track
    - iv. 5 MPH at grade crossings and sharp curves/ super elevation
    - v. Creep over switches, you should stop 100 feet before the switch and make sure the track is in the proper alignment for the path you wish to travel. Going backwards through a turnout WILL cause the vehicle to derail and cause damage to the vehicle, rail and components, if a passenger is in the cab they will get out and watch that the rail gear is going through the switch and frog correctly. If unclear of the correct switch position for travel contact supervisor.
    - vi. When motoring through stations do not travel faster than 1 mph and a spotter will be utilized. If no spotter is available, the driver will stop at least 100 feet before the station, secure the equipment with rail chocks/skates and walk the station area to make sure nothing is fouling the track. Sound the horn three times when entering and exiting a station.

*It is the Project Manager/Job Superintendents responsibility to insure that only designated operators run MEC owned or rented equipment.*

Attachment 1: Page 4 of 6.



## DISTRICT GUIDELINES FOR OPERATION OF HIRAIL EQUIPMENT

- e. Never leave HiRail equipment unattended with the motor running.
5. **DO NOT attempt to rescue runaway HiRail equipment at the risk of personal injury.**
6. Use of equipment attached to HiRail trucks in a mobile application (Buckets, Platforms, etc...).  
ANSI A92.2 Sections 9.5 & 10.9
  - a. Before engaging in mobile operations the operator shall determine that the aerial device is specifically designed for mobile operations.
  - b. Equipment outfitted with creep drive systems will also abide by the following guidelines.
  - c. **Operators are only allowed to be in the aerial bucket or on a platform while the vehicle is moving when working from pole to pole. When traveling from one work area to another that are more than 500 feet all personnel must be in the cab of the vehicle with their seat belts fastened.**
  - d. **Operators are allowed to be at the controls of a boom truck (crane) while using the truck to string contact and messenger wire.**
  - e. All other boom truck operations require the operator to be in the cab of the truck when traveling on the rail.
  - f. The aerial lift manufacturer's guidelines for mobile operations must be followed.
  - g. Avoid traveling on any surface that adversely affects vehicle safety.
  - h. Maintain a safe distance from obstacles.
  - i. Maintain communication between the driver and the operator. Under all travel conditions, the driver shall limit travel speed in accordance with conditions of the ground surface, congestion and slope. **Maximum allowable speed is 10 MPH.**
7. Inspection and Maintenance – Periodic and proper lubrication and maintenance is important to the safe and reliable operation of the equipment.
  - a. The operator is responsible for completing the applicable Daily Visual Inspection, vehicle, attachments and its HiRail gear each day it is used. The operator's manual will detail specific items to inspect, the following are some of the most common:
    - i. Inspect rail sweeps for condition and adjustment. No more than 1/8" above head of rail.
    - ii. Inspect proper operation of assist brakes. (Proper brake pad adjustment is 1/8"-1/4")
    - iii. Inspect power source for oil level, leaks and operation.
    - iv. Inspect rail wheels for condition and wear.
    - v. Inspect lock pins for condition and operation.
    - vi. Inspect vehicle rims and tires. (Under or over inflation will drastically change the effective traction and guidance of the HiRail gear.)
    - vii. Inspect hydraulic cylinders for leaks and condition of pins.
    - viii. Inspect pivot pins for condition and grease.
    - ix. Inspect hydraulic hoses for damage and leaks.
    - x. Inspect steering lock for operation and condition. (Not required for HiRail gear mounted behind the cab)
  - b. Operators will immediately remove any HiRail equipment from service that is found to be unsafe to operate. HiRail equipment removed from service must be reported to the operator's immediate supervisor.

*It is the Project Manager/Job Superintendents responsibility to insure that only designated operators run MEC owned or rented equipment.*

Attachment 1: Page 5 of 6.

DESIGNATED OPERATOR  
WRITTEN EXAM

LIGHT DUTY HIRAIL

8. List 3 Pre operational inspection items (each answer worth 1 point)

- ✓ 1 Inspect proper operation of Assit Breaks
- ✓ 2 Inspect vehicals tires & rims
- ✓ 3 Inspect hydro hoses for damage or leaks

9. When traveling on the rail more than 500' operators shall

- a. Ride in the bucket or platform
- b. Ride in the belly of the truck
- c. Ride in the cab of the truck with seatbelt fastened
- d. Stow the areial device and attachments
- ✓ e. Both c & d

✓ 10. Never operate on unfinished track that is super elevated

True False

✓ 11. When parking equipment on rail you do not need to set the parking brake

True False

✓ 12. It is permissible to leave equipment idle on rail unsupervised

True False

✓ 13. Operators are not allowd to be in the bucket or platform when moving pole to pole

True False

✓ 14. At the start of shift the operaotr must test the rail gear assist brakes

True False

✓ 15. When ready to travel on the rail the operator shall make sevril practice starts and stops to gauge the condition of the rail

- a. Daily
- b. Monthly
- c. Weekly
- d. Every other day

## Appendix D – CENV Incident Report



### Washington Metropolitan Area Transit Authority

#### CENV

#### Incident Report

#### CR7972 Derailment at E99 road crossing (Greenbelt Yard)

September 12, 2022

## **List of Figures**

**Figure 1** – Rear of hi-rail flatbed CR7972

**Figure 2** – Point of derailment/Flange marks

**Figure 3** – Loss of contact

**Figure 4** – Wheel loading measurement

## **List of Attachments**

**Attachment A** – CR 7972 Hi-rail inspection



## **Executive Summary**

At approximately 0238 hours on the morning of September 10<sup>th</sup>, 2022, behind signal E99 078 at the road crossing in E99 (Greenbelt yard), hi-rail flatbed CR7972 derailed. (Figure 1).



**Figure 1** – Rear of hi-rail flatbed CR7972

Inspection of the vehicle revealed that the left side tires were overinflated to 125 psi; 35 psi greater than the hi-rail maximum of 90 psi. Evaluation of the road crossing at the point of derailment (POD) found that the asphalt was higher than the top of rail (TOR) in the area of derailment. This height difference, combined with the over inflated tires and track radius all contributed as factors in the derailment; however, the root cause is most likely the raised asphalt adjacent to the rail.

## **Introduction**

WMATA regularly contracts its capital improvement projects. Typically, the Contractor will use hi-rail trucks to perform the work due to lower cost and ease of transport as compared to rail-bound vehicles. At the start of a project, the contractor will enter the system from the closest maintenance yard and travel to the work site. Contractor vehicles are operated by the contractor but a WMATA pilot is required during contractor vehicle movement. While vehicles are maintained by the contractor, there is a CMOR program that inspects contractor equipment, both hi-rail and rail-bound, at the start of projects and every six months thereafter.

## **Findings of Investigation**

At approximately 0238 hours on the morning of September 10<sup>th</sup>, 2022, behind signal E99 078 at the road crossing in E99 (Greenbelt yard), hi-rail flatbed CR7972 derailed. According to track alignment data (TC-TA-3), the area of derailment was in an approximate 383-foot radius curve. CTEM was made aware of the derailment, responded and assisted with moving the vehicle off the roadway. At approximately 0421, the vehicle cleared the roadway and was driven over-the-road to a parking/layup area in the Greenbelt yard. The Incident Recovery Team, CTEM and CENV began inspection of the unit. No issues or damage were found.

From flange marks left on the asphalt, it was determined the rail wheels lost contact with the rail upon entering of the grade crossing (Figure 2).



**Figure 2 – Point of derailment/Flange Marks**

The vehicle was inspected by SAFE, CENV and CTEM and found to have excessive tire pressure on

the rear left-side tires of the tandem axles. Over inflated tires can reduce compliance, changing the weight distribution between the tires and rail wheels and would be a likely contributor to this incident. Highway tire pressure is higher than on-rail pressure. It is the operator's responsibility to adjust the tires from highway pressure to hi-rail pressure before boarding the tracks.

Further inspection noted no damage resulting from the incident.

September 15, CR7972 was taken back to the road crossing with the corrected tire pressure and the rear hi-rail wheels began to climb immediately after both sets of tires were on the asphalt of the road crossing, although further into the crossing and not as extreme as the original incident (Figure 3).



**Figure 3 – Loss of contact**

Evaluation of the road crossing at the POD found that the asphalt was approximately 0.4 inches above TOR on the right side of the rear wheel set and 0.6 inches above TOR on the left side of the forward wheel set.

CENV requested that the hi-rail gear be reinspected by a 3<sup>rd</sup> party to ensure that it was properly adjusted. No issues with the adjustment were found (Attachment A). To confirm proper weight distribution CENV weighed the vehicles rear tandem axles and hi-rail axle. All axles were within 10% of each other indicating an acceptable distribution (Figure 4).



**Figure 4 – Wheel loading measurement**

## **Conclusion**

The investigation revealed that the road crossing asphalt at the POD was approximately 0.5 inches above TOR; this is believed to have led to unloading the left rear hi-rail wheel. Once unloaded the hi-rail wheel derailed on the inboard side of the radius following the path of the vehicles cord at the POD.

Although over inflated tires, at the time of incident, exacerbated the rail wheel unloading, correctly adjusted hi-rail vehicles lost contact with the rail on the Greenbelt grade crossing during testing.

## **Recommendations**

- Ensure the roadway, at any road crossing, is kept at or below the TOR for at least 12 inches to each side of the running rails, both field and gauge side, to prevent hi-rail wheel unloading.
- Ensure all WMATA pilots witness the walkaround inspection, including inspecting the tire pressure as required by CMOR OAP 101.1.

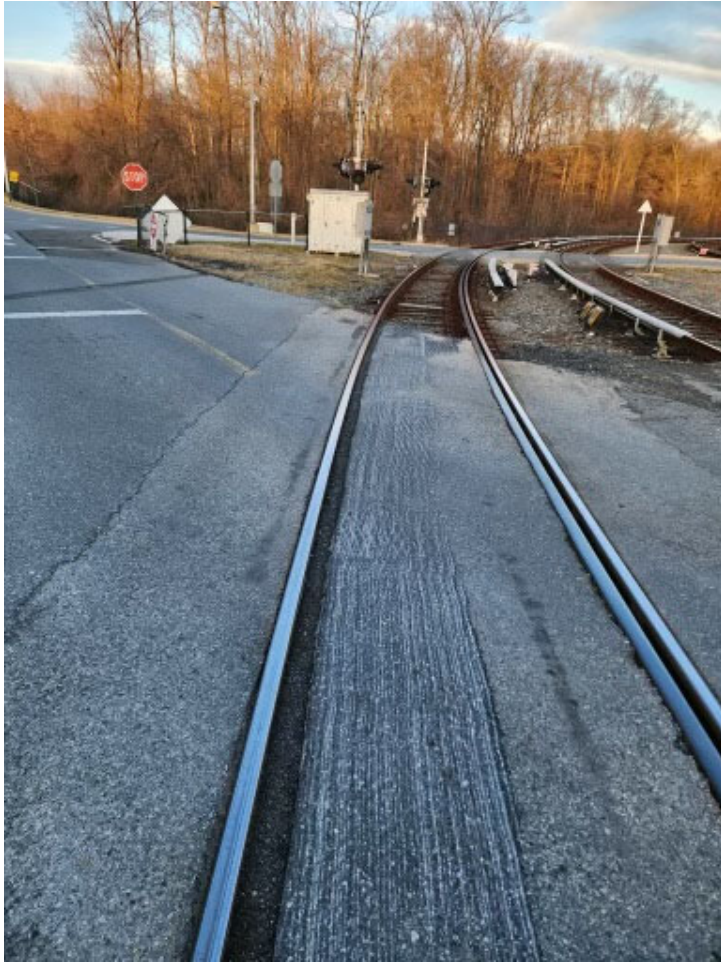


## Appendix E – CR7972 Hi – Rail Inspection

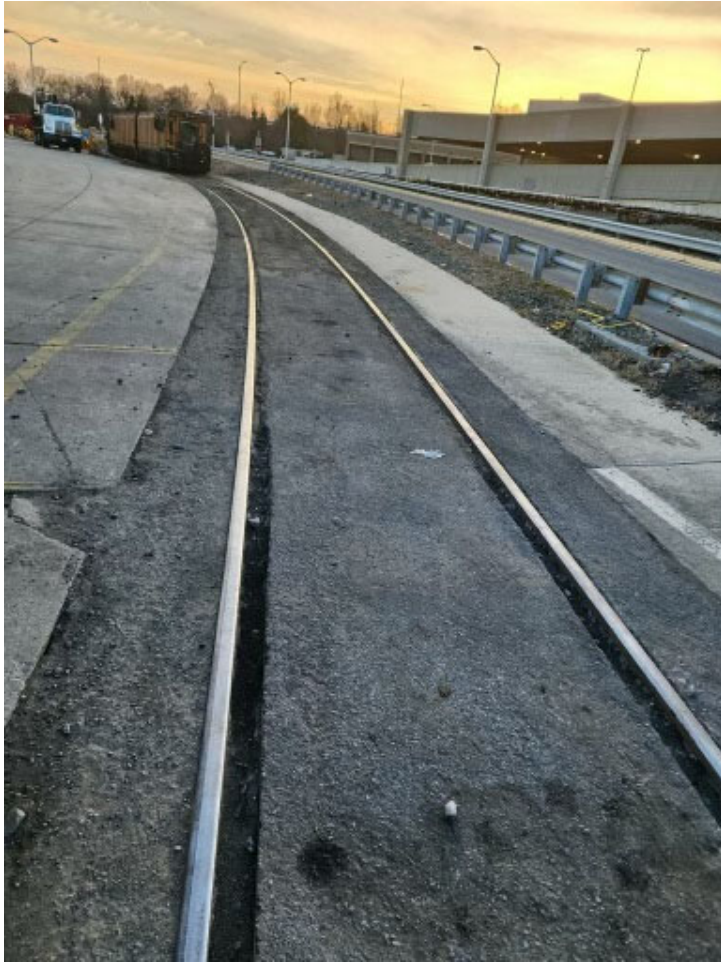
ALIGNMENT PROCEDURE		DATE: 9-3-2022																				
<p>A) STEPS 1) and 2) must be completed in listed order and are assumed to be within specifications and should only be addressed, if after alignment of the railgear, excessive flanging occurs.</p> <p>1) Frame should be square, to within 1/8" maximum, on the diagonal.</p> <p>2) Rear drive axle should be square to frame within 1-1/8" maximum on the diagonal to achieve 0° thrust angle. this should be checked by a qualified alignment shop.</p> <p>B) The following procedure applies to shop or field inspection.</p> <p>1) Check air pressure in all tires. tires should be inflated to the minimum rating of the wheel or tire.</p> <p>2) Place vehicle on straight and level track, or 3" channel to simulate rail. Lower the railgear to the rail so that front to rear and diagonal measurements can be made. (Note: these measurements can be made from any convenient locations, as long as it stays consistent from side to side.</p> <p>3) If diagonal measurement is out of tolerance, adjustment of the front railgear must be made. The procedure for this is as follows (for D-1 &amp; D-2 only): Place shim material between the stop block on the pivot arm (see dwg below) &amp; where it comes into contact with the long arm. The location for the shim is most accessible from behind the front Railgear axle (example: shim on left side, it will push left axle forward). Once proper shimming has been obtained, weld the shim into place on the pivot arm. Max. allowable 1/4" - Contact DMF if outside the maximum range.</p>																						
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>SPECIFICATION</th> <th>AS-BUILT</th> <th>SPECIFICATION</th> <th>TOLERANCES</th> </tr> </thead> <tbody> <tr> <td>A-1 27 1/2"</td> <td>=</td> <td>A-2 27 1/2"</td> <td>± 1/8"</td> </tr> <tr> <td>B-1 50"</td> <td>=</td> <td>B-2 49 1/8"</td> <td>± 1/4"</td> </tr> <tr> <td>C-1 29 1/2"</td> <td>=</td> <td>C-2 29 1/2"</td> <td>± 1/8"</td> </tr> <tr> <td>D-1 30"</td> <td>=</td> <td>D-2 30"</td> <td>± 1/4"</td> </tr> </tbody> </table>			SPECIFICATION	AS-BUILT	SPECIFICATION	TOLERANCES	A-1 27 1/2"	=	A-2 27 1/2"	± 1/8"	B-1 50"	=	B-2 49 1/8"	± 1/4"	C-1 29 1/2"	=	C-2 29 1/2"	± 1/8"	D-1 30"	=	D-2 30"	± 1/4"
SPECIFICATION	AS-BUILT	SPECIFICATION	TOLERANCES																			
A-1 27 1/2"	=	A-2 27 1/2"	± 1/8"																			
B-1 50"	=	B-2 49 1/8"	± 1/4"																			
C-1 29 1/2"	=	C-2 29 1/2"	± 1/8"																			
D-1 30"	=	D-2 30"	± 1/4"																			
<p><b>RAIL WHEEL LOAD ADJUSTMENT PROCEDURE</b></p> <p>Tire traction varies w/ every truck based on several factors such as weight &amp; tire design. It can also vary on the same truck as equipment is added or deleted. Thus, we recommend performing the traction adjustments after all equipment is installed or removed. Since every truck differs, there is no exact procedure. However, we have found the following two methods to be a good guide. The true test is how the vehicle performs on rail.</p>																						
<p><b>METHOD #1</b></p> <p>Note: Method #1 is a visual procedure of the tire capping on rail.</p> <ol style="list-style-type: none"> <li>Grind off the welds on the (2) four hole mounting plates at the rear mounting bracket.</li> <li>Loosen the (8) rear bracket mounting bolts.</li> <li>Lower the railgear supporting the railgear with a floor jack or with the unit itself.</li> <li>Remove or add spacer shim material located between the bottom of the truck frame and the shelf on the rear mounting bracket. Add shim to decrease traction and remove shim to increase traction (ref. side dwg. for illustration of proper tire capping).</li> <li>Raise Railgear once again to contact the bottom of the truck frame.</li> <li>Re-tighten the rear mounting bracket bolts to 154 ft/lb. torque and re-weld the mounting plates, and shims to the bracket (per rear install detail in section 5.1). If multiple spacers are used, remember to weld spacers to one another.</li> </ol>																						
<p><b>METHOD #2</b></p> <p>Note: Method #2 distributes the vehicles rear axle(s) weight(s) equally over all rear axes, including the Railgear.</p> <ol style="list-style-type: none"> <li>If truck scales are available, weigh the vehicle's rear axle (if tandem, weigh both)</li> <li>With front and rear Railgear in the rail position, add or remove shims until rear Railgear axle weight is distributed equally between rear truck axle &amp; Railgear. If truck has tandem axle, the weight should be equally distributed over all 3 axes (tandem &amp; railgear axle - 1/3, 1/3, 1/3).</li> <li>Once weight is equally distributed, then raise Railgear to the highway position.</li> <li>Re-tighten the rear mounting bracket bolts to 154 ft/lb. torque and re-weld the mounting plates, and shims to the bracket (per rear install detail in section 5.1). If have multiple spacers, remember to weld spacers to one another.</li> </ol>																						
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>REV</th> <th>DATE</th> <th>DESCRIPTION</th> <th>BY</th> <th>APP</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>4/17/12</td> <td>ADDED AS PER 1630 MANUAL CHANGES</td> <td>JDI</td> <td></td> </tr> <tr> <td>2</td> <td>9/14/09</td> <td>UPDATED AS PER 1630 MANUAL CHANGES</td> <td>JBG</td> <td></td> </tr> </tbody> </table>			REV	DATE	DESCRIPTION	BY	APP	1	4/17/12	ADDED AS PER 1630 MANUAL CHANGES	JDI		2	9/14/09	UPDATED AS PER 1630 MANUAL CHANGES	JBG						
REV	DATE	DESCRIPTION	BY	APP																		
1	4/17/12	ADDED AS PER 1630 MANUAL CHANGES	JDI																			
2	9/14/09	UPDATED AS PER 1630 MANUAL CHANGES	JBG																			
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2">DESIGNED BY</th> <th colspan="2">TITLE</th> </tr> </thead> <tbody> <tr> <td>DESIGNED BY</td> <td>DATE</td> <td>ALIGNMENT PROCEDURE &amp; TEAR SHEET &amp; TRACTION ADJUSTMENT PROCEDURES</td> <td></td> </tr> <tr> <td>DESIGNED BY</td> <td>DATE</td> <td>DIVERSIFIED METAL FABRICATORS, INC. (404) 75-1512</td> <td></td> </tr> <tr> <td>DRAWN BY: TSH</td> <td>APPROVED BY:</td> <td>DATE: 12/20/91</td> <td>DRAWING NUMBER: M1630115</td> </tr> <tr> <td></td> <td></td> <td></td> <td>REV: 8</td> </tr> </tbody> </table>			DESIGNED BY		TITLE		DESIGNED BY	DATE	ALIGNMENT PROCEDURE & TEAR SHEET & TRACTION ADJUSTMENT PROCEDURES		DESIGNED BY	DATE	DIVERSIFIED METAL FABRICATORS, INC. (404) 75-1512		DRAWN BY: TSH	APPROVED BY:	DATE: 12/20/91	DRAWING NUMBER: M1630115				REV: 8
DESIGNED BY		TITLE																				
DESIGNED BY	DATE	ALIGNMENT PROCEDURE & TEAR SHEET & TRACTION ADJUSTMENT PROCEDURES																				
DESIGNED BY	DATE	DIVERSIFIED METAL FABRICATORS, INC. (404) 75-1512																				
DRAWN BY: TSH	APPROVED BY:	DATE: 12/20/91	DRAWING NUMBER: M1630115																			
			REV: 8																			

## Appendix F – Photos of Grade Crossing after Resurfacing











## Appendix G – Switch Order

### WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY GENERAL ORDERS AND TRACK RIGHTS SYSTEM SWITCH ORDER

SWITCHING ORDER: 2022253527 STATUS: Closed Secondary Switch Order  
 LOCATION & EQUIPMENT REQUESTED: E99 YARD, 129, 130  
 DATES NEEDED: 09/10/2022 THRU 09/17/2022 TIME FROM: 04:00 TO: 00:00  
 DATE APPROVED: 09/10/2022 TIME APPROVED: 03:13  
**LOCK OUT / TAG OUT: No**  
 EQUIPMENT CONFIRMED DE-ENERGIZED BY UNIT:  
 -----  
 OUTAGE REQUESTED BY: [REDACTED] OF: TRPM PHONE: [REDACTED]  
 EMERGENCY CONTACT: [REDACTED] EMERGENCY CONTACT PHONE: [REDACTED]  
 TAG #: 2022253527-A RAIL SUPPORT REQUEST:  
 GIVEN TO: [REDACTED] OF: TRST/STRUC ON: 09/10/2022 AT: 04:27  
 CLEARED BY: [REDACTED] OF: TRST/STRUC ON: 09/10/2022 AT: 04:34  
 REMARKS: em. s/o for derailed unit  
 CANCELLATION DATE: TIME: REASON:

DE-ENERGIZED							ENERGIZED						
DESK OPR	Unit #	DATE	TIME	LOCATION	EQUIPMENT	TAG PLACED	DESK OPR	Unit #	DATE	TIME	LOCATION	EQUIPMENT	TAG REMOVED
[REDACTED]	[REDACTED]	9/10/2022	04:22	E99TB	81	2663	[REDACTED]	[REDACTED]	09/10/2022	04:59	E99TB	81	2663
[REDACTED]	[REDACTED]	9/10/2022	04:22	E99TB	82	2661	[REDACTED]	[REDACTED]	09/10/2022	04:59	E99TB	82	2661
[REDACTED]	[REDACTED]	9/10/2022	04:23	E99TP	31	776	[REDACTED]	[REDACTED]	09/10/2022	04:59	E99TP	31	776
Gaea	[REDACTED]	9/10/2022	04:23	E99TP	32	2411	[REDACTED]	[REDACTED]	09/10/2022	04:59	E99TP	32	2411

#### Switch Order 2022253527 Execution Steps

##### Step 1 Start Switch Order Execution - Completed

Recorded by [REDACTED] at 09/10/2022 04:21

##### Step 2 Verified crew is on location with Switch Order and PPE - Completed

Recorded by [REDACTED] at 09/10/2022 04:21

Attachment 1 of 2: This was the switch order to have third power de-energized and restored.

**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY  
GENERAL ORDERS AND TRACK RIGHTS SYSTEM  
SWITCH ORDER**

**Step 3 De-Energization - Completed**

Recorded by [REDACTED] at 09/10/2022 04:23

**Step 4 De-Energize Circuit Testing - Completed**

Recorded by [REDACTED] at 09/10/2022 04:24

**Step 5 Verification - Completed**

Recorded by [REDACTED] at 09/10/2022 04:25

Comments:

**Step 6 Issue Red Tag - Completed**

Recorded by [REDACTED] at 09/10/2022 04:27

**Step 7 Clear Red Tag - Completed**

Recorded by [REDACTED] at 09/10/2022 04:34

**Step 8 Permission received from Power Desk Assistant Superintendent to energize - Completed**

Recorded by [REDACTED] at 09/10/2022 04:42

Comments:

**Step 9 Energization - Completed**

Recorded by [REDACTED] at 09/10/2022 04:59

**Switch Order 2022253527 De-Energize Circuit Testing**

**Equipment 81 at E99TB tested by 1137 and 1374**

Recorded by [REDACTED] at 09/10/2022 04:24

**Equipment 82 at E99TB tested by 1137 and 1374**

Recorded by [REDACTED] at 09/10/2022 04:24

**Equipment 31 at E99TP tested by 1137 and 1374**

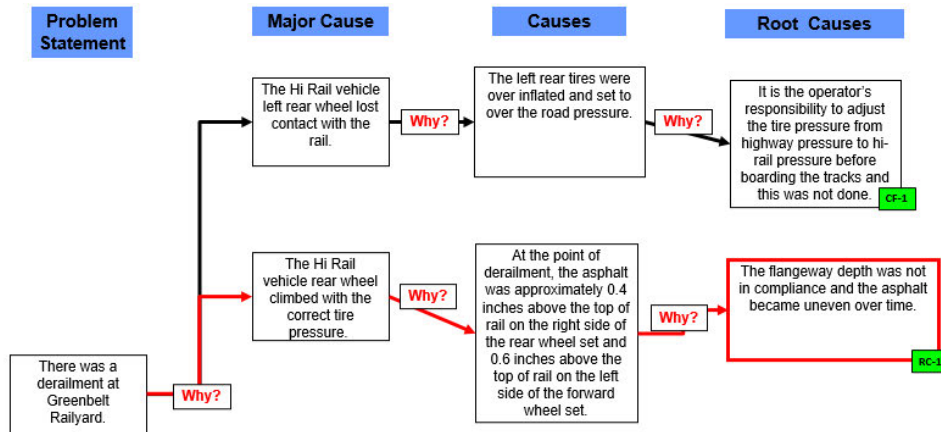
Recorded by [REDACTED] at 09/10/2022 04:24

**Equipment 32 at E99TP tested by 1137 and 1374**

Recorded by [REDACTED] at 09/10/2022 04:24

Attachment 2 of 2: This was page 2 of the switch order to have third power de-energized and restored.

## Appendix H – Root Cause Tree



## Root Cause Analysis

