



WMSC Commissioner Brief: W-0148 – Derailment – near Deanwood Station – October 1, 2021

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

Safety event summary:

Tie Remover and Inserter Machine (TRIPP) TR05 derailed near Deanwood Station while traveling toward Minnesota Ave Station. The Equipment Operator operated the vehicle above the permitted speed limit and did not immediately report the derailment to the Rail Operations Control Center (ROCC). The investigation suggests the Equipment Operator was operating the vehicle in 'work mode' rather than 'travel mode', increasing the risk that this type of derailment would occur due to the way the vehicle interacts with the rails in each mode. In work mode, the vehicle is not supposed to be moved more than 5 mph.

TR05 was the trailing unit of a two-unit convoy with Prime Mover (PM) 43. The convoy was traveling against the normal flow of traffic on track 1 from Deanwood Station to the D&G Junction, where the units would be able to switch over to track 2 to conduct work at Minnesota Ave Station. The D&G Junction is an aerial junction that has a pocket (third) track. It is also where Orange Line tracks from New Carrollton merge with Blue and Silver Line tracks from Largo Town Center.

TR05 was travelling at approximately 20 mph, 5 mph greater than the maximum permitted speed in a convoy block of 15 mph, when the front end of the unit derailed after departing Deanwood Station. Metrorail rules require the TRIPP Machine be operated at no greater than 15 mph in any circumstance.

Approximately six minutes after the derailment, a ROCC Rail Traffic Controller contacted the Equipment Operator of TR05 via radio to ask if the unit was still moving. Instead of reporting the event then, the Equipment Operator indicated they would contact the Controller via telephone, further delaying the initial report of the derailment.

After receiving notification of the derailment, approximately seven minutes after it occurred, a ROCC Controller de-energized third rail power. The TR05 Equipment Operator requested Foul Time to conduct a ground walk around to check the extent of any damage and to confirm derailment. The Controller denied the request because the Equipment Operator did not have the required hot stick to confirm third rail power was de-energized. The Roadway Worker in Charge (RWIC) assigned to the work location the unit was heading to, was dispatched to the derailment location to hot stick and confirm power was down.

Initial inspections by Automatic Train Control Maintenance (ATCM) and Car Track Equipment Maintenance (CTEM) personnel were conducted at the scene and there was no damage found to the ATCM equipment or structural damage to the unit. CTEM noted that the unit was in travel mode and the low/no air pressure alarm was on. SAFE personnel also arrived at the location to investigate. TR05 was rerailed and the unit was operated back to New Carrollton Yard under its own power.

The Equipment Operator was removed from service for post-event toxicology testing.

During an interview, the TR05 Equipment Operator stated there were two flashing red lights and a fault that read "Crankcase Pressure Signal Extremely High", displayed on the unit's dashboard during their pre-trip inspection. A mechanic cleared the indications and told the equipment operator that the unit was safe for use.



The Equipment Operator said in the interview that the same flashing red lights and fault reappeared as the vehicle entered Deanwood Station, but the Equipment Operator made no attempt to stop the vehicle. As TR05 exited the station, the front end derailed.

Post-incident inspections and analysis performed by engineers and maintenance personnel with the Office of the Chief Mechanical Officer (CMOR), determined that TR05 had multiple deficiencies, including an inoperative camera system monitor and headlights, as well as a missing right front gripper pin. The gripper pin helps to hold parts of the vehicle in place during transport and storage to ensure safe movement.

Following the event, the Office of Maintenance of Way Engineering (MOWE) provided a Memorandum to the Department of Safety and Environmental Management (SAFE) about the track conditions at the derailment location, stating that if the vehicle was in work mode while negotiating curve 343, this would likely have caused the units' wheel to lift off the rail and result in a derailment. Curve 343 was out of tolerance with WMATA's design criteria. The rail rate of climb is 3.24%, exceeding the design rate of 2.92%. In travel mode the vehicle should be able to negotiate a rail rate of climb up to 12%.

Probable Cause:

The probable cause of this event is Metrorail's inadequate training and supervisory oversight for the safe operation of work vehicles, particularly complex units such as the TRIPP machine.

Corrective Actions:

Metrorail will first determine the level of effort required to install overspeed alarms and forward-facing, rear-facing and cab video recorders on self-propelled Class 2 Vehicles (roadway maintenance machines).

Metrorail will then develop procedures for installation and install data recorders and video recorders on Class 2 vehicles.

WMSC staff observations:

The missing gripper pin may have contributed to the derailment. The gripper may have been dangling before becoming caught on a tie while the unit was in motion causing it to derail.

In the WMSC Audit of Roadway Maintenance Machine (RMM) Inspection, Maintenance and Training, issued on March 9, 2021, the WMSC found that not all Equipment Operators are fully trained on each type of vehicle they may be directed to operate, and at least some of their training has not included sufficient hands-on experience. The audit also found that Equipment Operator certifications for specific vehicles do not expire or require recertification. These CAPs, C0088 and C0089, remain open and Metrorail is in the process of implementing these corrective actions.

It is important to the safety of Metrorail personnel and riders that emergencies such as derailments be reported immediately over the radio to ensure timely and appropriate response as well as to maintain situational awareness. Elements of these reporting improvements are included in Metrorail's CAP C0070 that Metrorail is in the process of implementing to address the integrity of safety event investigations.

Staff recommendation: Adopt final report.



Washington Metro Area Transit Authority
Department of Safety and Environmental
Management (SAFE)
FINAL REPORT OF INVESTIGATION A&I E21476

Date of Event:	10/01/2021
Type of Event:	Derailment
Incident Time:	01:34 hours.
Location:	Deanwood Station, Track 1, CM 360+50
Time and How received by SAFE:	01:43 hours. IMO
WMSC Notification Time:	03:10 hours.
Responding Safety Officers:	WMATA SAFE: Yes WMSC: No Other: N/A
Rail Vehicle:	Nordco Tie Remover and Insertter (TR) 05
Injuries:	None
Damage:	None
SMS I/A Number:	20211001#95911

Deanwood Station – Derailment

October 1, 2021

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Abbreviations and Acronyms

AIMS	Advanced Information Management System
ATCM	Automatic Train Control Maintenance
CAP	Corrective Action Plan
CCTV	Closed-Circuit Television
CM	Chain Marker
CTEM	Car Track Equipment Maintenance
FT	Foul Time
FT/S	Feet per second
ITSS	Office of IT Systems & Software
MOWE	Chief Maintenance of Way Engineering
MSRPH	Metrorail Safety Rules and Procedures Handbook
NOAA	National Oceanic and Atmospheric Administration
OPMS	Operations Management Services
PM	Primer Mover
RTC	Rail Traffic Controller
RTRA	Office of Rail Transportation
ROCC	Rail Operations Control Center
RWIC	Roadway Worker in Charge
SAFE	Department of Safety and Environmental Management
SE	Super Elevation
SMS	Safety Measurement System
TGV	Track Geometry Vehicle
TKMN	Track Maintenance
TR	Tie Remover and Insertter
TRST	Office of Track and Structures
WMATA	Washington Metropolitan Area Transit Authority
WMSC	Washington Metrorail Safety Commission

Executive Summary

On Friday, October 1, 2021, Tie Remover and Inserter Machine (TRIPP) TR05 was the trailing unit of a convoy with Prime Mover (PM) 43, traveling inbound on Track 1 to the D&G Junction to then switch over to Track 2 to conduct work at Minnesota Avenue Station. At approximately 01:40 hours, the Rail Operation Control Center (ROCC) Rail Traffic Controller (RTC) contacted the Office of Track and Structure (TRST) Equipment Operator of TR05 to ask if they were still moving. The Equipment Operator responded that they would give the RTC a call via landline. When they called the RTC, they informed them that the front end of TR05 came off the rail as they were leaving Deanwood Station platform at chain marker (CM) D1 359+00. Based on the Advanced Information Management System (AIMS) data review, third rail power was de-energized at 01:48 hours. The Equipment Operator contacted the RTC to request foul time (FT) to conduct the ground walkaround. Before the RTC granted the FT, they asked Equipment Operator if they had a hot stick. The Equipment Operator reported that they did not, and the request was denied. The Roadway Worker in Charge (RWIC) was instructed to hot stick the area. Automatic Train Control Maintenance (ATCM) conducted a visual inspection of the incident area and determined there was no damage to any ATCM equipment. Car Track Equipment Maintenance (CTEM) mechanics performed an initial inspection of TR05 at the scene and noted TR05 was in travel mode, the air alarm was on, but there was no structural damage to the unit or leaks. TRST and SAFE performed an initial field assessment and determined that the derailment occurred in proximity to CM D1 360+50, while moving in the inbound direction, coming to rest at approximate CM D1 359+40. During the field assessment, track gauge was measured from the point of rest back through the platform limits and found to be in tolerance. No crosstie or fastener defects were noted.

Based on AIMS playback, TR05 came to a stop, occupying track circuit D10-D1-353 at approximately 01:37 hours. The Office of IT Systems & Software (ITSS) provided a track circuit occupancy chart that showed TR05 traveled 2,161 feet in the 72 seconds before it stopped. The speed translates to 30 feet per second (ft/s) or an average of 20 mph. Per TRST guidelines and a sticker on the speedometer, the maximum permitted speed for this unit was 15 mph.

The office of Maintenance of Way Engineering (MOWE) provided a memorandum to the Department of Safety and Environmental Management (SAFE) about the track conditions at the derailment location.

During the virtual interview, Equipment Operator stated they performed a pre-trip inspection before moving TR05. During the pre-trip inspection, there were two flashing red lights and a fault message displayed on the dashboard. The flashing red lights and fault message were reported to a mechanic. The mechanic cleared the flashing red lights and fault message and informed Equipment Operator that the unit was safe for mainline duties. As Equipment Operator entered the platform at Deanwood Station, the red lights that were flashing during the pre-trip inspection started flashing again. When Equipment Operator was exiting Deanwood Station, the front of TR05 derailed. Equipment Operator noticed the rear airbags were fully inflated, but the front airbags were deflated.

The ROCC removed Equipment Operator from service for post-incident toxicology testing.

Based on ARS playback, at 04:39 hours, TR05 was re-railed without further incident. The RWIC informed the RTC that there were no oil or fuel spills from TR05 and no damage to the roadway. At approximately 04:55 hours, TR05 was given an absolute block to return to New Carrollton yard.

TR05 was operated under its own power back to the New Carrollton Yard. At approximately 05:04 hours, the RWIC contacted the RTC to inform them that all personnel and equipment were cleared from the roadway, tracks were revenue ready, third rail power could be restored, and they could send the test train. At approximately 05:13 hours, the Test Train Operator confirmed with the RTC that the tracks were revenue ready.

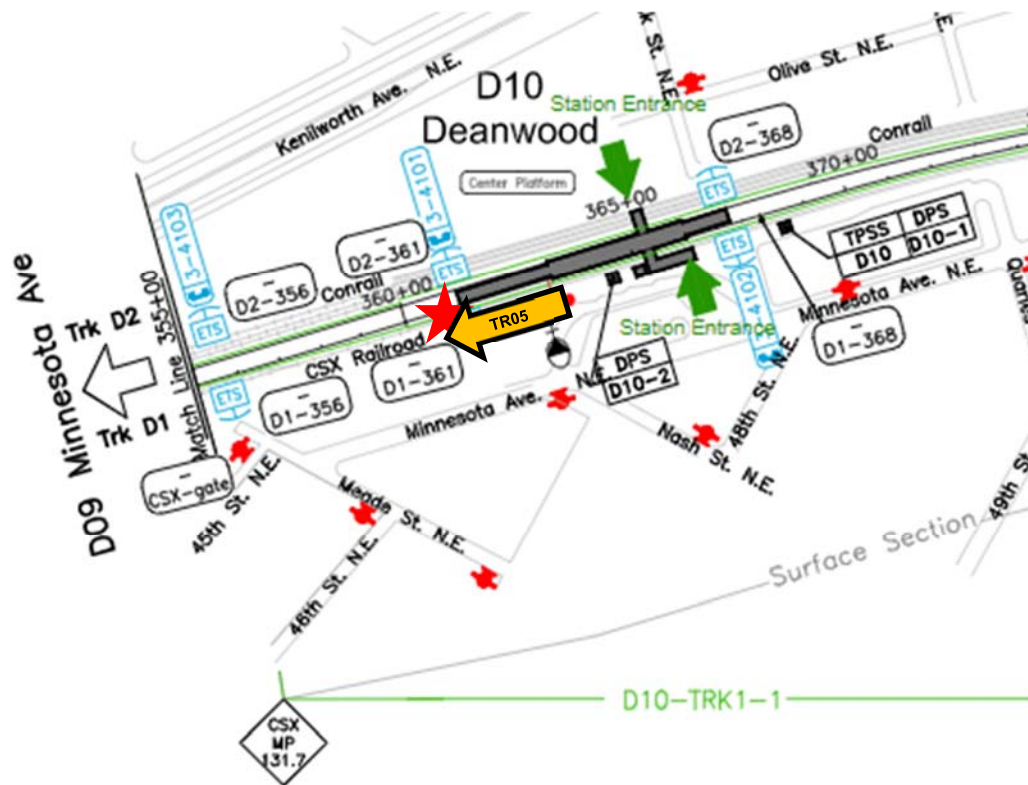
Due to the lack of data loggers and additional source data, a root cause could not be determined. A contributing factor to the derailment at Deanwood Station is human error, with the Equipment Operator operating the unit at an average speed higher than permitted by TRST rules and procedures just prior to the derailment. Historical derailment incidents involving the TRIPP machines have been linked to operating in an overspeed condition while in Work mode (e.g., greater than 5 mph) or with a malfunctioning air suspension. The most recent derailment involving a TRIPP machine, in April 2021, was the result of an overspeed condition while in Work mode. In the April 2021 derailment, the Equipment Operator reported choosing to operate in Work mode to improve ride quality/comfort.

While a root cause was not determined, track conditions leading up to the point of derailment were evaluated and identified as within tolerance for TR05 to safely negotiate in travel mode. During post-derailment inspections and testing, the vehicle systems functioned as designed. Personnel were unable to detect any mechanical failures with TR05.

Incident Site

Deanwood Station, CM 360+50, Track 1

Field Sketch/Schematics



***This image shows the approximate location where TR05 derailed.*

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 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).
 - TRST Equipment Operator
 - TRST RWIC
- Documentation Review – Collection of relevant work history information and process documentation contained in WMATA systems of record. These records include:
 - Employee Training Procedures & Records
 - 30 Day Work History
 - Metrorail Safety Rules and Procedures Handbook (MSRPH)
 - National Oceanic and Atmospheric Administration (NOAA) data
 - Preventive Maintenance Manual Nordco Tie Remover/Insert Machine Review
 - Car Track Equipment Maintenance (CTEM) Inspection Data Review
 - Track Maintenance (TKMN) Data Review
 - Maintenance of Way Engineering (MOWE), Track Engineering Analysis Report
 - Office of Track and Structures (TRST) Inspection Data Review
 - Office of IT Systems & Software (ITSS) Data Review
 - Certifications
- System Data Recording Review – Collection of information contained in Metro Data Recording Systems. This data includes:
 - Audio Recording System (ARS) playback including OPS 2 Radio, Phone-12059, ROCC Asst Sup. 12063
 - The Office of Chief Mechanical Officer (CMOR) Incident Investigation Team (IIT)
 - Advanced Information Management System (AIMS)

Investigation

On Friday, October 1, 2021, at approximately 01:40 hours, the ROCC RTC contacted the TRST Equipment Operator of TR05 to ask if they were still moving. TR05 was the trailing unit of a convoy with PM 43 traveling inbound on Track 1 against the normal flow of traffic to the D & G Junction, to then switch over to Track 2 to conduct work at Minnesota Avenue Station. When the Equipment Operator called the RTC, they informed them that the front end of TR05 came off the rail while leaving Deanwood Station platform at CM D1 359+00. The RTC asked the Equipment Operator if the unit derailed, or if there was a piece of equipment hanging from the unit. The Equipment Operator responded that they were not sure because they were still sitting in the operator cab and never exited to inspect what happened. Third rail power was de-energized at 01:48 hours. The ROCC Assistant Operation Manager instructed the Equipment Operator to complete a radio

check with the ROCC, conduct a ground walkaround of the unit, and let the ROCC know if there was any damage to the rail or to the unit. The Equipment Operator contacted the RTC to request FT to conduct a ground walkaround, which was denied due to the Equipment Operator not possessing a hot stick. The RTC then instructed the Equipment Operator to stand by and stand clear. On their arrival, the RWIC was instructed to hot stick the area. ATCM conducted a visual inspection of the incident area and determined there was no damage to ATCM equipment. CTEM did an initial inspection of TR05 at the scene and noted that the operating mode switch was on Travel Mode and the low/no air pressure alarm was on. TRST and SAFE performed an initial field assessment and determined that the derailment occurred in proximity to CM D1 360+50, while moving in the inbound direction, coming to rest at approximate CM D1 359+40. During the field assessment, track gauge was measured from the point of rest back through the platform limits and found to be in tolerance. No crosstie or fastener defects were noted.

TR05 came to a stop, occupying track circuit D10-D1-353 at approximately 01:37 hours. ITSS provided a track circuit occupancy chart that showed TR05 moved 2,161 feet in 72 seconds before it stopped. The ITSS track circuit occupancy chart revealed that TR05 traveled 30 feet per second, which calculated to traveling at an average speed of 20 mph just prior to the derailment. As noted on a decal above the speedometer, the maximum permissible speed for TR05 is 15mph.

MOWE provided a memorandum report regarding the track conditions at the derailment location. The derailment occurred in proximity to D1 360+50 moving in the inbound direction, against normal traffic. "Existing TGV data shows cross level exceptions on the curve in question. Curve 343 is 243.67 ft. in length, with a maximum [superelevation] of 3.5 inches and a maximum radius of 1878 feet. This is a spiral-to-spiral curve with no full body curve radius. The curve spiral is a transitional track geometry where SE and curve radius gradually and consistently increases or decreases to meet the curve design. The combination of lower cross level than design followed by a higher cross level than design and vice versa within the spiral can create a rate of climb that is more aggressive than intended according to the design... If this vehicle negotiated curve 343 in Work mode, this would have likely resulted in a 'wheel lift off rail' situation and derailment."

During the virtual interview, Equipment Operator stated they performed a pre-trip inspection before moving TR05. During the pre-trip inspection, there were two flashing red lights and a fault message, "Crankcase Pressure Signal Extremely High," displayed on the dashboard. The flashing red and fault message was reported to a mechanic. The mechanic inspected the unit, cleared fault message and informed Equipment Operator that the unit was safe for mainline duties. No defects were noted by the inspecting mechanic. The Equipment Operator stated during their interview that as they entered the platform at Deanwood Station, the red lights that were flashing during the pre-trip inspection started flashing again. After exiting Deanwood Station's platform, the front of TR05 derailed. The Equipment Operator reported the rear airbags were fully inflated, and the front airbags were deflated.

The Equipment Operator was removed from service for post-incident toxicology testing.

Based on ARS playback, at 04:39 hours TR05 was re-railed without further incident. The RWIC informed the RTC that there were no spills from TR05 and no damage to the roadway. At approximately 04:55 hours, TR05 was given an absolute block to return to New Carrollton yard. TR05 was operated on its own merit back to the New Carrollton yard. At approximately 05:04 hours, the RWIC contacted the RTC to inform them that all personnel and equipment were cleared from the roadway, tracks were revenue ready, third rail power could be restored, and they could send the test train. At approximately 05:13 hours, the Test Train Operator confirmed with the RTC that the tracks were revenue ready.

Post-incident inspections and analysis performed by engineers and maintenance personnel with the office of the Chief Mechanical Officer (CMOR), determined that TR05 operated as designed with no deficiencies noted with the equipment. The speedometer was tested and found to be in calibration. The suspension system was tested and found to be operating as designed. While the unit is equipped with a Global Positioning System (GPS) device, the device was not functioning at the time of the incident.

Chronological Event Timeline

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

Time	Description
01:13 hours	<p><u>Equipment Operator</u>: Contacted the ROCC to give their name, call number, and inform them that they were holding at D13-04. Advised that their work location was at Minnesota Avenue Station.</p> <p><u>RTC</u>: Affirmed radio transmission and asked if TR05 was comfortable as the trailing unit of the convoy.</p> <p><u>Equipment Operator</u>: Confirmed they were the comfortable as the trailing unit, clearing all stations interlockings. [Ops. 2]</p>
01:40 hours	<p><u>RTC</u>: Contacted Equipment Operator to ask if they were still moving.</p> <p><u>Equipment Operator</u>: Informed the RTC they would give them a landline. [Ops. 2]</p>
01:41 hours	<p><u>Equipment Operator</u>: Contacted the RTC via landline and informed the RTC that the front end of TR05 came off the rail leaving Deanwood platform at CM D1 359+00. They were approximately 100 feet from the edge of the platform.</p> <p><u>RTC</u>: Asked Equipment Operator what they needed.</p> <p><u>Equipment Operator</u>: Stated if PM 43 could come back and if they had a jack, they could get the front end back on the rail.</p> <p><u>RTC</u>: Asked if the unit derailed or was it a piece of equipment hanging from the unit?</p> <p><u>Equipment Operator</u>: Stated they did not examine it because they were still in the unit, but they knew the front of the unit was off. [Phone-12059]</p>
01:44-01:47 hours	<p><u>ROCC Assistant Operation Manager</u>: Asked Equipment Operator the CM where they were located, if the front of the unit came off the rail, the Equipment Operator's telephone number, and if the unit contacted anything.</p> <p><u>Equipment Operator</u>: Stated they did not contact anything; they were still sitting in the operator cab, but they heard the way the wheels were rubbing against the rail.</p> <p><u>ROCC Assistant Operation Manager</u>: Instructed Equipment Operator to give Central a radio check, complete a ground walkaround the unit, and let them know if there is any damage to the rail or the unit. The ROCC Assistant Operation Manager also asked the Equipment operator to confirm when the issue occurred.</p> <p><u>Equipment Operator</u>: Stated it happened about 3 minutes before they called, and they were about 100 feet from Deanwood Station. Stated they were not injured. [ROCC Asst Sup. 12063]</p>

Time	Description
01:49 hours	<p><u>Equipment Operator</u>: Contacted the RTC to request FT.</p> <p><u>RTC</u>: Acknowledged they were requesting FT and asked for a CM.</p> <p><u>Equipment Operator</u>: Responded D1 359+00 right from Deanwood Station platform.</p> <p><u>RTC</u>: Affirmed and gave a repeat back. Asked Equipment Operator if they had a hot stick.</p> <p><u>Equipment Operator</u>: Responded they did not have a hot stick. [Ops. 2]</p>
01:50 hours	<p><u>RTC</u>: Instructed TR05 Operator to stand by and stand clear. [Ops. 2]</p>
01:51 hours	<p><u>RTC</u>: Contacted MOC to inform them that there was a derailment at D1 359+00, Unit TR05. Requested they provide them with an incident number. [Phone-12059]</p>
01:54 hours	<p><u>RWIC</u>: Contacted the RTC and asked if PM 43 could be routed to Deanwood 1 to possibly be used to re-rail TR05.</p> <p><u>RTC</u>: Affirmed and gave a repeat back. [Ops. 2]</p>
01:59 hours	<p><u>RTC</u>: Contacted MTPD to report a derailment at Deanwood, Track 1</p> <p><u>MTPD</u>: "What was the exact location of the derailment?"</p> <p><u>RTC</u>: Stated it happened about 100 feet from the station</p> <p><u>MTPD</u>: Asked for the train number.</p> <p><u>RTC</u>: Informed them it was not a train but a maintenance unit. [Phone-12059]</p>
02:08 hours	<p><u>RTC</u>: Granted the RWIC FT from Deanwood Station platform to D1 361+00 and informed them D98 3644 signal was red.</p> <p><u>RWIC</u>: Affirmed and gave repeat back. [Ops. 2]</p>
02:14 hours	<p><u>RTC</u>: Instructed the RWIC to hot stick and provide a CM once it was completed.</p> <p><u>RWIC</u>: Affirmed and gave repeat back. [Ops. 2]</p>
02:15 hours	<p><u>RWIC</u>: Contacted the RTC to inform them that hot stick confirmed third rail power was de-energized at CM 360+00.</p> <p><u>RTC</u>: Affirmed and gave repeat back. [Ops. 2]</p>
02:32 hours	<p><u>Track Mechanic</u>: Contacted the RTC to request permission to enter the roadway at Track 1 Deanwood Station.</p> <p><u>RTC</u>: Gave Track Mechanic permission to go direct with the RWIC.</p> <p><u>RWIC</u>: Granted the Track Mechanic permission to enter the roadway. [Ops. 2]</p>
02:36 hours	<p><u>RWIC</u>: Contacted the RTC to ask if they could move PM 43 to D2 359+00.</p> <p><u>RTC</u>: Acknowledged their request and stated they would move PM 43 to D2 359+00. [Ops. 2]</p>
02:40 hours	<p><u>RTC</u>: Contacted Track Mechanic to request an update.</p> <p><u>Track Mechanic</u>: Confirmed their preliminary investigation revealed no damage to the roadway or the unit. CTEM was still conducting their investigation and would provide an update. [Ops. 2]</p>
02:41 hours	<p><u>ATC Unit</u>: Contacted the RTC to inform them that they were at Deanwood Station to do a roadway inspection. [Phone-12059]</p>
02:53-02:54 hours	<p><u>ATC Unit</u>: Contacted the RWIC for permission to enter the work area for the investigation.</p> <p><u>RWIC</u>: Asked their location and unit number.</p> <p><u>ATC Unit</u>: Provided the requested information.</p> <p><u>RWIC</u>: Granted the ATC Unit permission to enter the work area. [Ops. 2]</p>

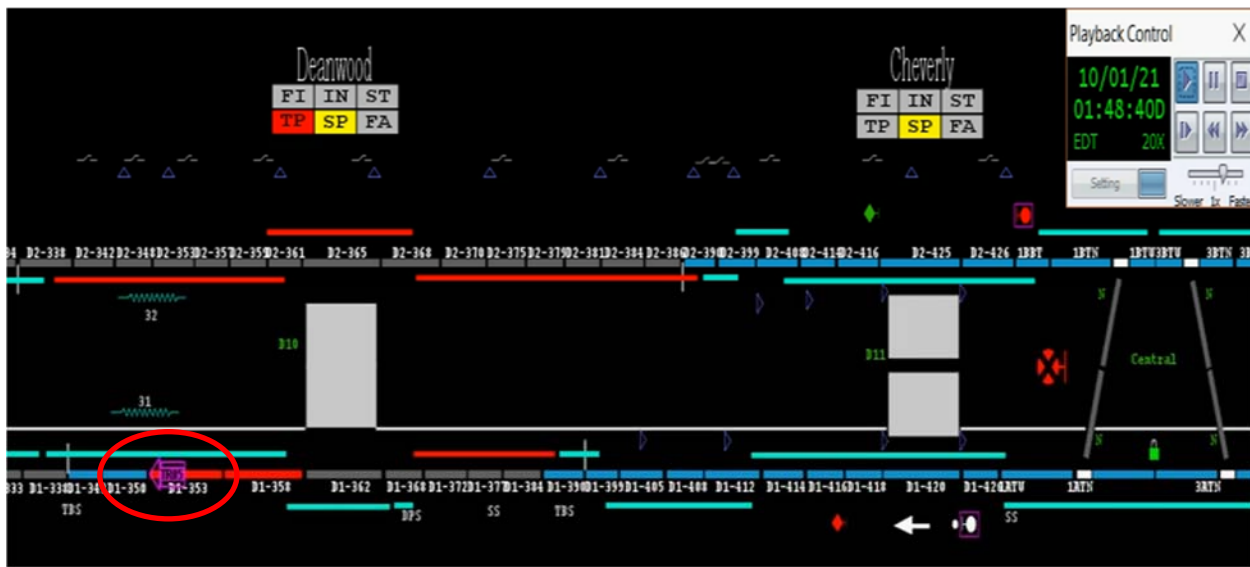
Time	Description
03:01 hours	<p><u>RTC</u>: Contacted Track Unit to ask if there is any damage to the unit and does it need to be towed.</p> <p><u>Track Unit</u>: Stated there was no damage to the unit and they believed it did not need to be towed.</p> <p><u>RTC</u>: Asked for clarity that the unit could be re-railed.</p> <p><u>Track Unit</u>: Confirmed the unit could be re-railed. [Ops. 2]</p>
03:14-03:15 hours	<p><u>SAFE Personnel</u>: Contacted the RTC to request permission to go direct with the RWIC.</p> <p><u>RTC</u>: Granted SAFE Personnel permission to go direct with the RWIC.</p> <p><u>SAFE Personnel</u>: Requested permission to enter work area for the purpose of the incident investigation.</p> <p><u>RWIC</u>: Granted SAFE Personnel permission to enter work location. [Ops. 2]</p>
03:19 hours	<p><u>SAFE Personnel #2</u>: Contacted the RTC to request permission to go direct with the RWIC to get permission to enter work location.</p> <p><u>RTC</u>: Granted SAFE Personnel #2 permission to go direct.</p> <p><u>SAFE Personnel #2</u>: Requested permission to enter the work area.</p> <p><u>RWIC</u>: Granted SAFE Personnel #2 permission to enter their work area. [Ops. 2]</p>
03:25-03:26 hours	<p><u>RTC</u>: Contacted the RWIC to ask for an update on the status of re-railing TR05.</p> <p><u>RWIC</u>: Responded that they were standing by waiting for mechanics to bring equipment and they would provide an update. [Ops. 2]</p>
03:29 hours	<p><u>RWIC</u>: Contacted the RTC to inform them that the mechanic arrived with the equipment.</p> <p><u>RTC</u>: Asked how long it would take to re-rail TR05.</p> <p><u>RWIC</u>: Informed the RTC that the mechanics stated it should take 30 minutes or less to re-rail TR05. [Ops. 2]</p>
03:50-03:52 hours	<p><u>RWIC</u>: Contacted the RTC to request FT so the mechanics could bring the equipment from PM 43 on Track 2 to Track 1 to re-rail TR05.</p> <p><u>RTC</u>: Granted FT so the equipment could be transferred. [Ops. 2]</p>
04:39 hours	<p><u>RWIC</u>: Informed the RTC that TR05 was re-railed, and they should be cleared in 15-20 minutes.</p> <p><u>RTC</u>: Asked the RWIC to confirm there were no spills or leakage from TR05 onto the roadway.</p> <p><u>RWIC</u>: Confirmed there were no spills from TR05, no damage to roadway, and ATC would confirm track circuits. [Ops. 2]</p>
04:45 hours	<p><u>RWIC</u>: Contacted the RTC to relinquish their FT on and give TR05 a block to the platform of Deanwood Station, Track 1 so ATC could complete the verification process.</p> <p><u>RTC</u>: Asked if all personnel were standing by and standing clear for TR05 to move to Deanwood Station.</p> <p><u>RWIC</u>: Confirmed all personnel were standing by and standing clear.</p> <p><u>RTC</u>: Asked for Track Unit to confirm TR05 could move on their own merit.</p> <p><u>Track Unit</u>: Confirmed TR05 could move on their own merit. [Ops. 2]</p>
04:47 hours	<p><u>RTC</u>: Granted TR05 permission to move to Deanwood Station, Track 1.</p>
04:55 hours	<p><u>TR05 Operator #2</u>: Contacted the RTC to let them know they were at Deanwood Station.</p> <p><u>RTC</u>: Informed them they had an absolute block all the way back to New Carrollton Yard. [Ops. 2]</p>

Time	Description
05:04 hours	<p><u>RWIC</u>: Contacted the RTC to inform them that all personnel and equipment were cleared from the roadway, tracks were revenue ready, third rail power could be restored, and to send the test train.</p> <p><u>RTC</u>: Acknowledged radio transmission and asked what speed the test train should be no greater than.</p> <p><u>RWIC</u>: Responded normal speed is sufficient. [Ops. 2]</p>
05:09 hours	<p><u>RTC</u>: Gave instructions to Test Train 818 to turn out from Track 3 to Track 1, proceed at normal speed from Minnesota to Deanwood and advise if there is a rough ride.</p> <p><u>Test Train Operator</u>: Gave a 100% repeat back. [Ops. 2]</p>
05:13 hours	<p><u>RTC</u>: Asked, in their professional experience “are the tracks revenue ready?”</p> <p><u>Test Train Operator</u>: Confirmed tracks are revenue ready. [Ops. 2]</p>

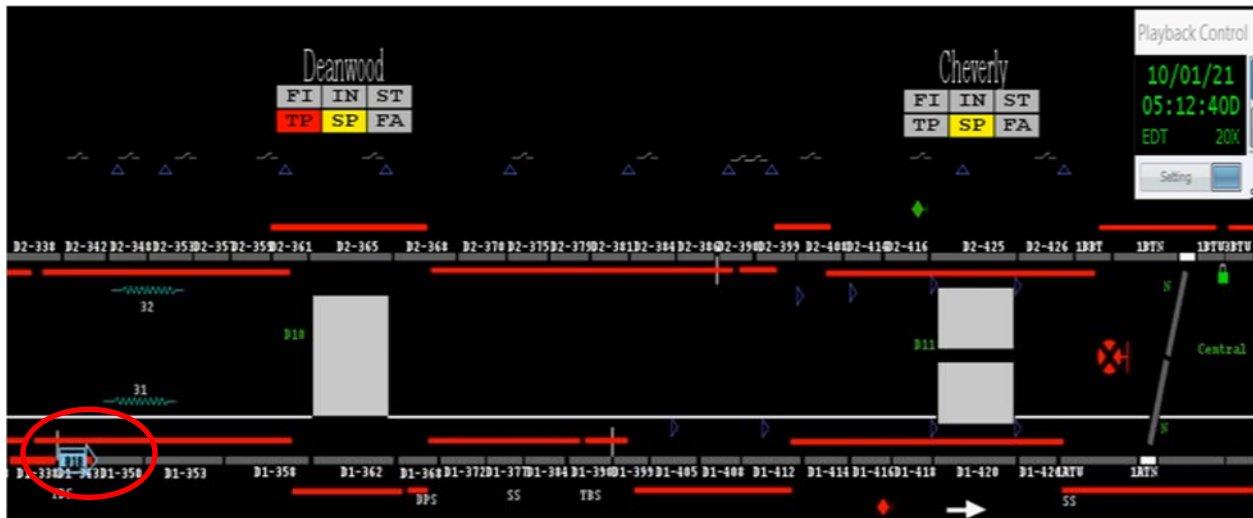
***Note: Times above may vary from other system's timelines based on clock settings.*

Automated Information Management System (AIMS)

Based on the Advanced Information Management System (AIMS) playback data review, third rail power was de-energized in the derailment area at 01:48 hours.



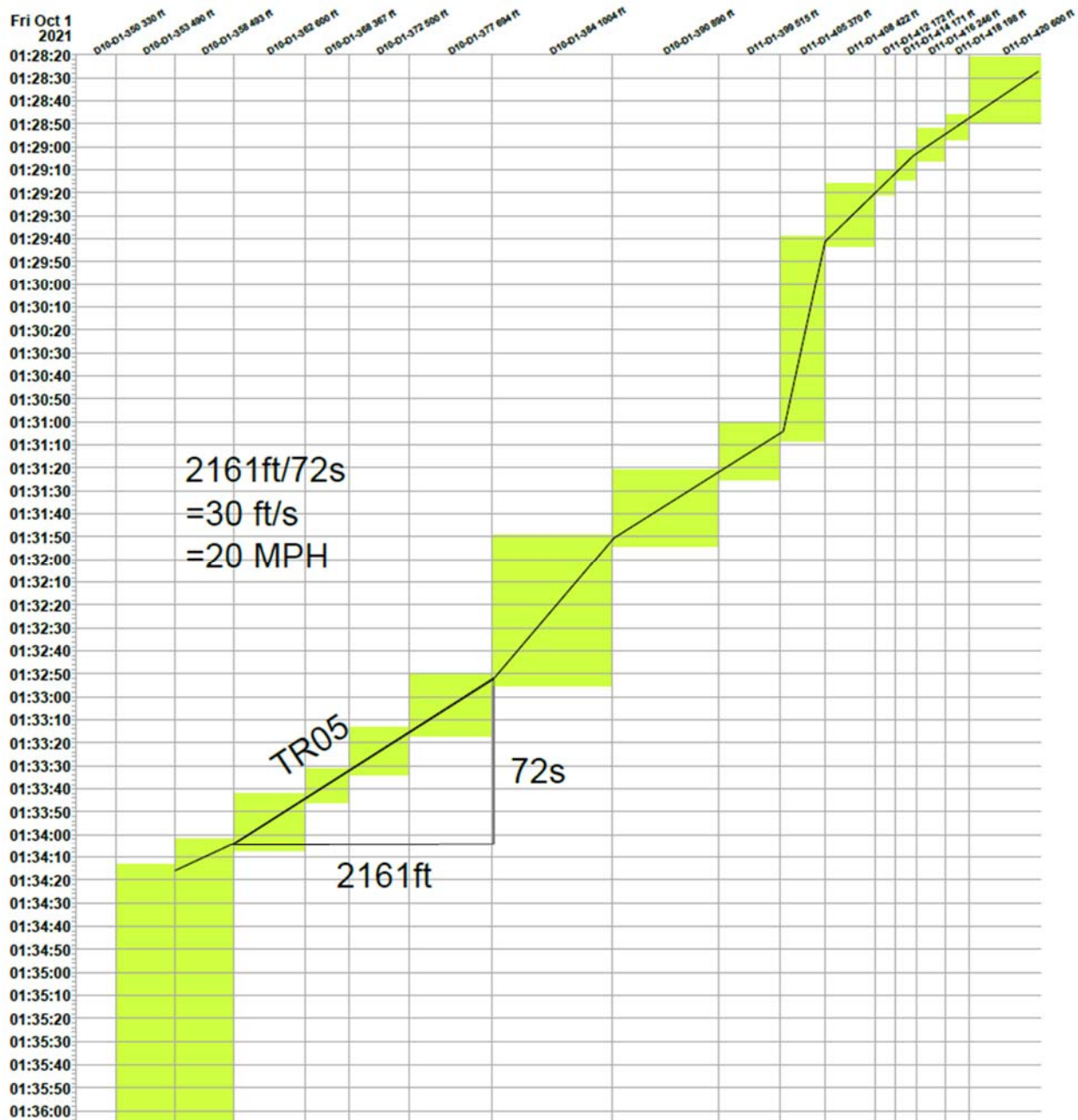
**This image shows the time that third rail power was de-energized in the derailment area.*



*This image shows third power re-energized and Test Train 818 going through the derailment area to make sure the tracks were safe for revenue service.

The Office of IT Systems & Software (ITSS)

Based on AIMS playback, TR05 came to a stop, occupying track circuit D10-D1-353 at 01:37 hours. The black diagonal line drawn through the green occupancies on the occupancy chart showed TR05 moving 2,161 feet in 72 seconds before it stopped. This translates to an average speed of 30 ft/s or 20 mph at the time of derailment.



**** This illustration represents a track circuit occupancy chart showing the calculation of TR05's average speed. The black diagonal line drawn through the green occupancies on the occupancy chart shows TR05 moving 2,161 feet in 72 seconds before it stopped; 2,161 feet in 72 seconds is 30ft/s or 20 mph.**

Office of the Chief Mechanical Officer (CMOR)

As a result of this event, CTEM personnel performed a post-derailment inspection of the involved TR05 unit and only identified deficiencies with systems that would not impact the vehicle performance. It was identified that the camera system monitor was inoperative (used for reversing, but does not record video), headlights were inoperative, and the right front gripper pin was missing (unit derailed to the left), however the suspension and other safety critical systems were compliant. It is unknown how long the items identified in the inspection form were broken. CTEM had no prior reports regarding these findings. These items were not identified as having issues during the last preventative maintenance inspection on March 18, 2021. Review of prior work orders did not reveal any failures of the camera system or headlights. There was a work order for a broken left side gripper pin on September 6, 2020 and again on June 11, 2021. The camera repair included replacing the monitor and camera due to defective monitor. The existing camera was not compatible with the new monitor resulting in its replacement as well. Both bulbs were replaced on the Headlight assembly. The most recent maintenance record leading up to the derailment was recorded on July 14, 2021 for both work head extend cylinders leaking.



CTEM Post-derailment & Accident Damage Inspection Form

(1 Form per Unit)

DATE: Oct 1, 2021 INSPECTOR: [REDACTED] UNIT #: TR05
INCIDENT #: 8562753 INCIDENT LOCATION: D10, CHAIN MARKER 359+00

GUIDELINES:

- This form is to be used for all rail vehicles involved in derailments, accidents.
- This form is to function as a guide to assist in ensuring that all vehicles are inspected to ensure that they still meet standards for operation.
- Some reference to codes and standards may be required to complete this inspection form.
- All inspection items on this form are to be marked as:
✓ = Passed X = Failed NA = Not Applicable UC = Unable to Check

NOTE: Any items that have failed are to be documented in the "Inspection Fault Report" field included on this form.

Incident Information:	
(NOTE: Use blank field under each question for additional information if answered Yes.)	
Did the unit contact the 3rd rail? (If Yes, where was the contact on the unit?)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Did the unit contact infrastructure such as a wall or platform? (If Yes, what was contacted?)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Did the unit contact another unit? (If Yes, what unit and where was the contact on the unit?)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Truck Inspection:	
Roller bearings - no visual damage and in accordance with Rule 36	✓
Roller bearings - no unusual noises; hand spun or run-by test	✓
Bearing Adapters - within wear limits and in accordance with Rule 37	NA
Drive systems - no visual damage or leaks	✓
Side frames and bolsters - no visual damage and in accordance with Rule 47 & 48	NA
Ride control - friction shoes & bearing adapters within limits and in accordance with Rule 46	NA
Springs - no damage, correctly seated and in accordance with Rule 50	✓
General - no visual damage, all components secured and in accordance with Rule 74	✓
NOTES:	
Uses air spring. Tram measured at 1/8" (1/8" allowable per AREMA)	

Chassis Inspection:	
Chassis and sub-frames - no cracks, twists, other visual damage	✓
Center plates and side bearing - no visual damage and in accordance with Rule 60, 61, and 62	NA
Body & decking - no structural, cladding, or decking damage	✓
Loading - load is balanced and secure	NA
Coupler and draft arrangement - no visual damage and in accordance with Rule 16	NA
General - no visual damage, all components secured and in accordance with Rule 74	✓
NOTES:	



CTEM Post-derailment & Accident Damage Inspection Form

Wheel Inspection:

Wheels - Discoloration, cracks, spalling, and signs of movement	√
Gauging - Back to back measurement and in accordance with Rule 43	√
Gauging - Flanges & tread, and in accordance with Rule 41	√
General - no visual damage	√

NOTES:

Brake Inspection:

Brake rigging & cylinders - no visual damage or apparent leaks	√
Brake hoses & trunk lines - no visual damage or apparent leaks	√
Brake piping, valving and cocks - no visual damage or apparent leaks	√
Brake operation - passes functional test	√
Friction shoes - greater than 3/8" and accordance with Rule 12	√
Rolling brake test - unit stop as designed without locking up wheels	√
Hand brake - no visual damage and applies as designed	NA
General - no visual damage, all components secured and in accordance with Rule 74	√

NOTES:

Miscellaneous Equipment Inspection:

Horn - operational	√
Lighting - operates as designed	X
Radio - perform radio check, operates as designed	√
Propulsion and braking controls - all controls operate as designed	√
Cameras - clear picture, operates as designed	X
Emergency equipment - Interlocks emergency valves, E-stops, etc., operate as designed	√
Locks & restraints - mechanical locks and restraints are in place and operate as designed	X

NOTES:

Camera system monitor inoperative. Headlights inoperative, all other lighting including perimeter lights work as intended. Right front gripper lock pin missing.

Inspection Fault Report:

All systems that could lead to derailment were found compliant. No definitive mechanical cause of derailment can be determined.

CTEM Maximo WO#: 16613056

Incident WO#: 16612947

Can unit be returned to service?

☒ Yes ☐ No

Inspector's Signature: _____

2021.10.01 12:17:25 -04'00'

CMNT Form 50.993, Rev. 0.0

Page 2 of 2

February 01, 2018

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CTEM Cost Analysis

Parts	\$0
Labor	\$1,710.00
Total	\$1,710.00

Incident Date: 10/01/21 Time: 01:34 hours
Draft Final Report – Derailment
E21476

Drafted By: SAFE 703 – 12/04/2021
Reviewed By: SAFE 71 – 12/06/2021
Approved By: SAFE 71 – 12/07/2021

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In addition to the inspection performed by CTEM, Car Engineering Vehicles (CENV) prepared an Incident report of their investigative findings. Key Findings are adopted as part of this report:

- Service Bulletin SBX005 restricts single axle vehicles to 15 mph.
- When in Work mode, operating speed must be reduced to 5 mph.
- Prior history of derailments involving TRIPP machines shows no records of derailments occurring in Travel mode with a properly functioning air suspension.
- A warning system (alarm) continuously activates when speed exceeds 5 mph in Work mode.
- The Low-Air Alarm was active on arrival by the responding mechanic, however this activation is expected when TR05 was shut down and restarted after the derailment, as the air suspension deflates when the machine is shut down.
- Speedometer tests were conducted in the New Carrollton Yard and demonstrated a 0.8 mph difference in gauge and actual speed over a 100-foot distance at 15 mph.

Maintenance of Way Engineering (MOWE)

MOWE Track Engineering conducted an analysis and field assessment after the derailment to determine whether track conditions were a contributing factor to the derailment. The POD is within a spiral to spiral curve, identified as Curve 343. While mild deviations from the spiral design were observed, the measured vehicle dynamics were within tolerance to navigate the area under normal operating conditions (e.g., Travel mode). The term “mild” considers the designed 2.92% and the existing 3.24% rail rate of climbs compared to the vehicle’s maximum rail rate of climb of 12%. Since the severity of a track geometry exception is compared to a vehicle’s ability to navigate it, the percentage of these rates of climb compared to TR05’s maximum ability are 24.7% and 27.0% respectively, and pose no issue to the safe operation of the vehicle. The difference between the existing and designed rail rates of climb holds little significance in terms of severity of the of the geometry exception since the rates of climb are compared to the maximum rate of climb the vehicle can negotiate. The following is an excerpt of their assessment and adopted as Appendix G.

“With help from CENV, the suspension limits of TR05 was evaluated. The vehicle has two suspension modes called, travel mode and Work mode. The suspension data provided suggests that under travel mode, the suspension of TR05 is flexible enough to address the existing rate of climb for cross level (super elevation) on the curve in question. In travel mode, TR05 should be able to negotiate a rail rate of climb of 12%, calculated from a 3.25” wheel vertical displacement over a 26’-2” axle spacing. The Deanwood curve currently has a rail rate of climb of 3.24% including mild geometry exceptions which exceeds the designed rail rate of climb of 2.92%.

However, in Work mode, TR05 can negotiate a maximum rail rate of climb of 2% which is less than the designed rail rate of climb on the Deanwood curve. 2% was calculated from a .5” wheel vertical displacement over a 26’-2” axle spacing. The use of the Work mode suspension selection would not be agile enough to handle the designed rail rate of climb on curve 343, as its 2% limitation is lower than the 2.92% designed rail rate of climb. If this vehicle negotiated curve 343 in Work mode, this would have likely resulted in a ‘wheel lift off rail’ situation and derailment.”

Interview Findings

SAFE conducted one interview via Microsoft Teams. This virtual interview identified the following key findings associated with this event:

Equipment Operator stated they saw flashing red lights and a fault message on the dashboard of TR05 while conducting the pre-trip inspection. The displayed message was "Fault: Crankcase Pressure Signal Extremely High." The Equipment Operator contacted a mechanic about the issue. The mechanic assessed the issue and was able to reset fault condition and informed the Operator of TR05 that the unit was safe to use. The Equipment Operator stated that during their pre-trip inspection, all the safety pins were in the gripper arms. Equipment Operator stated that after the derailment, they noticed the rear airbags were fully inflated, but the front airbags were deflated. Equipment Operator stated that when they entered Deanwood platform, the red lights that they reported prior to leaving the yard came back on.

Findings

- The point of derailment was CM D1 360+50.
- TR05 traveled an additional 110 feet before coming to a rest.
- The point of rest was at CM D1 359+40.
- TR05 was in a right spiral approaching tangent track when the left front wheel climbed the outside rail and derailed away from the third rail.
- Track Circuit data indicated an average speed, over a 2161-foot distance, prior to the derailment as 20 mph.
- CTEM Mechanic operated the unit to New Carrollton Yard from the derailment site and reported no deficiencies with the air suspension or other systems.
- There were no deficiencies with the safety systems or critical dimensions with the track or vehicle conditions that would have likely contributed to the derailment.
- In travel mode, TR05's air suspension would allow it to safely navigate a curve with a rail rate of climb of 12%, significantly higher than the observed condition of 3.24%.
- In Work mode, TR05 air suspension would only allow it to safely navigate a curve with a rail rate of climb of 2%, which is lower than the observed condition of 3.24%.
- The observed rail rate of climb for Curve 343 was 3.24%, which exceeds the design rail rate of climb of 2.92% but is not significant enough to result in a travel mode derailment for this vehicle.
- Track conditions were assessed on scene by TRST and SAFE personnel. Gauge, crosstie, and fastener conditions in the immediate area preceding the point of derailment were found to be within tolerance.
- During the post-derailment inspection by CTEM and SAFE personnel, the unit was found to be in travel mode. There is no video monitoring system or event recorder onboard TR05 to verify the condition at the time of the derailment.
- Track work was completed in May 2021 to re-align Curve 343's super elevation back to design.
- There were no reported ultrasonic rail defects identified within the derailment area.

Weather

On October 1, 2021, at the time of the incident, NOAA recorded the temperature as 60 ° F, with clear skies throughout the night. Weather was not a contributing factor in this incident (Weather source: NOAA) – Location: Washington, DC.)

Human Factors

Evidence of Fatigue

Conditions were evaluated 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. Equipment Operator reported feeling fully alert at the time of the incident. Equipment Operator reported experiencing no symptoms of fatigue in the time leading up to the incident.

Fatigue Risk

Incident data was evaluated for fatigue risk factors. Risk factors for fatigue were present. The incident time of day (01:34 hours) did not suggest an increased risk of fatigue-related impairment. Equipment Operator reported some variation in the sleep schedule in the days leading up to the incident. Equipment Operator performed day and night work in the days leading up to the incident. Equipment Operator was awake for 4.16 hours at the time of the incident and reported eight (8) of sleep in the 24 hours preceding the incident. The off-duty period preceding the incident was sixteen (16) hours, which provides an opportunity for 7-9 hours of sleep. This was a comparable amount of time for Equipment Operator's usual workday sleep durations. Equipment Operator reported no issues with sleep.

Post-Incident Toxicology Testing

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

Immediate Mitigation to Prevent Recurrence

- TR05 Operator was removed from service for post-incident testing.
- TR05 was removed from service for post-incident investigation inspections and received progressive disciplinary action for their role in the derailment.
- The immediate derailment area was inspected by ATCM and TRST.
- A test train was used to make sure the derailment area was safe for revenue service.

Probable Cause Statement

Due to the lack of data loggers and additional source data, a root cause could not be determined. A Contributing Factor to the derailment at Deanwood Station is human error, with the Equipment Operator operating the unit at an average speed higher than permitted by TRST rules and procedures just prior to the derailment. Historical derailment incidents involving the TRIPP machines have been linked to operating in an overspeed condition while in Work mode (e.g., greater than 5 mph) or with a malfunctioning air suspension. The most recent derailment involving a TRIPP machine, in April 2021, was the result of an overspeed condition while in Work mode. In the April 2021 derailment, the Equipment Operator reported choosing to operate in Work mode to improve ride quality/comfort.

While a root cause was not determined, track conditions leading up to the point of derailment were evaluated and identified as within tolerance for TR05 to safely negotiate in travel mode.

During post-derailment inspections and testing, the vehicle systems functioned as designed. Personnel were unable to detect any mechanical failures with TR05.

Recommendations/Corrective Actions

Corrective Action Code	Description	Resp. Party	Due Date
95911_SAFE CAPS_CENV _001	Determine level of effort of installing an overspeed alarm* device in self-propelled Class 2 Vehicles.	CENV	10/12/2022
95911_SAFE CAPS_CENV _002	Determine level of effort of installing forward-facing, rear-facing, and cab video recorders on self-propelled Class 2 Vehicles.	CENV	10/12/2022
95911_SAFE CAPS_CENV _003	Develop procedures for installation of data recorders and video records on self-propelled Class 2 vehicles.	CENV	06/20/2027
95911_SAFE CAPS_CMNT _004	Install data recorders and video recorders to record events deemed appropriate by CENV., vehicle speed, emergency stop, and ignition status. NOTE: There are 30 Class 2 configurations. The expanded list for individual configurations will vary and is not fully developed.	CTEM	05/20/2028
95911_SAFE CAPS_TRST _001	TR05 Operator to complete appropriate equipment reinstruction.	TRST	12/31/2021
95911_SAFE CAPS_TRST _002	Share findings and probable cause of derailment event with all Equipment Operators.	TRST	12/31/2021

***Definition of overspeed alarm:** 15 or 30 MPH dependent on vehicle type.

Appendices

Appendix A – Interview Summaries

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

Office of Track and Structures (TRST)

Equipment Operator

The Equipment Operator is a WMATA employee with nine (9) years of service and has worked as an Equipment Operator for eight (8) years. The Equipment Operator is RWP Level 4 certified and must recertify by April 30, 2022. They stated that they complete a “bundle” training which is training on all the Nordco machinery when there is tie work. The Equipment Operator had no history of sleep issues to report and stated feeling fully alert at the time of the incident. The Equipment Operator reported working sixty-two (62) hours of overtime in the two (2) weeks leading up to the incident. Equipment Operator attended a Roadway Job Safety Briefing (RJSB) before going to TR05 to conduct a pre-trip inspection. While conducting the pre-trip inspection, Equipment Operator noticed there were two (2) flashing red lights and a fault message, “Crankcase Pressure Signal Extremely High,” on the dashboard screen. Equipment Operator has operated this type of machinery for approximately seven (7) years and noted he had never seen this fault displayed before. Equipment Operator requested a mechanic regarding the issues. The mechanic came on scene and resolved the issues. The mechanic informed Equipment Operator that the unit was safe for mainline duties. Equipment Operator proceeded with using TR05 for their assigned duties. Equipment Operator mentioned TR05 rocks back and forth when traveling on the mainline. Equipment Operator stated when they entered Deanwood platform, the red lights that they reported prior to leaving the yard came back on. Equipment Operator stated when the red lights came on, they were in the process of stopping because when TR05 is in the platform limits, the gripper arms can contact the granite edge due to TR05 rocking back and forth. As Equipment Operator was exiting the platform, the front of TR05 derailed. Equipment Operator mentioned they were operating TR05 in travel mode at the time of the derailment. Equipment Operator stated when they did a walkaround of TR05, they noticed the rear airbags were fully inflated and the front airbags were deflated. Equipment Operator believed the front airbags became deflated as they were traveling. *

**Note: This claim was unable to be substantiated or reproduced by CMOR personnel.*

RWIC

The RWIC is a WMATA employee with twelve (12) years of service and has been a Track Maintenance Supervisor for the last two and a half (2.5) years. The RWIC is RWP Level 4 certified and must recertify by August 31, 2022. The RWIC had no history of sleep issues to report and stated feeling fully alert at the time of the incident. The RWIC stated their normal work schedule is 22:00 – 04:00 hours but clocked in early at 16:30 on September 30, 2021 for overtime. The RWIC stated September 30, 2021 was a normal workday. The RWIC was briefed by the Yard Lead, completed preliminary paperwork, and conducted a RJSB. The RWIC left the yard by vehicle and not with the PM. The RWIC stated when there is a convoy block traveling, they should keep at least a 500 feet distance between units. The RWIC stated the Operator of TR05 informed them that there were lights and alarms buzzing while conducting their pre-trip inspection of TR05. The RWIC has experience operating TR05 on several occasions. The RWIC mentioned there is

always some type of mechanical issues with the TR units due to the amount work hours. The RWIC stated they were monitoring the radio at the time of the incident and when they heard the Operator of TR05 request to contact the ROCC via landline, they immediately started heading to their location and contacted the ROCC to find out what happened. The RWIC stated from their experience these units have derailed regularly in the past. The RWIC stated from their knowledge the derailments are due to the engineering of the units. The RWIC mentioned that there has been times that these units have derailed and speed was not a factor. The RWIC stated they did not see any damaged ATC or power cables, no cracked rails, and took a visual and physical measurement of the point of derailment to the point of rest. The RWIC stated when these units derail when speed is a factor they normally travel approximately 150-200 feet when they derail and that is making contact with the various track components.

Appendix B – TRST Pre-Trip Inspection Log

WMATA CLASS 2 RAIL VEHICLE PRIOR TO USE INSPECTION

Initials (Operator /Flag Person)

1	Check for wheel chocks and that the required quantity for unit(s) in consist are present.
2	Check angle cocks, train line seals, air tool and drain valves. (Open or close as required).
3	Check main engine for proper oil level.
4	Check for any loose, broken, torn, cracked, or leaking components as you make your walk around inspection.
5	If using auxiliary components such as cranes, generators and compressors, check all controls, movements, fluid levels, and safety devices.
6	Start machine and check all switches, gauges, and warning indicators.
7	Check for sufficient air pressure and if equipped with A-9, make sure it is at 90 psi in the release position.
8	Check transmission for correct oil level and any abnormal sounds or functions.
9	Ensure all equipment, tools, supplies or loose debris are secured on decks and not posing any safety hazards.
10	If equipped and scheduled for use, inspect work head assemblies for wear, out of adjustment and damage. Check oil fill reservoirs and grease all fittings.
11	If equipped, inspect E-couplers, tow bars, and revenue train couplers. Make sure all tools are properly stored and secured while maintaining proper housekeeping of materials and equipment.
12	Gas cylinders should be secured and in their proper location.
13	Ensure all work heads and components such as crane booms, outriggers, measuring huggies, clamp frames, plows, turn tables and extension arms are pinned and locked with safety devices prior to travel.
14	Check fuel and hydraulic tanks for proper level.
15	Check all wheels, brakes, visible linkage, and suspension on all rolling stock vehicles.
16	Check for cracked, broken, missing windows and side boards. Make sure there are no bent or loose railings, steps, or cabinet enclosures that are missing safety chains, locks or latches.
17	Turn on and inspect all lighting on unit(s) in consist for any defects or problems.
18	Check that back up alarms and horns sound.
19	Fire extinguishers should be charged and secured. Sign the monthly inspection log (if not already signed).
20	Verify the radio(s) is/are able to transmit and receive clearly.
21	Inspect all items in flagman's booth for proper operation and functionality.
22	Ensure loads are secure, evenly distributed and are not hanging over the side or ends of flat car.
23	Check all Flat Car emergency dump valves and hand brakes.
24	Inspect hi-rail components for thin flanges, leaking cylinders, safety pins, tires, shunts, and proper tuck when on hi-rail.
25	Perform a stretch test. <input type="checkbox"/> Successful Test <input checked="" type="checkbox"/> N/A
26	Perform a rolling brake test (all class 2 vehicles).
27	Perform standing brake test (all flatcars, PM26-PM53 only).
28	Verify the intercom headsets are able to transmit and receive clearly (if applicable).
29	Operators and Pilots have reviewed, and have in their possession, mainline and yard maps showing their intended routing, curves and interlockings and restrictions and other vital information.

Note: When transporting units for PMI, make ensure cabs, decks, platforms and operating stations are clear and free from trash, debris, tools, materials and supplies.

Notes/Comments:

Print Name(s): [Redacted] ID# (s): [Redacted]

Signature(s): [Redacted] Equipment#: TR05

Yard or location where inspection is performed: New Carrollton

Date: 9-30-21 Time of Inspection: 22:31

TRST-CMP-FRM-C2RVPUIC-REV 5.2 | 04122021

Appendix C – TRST Daily Equipment Movement and Request Log

Track and Structures

Daily Equipment Movement and Request Log

Operator's Name [REDACTED] Call Number [REDACTED]

Equipment Number TR05 Location of Equipment D99

Did you make yard moves? NO Main work location? DOA

Time you requested lead to mainline (tower)? 23:20

What time did you receive a lead to mainline? 01:08

What time did you request a lead to ROCC? 01:13

What time did you receive a lead from ROCC? 01:14

Arrival time to work area? _____ Equipment pre-trip complete? Yes

What time did you request a lead to depart work location? _____

What time did you receive a lead to depart work location? _____

Departure time from work area? _____

Time cleared mainline? _____ Final location of your equipment? D99

Was equipment held up in route to work location? Yes or No _____

Does unit have an emergency tow bar? Yes or No _____

Operator's Signature [REDACTED] Date 09-30-21

Supervisor (Print) _____

Start Fuel Level $\frac{1}{4}$ $\frac{1}{2}$ $\frac{3}{4}$ Full End Fuel Level $\frac{1}{4}$ $\frac{1}{2}$ $\frac{3}{4}$ Full

Comments Called Mechanic at 22:37 about
Flashing Red lights.

Document# 201503-003

Appendix D – Photographs and Illustrations



Figure 1- TR05. This machine is a single-operator, climate controlled, enclosed cab machine.



Figure 2: This image shows personnel measuring track gauge in the area of the point of derailment (POD) for TR05.



Figure 3: This image shows the place of rest of the front right wheel of TR05 after derailing.



Figure 4: This image shows the front left wheel of TR05 on the ground after derailing.

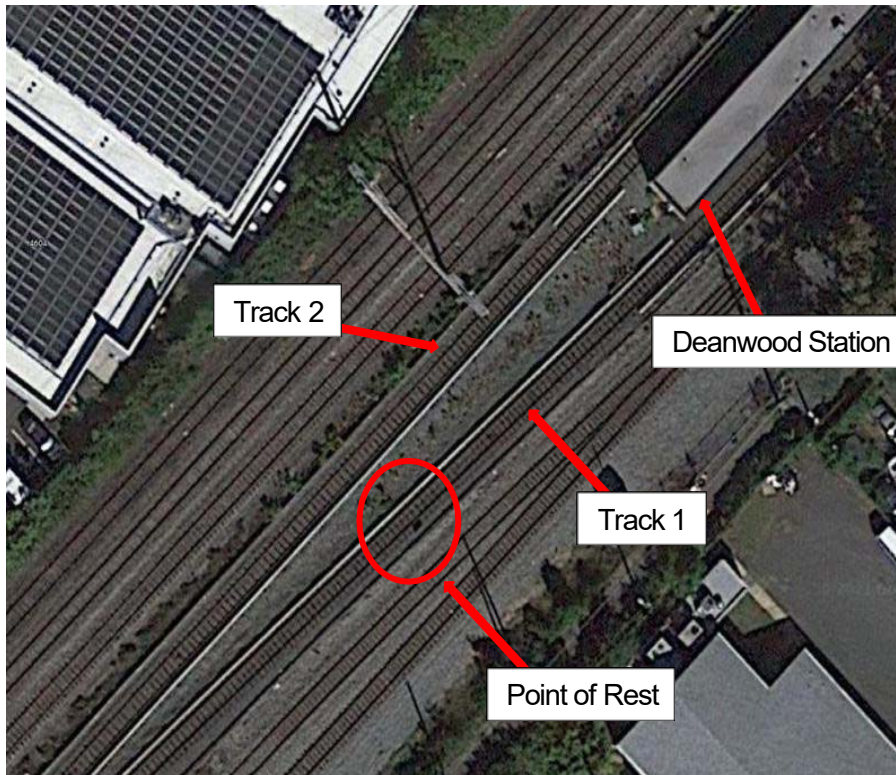


Figure 5: This image is an aerial view of the point of rest.



Figure 6: This image is the inbound view of Curve 343 at Deanwood Station.



Figure 7: This image shows the outbound view of Curve 343 at Deanwood Station.

Appendix E – CTEM Post-Derailment & Accident Damage Inspection Form



CTEM Post-derailment & Accident Damage Inspection Form

Print

(1 Form per Unit)

DATE:	Oct 1, 2021	INSPECTOR:	[REDACTED]	UNIT #:	TR05
INCIDENT #:	8562753	INCIDENT LOCATION:	D10, CHAIN MARKER 359+00		

GUIDELINES:

- This form is to be used for all rail vehicles involved in derailments, accidents.
- This form is to function as a guide to assist in ensuring that all vehicles are inspected to ensure that they still meet standards for operation.
- Some reference to codes and standards may be required to complete this inspection form.
- All inspection items on this form are to be marked as:

✓ = Passed X = Failed NA = Not Applicable UC = Unable to Check

NOTE: Any items that have failed are to be documented in the "Inspection Fault Report" field included on this form.

Incident Information: (NOTE: Use blank field under each question for additional information if answered Yes.)	
Did the unit contact the 3rd rail? (If Yes, where was the contact on the unit?)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Did the unit contact infrastructure such as a wall or platform? (If Yes, what was contacted?)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Did the unit contact another unit? (If Yes, what unit and where was the contact on the unit?)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Truck Inspection:	
Roller bearings - no visual damage and in accordance with Rule 36	<input checked="" type="checkbox"/> ✓ <input type="checkbox"/> X
Roller bearings - no unusual noises; hand spun or run-by test	<input checked="" type="checkbox"/> ✓ <input type="checkbox"/> X
Bearing Adapters - within wear limits and in accordance with Rule 37	<input type="checkbox"/> NA <input type="checkbox"/> UC
Drive systems - no visual damage or leaks	<input checked="" type="checkbox"/> ✓ <input type="checkbox"/> X
Side frames and bolsters - no visual damage and in accordance with Rule 47 & 48	<input type="checkbox"/> NA <input type="checkbox"/> UC
Ride control - friction shoes & bearing adapters within limits and in accordance with Rule 46	<input type="checkbox"/> NA <input type="checkbox"/> UC
Springs - no damage, correctly seated and in accordance with Rule 50	<input checked="" type="checkbox"/> ✓ <input type="checkbox"/> X
General - no visual damage, all components secured and in accordance with Rule 74	<input checked="" type="checkbox"/> ✓ <input type="checkbox"/> X
NOTES:	
Uses air spring. Tram measured at 1/8" (1/8" allowable per AREMA)	

Chassis Inspection:	
Chassis and sub-frames - no cracks, twists, other visual damage	<input checked="" type="checkbox"/> ✓ <input type="checkbox"/> X
Center plates and side bearing - no visual damage and in accordance with Rule 60, 61, and 62	<input type="checkbox"/> NA <input type="checkbox"/> UC
Body & decking - no structural, cladding, or decking damage	<input checked="" type="checkbox"/> ✓ <input type="checkbox"/> X
Loading - load is balanced and secure	<input type="checkbox"/> NA <input type="checkbox"/> UC
Coupler and draft arrangement - no visual damage and in accordance with Rule 16	<input type="checkbox"/> NA <input type="checkbox"/> UC
General - no visual damage, all components secured and in accordance with Rule 74	<input checked="" type="checkbox"/> ✓ <input type="checkbox"/> X
NOTES:	

CMNT Form 50.993, Rev. 0.0

Page 1 of 2

February 01, 2018

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Incident Date: 10/01/21 Time: 01:34 hours
Draft Final Report – Derailment
E21476

Drafted By: SAFE 703 – 12/04/2021
Reviewed By: SAFE 71 – 12/06/2021
Approved By: SAFE 71 – 12/07/2021

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CTEM Post-derailment & Accident Damage Inspection Form

Wheel Inspection:	
Wheels - Discoloration, cracks, spalling, and signs of movement	<input checked="" type="checkbox"/>
Gauging - Back to back measurement and in accordance with Rule 43	<input checked="" type="checkbox"/>
Gauging - Flanges & tread, and in accordance with Rule 41	<input checked="" type="checkbox"/>
General - no visual damage	<input checked="" type="checkbox"/>
NOTES:	
Brake Inspection:	
Brake rigging & cylinders - no visual damage or apparent leaks	<input checked="" type="checkbox"/>
Brake hoses & trunk lines - no visual damage or apparent leaks	<input checked="" type="checkbox"/>
Brake piping, valving and cocks - no visual damage or apparent leaks	<input checked="" type="checkbox"/>
Brake operation - passes functional test	<input checked="" type="checkbox"/>
Friction shoes - greater than 3/8" and accordance with Rule 12	<input checked="" type="checkbox"/>
Rolling brake test - unit stop as designed without locking up wheels	<input checked="" type="checkbox"/>
Hand brake - no visual damage and applies as designed	NA
General - no visual damage, all components secured and in accordance with Rule 74	<input checked="" type="checkbox"/>
NOTES:	
Miscellaneous Equipment Inspection:	
Horn - operational	<input checked="" type="checkbox"/>
Lighting - operates as designed	X
Radio - perform radio check, operates as designed	<input checked="" type="checkbox"/>
Propulsion and braking controls - all controls operate as designed	<input checked="" type="checkbox"/>
Cameras - clear picture, operates as designed	X
Emergency equipment - interlocks emergency valves, E-stops, etc., operate as designed	<input checked="" type="checkbox"/>
Locks & restraints - mechanical locks and restraints are in place and operate as designed	X
NOTES:	
Camera system monitor inoperative. Headlights inoperative, all other lighting including perimeter lights work as intended. Right front gripper lock pin missing.	
Inspection Fault Report:	
All systems that could lead to derailment were found compliant. No definitive mechanical cause of derailment can be determined.	
CTEM Maximo WO#: 16613056 Incident WO#: 16612947	
Can unit be returned to service? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Inspector's Signature:	

CMNT Form 50.993, Rev. 0.0

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February 01, 2018

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Appendix F – CTEM Work Order Details



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

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MX76PROD

Work Order #: 16613056
Type: CM



Status: COMP
10/01/2021 12:36

Work Description: Incident: Derailment at Deanwood (D10) / Inspection
Job Plan Description:

Work Information			
Asset: MTR05	TR05, TRIPP MACHINE, NORDCO, S/N 760501-11	Owning Office: TRST-TRAK-GBLT	Parent:
Asset Tag: MTR05		Maintenance Office: CTEM-ALEX-HVYR	Create Date: 10/01/2021 05:49
Asset S/N: 760501-11		Labor Group: CTEM-NCAR-HVY	Actual Start: 10/01/2021 05:58
Location: 2279	F99, BRANCH AVENUE YARD	Crew:	Actual Comp: 10/01/2021 12:36
Work Location: 8579	D10, DEANWOOD, WAYSIDE	Lead:	Item: CTEM49200037
Failure Class: CTEM001	GENERAL	GL Account: WMATA-02-33380-50499070-041-*****-OPR**	
Problem Code: 1025	ACCIDENT/COLLISION/DERAIL	Supervisor:	Target Start:
Requested By:		Requestor Phone:	Target Comp:
Chain Mark Start:		Chain Mark End:	Scheduled Start:
Create-Mileage: 0.0		Complete-Mileage: 0.0	

Task IDs

Task ID

10 Rerailment of unit

Received call at 01:56 for unit derailed at D10 (Deanwood). Sent two mechanics to pick up re-rail equipment, while I and two other mechanics went to D10 arrived about 02:30. We look over the unit for any damage and leaks nothing server damage was found at this time. Did take note that the unit was in travel mode and the air alarm was on. The mechanics arrived with re-rail equipment about 03:30. We unloaded the equipment and started rerailing about 03:45 finished in about an hour. Unit went back to New Carrollton and Cleared around 05:00.



Mechanics were assigned to CIP jobs. Labor was charged to their assigned work locations.

Component: 000-400-AJ0 CTEM_TIE REMOVER_INSERTER Work Accompl: RECOVERED Reason: DERAILED Status: COMP Position: Warranty?: N

20 Post Incident Inspection

Attached is the results of the inspection of TR05. All systems that could lead to derailment were found compliant. No definitive mechanical cause of derailment can be determined.

Component: 000-400-AJ0 CTEM_TIE REMOVER_INSERTER Work Accompl: INSPECTED Reason: INSPECTION Status: COMP Position: Warranty?: N

Actual Labor									
Task ID	Labor	Start Date	End Date	Start Time	End Time	Approved?	Regular Hours	Premium Hours	Line Cost
		10/01/2021	10/01/2021	06:00	11:00	Y	05:00	00:00	\$209.83
		10/01/2021	10/01/2021	06:00	11:00	Y	05:00	00:00	\$208.79

WT_plust_woprnt.rptdesign

10/1/2021 12:36

Incident Date: 10/01/21 Time: 01:34 hours
Draft Final Report – Derailment
E21476

Drafted By: SAFE 703 – 12/04/2021
Reviewed By: SAFE 71 – 12/06/2021
Approved By: SAFE 71 – 12/07/2021

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

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MX76PROD

Work Order #: 16613056
Type: CM



Status: COMP
10/01/2021 12:36

Work Description: Incident: Derailment at Deanwood (D10) / Inspection
Job Plan Description:

Actual Labor									
Task ID	Labor	Start Date	End Date	Start Time	End Time	Approved?	Regular Hours	Premium Hours	Line Cost
Total Actual Hour/Labor:							10:00	00:00	\$418.61
Failure Reporting									
Cause	Remedy			Supervisor			Remark Date		
1571	DERAIL INSPECTION REQD			3192	TESTED / INSPECTED			10/01/2021	
Remarks: Performed Rerailment and post Incident Inspection of unit									

WT_plust_woprnt.rptdesign

10/1/2021 12:36

Incident Date: 10/01/21 Time: 01:34 hours
Draft Final Report – Derailment
E21476

Drafted By: SAFE 703 – 12/04/2021
Reviewed By: SAFE 71 – 12/06/2021
Approved By: SAFE 71 – 12/07/2021

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Appendix G – MOWE Track Engineering Analysis Memorandum



M E M O R A N D U M

SUBJECT: TR05 Derailment D1 CM
359+00

DATE: 10/6/2021 *revised*
12/6/21

FROM: MOWE-Track Engineering-

TO: SAFE-

According to the Rail Operation Control Center (ROCC) Assistant Superintendent Summary log, on October 1, 2021 at approximately 01:43 a Class II Operator informed ROCC of a derailment, of Rail Maintenance Machine (RMM) TR05 at chain marker (CM) D1 359+00. According to Track Maintenance (TKMN) the derailment occurred approximately at D line track 1 360+50 moving in the inbound direction, against normal traffic.

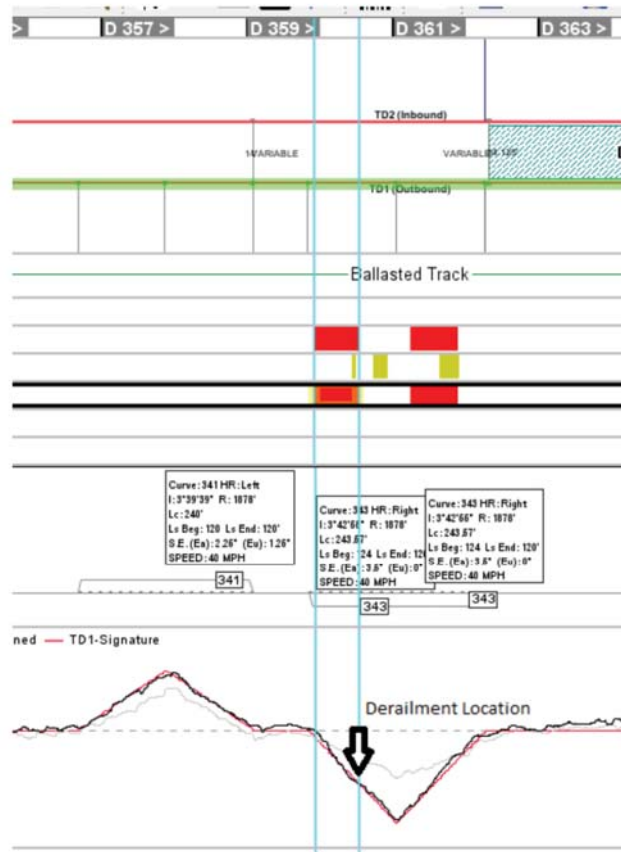
Existing Track Geometry Vehicle (TGV) shown in *Figure 1*, exhibits cross level exceptions on the curve 343 in which the incident is believed to have occurred. Curve 343 is 243.67 ft. in length, with a maximum super elevation (SE) of 3.5 in. and a maximum radius of 1878 ft. This is a spiral to spiral curve with no full body curve radius.

Within Figure 1, the red line illustrates the original design cross level (super elevation) across curves 341 and 343. The gray and black lines illustrate the two most recent geometry measurements of the track. Curve 343 is a left hand curve in the normal direction of travel, and the increase in super elevation is shown in the downward direction within the figure. In comparison curve 341 is a right curve and increase in superelevation is shown in the upward direction. The two vertical blue lines indicate the start and end of geometry exceptions identified by the TGV. The black data line was measured during the TGV's September 2021 geometry run and the gray illustrates the May 2021 geometry run data. Trackwork had been completed since May to re-align the curve's super elevation back to design reflecting a significant difference between the May and the September data. However, the original design is compact in nature and applies shortened spiral lengths that create an aggressive cross level rate of change within the curve's spiral. This leaves little tolerance for deviations in the cross level before triggering a geometry exception. The reworked superelevation is close to the intended design but likely is the best that work crews can achieve. Current deviations in the reworked alignment show approximately 1/4" cross level deviations lower than design on both ends of the curve, and in the center of the inbound

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spiral (left portion of the V shaped geometry measurement) a section with a deviation slightly higher than $\frac{1}{4}$ " from the design.



The curve spiral is a transitional track geometry where super elevation and curve radius gradually and consistently increases or decreases to meet the curve design. The combination of lower cross level than design followed by a higher cross level than design and vice versa within the spiral can create a

M E M O R A N D U M

cross level rate of climb that is more aggressive than the design. This was investigated as a potential influencing factor on TR05's derailment, where car body dynamics may not have been able to negotiate the exiting cross level rate of climb.

With help from CENV, the suspension limits of TR05 was evaluated. The vehicle has two suspension modes called, travel mode and work mode. The suspension data provided suggests that under travel mode, the suspension of TR05 is flexible enough to address the existing rate of climb for cross level (super elevation) on the curve in question. In travel mode, TR05 should be able to negotiate a rail rate of climb of 12%, calculated from a 3.25" wheel vertical displacement over a 26'-2" axle spacing. The Deanwood curve currently has a rail rate of climb of 3.24% including mild geometry exceptions which exceeds the designed rail rate of climb of 2.92%.

However, in work mode, TR05 can negotiate a maximum rail rate of climb of 2% which is less than the designed rail rate of climb on the Deanwood curve. 2% was calculated from a .5" wheel vertical displacement over a 26'-2" axle spacing. The use of the work mode suspension selection would not be agile enough to handle the designed rail rate of climb on curve 343, as its 2% limitation is lower than the 2.92% designed rail rate of climb. If this vehicle negotiated curve 343 in work mode, this would have likely resulted in a 'wheel lift off rail' situation and derailment.

Rail rate of climb is a measurement that normalizes rail geometry with that of the vehicle suspension and car body stiffness. It is calculated by dividing the vertical difference in rail elevation or wheel displacement, by the horizontal distance over which the vertical displacement occurs, multiplied by 100, to achieve a percentage value. These calculated values are shown in *Figure 2*, where the rate of climb ability of TR05 in travel mode and work mode is shown in dotted blue and grey lines respectively. Curve 343's rail rate of climb inclusive of geometry exceptions is shown in orange and is well beneath TR05's suspension abilities in travel mode but is a little steeper than the suspension abilities in work mode. It is not believed that the existing track conditions alone on curve 343, would cause a derailment of TR05 when operating in travel mode.

M E M O R A N D U M

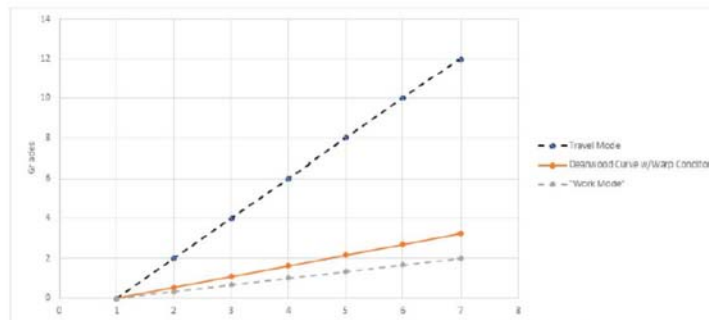


Figure 2-TR05 Suspension Limits

Internal rail defects are not an influencing factor in this derailment as there were no reported ultra-sonic rail defects identified within the area of concern.