National Transportation Safety Board

Office of Railroad, Pipeline and Hazardous Materials Investigations

Washington, D.C. 20594

Collision of New Jersey Transit Passenger Train 1614 at Hoboken Station

Hoboken, New Jersey

September 29, 2016

Mechanical Group Factual Report

Accident

NTSB Accident Number:	DCA16MR011
Date of Accident:	September 29, 2016
Time of Accident:	8:41 a.m. (EDT[1])
Type of Trains:	NJT Passenger Train 1614
Railroad Owner:	NJT
Train Operator:	NJT
Fatalities:	1
Injuries:	110
Location of Accident:	Hoboken, NJ

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[1] Eastern daylight time

Accident Summary

For a summary of the accident, refer to the Accident Synopsis Report in the docket for this investigation, NTSB Docket DCA16MR011.

Train Consist

New Jersey Transit (NJT) passenger train 1614 consisted of one controlling car (cab car), three passenger coaches (trailer car) and one locomotive power unit. The train weighed about 689,660 lbs. and was about 405 ft. in length. The train consist data is shown in table 1.

Sequence	Car Type	Number	Seats	Weight
1	Cab car	6036	109	107,140 lbs.
2	Trailer car	6577	117	101,840 lbs.
3	Trailer car	6575	117	101,840 lbs.
4	Trailer car	6521	117	101,840 lbs.
5	Locomotive	4214	2	286,000 lbs.

Table 1. NJT Train 1614 consist.

Railroad Equipment Involved in the Collision

The cab car, 6036, from the collision train was a Comet V series cab car manufactured by Alstom in 2003. All Comet V series cars are designed for locomotive hauled push-pull operation in a train consist of up to 12-cars. The cab car measures approximately 85 ft. (length), by 10 ft. (width), by 13 ft. (height). Two truck assemblies are positioned equidistantly from the center of the car near the ends. Each truck assembly contains two axles with four tread brake units and four inboard disc brake systems.

The cab car features an engineer's console that contains all the controls and indicators for controlling train operations including the speed display unit (SDU), master controller and the brake cab control unit (operator's brake valve). (See figure 1.) The SDU displays the required speed limit as received from the coded train rails in cab signaled territory and the actual speed. The cab car also features a master controller, which is used to control the traction power and direction of travel. The master controller is comprised of a reverser handle that allows the operator to select between

Forward, Reverse and Neutral, and a throttle lever.[2] The throttle lever has nine numbered detent positions for propulsion and nine numbered detent positions for dynamic braking and an Idle position.[3] The throttle features a mechanical interlock when in the Idle position requiring the operator to release a mechanical interlock before selecting a power mode. Tractive effort is achieved by pulling the throttle toward the operator.

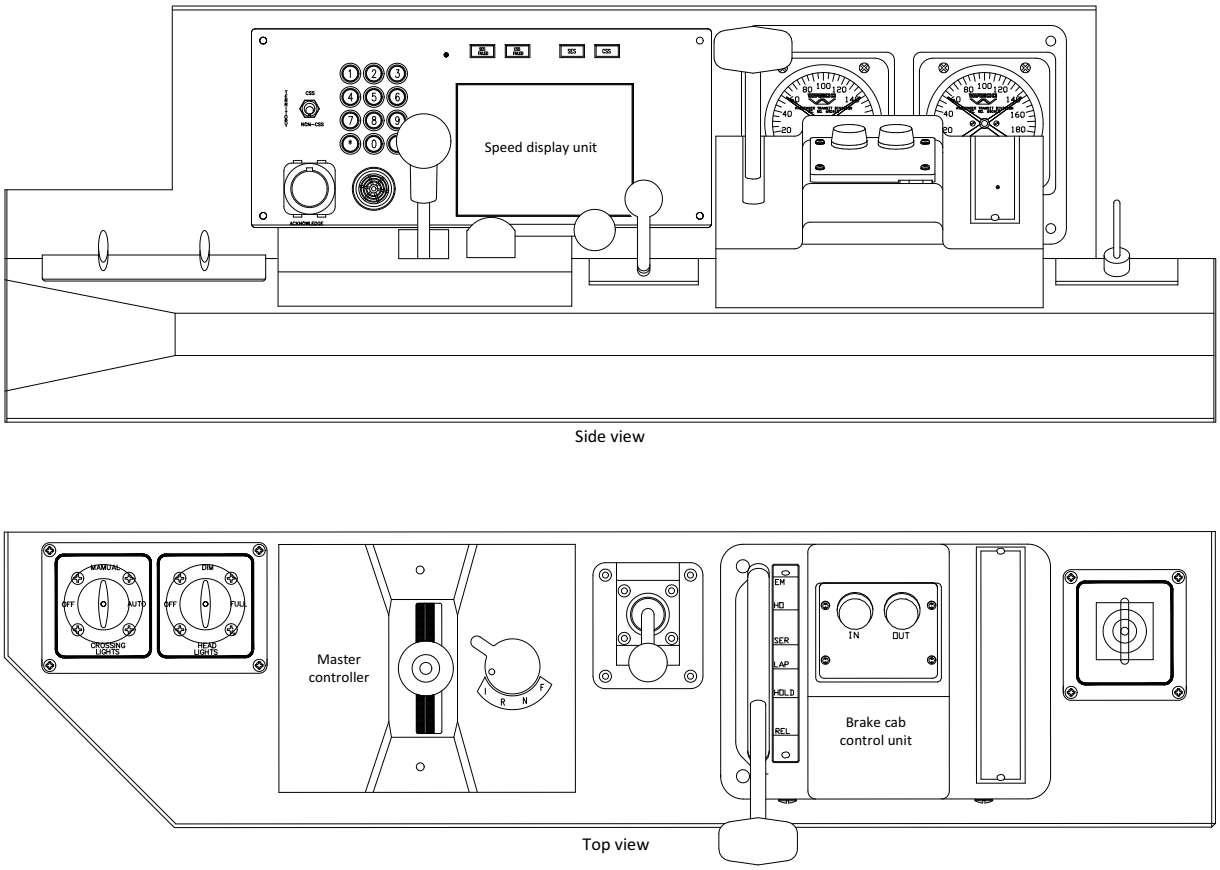

Figure 1. NJT Comet V series operating console.

The brake cab control unit (BCUU) is a device used by the operator to control the application and release of the train brakes by regulating the brake pipe pressure. (See figure 1.) The BCUU has six handle positions that perform the following functions:

1. Release position, charges the brake pipe and releases the brakes

[2] The 'Isolate' (I) position on the controller de-energizes the control system functions in the cab car and is used when the cab car is unattended. The reverser can be removed from the controller to secure the equipment and prevent unauthorized used.

[3] The dynamic brake feature on NJT Comet V cab cars is not active. All braking is achieved via electro pneumatic friction braking when trains are operated by this car series.

2. Hold position, recharges the brake pipe to full pressure while the brake cylinder is maintained electromechanically, thereby holding the train brakes applied
3. Lap position, stops any further brake pipe reduction and is used primarily when the desired level of braking is reached
4. Service position, decreases the brake pipe at a controlled rate and allows for a service brake application
5. Handle off position, used when the car is in the trailing position or when towed
6. Emergency position, initiate the emergency train brake

The trailer cars from train 1614 were manufactured between 2002 and 2004 by Alstom. The trailer car measures approximately 85 ft. (length), by 10 ft. (width), by 13 ft. (height). Two truck assemblies are positioned equidistantly from the center of the car near the ends. Each truck assembly contains two axles with four tread brake units and four inboard disc brake systems.

Each trailer car is equipped with a 26-C Control Valve which is a pneumatic device designed for use on passenger carrying rail vehicles in equipment arrangements where the air pressure does not exceed 150 psi. It functions to direct a flow of air under pressure into or exhausts air from the brake cylinder pipe, or directs a flow of air under pressure to an intermediate brake cylinder relay valve in response to changes in brake pipe pressure at the control valve itself.

Train 1614's braking system used either electrical or pneumatic trainline signals to control air brake operation of the locomotive, cab, and trailer cars. When a cab car is in a trailing configuration and in emergencies, the braking system can perform all train braking functions pneumatically, without electrical application, by control of pressure in the trainline brake pipe from a controlling locomotive. This system consists of a locomotive-driven air compressor, two trainline air lines, reservoirs, valves, brake actuators, and associated devices. When Comet V cab cars are operating in the lead, braking is controlled with an EPIC/26-C/CS-2 Brake System, which is a computer-controlled electro-pneumatic service braking system, providing service braking, emergency braking, and wheel slip protection. In a leading configuration, the cab car controls all braking functions of the train.

The rear locomotive involved in this accident was a GP-40 PH2-B re-manufactured by Conrail in 1994 originally manufactured by Electro Motive Diesel between 1965 and 1969. This unit is a

four-axle, two-truck, 3000 HP diesel-electric locomotive. Each truck is powered by two transversely mounted direct current (DC) traction motors, each of which drives an axle by means of a dedicated gearbox.

The locomotive unit measures approximately 62.5 ft. (length), by 10 ft. (width), by 15 ft. (height), and weighs (fully loaded with fuel, traction sand, etc.) about 286,000 lbs. A fuel tank, having a capacity of about 2,500 gallons, is located between the truck assemblies.

When GP40PH-2B locomotives are operating in the lead, braking is controlled with a 26L/CS2 air brake system, which includes an electro-pneumatic automatic brake, independent brake, cut-off valve, a trainline air pressure regulating valve, and a multiple unit valve. The system is used to control the application and release of the train brakes, providing service braking, emergency braking, and wheel slip protection. In a leading configuration, the locomotive controls all braking functions of the train.

Wreckage

Equipment damage is estimated by NJT at $6.0M. The damage is summarized in table 2 below.

Disposition	Car Type	Number	Estimated damage
Destroyed	Cab car	6036	$4.0M
Damaged	Passenger Car	6577	$0.50M
Damaged	Passenger Car	6575	$0.50M
Damaged	Passenger Car	6521	$0.50M
Damaged	Locomotive	4214	$0.50M

Table 2. Preliminary equipment damage

Equipment Pre-Accident Inspection

NJT passenger train 1614 originated in Woodbine Yard, Spring Valley, New York. The train consist was equipped with locomotive 4214 and records indicate the Federal Railroad Administration (FRA) required Class I air brake test was successfully completed at 2:20 a.m. on September 29, 2016. NJT passenger train 1614 was also equipped with cab car, 6036, and records show it passed the FRA required Class I air brake test at 4:25 a.m. on September 29, 2016. Pre-trip cab signal tests were completed on the 4214 and the 6036, both were completed on September

28, 2016 at 12:30 p.m. and 11:55 p.m. respectively. All inspections were completed by qualified mechanical personnel and qualified personnel. In interviews with NTSB investigators, the engineer reported no problems with the brake system or the performance of train 1614 on the day of the accident.

Title 49, *Code of Federal Regulations* (*CFR*) Part 238, Subpart D, requires that a running brake test be completed as soon as conditions safely permit on each passenger train after the train has received a Class I brake test. Title 49, *CFR* 238.319(c) states, "the running brake test shall be conducted in accordance with the railroad's established operating rules, and shall be made by applying brakes in a manner that allows the engineer to ascertain whether the brakes are operating properly." Investigators examined the event recorder data from the day of the accident at the time train 1614 began its trip. The data shows the brakes were applied moments after train 1614 began to move and the train subsequently reduced its speed in response to the requested brake command. See attachment 16. For additional information Cab Car Event Recorder Specialist's Factual Report in the docket for this investigation, NTSB Docket DCA16MR011.

Equipment Post Accident Inspections

NTSB investigators formed a mechanical group of qualified inspectors to evaluate the mechanical condition of the equipment involved in this accident.

On September 30, 2016, investigators completed visual inspections of train 1614 at its initial point of rest. Investigators observed all wheels on the equipment had: full tread, full flanges and normal wheel tread wear. All undamaged brake rigging appeared normal and all brake pads, discs and brake pads were within their acceptable tolerance.

Nothing significant was observed on any undercarriage component that could be observed from where the cars came to rest. Areas obscured by wreckage and debris were evaluated during the recovery operations wherein, no observations of defects were noted. The team observed indications of sand from the sanding system of the rear locomotive at its final point of rest. (See figure 2.)

Figure 2-Sand on rail and under the front left wheel from locomotive 4214

The team measured the witness indications of the discharge. There was 25-inches on the rails under each sanding wheel in a way that indicated the train rolled back after the collision.

On October 7, 2016, investigators assembled in the Meadows Maintenance Complex (MMC), in Kearny, NJ, after the removal of the accident train from Hoboken terminal. The train was moved with one additional locomotive tied to the rear. The train moved to the MMC without incident.

Cab car 6036 was examined to determine if the EPIC II brake control system, master controller and other systems could be repaired in order to complete a trainline testing. As a result of the accident, the electrical portion of trainline system was destroyed and the communication network necessary to evaluate brake and propulsion systems could not be repaired. Investigators then identified the key operating system equipment to assess the mechanical condition of the train's braking and propulsion systems.

The following key components from 6036 were identified by the team for functional testing in another known good cab car:

- EPIC brake controller
- Throttle
- Translator
- Speed display unit (SDU)

- Alerter
- Radio/PA system – (included the radio head and the control portion)

Investigators further examined the accident damage to the pneumatic portion of the braking systems on the cab car and the trucks and made field repairs to those systems requiring minimal intervention so post-accident testing brake application and release could be completed. The car was uncoupled from the accident train to complete the repair to the air lines. Once the air lines were repaired to a condition that would allow the brake pipe to charge and the brake reservoirs to hold air, a single car brake set, release and emergency application was completed without incident on October 8, 2016.

On October 9, 2016, the car was then coupled to the accident train and a FRA Class I brake test was successfully completed using locomotive 4214 to apply and release the brakes. With the exception of minor air leaks because of the accident, the team noted no exceptions with the results.

While 6036 was removed for its repair, an exemplar cab car, 6047, was coupled to the accident train and the car's (6047) identified key systems as described above were functionally tested before the accident train's key components were installed for a functional test. With the exception of the cab signal departure test, all systems functioned as expected.[4] In addition, an emergency brake application was made with 6047 and the team did observe a sand application at the rear locomotive, 4214.

The first key component installed into 6047 was the EPIC brake controller from 6036. An FRA Class I air brake test was completed as well as an emergency application. No exceptions were noted.

The throttle and translator were installed next. A propulsion/traction test box was installed on the rear locomotive (4214) to evaluate the trainline propulsion request received by the locomotive from the cab car. Again, the test was completed with cab car 6047's original key components; then again with cab car 6036's components installed. The test validated that the correct propulsion commands were supplied to the locomotive thus verifying the equipment was properly functioning.

[4] The speed display unit in 6047 was not operational thus preventing a cab signal departure test.

The alerter system from cab car 6036 was installed into cab car 6047. The alerter system causes traction power to be removed and alerter penalty braking to be initiated if it does not receive a signal from one of several operator controlled devices within a specific period of time. The illumination of an alarm light on the alerter panel is followed by an increasingly audible and visual warning signal. If, at the end of the time allowed, the alerter system does not detect some reset-generating operator activity, it will command an automatic brake application and disable the locomotive's traction power.

An integrated self-test feature was used to test the system. The system functioned as expected with one noted exception; there was no audible tone from the system. Investigators reviewed the forward facing camera/audio data from the day of the accident. During the train trip and prior to the accident, the sound of the alerter tone was audible. Investigators attributed the inoperative audible alerter tone from the post-accident test to damage as a result of the accident.

The radio system from cab car 6036 was installed in cab car 6047. A radio check and passenger intercom check was completed without incident. The passenger intercom system was evaluated in the three accident coach cars, 6577, 6575 and 6521. All car intercoms function as designed.

Because cab car 6047 was not able to pass the daily cab signal departure test, the SDU from 6036 was not installed in this car for evaluation. Another exemplar cab car was identified, 6070, to complete the test. This car passed a daily cab signal departure test with its originally installed equipment. The SDU from 6036 was installed into 6047 and a daily cab signal departure test was successfully completed.

The table below summarizes the tested key components and the results.

Key Component	Function test pass/fail
EPIC brake controller	Pass
Throttle	Pass
Translator	Pass
Alerter	Pass[5]
Speed display unit	Pass
Radio / PA system	Pass

Table 3-Key component test results

[5] The audible portion of the alerter was not functional at the time of test.

Follow-up Tests

On January 17, 2017, investigators assembled at the WABTEC Corporation (WABTEC) in Germantown, Maryland, to complete a full evaluation of the system components that make up the EPIC II brake control system. As mentioned above, the EPIC II brake control system is a computer-controlled electro-pneumatic service braking system, providing service braking, emergency braking, and wheel slip protection. The system is comprised of the following components:

1. Brake Cab Control Unit (BCCU)
2. Cab Control Computer (CCU)
3. Locomotive Interface Unit (LIU)
4. Brake Control Unit (BCU)
5. Pneumatic Operating Unit (POU)

The equipment from the EPIC II brake control system from the accident train was transported to Germantown, Maryland, by NJT in advance of the testing. WABTEC supported the investigation by conducting a full comprehensive qualification test of all five components according to their test procedures, WI1050-WGS Rev B – System test and TP1067 Rev H – LIU test. (See figure 3.) Investigators witnessed all phases of the testing and results. The results of the testing showed that all components were functioning within their tolerances as designed. Copies of the test and the results will be included as appendices to this report.

Figure 3-Photograph of test set up of the EPIC II brake components

In addition to providing all computer-controlled electro-pneumatic service braking, the EPIC II system also features integrated system diagnostics and fault log capture capability. Investigators requested that WABTEC access the BCU from 6036 using a portable test unit and download all system faults. The faults were successfully downloaded. The data showed two faults that occurred on September 29, 2016 at 8:42 a.m.; both faults are attributable to the accident.

Records Review

During the on-scene phase of this investigation, investigators collected the daily and periodic inspection records from the locomotive and cab car involved in the collision. The daily inspection requirements are outlined in Title 49 *CFR* 229.21. The rule requires that, except for MU locomotives, each locomotive in use shall be inspected at least once during each calendar day.[6] A written report of the inspection shall be made. This report shall contain the name of the carrier; the initials and number of the locomotive; the place, date and time of the inspection; a description of the non-complying conditions disclosed by the inspection; and the signature of the employee making the inspection. Investigators reviewed the daily inspection records for the leading locomotive, 4214 and the cab car, 6036. The records complied with the rule.

Periodic inspection requirements for locomotives and cab cars are outlined in Title 49 *CFR* 229.23. Each periodic inspection is to be recorded on FRA form F6180-49A, or the blue card. At the first periodic inspection in each calendar year, the carrier shall remove from each locomotive, the blue card covering the previous calendar year and replace it with a current record that will cover the current year. If a locomotive does not receive its periodic inspection in a calendar year before April 2, because of out of use, the form must be replaced. The interval between any two periodic inspections cannot exceed 92-days unless the locomotive is equipped with advanced microprocessor based on-board electronic condition monitoring controls. The interval for these locomotive types is 184-days.

[6] *MU locomotive* means a multiple unit operated electric locomotive; (1) With one or more propelling motors designed to carry freight or passenger traffic or both; or (2) Without propelling motors but with one or more control stands and a means of picking-up primary power such as a pantograph or third rail.

Investigators reviewed the daily inspection records for the leading locomotive, 4214 and the cab car, 6036. The records complied with the rule.

END OF REPORT

Attachments

1. Locomotive 4214 Class I air brake test report
2. Locomotive 4214 cab daily signal test report & Cab car 6036 daily cab signal test report
3. Cab car 6036 Class I air brake test report
4. 6036 Alerter test report
5. 6036 Master controller test report
6. 6036 Translator test report
7. FRA form F6180-49A Locomotive Inspection Record and Repair Record-locomotive 4214
8. FRA form F6180-49A Locomotive Inspection Record and Repair Record-cab car 6036
9. EPIC II WI1050-WGS Rev B – system test plan
10. EPIC II WI1050-WGS Rev B – system test results
11. EPIC II TP1067 Rev H – LIU test plan
12. EPIC II TP1067 Rev H – LIU test results
13. EPIC II Brake Control Unit event log
14. Cab Car 6036 Event Recorder Data – Cab Signal Pre-Departure Test
15. Cab Car 6036 Event Recorder Data – Running Brake Test

Group Member to the Investigation - Acknowledgment Signatures

The undersigned designated *Group Member to the Investigation* representatives attest that the information contained in this report is a factually accurate representation of the information collected during the on scene phase of this investigation, to the extent of their best knowledge and contribution in this investigation.

_____ Date _____

Thomas Bacon, FRA

_____ Date _____

Frank D'Angelo, NJT

_____ Date _____

Jerry D'Andrea, NJT