



National Transportation Safety Board

Office of Railroad, Pipeline, and Hazardous Materials Investigations
Human Performance and Survival Factors Division
Washington, D.C. 20594

December 19,
2021

MBTA Accident Brookline, MA

July 30, 2021
About 6:03 p.m. EST

NTSB Accident Number: #RRD21FR013
Trolley Collision with Derailment

Human Performance / System Safety Group Factual Report

Human Performance / System Safety Group

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Accident Summary

For a summary of the accident, refer to the *Accident Summary* report, within the docket.

1. DETAILS OF THE ACCIDENT

The accident occurred on the Massachusetts Bay Transportation Authority’s (MBTA’s) Green Line, on the B-Branch which runs a circular route covering 23 miles in the Boston vicinity. The B-Branch runs on a curb separated guideway in the middle of Commonwealth Avenue. On Friday, July 30, 2021, at approximately 6:03 p.m. EST a MBTA light rail vehicle consist (trolley) collided into the rear of another MBTA trolley.



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Preliminary evidence indicates that the operator of the striking train placed the master controller in a full power position after the last station stop and road intersection. This accelerated the

¹ Human Performance and System Safety Group Field Notes

equipment up a 3% grade to 31 m.p.h. for about ¼ mile in a 10 m.p.h. speed limit area, before striking a moving train ahead on the same line. There is no evidence that the operator attempted to stop before striking the train in front of it; the emergency brake was not activated until impact and the operator released the master controller. Estimated impact speed of the striking train was 31 m.p.h. The struck train was moving at approximately 10 m.p.h. at the time of the collision. The impact accelerated the struck trolley to about 24 m.p.h.

Each train consisted of two coupled cars²:

Struck train-

Leading Trolley 3862 (Series 8), partially derailed

Trailing Trolley 3705 (Series 7), partially derailed

Striking train-

Leading Trolley 3894 (Series 8), partially derailed

Trailing Trolley 3697 (Series 7), did not derail

There was no indication from the operator that there was a mechanical failure³. Investigators went to the accident location for observations including track conditions. There were no abnormalities noted and only superficial damage to the track structure as a result of this accident⁴.

Brakes are controlled for each vehicle in the consist by the trolley operator located in the leading trolley. There is an additional trolley operator in each additional trolley who operates the doors on that trolley and they are available for fare collection at street level stations and passenger safety. Investigators observed MBTA car shop employees conduct a full brake diagnostic on Trolley 3894, which was passed without exception.⁵

Investigators observed the deadman feature, which is built into the master controller handle (Photo 2). To engage the propulsion via the master controller it must first be rotated 90-degrees and held in that position (Photo 3). With the master controller moved forward, in ‘propulsion’, letting go of the controller (for example, due to incapacitation) immediately places the train in emergency braking. The handle must be placed into full-service brake to recover the brake system.⁶ The trolleys are not equipped with forward collision avoidance or Positive Train Control, however MBTA is developing a Train Protection System for the Green Line. One of its

² NTSB Vehicle Performance and Engineering Field Notes and Factual Report.

³ NTSB Operations Field Notes and Factual Report

⁴ NTSB Vehicle Performance and Engineering Field Notes and Factual Report.

⁵ NTSB Vehicle Performance and Engineering Field Notes and Factual Report.

⁶ NTSB Vehicle Performance and Engineering Field Notes and Factual Report and the NTSB Operations Field Notes and Factual Report.

safety features will be reducing the risk of train-to-train collisions and enforcing train speed limits.⁷

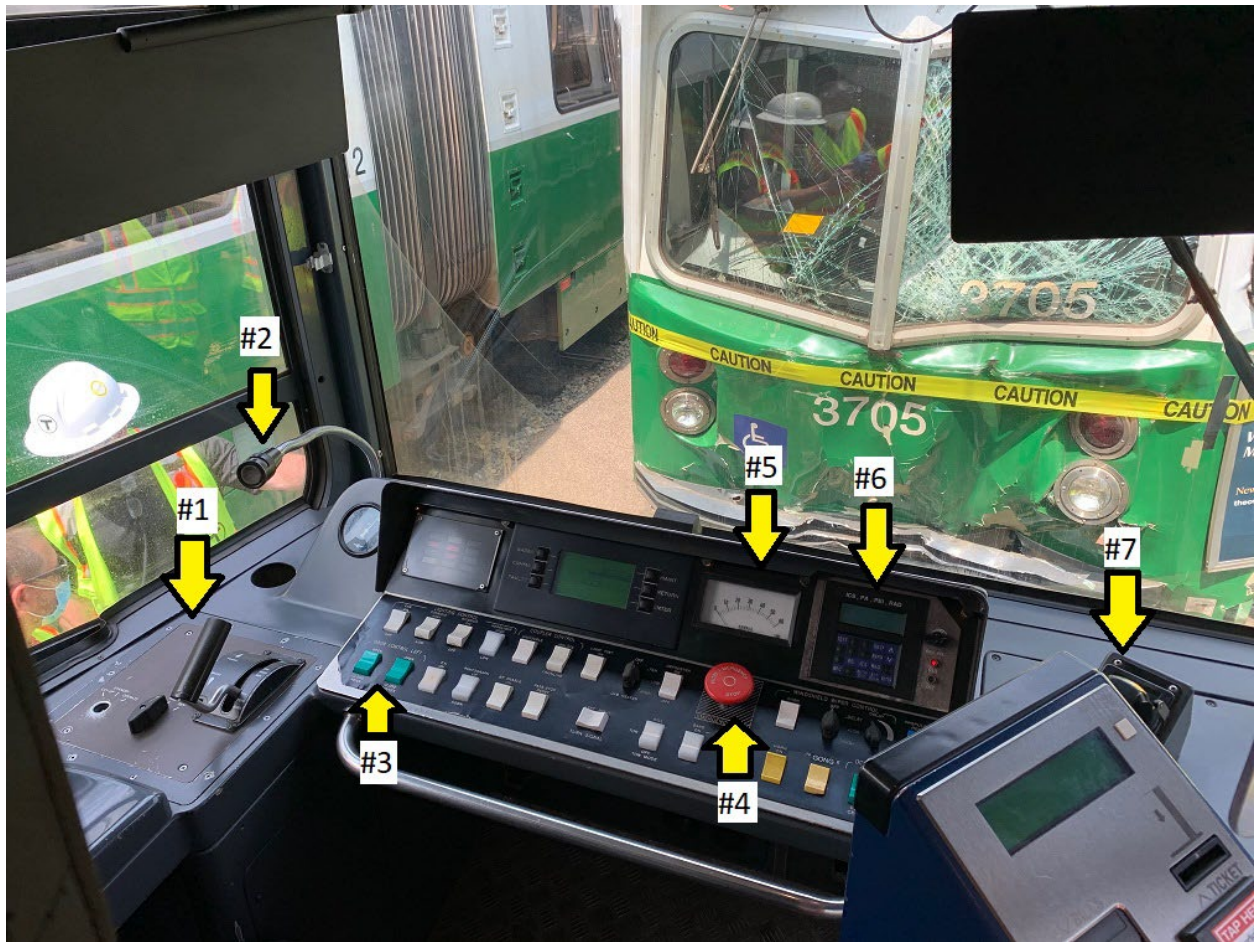


Photo 2: Operator's cab of a Type 8 vehicle (striking vehicle, car 3894).

- 1) The master controller handle and vehicle deadman (activated by turning clockwise)
- 2) Public address system
- 3) Green buttons on Type 7, Type 8 and Type 9 streetcars are door controls
- 4) Circular red plungers on Type 7, Type 8 and Type 9 vehicles are the emergency brake applicators. These are commonly referred to as “the mushroom”
- 5) Vehicle speedometer
- 6) Communications Control Panel (CCP). The CCP allows for the operator to talk to other train crew members via an intercom (ICS), or to communicate with the OCC by radio (RAD), and passengers via the Passenger Emergency Intercom (PEI)

⁷ NTSB Operations Field Notes and Factual Report. The Green Line Train Protection System is scheduled for completion July 2024.

- 7) Hidden behind the farebox is the handset for the radio/intercom/PEI.

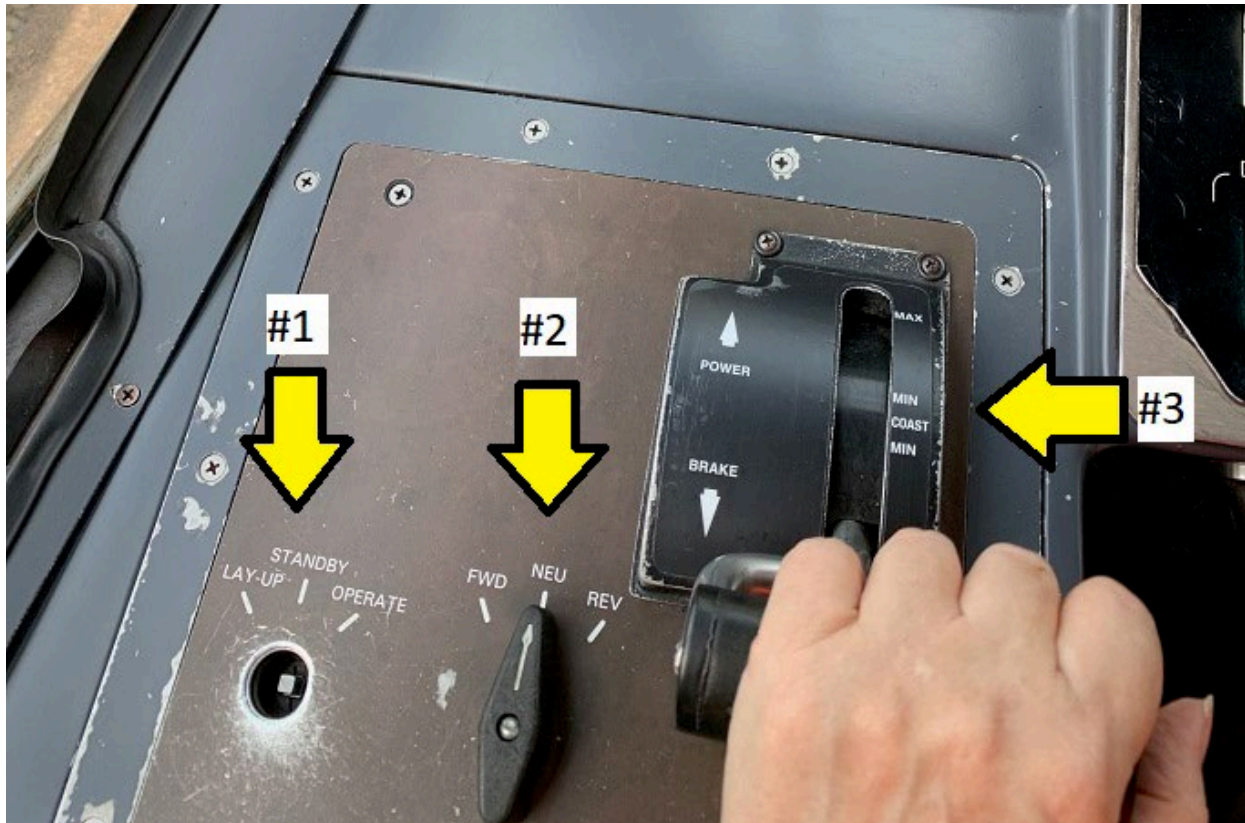


Photo 3: Close up photograph of the master controller, transfer switch, and reverser on a Type 8.

- 1) Transfer switch: This is where the operator places his or her key to give power to the train. “Lay up” is the “off” position. “Standby” is the is the position for the car to be powered up, but with the master controller still locked. Trailer car operators have their cars in standby at all times. “Operate” provides power to the master controller and readies the cab to be the lead car of a consist.
- 2) Reverser: The reverser provides direction to the vehicle’s motors. When in lay-up or standby, the reverser must be in neutral. Once placed into operate, the reverser can be placed in forward or reverse.
- 3) The master controller: The master controller is present on both the Type 8 and Type 9 vehicles. It is used by the operator of the lead car of a consist. The forward-most position of the controller is maximum power. In the center is coast. Below coast, closer to the operator, is braking. The further the controller is pulled back, the more braking power will be applied. The two furthest back positions are full service brake + track brake, and emergency, the latter does the same thing as the mushroom emergency brake.

A preliminary review of operating data from the equipment indicated that there were no operating anomalies during the previous five station stops completed by the operator of the striking train.

During his interview, the Striking Trolley Lead Car Operator stated that he saw his leader train (3862-3705) in the vicinity of the Boston University East station. Several blocks further up the line, he described passing through the area of the St. Paul Street station⁸. He said he saw the vertical “white light” (this is the MBTA’s traffic signal, giving trolleys the indication to proceed). After that, he said things went “black”. He then described being upright and thinking “why am I up? Why is there a train in front of me? I can’t panic.”⁹

The Striking Trolley Lead Car Operator provided a statement to the Reservoir Superintendents office stating, “I believe I fell asleep.” He clarified what he meant in the written statement during his interview; that he did not know what happened, but via a process of elimination, he offered the belief that he fell asleep.

2. OPERATIONAL FACTORS

This section provides information on the trolley operators’ most recent recertification and their work schedules for the month of the accident.

A. Recertifications and Training

1) Trolley Operators’ Recertifications

The Striking Trolley Operator’s most recent recertification was January 21, 2021.

The Striking Trolley Trailing Operator’s most recent recertification was May 26, 2021.

The Struck Trolley Operator’s most recent recertification was December 31, 2020.

The Struck Trolley Trailing Operator’s most recent recertification was April 21, 2021.

2) Fatigue Training

The HP group met with the training department and was briefed on the MBTA training material for Fatigue Risk Management. Potential revisions were discussed. The training materials will be included in the docket.

B. Work Schedules

The workload and work schedules were determined for the lead car operators and trailing car operators of the striking trolley and the struck trolley. The assigned task workload for the day of the incident was normal for the crews of both trolleys.

⁸ The St. Paul Street station is the station immediately preceding the site of the accident.

⁹ Interview with the Striking Trolley Lead Car Operator.

1) Striking Trolley Lead Car Operator

The Striking Trolley Lead Car Operator was hired by MBTA on September 15, 2015, and was age 49 at the time of the accident. Their work schedule for the 30 days (July 1 – 30, 2021) leading up to the accident were as follows:

Days Off - Mon, Tue

Absences –

None

Sunday Run Assigned #645 @ Mattapan

Days Performed- 7/4, 7/11, 7/18, 7/25

Hours- 1:50pm- 10:00pm

Assignment- Mattapan Yard Shifter

Wednesday- Friday Run Assigned #619 @ Boston College

Days Performed- 7/1, 7/2, 7/7, 7/8, 7/9, 7/14, 7/15, 7/16,
7/21, 7/22, 7/23, 7/28, 7/29, 7/30

Hours- 3:04pm-6:23pm/7:09 pm-11:28pm

Trip Times- 3:19pm, 5:01pm, 7:11pm, 8:46pm, 10:16pm

Saturday Run Assigned #666 @ Mattapan

Days Performed- 7/3, 7/10, 7/17, 7/24,

Hours- 1:50pm- 10:00pm

Assignment- Mattapan Yard Shifter

2) Striking Trolley Trailing Car Operator

The Striking Trolley Trailing Car Operator was hired by MBTA on February 4, 2018, and was age 27 at the time of the accident. Their work schedule for the 30 days (July 1 – 30, 2021) leading up to the accident were as follows:

Days Off- Wed, Thu

Absences-

7/4- FMLA Unpaid

7/9- FMLA Unpaid

7/11- FMLA Unpaid

7/25- FMLA Paid

7/26- FMLA Unpaid

Sunday Run Assigned #532 @ Riverside(1st half) Reservoir(2nd half)

Days Performed- 7/18,

Hours- 6:00am-9:32am/10:56am-3:26pm

Trip Times - 6:15am, 7:55am (Riv.) 10:55am, 12:25pm, 2:05pm (Res.)

Monday and Tuesday Run Assigned #573 @ Riverside (1st half) Reservoir (2nd half)

Days Performed- 7/5, 7/6, 7/12, 7/13, 7/19, 7/20, 7/26, 7/27

Hours- 6:00am-9:32am/10:56am-3:26pm

Trip Times -6:15am, 8:00am (Riv.) 10:58am, 12:32pm, 2:07pm(Res.)

Friday Run Assigned #620 @ Boston College

Days Performed- 7/2, 7/16, 7/23,7/30

Hours- 3:07pm-6:23pm/7:09pm-11:33pm

Trip Times -3:19pm, 5:01pm, 7:11pm, 8:46pm, 10:16pm

Saturday Run Assigned #550 @ Boston College

Days Performed- 7/3, 7/10, 7/17, 7/24,

Hours- 9:40am-2:31pm/3:52pm-7:00pm

Trip Times - 9:55am, 11:31am, 1:08pm, 3:54pm, 5:39pm

3) Struck Trolley Leading Car Operator

The Struck Trolley Leading Car Operator was hired by MBTA on June 23, 2014, and was age 44 at the time of the accident. Their work schedule for the 30 days (July 1 – 30, 2021) leading up to the accident was the Vacation Relief schedule, with work varying weekly. The schedule, as worked, follows:

Absences:

7/1- FMLA Paid/Unpaid

7/2- FMLA Unpaid

7/10- FMLA Paid/Unpaid

7/20- FMLA Unpaid

7/21- FMLA Unpaid

7/22- FMLA Paid/Unpaid

Week ending 7/3/21, Days Off- Sun, Sat

Week ending 7/10/21, Days Off- Sun, Mon

Tuesday Run Assigned @ Boston College

Days Performed- 7/6
Hours- 7:30am-2:30pm Cover
Assignment- - Worked as Directed (EDC) Extra Detail Car

Wednesday Run Assigned #579 @ North Station
Days Performed- 7/7
Hours- 7:30am-11:47am/12:58pm-3:47pm
Trip Times – 7:40am, 9:03am, 10:28am, 1:00pm, 2:27pm

Thursday Run Assigned @ North Station
Days Performed- 7/8
Hours- 9:30am-5:20pm Cover
Assignment- Worked as Directed (EDC) Extra Detail Car

Friday Run Assigned @ North Station
Performed- 7/9
Hours- 6:00am-1:50pm Cover
Assignment- 9:20am, 10:45am, 12:11pm

Week ending 7/17/21, Days Off- Sun, Sat

Monday- Friday Run Assigned #595 @ Boston College
Days Performed- 7/12, 7/13, 7/14, 7/15, 7/16
Hours- 10:00am-6:00pm (OAD) Operate as Directed
Assignment- Varies

Week ending 7/24/21, Days Off- Sun, Sat

Monday- Friday Run Assigned #594 @ Boston College
Days Performed- 7/19, 7/23
Hours- 10:00am-6:00pm (OAD) Operate as Directed
Assignment- Varies

Week ending 7/31/21, Days Off- Sun, Thu, Sat

Monday- Wednesday Run Assigned #1409 @ Boston College
Days Performed- 7/26, 7/27, 7/28
Hours- 6:10am-11:10am/12:49pm-5:32pm
Trip Times - 6:22pm, 8:04am, 9:45pm, 12:51pm, 2:30pm, 4:10pm

Friday Run Assigned #1410 @ Boston College

Days Performed- 7/30

Hours- 7:20am-12:11pm/1:34pm-6:15pm

Trip Times 7:20am, 9:02am, 10:45am, 1:36pm, 3:12pm, 4:53pm

4) Struck Trolley Trailing Car Operator

The Struck Trolley Trailing Car Operator was hired by MBTA on May 6, 2003, and was age 44 at the time of the accident. Their work schedule for the 30 days (July 1 – 30, 2021) leading up to the accident were as follows:

Absences:

7/1- VAC

7/2- FMLA Unpaid

7/4- FMLA Unpaid

7/14- FMLA Paid/Unpaid

7/20- 2nd half FMLA Unpaid

7/29- FMLA Unpaid

Days Off- Sun, Mon, Sat

Tuesday-Friday Run Assigned #1411 @ Boston College

Days Performed- 7/6, 7/7, 7/8, 7/9, 7/13, 7/14, 7/15, 7/16,

7/20, 7/21, 7/22, 7/23, 7/27, 7/28, 7/30

Hours- 7:20am-12:11pm/1:34pm-6:15pm

Trip Times- 7:20am, 9:02am, 10:45am, 1:36pm, 3:12pm, 4:53pm

3. ORGANIZATIONAL OVERSIGHT

A. Internal Oversight

This section provides factual information on trolley crew supervision and organizational factors.

The immediate supervisor of the trolley operators are the inspectors. The chief inspectors for B-Branch and C-Branch and the Boston College Pullout Inspector were interviewed.

During his interview, the Chief Inspector for B-Branch stated that part of his duties on the day of the incident was to manage the headway of the trains on the B-Branch (inclusive of expressing and holding trains) and to enforce rules compliance and document violations, especially when train spacing is less than 500'. As a Chief Inspector, has never had to enforce the rules on spacing of trains.

He stated there was an MBTA train-on-train trolley accident in 2009, which the NTSB investigated. In that incident, he was the operator of the trailing car of the struck train.

To assist in performing his duties, he stated that he uses a third-party cell phone app to track Green Line trains. When asked for examples of how or why an operator could be relieved mid-trip, he indicated that operators most typically call OCC to take restroom breaks. Trains will be held if an operator has an illness or medical emergency requiring an EMS response. As a former operator and inspector, he would offer advice to new operators to “take your time, don’t do anything foolish” and believes that a train control system needs to come soon because there is too much room for mechanical/human error.

The Chief Inspector for C-Branch stated that he oversees a sector and was assigned to the Green Line’s C-Branch on the date of the accident. He described his job as a Chief Inspector as the “eyes and ears of the system and the first to respond as a front-line supervisor.” On the day of the accident, his shift began at 5:30 p.m. He responded to a report of a trespasser at Brookline Village. Shortly after, he heard an initial radio call “Accident – Babcock Street – emergency.” He then heard “Pleasant Street – emergency.”

He left the C-Branch and arrived at the scene of the accident where he observed damage to the equipment and began to assist. He saw 20 to 30 people on the platform. He first assessed the condition of the crew of the struck train and saw the trailer car operator was visibly upset. He assessed any injuries and had them sit on the platform. He found the operator of the striking train sitting in a passenger seat behind the operator’s cab and asked him if he was good. The operator replied, “I’m good.” He described the operator of the striking train as an even keeled individual and his response and actions didn’t seem out of his norm. He noted it appeared to him the emergency handle of the center doors had been used by passengers to self-evacuate. He also recalled the toggle switches were thrown to open the front doors. He stated that all the operators seemed normal, given the circumstances. He stated that he aided one of the more noticeably upset operators by seating her in his MBTA assigned vehicle and covered the windshield with a safety vest to protect her from the media.

The Boston College Pullout Inspector stated that his job duties included car count, requesting additional vehicles from the Reservoir yard, fitness for duty checks, and assigning trains while managing the vehicle headway from BC (Photo 4). He has never had an employee report for work not fit for duty. He stated that he visually observes and assesses the fitness for duty of every operator reporting for work on the line during his shift, including the operator of the striking train. He described the operator of the striking train’s appearance as within the normal limits, with nothing unusual to report. He further stated that the operator of the striking train was wearing his prescription glasses and was not wearing sunglasses.



Photo 4: Inspector's booth from the Boston College station lobby at the starting point of the Green Line's B-Branch.

The office in the foreground is where the pullout Inspector manages car counts, crew assignments, and performs fitness for duty checks. He or she is also equipped with a vehicle tracking system, a radio, and telephones to communicate with their line Chief, the District Supervisors, and the OCC.

The Light Rail Dispatcher and the Spare Light Rail Dispatcher were interviewed and described their positions at the Operation Control Center (Photo 5). They provided details of the events following the accident.



Photo 5: MBTA’s Operations Control Center (OCC).

The Green Line consoles are shown with a dispatcher in the foreground. Ahead of the dispatcher are three sections. To the left is the GPS data, outlining train locations on each of the five branches (B- Boston College, C- Cleveland Circle, D- Riverside, E- Heath Street and Mattapan-Ashmont High Speed Line). The lower right shows the dispatchers a series of live camera views of some of the Green Line’s busiest locations. The upper right shows a map of the AVI tracking system within the central subway (serving the B, C, D, and E branches). Two dispatchers work in tandem (the second dispatcher is to the right, out of view) 24/7 to manage the operations along the 5 branches and to respond to any situations that arise. Interim Deputy Division Chief of OCC & Training, William Hogan, is seen on the left giving the investigative group a briefing of the 7th floor control room at 45 High Street.

The MBTA’s Transit Safety Plan provides safety policy and processes for MBTA employees. The MBTA did not have a Safety Management System in place at the time of the accident.

C. External Oversight

The following agencies are responsible for external oversight of MBTA:

1) Federal Oversight (Federal Transit Administration):

On July 19, 2018, the Federal Transit Administration (FTA) published the Public Transportation Agency Safety Plan (PTASP) Final Rule, which requires certain operators of public transportation systems that receive federal funds under FTA's Urbanized Area Formula Grants to develop safety plans that include the processes and procedures to implement Safety Management Systems (SMS). The PTASP rule became effective on July 19, 2019. FTA published a Notice of Enforcement Discretion on April 22, 2020 effectively extending the PTASP compliance deadline from July 20, 2020 to December 31, 2020.

The plan must include safety performance targets. Additional guidance on planning and target setting is located on FTA's Performance-Based Planning pages. Transit operators also were required to certify they have a safety plan in place meeting the requirements of the rule by December 31, 2020. The plan must be updated and certified by the transit agency annually.

2) State Safety Oversight (Massachusetts Department of Public Utilities):

The Massachusetts Department of Public Utilities (DPU) Transportation Oversight Division is responsible for the oversight of equipment safety and operations for the Rail Fixed Guideway Public Transportation Systems (RFGPTS) in accordance with 220 CMR 151.00. The MBTA is the only Massachusetts transit authority which operates a RFGPTS. The Division annually reviews, tests, and approves the Public Transportation Agency Safety Plan (PTASP) created by the MBTA, along with monitoring of the MBTA's compliance with the Divisions System Safety Program Standard (220 CMR151.00). The Division also performs random inspections of MBTA light and heavy rail subway cars and operation facilities which include all carhouses. Division staff review and participate in internal safety audits to further enhance compliance and safety plans. The Division also conducts external safety audits which are designed to monitor compliance with program requirements.

4. MEDICAL FACTORS

The toxicology report for the Striking Trolley Leading Car Operator was negative. The NTSB Medical Officer's Research and Engineering report provides additional information regarding the trolley crews.

5. BEHAVIORAL FACTORS

A. Disciplinary Actions

This section focuses on the history of disciplinary actions of the Striking Trolley's Lead Car Operator as provided by MBTA. This list covers the period from July 15, 2015 (the oldest instance available in their electronic record system, LaborSoft). Information on reinstruction is included where applicable:

1. 7/15/2015 – Issued 1 Day Administrative Suspension for an AWOL.

2. 11/19/2015 – Issued a 3 Days Safety Suspension for a Trolley/Auto Accident deemed Preventable.

On November 30, 2015, The Striking Trolley’s Lead Car Operator received and passed reinstruction on rules, with emphasis on defensive driving and proper clearance thru intersections and platforms. This was completed due to his trolley making contact with an automobile at the Boston University Bridge.

3. 5/21/2016 – Issued 3 Days General Rules Suspension for bypassing a customer in a wheeled-mobility device.

4. 7/2/2016 – Issued 10 Days Suspension/Final Warning for Speeding – traveling 19 mph in a 10 mph speed zone.

On July 18, 2016 the Striking Trolley’s Lead Car Operator received and passed reinstruction on obeying the posted speed limit, following a radar/Speed violation.

5. 8/29/2016 – Issued 70 Days/RFD for failing to recognize, report, and overcome door failure and failing to allow customers the ability to depart his train. This was reported as SETTLED by Labor Relations on 4/24/2017 RTW agreement with 2 years on a final warning on Safety Track.

6. 6/30/2017 – Issued 70 Days/RFD for operating his train into a yard area with a customer on board. This was reported as SETTLED by Labor Relations on 9/27/2017 RTW agreement with 3 years on a final warning on Safety Track.

B. Training

This section focuses on recent training received by the Striking Trolley Lead Car Operator.

Most recently, the Striking Trolley Lead Car Operator passed the MBTA’s Light Rail Training Department’s Motorperson Recertification Test on January 9, 2020 with a score of 100% and on January 21, 2021 with a score of 80%. As part of both tests, he correctly answered a question on the safe following distance between two moving trains on street level as 500 feet distance¹⁰.

C. Fatigue

¹⁰ MBTA training records for the Striking Train Lead Car Operator.

During his interview, the Striking Trolley Lead Car Operator stated he gets enough sleep every night¹¹ and is a “light sleeper”. He indicated that ambient noise in his apartment building has contributed to some sleep loss in the past.

He further stated he had been “drowsy” on the job in the past. He provided one example of a work night when he did not believe he could safely complete his last trip. He then called the operator in his trailer car and asked the operator to swap positions with him for the remainder of the run. That operator complied, and the trip was completed without incident.

7. Environmental Factors:

A. Weather

The sky was clear with no precipitation at the time of the accident. No sun glare was reported by the Struck Train Lead Car Operator.¹²

B. Ambient noise

The trolley operators reported during interviews that road construction was ongoing near this incident location at the time of the incident and that the normal sounds of construction activities were present in the time leading up to the accident.

C. Time of day

The accident occurred about 6:03 p.m.

D. Reported distractions and cell phone data.

No unusual distractions, either inside or outside of the trolley were reported during interviews with the trolley operators and a witness who was on the striking trolley.

The Striking Train Lead Car Operator stated in his interview, regarding collecting fares from passengers, that lots of people with cash slows them down on their route.

Trolley operators are not authorized to have cell phones in the trolley with them and are instructed to secure their cell phones prior to reporting to work. Communications during trolley operations are conducted via intercom and radio. Cell phone data from the striking train’s lead

¹¹ The Striking Trolley Lead Car Operator provided details on his sleep schedule during his interview, which will be in the docket.

¹² Interview with the Struck Train Lead Car Operator.

car operator was subpoenaed and received from the cell phone carrier. NTSB's research and engineering division's cell data report will be placed in the docket.