



# **National Transportation Safety Board**

Office of Railroad, Pipeline and Hazardous Materials Investigations

Washington, DC 20594

Collision of Amtrak Passenger Train P091-03 with CSX Local Train F777-03  
Cayce, South Carolina  
February 4, 2018

RRD18MR003

Mechanical Group Factual Report

## Accident

NTSB Accident Number: RRD18MR003  
Date of Accident: February 4, 2018  
Time of Accident: 2:27 a.m. (EST<sup>1</sup>)  
Striking Train : Amtrak Passenger Train 91(03)  
Railroad Owner: Amtrak  
Struck Train: CSX Local F777(03)  
Railroad Owner: CSX Transportation (CSXT)  
Fatalities: 2  
Passengers: 139  
Location of Accident: Cayce, SC

## Mechanical Group Members

National Transportation Safety Board  
Group Chairman  
Michael Hiller

Federal Railroad Administration  
Ryan Coston  
Railroad Safety Inspector  
Motive Power & Equipment  
Region 3

Amtrak  
George Hull  
Deputy Chief Mechanical Officer

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Senior Manager Equipment Engineering  
Rolling Stock Engineering

Amtrak  
Devon Parsons  
Senior Manager Equipment Engineering  
Diesel Rolling Stock Engineering

CSX, Inc  
Mike Houck  
Mechanical Superintendent

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<sup>1</sup> Eastern standard time

## Accident Summary

For a summary of the collision, refer to the Accident Summary Report in the docket for this investigation, RRD18MR003.

## Train Consist

Amtrak passenger train 91 consisted of one locomotive, three passenger coaches, one lounge car, two sleeper cars and a baggage car. The train weighed approximately 1,119,000 lbs. and was about 667 ft. in length. The car is shown in table 1.

Sequence	Car Type	Number	Capacity
1	Locomotive	47	2
2	Passenger Coach	25037	59
3	Passenger Coach	25072	59
4	Passenger Coach	25020	59
5	Lounge Coach	28002	49 <sup>2</sup>
6	Sleeper Coach	62012	30
7	Sleeper Coach	62008	30
8	Baggage Coach	61048	0

Table 1. Train 91 consist

The CSX local train, F777, consisted of two locomotives and 34 auto rack freight cars. The struck locomotive was CSXT130 and the second locomotive was the CSXT36. The train weighed about 4.3 million lbs.

## Railroad Equipment Involved in the Derailment

### Locomotive

Amtrak locomotive AMTK47 is a General Electric manufactured Genesis P42-8 type passenger locomotive. This type of locomotive was manufactured between 1998-2001 as a single, monocoque carbody design for aerodynamics and fuel efficiency. Amtrak purchased 207 units and VIA Rail Canada obtained 20 units. All Genesis locomotives can provide 480V AC head-end power (HEP) to the train drawn from an alternator powered by the main engine at a maximum rating of 800 kilowatts.

These units produce 63,000 lbf of tractive effort from a 4250 horsepower 7FDL16 Diesel engine supplying 4 DC electric traction motors and 60Hz HEP (head end power) transformer and regulator. The Genesis locomotive operates on the standard gauge (56 ½ - inches) with a wheel diameter of 40 inches and two (2) axle trucks. The unit overall length is 69 feet and the height is 14-feet 4-inches. The unit weight is 268,240 lbs. with a maximum speed of 110 mph and carries 2200 US gallons of diesel fuel with an integrated fuel tank on each side of the locomotive. Genesis braking

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<sup>2</sup> These seats are not sold albeit the lounge coach car can seat 49 patrons.

is New York Air Brake Computer Controlled Brake (CCB I) system. Amtrak uses the P42 as the main motive power of its off-corridor operations around the United States.

Amtrak's entire locomotive fleet that operate long distance service is in the process of undergoing Positive Train Control (PTC) activation, with one of those systems being Interoperable Electronic Train Management System (I-ETMS) which will be the PTC system implemented in the territory of the incident. This will allow Amtrak locomotives to seamlessly communicate with CSX wayside and both CSX and Amtrak's PTC back office environments.

I-ETMS was initially installed on the leading locomotive, AMTK 47, in September 2014 at Amtrak's Beech Grove back shop facility in Indiana. I-ETMS installation included the Train Management Computer (TMC), antennas, radio cabling, and locomotive interface wiring. AMTK 47 was not yet commissioned and was planned to be completed before September 2018. Commissioning includes installation of two cellular modem assemblies upgraded to 4G, installation of updated Slot 10 card and software into the TMC, and the upgraded 220 MHz Data Radio. All locomotive systems related to I-ETMS including the TMC, Cab Signal, Data Radio, Modems, and Event Recorder are verified to be operational and communicating with wayside systems.

Amtrak's locomotives that are commissioned are waiting on the Nationwide Back Office Server to be in production before they can initialize and operate with I-ETMS active. Testing is completed by observing communication with available host systems that are transmitting or utilization of local test systems.

The operating cab features an engineer's console that contains all the controls and indicators necessary for the operation of the locomotive, including three full-screen monitors, designated as Integrated Function Display (IFD) as well as an I-ETMS Wabtec monitor. Also located in the operating cab are the windshield and wiper assembly, and the seats for the engineer and assistant engineer.



Figure 1-Exemplar photograph of P42-8 operating cab (Amtrak)

The P42-8 carbody is comprised of four major elements: platform, side walls, front cab, and three detachable roof sections (roof panel numbers 1, 2, and 3). It is designed to allow compression forces of 800,000 lbs. (400 tons) of buff load and is equipped with an Association of American Railroads (AAR) F-type coupler.

Lighting for the P42-8 consists of an exterior and interior system. The exterior lights include headlights, marker lights, auxiliary lights, and step lights. The interior lights are made up of cab lights, machinery room lights, and console lights. The P42-8 is equipped with a forward-facing camera and a permanent core memory (PCM) event recorder.

CSX lead Locomotive CSXT130 and trail locomotive CSXT36 were General Electric Manufactured AC4400CW type locomotives. This type of locomotive was manufactured between 1993-2004 and is operated by all class 1 freight railroads in the US with a total 2598 units in North America.

These units produce 180,000 lbf of tractive effort from a 4400hp 7FDL16 diesel engine suppling 6 AC electric traction motors. The AC4400 operates on the standard gauge with a wheel diameter

of 42 inches and two 3 axle trucks. The unit overall length is 73 feet 2 inches and the height is 15 feet 6 inches. The unit weight is 426,000 lbs. and carries 5000 US gal of Diesel Fuel. The maximum rated speed is 70mph. Braking system is New York Air Brake CCB-I.

### **Passenger Cars**

Amtrak passenger cars involved in the derailment are designated as Amfleet II cars, built by the Budd Company (Philadelphia, PA). They were placed into regular mainline service in 1983. Of the 150 Amfleet II cars delivered, 145 remain in service. They primarily serve in the long-distance service east of Chicago, Illinois.

The Amfleet II carbody structure, apart from the high-strength low-alloy steel (HSLA) end underframe and cross bearers, is constructed entirely of stainless steel. The exterior skin is formed in corrugations for strength and appearance. Only in the window areas are flat formed panels used. At the time they were built, the carbody's strength exceeded all applicable AAR and FRA requirements, including a full 800,000 lb. compression strength applied at the draft gear and lateral anti-climbers. Additionally, to improve the strength of the cars, the end collision post assemblies were made stronger than AAR requirements of the day by designing these assemblies for an ultimate horizontal load of 300,000 lbs. applied 18 inches from the floor and at a 15-degree angle. The vertical end collision posts are constructed of stainless steel and are located on either side of the end door openings. They are fastened securely into a horizontal end plate at the top and are welded to low-alloy, high-tensile (LAHT) steel stubs extending up from and welded to the end underframe at the bottom.

Each passenger 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 psig. It responds to change in brake pipe pressure to direct air through the relay valve into the brake cylinder to apply the brakes.

The truck assemblies on the coaches and lounge are Budd Pioneer II type. The Pioneer II truck is a fabricated, H-frame, four-wheel truck. They use a combination of steel-coil and air springs and ride on inboard wheel bearings. The side frames are hollow tubes fabricated in two matching halves. A welded triangular structure integral with each side frame is terminated in a half bearing at the central pivot that is attached to the bolster. This arrangement provides independent pitch motion of the two side frames in that the wheels can negotiate cross level irregularities with satisfactory load equalization. Hydraulic rotary shocks provide vertical and horizontal damping in the secondary suspension.

The truck assemblies on the sleeper and baggage car are GSI 70 style trucks. The GSI truck is a cast, H-frame, two axle truck. Utilizing only steel-coil springs, the trucks are fully equalized and ride on outboard bearings. The truck bolster rests in the center pivot of the truck frame and

supports the carbody on another set of steel-coil springs. Hydraulic telescoping shocks provide vertical and horizontal damping in the secondary suspension.

For both truck designs, laterally spaced anchor rods provide the longitudinal connection between the bolster and the car body. Each truck assembly contains two axles with four tread brake units and four inboard disc brake systems.

### **Auto Rack Freight Cars**

The auto rack freight cars are an all steel raised side sill flat car, 89-feet 4-inches in length having a floor height of 31-½ inches at the center of the car with an estimated unloaded weight of 101,000 lbs. The underframe includes a fabricated center sill with cast steel or forged strikers, crossties, bolsters, and cross-bearers. The underframe is equipped with an end of car cushion unit and is configured for automobile bi-level and tri-level auto rack service.

The auto rack freight car is equipped with a body mounted 8-1/2 X 12 brake system, with a double acting slack adjuster. The air brake system is constructed and applied in accordance with AAR Specification S-401.

### **Wreckage**

Equipment damage is estimated by Amtrak at \$24.8 M. the damage is summarized in table 2 below.

<b>Disposition</b>	<b>Car Type</b>	<b>Number</b>	<b>Estimated damage</b>
Destroyed	Locomotive	47	\$5,026,000.00
Destroyed	Passenger Coach	25037	\$2,820,000.00
Destroyed	Passenger Coach	25072	\$2,820,000.00
Damaged	Passenger Coach	25020	\$2,820,000.00
Destroyed	Lounge Coach	28002	\$3,077,000.00
Damaged	Sleeper Coach	62012	\$2,769,000.00
Damaged	Sleeper Coach	62008	\$2,769,000.00
Damaged	Baggage Coach	61048	\$2,742,000.00
<b>Total Amtrak equipment damage</b>			<b>\$24,843,000.00</b>

Table 2-Amfleet II damage estimates.

Equipment damage is estimated by CSX is \$350,000.00.

Total equipment damages are estimated at \$25,193,000.00.

### **Equipment Pre-Accident Inspection**

Amtrak passenger train 91, which originated in New York City, New York underwent an FRA Class I air brake test by qualified inspectors at 12:10 a.m. on February 3, 2018, with a scheduled destination of Miami, FL. The long-distance consist of coach, lounge, sleeper, and baggage cars

was equipped with lead Amtrak City Sprinter (ACS64) Locomotive AMTK 665 in electrified territory until Washington, DC when P42-8 diesel locomotive AMTK 47 was replaced for the continued trip south.

Prior to departing Washington, DC an FRA pre-departure check was required to be completed per requirements prescribed in Title 49 *Code of Federal Regulations (CFR)*, Part 232.211, Class III Brake Tests-Trainline Continuity Inspection. Recovered records showed the inspection was completed on February 3, 2018, at 9:28 p.m., when the lead locomotive was changed. Upon departure from Washington DC, Train 91 made scheduled station stops at Alexandria, VA; Richmond, VA; Petersburg, VA; Rocky Mount, NC; Raleigh, NC; Cary, NC; Southern Pines, NC; Hamlet, NC; Camden, SC and Columbia, SC with no reported problems by the train crew with the consist or brake system.

CSX train F777-03 originated at Cayce, SC. Its prior designation had been Q211-01. CSX train Q211-01 departed Louisville, KY, destined for Cayce, SC. An FRA Class I air brake test was completed on February 1, 2018, at 10:30 a.m. The train consisted of the CSXT36 and CSXT130, 56 loads and weighed 4,181 tons and was 5,410 feet in length. Q211-01 arrived in Nashville, TN, on February 1, 2018 at 6:40 p.m., consist unchanged, and was re-crewed.

The train departed Nashville, TN the same day at 7:25 p.m. On February 2, 2018 at 4:55 a.m. The train arrived at Wauhatchie, TN. The Q211-01 consist changed to 61 loads, 7 Empties weighing 5,064 tons with a length of 6,201 feet. The train was re-crewed and departed Wauhatchie, TN on February 2, 2018 at 06:40 a.m. The 12 cars that were added received a Class I air brake test on February 2, 2018, at 3:30 a.m. The train arrived at Cartersville, GA on February 2, 2018 at 11:41 a.m. and departed the same day at 1:02 p.m. with a consist change of 64 loads and 21 empties with 5891 tons and 7,182 feet. The only test required was a train crew inspection no documentation was found in the wreckage to verify this was completed.

The train arrived at Howells Transfer (Atlanta), GA on February 2, 2018 at 5:08 p.m. The consist was changed to 106 loads and 7 empties with 9,856 tons and 9,381 feet and was re-crewed. The train received a Class I air brake test on the 26 cars that were picked up at 4:00 a.m. the same day. The train departed Howells Transfer, GA on February 2, 2018 at 7:20 p.m. On February 2, 2018 at 11:29 p.m. the train arrived at Lawrenceville, GA and the consist changed to 66 loads and 7 empties with 6,881 tons and 5,621 feet. The train departed Lawrenceville, GA on February 3, 2018 at 12:06 a.m. The train arrived Greenwood, SC on February 3, 2018 at 5:58 a.m. and the consist changed to 46 loads and 2 empties with 3,854 tons and 4,358 feet. The train was re-crewed and departed Greenwood, SC on February 3, 2018, at 8:01 a.m. Q211-01 arrived at Cayce, SC on February 3, 2018 at 12:54 p.m. with 46 loads and 2 empties with 3854 tons and 4,358 feet. The train was then made to the F777, two locomotives and 34 unloaded auto rack cars. The train crew had yet to complete the departure inspections for F777.



## Wreckage description

At approximately 2:27a.m on February 4<sup>th</sup>, 2018, Amtrak train 91 was travelling south in CSX territory approaching milepost S366.9 and the north end switch (T-21) of Silica storage track. The switch was lined to the siding and according to the preliminary data from the Amtrak locomotive event recorder, as the train approached the switch, the data indicate the Amtrak train sounded the horn, about one second later event recorder data showed the emergency brake handle was transitioned from release to handle off, then transitioned to emergency brake. Throttle was reduced from notch 8 down to 0. This series of transitions took about four seconds. Brake pipe pressure dropped from 110 psi to zero psi in about 3 seconds. One second later the data ends. The train proceeded approximately 700 feet through the siding before striking CSXT130 head-on.

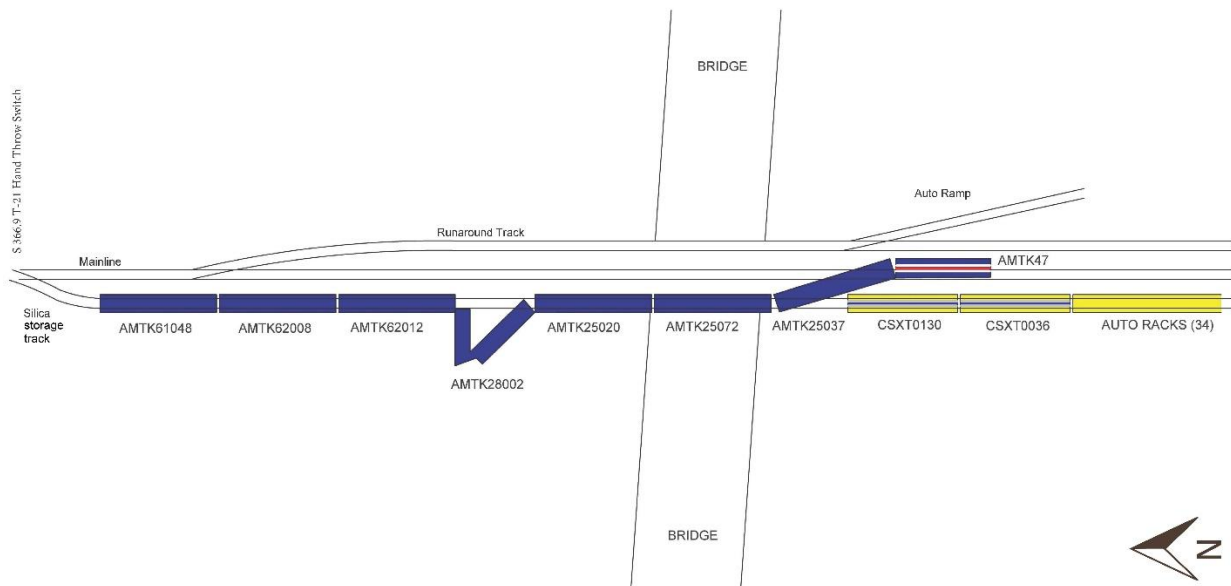


Figure 2-Illustration of the resting position of the trains.

Amtrak locomotive AMTK 47 was lifted above the CSX locomotive CSXT130 and towards the Amtrak locomotive's fireman's (conductor's) side. The lead truck and engineer's side of the cab were sheared off the Amtrak locomotive as it came to rest on its left side. The cab of CSX locomotive 130 was crushed and the CSX train was pushed backwards approximately 15 feet from the point of collision.

The Amtrak wreckage continued to decelerate for approximately 130 feet beyond the point of collision, shoving the lead coach car into the air as the Amtrak locomotive rolled left. The trucks of the first coach were broken off and came to rest under the car. The lead coach buckled slightly as it lodged into the rear of the Amtrak locomotive. The second coach remained upright but derailed and buckled. The third coach remained on the rail without significant damage.



Figure 3-Photograph showing first passenger coach.

The lounge car was forced off the Silica storage track and bent laterally, shearing open the left side of the car and crumpling the right side.



Figure 4-Photograph of the lounge coach.

The two sleepers following the lounge were derailed upright with minor damage and the baggage car's first truck came off the rail, coming to rest just inside the north end switch.

## **Equipment Post Accident Inspections**

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

On Monday February 5, 2018, investigators worked with CSX to separate CSXT36 from CSXT130 along with the 34 auto rack cars. Investigators arrived at the accident site, job safety briefed with CSX employees, and witnessed a Federal Railroad Administration (FRA) Class 1 airbrake test on the 34 empty auto racks and one locomotive (CSXT36). The test was completed with no defects. The brake pipe leakage was 1 psi.

Initial examination of locomotive CSXT130 occurred on the afternoon of Sunday Feb 4<sup>th</sup> weather conditions were cloudy with light rain. Photo documentation of the site was completed of the unit

at its resting point post emergency services and recovery of crew and the video recorder. The front of AMTK47 wreckage was pulled down and south to expose the locomotive event recorder.

Investigators inspection began on the morning of the 5<sup>th</sup>. Weather conditions were clear and sunny. The initial work was to pull apart the front of the locomotive to locate the engineer's operating console and brake valve controls. During this evolution the artifacts recovered included mostly paperwork items from both cabs of the AMTK47 and CSXT130. Photographs were also taken of various areas of interest. The next step was to pull the CSXT130 south to clear the area. The event recorder and documentation was then removed from the CSXT130. Once removed the AMTK 47 engineer's brake control valve was observed on the top of the CSXT130 fuel tank. Damage to the brake valve resulted in no conclusions to the status of the brake handles at the time of collision.



Figure 5. AMTK 47 brake control valve.

The inspection of AMTK 47 continued with the visual inspection for artifacts from the debris field of the area and the locomotive body. This included identification the major components of the truck assemblies. The damage was extreme, and no other inspections or tests were deemed possible

to provide any conclusive results. Area excavating continued by pulling the front quarter of the locomotive platform forward which had folded underneath the unit to expose what was trapped under this section. No significant findings were observed, and the locomotive was released to the wreck crew to remove to the nearby staging area.

To assess the wrecked Amtrak passenger cars, a preliminary assessment was conducted at the equipment's resting place at the accident location, followed with inspections after the equipment had been moved to the nearby staging area. Truck assemblies, wheels, brake systems, couplers, and car structure were all inspected to determine whether any damage or defects may have been present to contribute to the accident.

AMTK 25037 (coach) was first inspected in the air and found to have the A end truck and bolster detached from the carbody. The bolster had separated from both the truck and carbody and had taken the A-end right anchor arm and a section of the car's side sill with it. The car structure buckled upward, deforming the center sill, side sills, roof, and floor structure of the car approximately 25' from the A end of the car. Undercar equipment boxes were crushed as the car rode over its A-end truck assembly. There were no notable defects of the truck assemblies, wheels, brakes, couplers, or carbody that appeared to have been present prior to the crash.

AMTK 25072 (coach) was found to have the floor buckled in multiple places and some exterior damage. The trucks and wheels were damaged when the car derailed but there were no notable defects for the trucks, wheels, brakes, couplers, or carbody that appeared to have been present prior to the crash.

AMTK 28002 (lounge) was bent in half and sustained full separation of the left side sill, wall, and roof. The center sill of the car was significantly deformed but remained connected. The right-side sill was crushed at the interior of the bend. Both trucks derailed and had significant damage from the derailment but remained intact and connected to the carbody. The truck and carbody brake components all showed evidence of damage resulting from the derailment. Both couplers remained with the car and intact. There were no notable defects to any of those components that appeared to have been present prior to the crash.

Amtrak passenger coach AMTK 25020, both sleeper cars and the baggage coach were deemed repairable and moved to the north end of the nearby runaround track wherein Investigators performed inspections.

The following passenger equipment was repositioned onto the staging area: truck assemblies, wheels, brake system components, couplers, safety appliances and car structures. All equipment was inspected to determine whether any preexisting damage or defects may have contributed to the accident. The AMTK 25020 (coach) had damage to the B-End right-side side car body where

it had collided with AMTK 28002. AMTK 62012 (coach) had damage to the A-End left-side, BL and A-End right-side truck anchor fixture sheared from the side sill. (car body bolts sheared off).



Figure 6. AMTK 62012 Car body truck anchor fixture sheared from side sill (A-End right side).

The B-end coupler was broken off behind the horn and was replaced. The BL car body and vestibule was damaged where it collided with AMTK 28002. AMTK 62008 (coach) had damage to B-End left-side and A-End right-side anchor arms (car body bolts sheared off). AMTK 61048 (baggage car) front trucks had derailed but did not sustain significant damage. The passenger equipment received an AAR Class I brake test with zero brake pipe leakage prior to moving to Cayce Yard. All observations found on this passenger equipment were consistent with post collision damage.

Investigators observed all wheels on all equipment were full, had full flanges and normal wheel tread wear. All equipment showed no evidence of wheel flats, or flat marks on the wheel's tread. All undamaged brake rigging appeared normal and all brake pads and discs appeared to be within their tolerance.

## Records Review

During the on-scene phase of this investigation, investigators collected the daily and periodic from the locomotives involved in the collision and locomotive AMTK 665 which was the locomotive of train 91 at its point of origination in New York on February 3, 2018. 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.<sup>3</sup> 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 locomotives, AMTK 665, AMTK 47, CSXT130 and CSXT36. The records complied with the rule.

Periodic inspection requirements for locomotives 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. Investigators reviewed the periodic inspection records for the locomotives involved in this accident and train 91's originating locomotive (AMTK 665); AMTK 47, CSXT130 and CSXT36. The records complied with the rule.

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<sup>3</sup> *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.

## **Attachments**

Attachment 1 – Amtrak Passenger Train 91 FRA Class I Brake Test Records

Attachment 2 – AMTK 665 Locomotive Daily Inspection Records

Attachment 3 – AMTK 47 Daily Inspection Records

Attachment 4 – AMTK 47 FRA form F6180-49A Blue Card

Attachment 5 – CSX Train Q211-01 FRA Class I Brake Test Records

Attachment 6 – CSXT 0036 FRA form F6180-49A Blue Card

Attachment 7 – CSXT 0036 Daily Inspection Record

Attachment 8 – CSXT 0130 FRA form F6180-49A Blue Card

Attachment 9 – CSXT 0130 Daily Inspection Record

Attachment 10 – Train list F777, 34 Auto Rack Cars (Compiled by NTSB)