NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF RAILROAD, PIPELINE & HAZARDOUS MATERIALS INVESTIGATIONS WASHINGTON, D.C. 20594

RAILROAD SIGNAL & TRAIN CONTROL SIGNAL FACTUAL

DCA-15-MR-010

Train Derailment in Philadelphia, Pennsylvania

On the Amtrak Northeast Corridor

May 12, 2015

SIGNAL GROUP FACTUAL

Prepared by: Timothy J. DePaepe, Signal Group Chairman

1. ACCIDENT

LOCATION:	Philadelphia, Pennsylvania
TRAIN:	Eastbound Passenger Train 188
OPERATOR:	Amtrak
DATE:	May 12, 2015
TIME:	9:21 p.m.
NTSB #:	**DCA-15-MR-010**

2. SIGNAL & TRAIN CONTROL GROUP

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3. ACCIDENT SUMMARY

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

The parties to the investigation include Federal Railroad Administration (FRA), National Railroad Passenger Corporation (Amtrak), Philadelphia Police Department, Philadelphia Office of Emergency Services, Philadelphia Fire Department, Brotherhood of Locomotive Engineers (BLET), Sheet Metal Air Rail Transportation Union, (SMART), Brotherhood of Maintenance of Way Employees BMWED.

4. DETAILS OF THE INVESTIGATION

4.1 Description of Railroad Signal System

Shore Interlocking, MP 82.1 consists of 15 Union Switch and Signal M-3 power switch machines. There are a total of 10 PL-3 Signals.

All main tracks on the Northeast Corridor are equipped with Cab Signals and all trains operating on the NEC are equipped with Automatic Train Control (ATC) consisting of cab signals with speed control. The ATC system provides for train separation in compliance with

FRA Regulations 49 CFR Part 236. The cab signal system in the area of the derailment of train 188 consists of 4 cab signal aspects as follows:

NORAC Rule	Name	Indication	Speed Enforced
280	Clear	Proceed not exceeding Normal Speed (Normal Speed is Maximum Authorized Speed by Timetable)	Limited only by speed governor on locomotive
282	Approach Medium	Proceed approaching the next signal at Medium Speed	45 mph
285	Approach	Proceed prepared to stop at the next signal. Trains exceeding Medium Speed must begin reduction to Medium Speed.	30 mph
290	Restricting	Proceed at Restricted Speed	20 mph

Following an accident that occurred at Boston's Back Bay station on December 12, 1990, Amtrak and FRA reviewed all curves on the Northeast Corridor (NEC) where trains might reach overturning speed if the operator failed to reduce speed from Normal Speed as the train approached the restricted curve. There were 10 curves where this could possibly occur between Boston and Washington, DC. On each of these curves where the overturning speed of the curve was less than the Normal Speed approaching the curve, a cab signal change point was added to drop the cab signal from Clear to Approach Medium for a calculated period of time. The time was calculated such that a train traveling at Normal Speed would be forced to slow down to the curve speed or well below overturning speed before the cab signal was upgraded back to clear.

Using the criteria described above and agreed to by FRA and Amtrak, a cab signal downgrade was installed to slow westbound trains traveling from Holmes interlocking to Shore interlocking to enforce a speed reduction from the Normal Speed of 110 mph to the curve speed. Since Normal speed for trains traveling eastbound towards Shore interlocking was 80 mph, which was below overturning speed (98 mph) for the curves east of Shore, no cab signal code change was installed. The thinking at that time was that no train would be exceeding 80 mph and even if it continued at that speed, the train would be well under overturning speed. Amtrak is now in the process of reviewing what was done in 1991 and intends to modify the signal system such that trains traveling eastbound toward Shore interlocking will receive a cab signal downgrade to Approach Medium ensuring that their speed will be down to, or below, the timetable speed for the curves east of Shore before reaching them.

4.1A Positive Train Control

In 2000 Amtrak installed an overlay system to the ATC system known as ACSES, which stands for Advanced Civil Speed Enforcement System on portions of the Northeast Corridor. Specifically this overlay system was installed between Cove interlocking in Boston, MA and Mill River interlocking in New Haven, CT on the New England Division; between County interlocking and Ham interlocking in New Jersey and between Ragan interlocking and Prince interlocking in Delaware and Maryland. The system was installed with the startup of the Acela service under an "Order or Particular Applicability" from FRA as a condition for operating at speeds over 125 mph.

The ACSES system was designed to enforce speeds that could not easily be enforced by the ATC system such as permanent speed restrictions on curves, bridges, etc. and maximum authorized speeds as prescribed in the operating timetable. The system was also designed to enforce a positive stop at interlocking home signals and also enforce temporary speed restrictions via a data radio communication system.

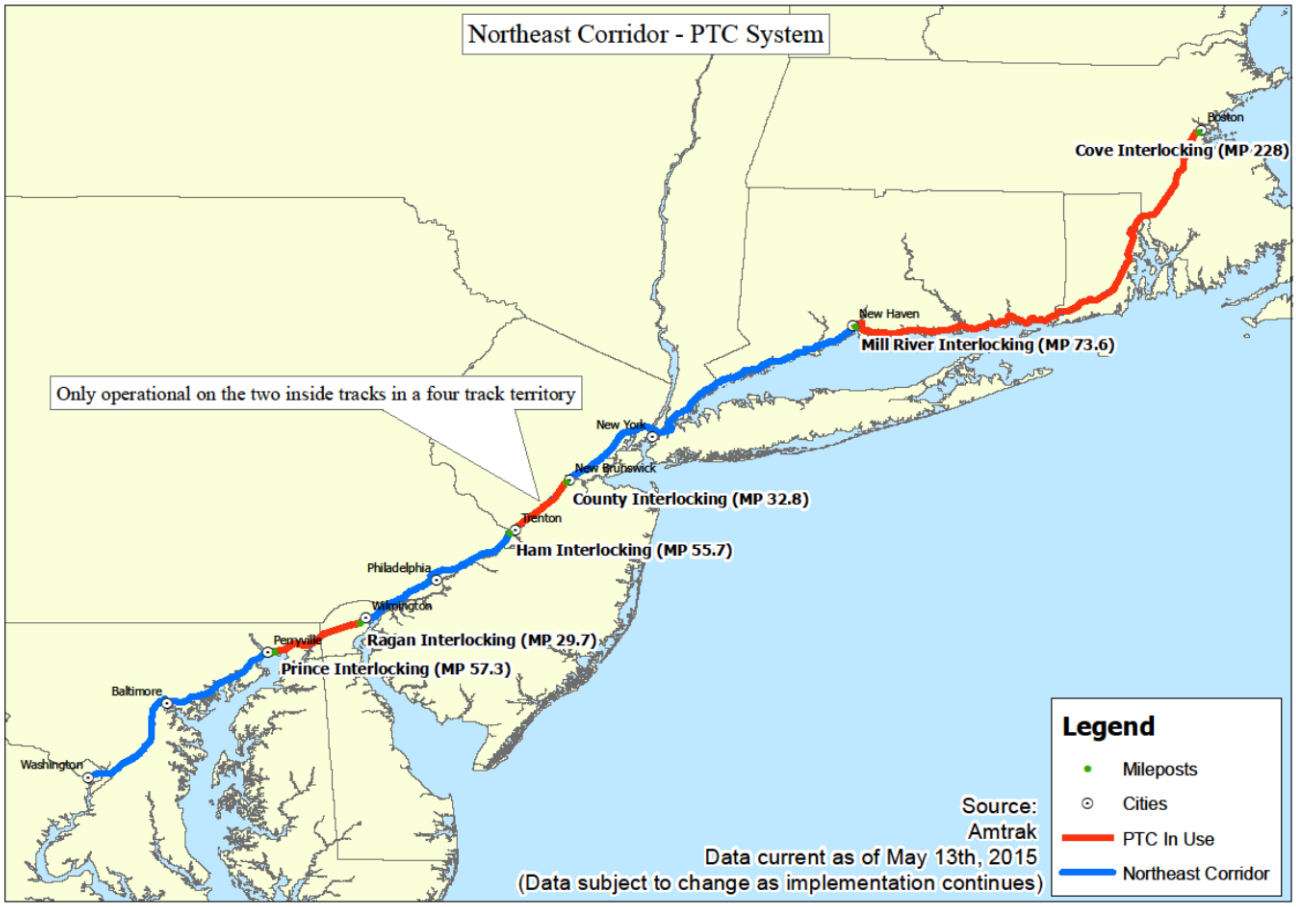

Figure 1. Northeast Corridor PTC In-Service Map

In 2010 FRA issued regulations for Positive Train Control systems in accordance with the Railroad Safety Improvement Act of 2008. FRA recognized ACSES as meeting the requirements of a PTC system. ACSES was the first PTC system to be certified by FRA. Since the time the first ACSES system was installed technology had changed and some of the components of the system had become obsolete. For these reasons, and the fact that the commuter railroads announced that they would be installing ACSES on their property, required Amtrak to update the system. Part of this update was to replace the obsolete unlicensed 900 MHz data radio system with a licensed, secure data radio system for better coverage, security and reliability.

Since 2010 Amtrak has made several attempts to secure radio spectrum in the 217-220 MHz band. Amtrak appealed to FCC to no avail. FCC insisted that Amtrak procure the spectrum on the secondary market and Amtrak was unable to do so until late last year and has only very recently secured licenses from FCC. Meanwhile most of the installation of the wayside

components (transponders, wayside interface units, radio towers and houses) has been completed. Large sections of the new territory are tested and ready for service except for the fact that the locomotive fleet is not yet equipped with the new data radios. Amtrak has installed new wayside data radios in parallel with the existing 900 MHz wayside radios so that conversion of the locomotive fleet to the new radio system can begin. Once the entire NEC locomotive fleet is equipped with the new radios, new sections of ACSES territory will be placed in service. The first section that will be placed in service is the section between Philadelphia and Washington, DC. This section has been fully installed and tested but cannot be placed in service until the locomotive fleet is fully equipped. This section will be followed by the Philadelphia to New York territory, then the Hellgate Line, Harrisburg Line, etc.

The locomotive radio conversions will begin as soon as all the material is received. This is expected to be within the next month. The conversions will take most of the summer and fall. Amtrak's mechanical department will provide a schedule once material delivery schedules are received. Amtrak expects to meet the current PTC deadline of Dec. 31, 2015 for ACSES on the NEC between Washington, DC and New Rochelle, NY and between Philadelphia and Harrisburg.

4.2 Data Logs

Data logs from the ARINC system were reviewed and partially reproduced below:

21:19:28.938D 05/12/15	SHORE	DETECTOR TRACK 2W1 INDICATION	OCCUPIED = CURRENT STATE
21:20:17.065D 05/12/15	SHORE	DETECTOR TRACK 2 INDICATION	OCCUPIED = CURRENT STATE
21:20:18.565D 05/12/15	SHORE	SIGNAL 2E CLEAR INDICATION	NOT_CLEAR = CURRENT STATE
21:20:31.503D 05/12/15	SHORE	DETECTOR TRACK 2W1 INDICATION	NOT_OCCUPIED = CURRENT STATE
21:20:33.003D 05/12/15	SHORE	DETECTOR TRACK 2E1 INDICATION	OCCUPIED = CURRENT STATE
21:20:42.316D 05/12/15	SHORE	DETECTOR TRACK 2 INDICATION	NOT_OCCUPIED = CURRENT STATE
21:20:43.253D 05/12/15	SHORE	32 SWITCH LOCKING RELAY INDICATION	NOT_LOCKED = CURRENT STATE
21:20:43.816D 05/12/15	SHORE	100 HZ POWER OFF ALARM	POWER_OFF100HZ = CURRENT STATE
21:20:43.816D 05/12/15	SHORE	100 HZ POWER OFF ALARM	POWER_OFF100HZ = CURRENT STATE
21:20:44.253D 05/12/15	SHORE	DETECTOR TRACK 1E2 INDICATION	OCCUPIED = CURRENT STATE
21:20:44.253D 05/12/15	SHORE	DETECTOR TRACK 2E2 INDICATION	OCCUPIED = CURRENT STATE
21:20:44.253D 05/12/15	SHORE	DETECTOR TRACK 3E1 INDICATION	OCCUPIED = CURRENT STATE
21:20:44.253D 05/12/15	SHORE	DETECTOR TRACK 3E2 INDICATION	OCCUPIED = CURRENT STATE
21:20:44.253D 05/12/15	SHORE	DETECTOR TRACK 4E1 INDICATION	OCCUPIED = CURRENT STATE
21:20:44.253D 05/12/15	SHORE	DETECTOR TRACK 4E2 INDICATION	OCCUPIED = CURRENT STATE
21:20:44.253D 05/12/15	SHORE	9W DRAGGING EQUIPMENT DETECTOR INDICATION	TRIPPED = CURRENT STATE
21:20:44.253D 05/12/15	SHORE	9W DRAGGING EQUIPMENT DETECTOR INDICATION	TRIPPED = CURRENT STATE
21:20:44.972D 05/12/15	SHORE	DETECTOR TRACK S1 INDICATION	OCCUPIED = CURRENT STATE
21:20:44.972D 05/12/15	SHORE	DETECTOR TRACK S2 INDICATION	OCCUPIED = CURRENT STATE
21:20:46.003D 05/12/15	SHORE	SIGNAL 1E CLEAR INDICATION	NOT_CLEAR = CURRENT STATE
21:20:46.503D 05/12/15	SHORE	DETECTOR TRACK 5 INDICATION	OCCUPIED = CURRENT STATE
21:20:46.503D 05/12/15	SHORE	DETECTOR TRACK 5W1 INDICATION	OCCUPIED = CURRENT STATE
21:20:46.503D 05/12/15	SHORE	DETECTOR TRACK 1E1 INDICATION	OCCUPIED = CURRENT STATE
21:20:46.566D 05/12/15	SHORE	DETECTOR TRACK 3 INDICATION	OCCUPIED = CURRENT STATE
21:20:46.628D 05/12/15	SHORE	DETECTOR TRACK 1 INDICATION	OCCUPIED = CURRENT STATE
21:20:46.628D 05/12/15	SHORE	DETECTOR TRACK 2 INDICATION	OCCUPIED = CURRENT STATE

A review of the data logs show that the Shore Interlocking 2E signal was requested by the dispatcher at 21:12:06 and went to "clear." At 21:20:18 Shore Interlocking 2E signal went to "not clear." The Signal Group Chairman reviewed the head end outward facing video of Train 188 and that video showed that the 2E signal at Shore was displaying a clear aspect the entire time it was in sight during the video.

4.3 Signal Maintenance Records

Amtrak signal maintenance reports were collected for the accident area at Shore Interlocking. The maintenance records were reviewed and indicate all signal tests and inspections were conducted in accordance with Amtrak protocols and FRA regulatory requirements.

4.4 Dispatcher Computer Screen Video

On May 15, 2015 signal group investigators received a copy of the Dispatcher computer screen video. The video revealed the following information points:

- At 21:18:01 Train 188 passes 2E signal at Clearfield Interlocking and occupies the 2T track circuit;
- At 21:20:18 Train 188 passes 2E signal at Shore Interlocking and occupies the 2T track circuit;
- At 21:20:33 Train 188 enters and occupies the 2E1T track circuit;
- At 21:20:42 Train 188 leaves the Shore Interlocking 2T track circuit;
- At 21:20:44 Track 4, 4E1T track circuit shows occupied; Track 3, 3E1T track circuit shows occupied; Track 1, 1ATR track circuit shows occupied; multiple alarms start showing up on the bottom of the dispatcher screen; and then all of the routes on the entire dispatcher board indicates red.

4.5 Post Accident Inspection/Testing Of Signal System

On May 14, 2015 representatives from the Federal Railroad Administration, Amtrak, and the NTSB began inspecting and testing the signal system. The post-accident inspection found all signal units and the signal cases at Shore Interlocking locked with no indications of tampering or vandalism to any of the signal equipment.

At Shore Interlocking ground readings were taken on all busses and were clear. All track circuits in the interlocking were .06 ohm shunted. All signals at Shore Interlocking were at stop when signal voltages were taken. The voltage readings were: 2W 9.0 volts; 3W 13 volts, 4W 13 volts, 9W 7.8 volts (led signal), 1W 6.8 volts (led signal), 1E 10 volts, 2E 8.8 volts, 3E 8.5 volts, 4E 8.8 volts, 5W 12.2 volts, 5E 9.4 volts.

Also switch obstruction, switch circuit controller and switch indication tests were performed on all switches, with no exceptions taken. Switch Correspondence tests were done on all crossovers, again no exceptions taken. Buss voltages were taken and found to be in the proper range.

Members of the signal group conducted signal indication locking, route locking, time locking, timer verification, traffic locking, verification of track circuits, inspection of insulated joints, testing of fouling circuits, and loss of shunt protection within and outside of Shore Interlocking. Ground readings were also completed at Shore Interlocking with no exceptions taken.

On May 12, 2015, the accident train, number 188, was routed eastbound, 2E to 2W signal on Track #2. This lineup produced a Clear Signal Aspect at the 2E Signal and a Clear Cab indication was displayed on the ADU in the locomotive proceeding through, and upon exiting Shore Interlocking. Investigators performed a reconstructive test of this train's movement to confirm Wayside and Cab Aspects the train should have received. In addition, the Switch Indication circuits for each switch in this route were opened to confirm that 2E Signal at Shore Interlocking went to stop as each circuit was opened. All tests found the Signal System working as intended and in compliance with required specifications.

Amtrak signal maintenance test and inspection records were collected. Examination of the signal data logs did not identify any condition that would prevent the signal system from operating as designed and intended.

4.6 FRA Emergency Order No. 31, Order No. 1.

On May 21, 2015, FRA issued Emergency Order No. 31, Order No. 1 in which they ordered Amtrak to implement code changes to its ATC System near the Frankford Junction curve in Philadelphia where the May 12 accident occurred in the timetable east (northbound) direction. The changes implemented must provide enforcement of the relevant passenger train speed limit of 50 mph for passenger trains approaching that curve. Amtrak has already completed actions to implement such changes.

Next, Amtrak must identify all other main track curves on the Northeast Corridor where there is a significant reduction (more than 20 mph) in the authorized passenger train approach speed upon the approach to those curves. After identifying such curves, Amtrak must develop and submit to FRA for review and approval an action plan to make appropriate code modifications to its existing ATC System or other signal systems to enable warning and enforcement of relevant passenger train speed restrictions. This requirement does not apply to portions of the Northeast Corridor where Amtrak's operations are governed by a Positive Train Control (PTC) system that is in use. To the extent that other railroads operate passenger trains at the same maximum authorized speeds as Amtrak in the curves affected by this Order, the modifications Amtrak makes to its ATC System or signal systems must also enforce the relevant speed restrictions for those trains.

If such code changes at identified curves will interfere with the timely implementation of PTC or are otherwise not viable, Amtrak must identify other actions it will take to ensure compliance with speed reductions (e.g., a procedure whereby a locomotive engineer and a second qualified employee communicate via radio ahead of relevant speed reductions, and where the second qualified employee may make an emergency brake application to slow the train if the locomotive engineer fails to do so). These alternative operational actions must be described in Amtrak's action plan submitted to FRA for approval. In addition, any alternative operational actions Amtrak adopts to ensure compliance with speed restrictions at identified curve locations on the Northeast Corridor also apply to passenger trains operated by other railroads at those curve locations.

In addition to the above requirements, Amtrak must also enhance speed restriction signage along its rights-of-way on the Northeast Corridor. Amtrak must identify in the action plan it submits to FRA the locations at which it intends to install such additional signage, and provide notice to FRA when such additional signage has been installed. Increasing the amount and frequency of signage provides a redundant means to remind engineers and conductors of the authorized speed, in addition to information they receive from the ATC System and operational documents such as timetable or bulletin.

4.7 Post Accident Actions by Amtrak to the Signal System

On May 16, 2015, in response to this accident, Amtrak signal personnel began making circuit changes which consisted of:

Revising the aspect from a clear signal to approach medium which resulted in a downgrade of the in-cab signal from the eastbound home signals to the distant approach signals at MP 83.4. This resulted in a 45 MPH maximum speed approaching Shore Interlocking.

In response to the May 21, 2015, FRA Emergency Order No. 31, Order No. 1 Amtrak has taken the following actions. Amtrak initiated a Northeast Corridor Curve Mitigation Plan addressing the issues raised in Emergency Order No. 31, Notice No. 1 concerning the treatment of curves on the Northeast Corridor following the derailment of train 188 on May 12, 2015. The following is a description of the planned mitigation for each curve identified in the survey previously submitted to FRA. Most of the mitigations involve code change points dropping the cab signal aspect from "clear" to "approach medium" which severely affects train performance in many cases. Amtrak proposed that once PTC is implemented, the code change points which create a negative impact on train performance will be removed since PTC will then be the mitigation against over-speed on the subject curves.

Boston to New Haven MP

This line is equipped with ACSES and all carriers are required to be equipped. Since the ACSES system enforces all speeds including curve speeds, Amtrak contends that no mitigations are necessary.

Mill River to Springfield MP 1.5 to 62.0

Curves 525, 526 and 527 (Hartford, CT) 20 mph with approach speeds of 80 mph both directions.

Mitigation:

Display Approach Medium on distant signals to Hart interlocking approaching from both directions with approach medium code to Hart interlocking.

Status:

Code changes were installed previously. Amtrak confirmed that the approach medium code is carried all the way to Hart interlocking from each direction. This is complete and in service.

Curves 541 and 542 (Curves on both sides of Connecticut River Bridge) 35 mph with approach speeds of 80 mph both directions.

Mitigation:

Northbound trains will receive an Advance Approach aspect on signal 48.4 with approach medium cab through the curve and across the bridge to signal 50.6. Southbound trains will receive approach medium cab at the cut section at MP 51.4. The clear aspect on signal 50.7 will be replaced with Advance Approach with approach medium cab. The approach medium cab will continue through the curve and across the bridge to cut section 49.1.

Status:
Complete and in service on 7/20/15

Milestones:
Complete design and issue changes to field – 06/30/2015
Complete changes in field and cut over – 07/20/2015

Curve 549 (Curve MP59.1 to 59.6) 45 mph with a northbound approach speed of 80 mph.

Mitigation:
Northbound trains will receive a code change from clear to approach medium at cut section 58.2 as they approach the curve.

Status:
Complete and in service on 7/20/15

Milestones:
Complete design and software changes and issue to field – 06/30/2015
Complete changes in field and cut over – 07/20/2015

Hellgate Line MP 5.1 to 18.8

Curve 230 which is a 40 mph curve with a maximum approach speed of 70 mph was the only curve identified in the survey however there are many curves on the line. The proposed mitigation for this line is to put ACSES transponders in service without the data radios. TSRs will not be enforced at this time but positive stop enforcement will be in effect. Once the locomotive fleet is outfitted with the new data radios, PTC will then be fully implemented. Amtrak will need FRA approval to do this.

Target completion – 15 days after receiving FRA approval. The ACSES Transponders are in service.

Empire Connection – Penn Station, NY to MNRR CP12

The first three curves north of MP 2 have a speed restriction of 25 mph. These curves begin right at MP 2. Trains approaching from Penn Station have an approach speed of 35 mph. Southbound trains approach the curves at 60 mph. Following the Back Bay accident approach medium code was applied in place of clear code between southbound signals 25-1 & -2 and CP Jervis (MP 1.5). This provides a forced speed reduction to well below overturning speed.

New York to Washington MP 0 to MP 88 (Track Chart Line AN)

Curves 252 & 253 (Curves east of Elmora interlocking) curve speed 55 mph.

Mitigation:
Approach Medium code change points were installed for both directions on all tracks following the Back Bay accident.

Status:

Complete and in service.

Curves 268 (curve west of Lincoln) 80 mph with approach speeds of 110 mph for trains in each direction on tracks 2 & 3.

Mitigation:

For westbound trains: Reduce code from clear to approach medium at MP 25.2, tracks 2&3. 2W/3W signals at Lincoln to display Approach Limited instead of Clear up to Signals on 2&3 tracks at Edison.

For eastbound Trains: Clear aspect on signals 288-3 & 2E at Edison reduced from Clear to Advance Approach with Approach Medium code and Signals 274-2 &-3 reduced from Clear to Approach Limited with AM code.

Milestones:

Design issued to field 06/08/2015

Completed changes in field and cut over 07/20/2015

Status:

Complete and in service on 7/20/15

Curves 290 &291 (between MP 74 & 75) 90 mph with approach speeds of 125 mph both directions on tracks 2 & 3.

Mitigation:

Westbound trains approaching curves at 125 mph are reduced from clear to approach medium code between MP72.5 and signals 735-2 & -3.

Eastbound trains approaching curves at 125 mph are reduced from clear to approach medium code between MP 76.5 to signals 754-2 & -3.

Status:

Completed and in service 6/03/2015

Curves 297 & 298 (Frankford Jct. curves) 50 mph with an approach speed of 110 mph for westbound trains and 80 mph for eastbound trains.

Mitigation:

An approach medium code change point was added for westbound trains on all tracks following the Back Bay accident. Following the derailment of train 188 the most favorable aspect for the eastbound distant signals to Shore interlocking was reduced to approach medium with approach medium code all the way to the eastbound home signals at Shore.

Status:

Complete and in service 05/17/2015

Curves 303.2 through 303.11 (Between Mantua and Penn Interlocking's in Philadelphia) 30 mph tracks 1 through 4 with an approach speed of 60 and 70 mph for westbound trains.

Mitigation:

Westbound signals on all 4 tracks at Mantua interlocking will be reduced from displaying clear to approach medium with approach medium code in track approaching these signals for all westbound trains.

Status:

Complete and in service on 7/11/15 & modified on 9/1/15

Milestones:

Plans issued to field 06/01/2015

Completed changes in field and cut over 07/11/2015 & modified on 9/1/15

Philadelphia to Washington MP0 to MP 134.6 (Track Chart Line AP)

Curves 305 and 306 (curves between Phil interlocking and South Penn) 70 mph with approach speed of 110 mph on tracks 2 & 3.

Mitigation:

Clear code is replaced with approach medium code between Phil interlocking and Signals 20-2 & 20-3. Signals 20-2 and 20-3 will display approach medium as their most favorable aspect.

Status:

Complete and in service on 7/12/15

Milestones:

Plans issued to field 06/01/2015

Complete changes in field and cut over 07/12/2015

Curve 327 (Curve north of Wilmington Station) 45 mph on track 3 and 40 mph on track 2 with an approach speed of 80 mph for southbound trains.

Mitigation:

Reduce clear aspects on signals 2S and 3S at Landlith interlocking to approach medium and clear code between Wine and Landlith reduced to approach medium code.

Status:

Changes complete and in service on 5/29/15

Curve 328 (Curve at MP 27 South of Wilmington Station) 40 mph on tracks 1 & 2 and 45 mph on track 3 with an approach speed of 120 mph.

Mitigation:

Approach medium code change points were installed following the Back Bay accident to slow northbound trains as they approached the curve leading to the Wilmington, DE station.

Status:

Complete and in service prior to 5/12/15

Curve 349 (First curve north of Grace interlocking) 95 mph with approach speed of 125 mph both directions.

Mitigation:

The overturning speed for this curve is 173.8 mph. The mitigation will be that all trains operating with cab signals will not be able to exceed 125 mph by virtue of the speed governor on the locomotive. Trains with failed cab signals are limited to 79 mph. All Amtrak trains operating on the NEC are equipped with ACSES and must have operative ACSES equipment before being dispatched. The ACSES system automatically enforces a maximum speed of 79 mph when the cab signal system is cut out even if the train is not in ACSES territory.

Curve 357 (First curve north of Gunpow interlocking) 100 mph on tracks 2 & 3 with an approach speed of 125 mph both directions.

Mitigation:

The overturning speed for this curve is 177.4 mph. The mitigation will be that all trains operating with cab signals will not be able to exceed 125 mph by virtue of the speed governor on the locomotive. Trains with failed cab signals are limited to 79 mph. All Amtrak trains operating on the NEC are equipped with ACSES and must have operative ACSES equipment before being dispatched. The ACSES system automatically enforces a maximum speed of 79 mph when the cab signal system is cut out even if the train is not in ACSES territory.

Curves 371 & 372 (Reverse curves at Bay interlocking) 60 mph with approach speed of 110 mph for southbound trains.

Mitigation:

Following the Back Bay accident approach medium code change points were installed for southbound trains.

Status:

Complete and in service.

Curve 382 and 381 (First curve north of Fredrick Road and first curve south of Bridge interlocking) 80 mph and 50 mph on tracks 2 & 3 with an approach speed of 110 mph for northbound trains.

Mitigation:

Northbound trains will receive approach medium code starting at the cut section south of signals 994-1, 994-2 and 994-3 (distant signals to Bridge interlocking). Signals 994-2 and 994-3 will display Approach Medium to the northbound home signals at Bridge interlocking.

Status:

Complete and in service on 6/30/15

Milestones:

Complete design to include first curve north of Fredrick Road 06/15/2015.

Complete changes in field and cut over 06/30/2015.

Approaching Washington Terminal the speed limit is 125 mph to MP 133 and 95 mph from MP 133 to CP Avenue. The speed for Washington Terminal is 20 mph or below.

Mitigation:

Following the Back Bay accident approach medium code change points were added to slow southbound trains as they approached New York Avenue.

Status:

Complete and in service.

Philadelphia to Harrisburg MP 0 to MP 104.6 (Track Chart Line AH)

Curve 624 (Curve east of Berwyn) 50 mph on tracks 2 & 3 with an approach speed of 80 mph both directions.

Mitigation:

Eastbound signals 178-2 and -3 will display Advance Approach instead of Clear as their most permissive aspect with approach medium code on the track to signals 162-2 &-3. Signal 163-3 will display Advance Approach instead of Clear for westbound trains with approach medium code on the track to signal 179-3. Track 2 is signaled for the eastbound direction only and no westbound adjustment will be necessary.

Status:

Complete and in service on 8/7/15.

Milestones:

Complete design and issue plans to field 07/02/2015.
Complete changes in field and cut over 08/07/2015.

Curves 638 & 639 (First and second curves west of signal 295) 60 mph on tracks 1 & 4 with approach speed of 90 mph. (This is 251 territory with track 1 signaled for eastbound trains and track 4 signaled for westbound trains)

Mitigation:

Eastbound track 1 – Approach medium code will be applied from Downs interlocking (MP 32.1) to signal 296-1.

Westbound track 4 – Signal 295-4 will display Advance Approach instead of Clear and approach medium code will be applied between signal 295-4 and Downs interlocking.

Status:

Complete and in service on 7/30/15.

Milestones:

Complete design and issue plans to field 07/21/2015.

Complete changes in field and cut over 07/30/2015.

Curve 657 (Curve west of MP 47) 80 mph with an approach speed of 110 mph.

Mitigation:

Eastbound signals 494-1 and 494-4 will display Cab Speed (flashing green) with 80 mph enforced by the ATC system to MP 47.5.

Westbound signals at Park interlocking will display Cab Speed with 80 mph enforced by the ATC system approaching the curve.

Status:

Scheduled for cutover on 9/18/15.

Milestones:

Issue changes to field 08/13/2015.

Completed changes in field and cutover.

Curves 661, 662 & 663 (Curves at Gap)55 mph with approaching speeds of 90 mph.

Mitigation:

Eastbound trains will receive approach medium code between MP 53 and MP 51.1.

Westbound trains will receive cab speed 80 code between MP 49.4 and 50.3 and approach medium code between MP50.3 and 52.0.

Status:

Scheduled for cutover on 9/17/15.

Milestones:

Issue changes to field 08/13/2015.

Complete changes in field and cut over.

Curves 671 & 672(Curves west of MP 60 and MP 61) 85 mph with an approach speed of 110 mph both directions.

Mitigation:

Eastbound trains will receive cab speed 80 code between MP 62.1 and 60.3.

Westbound trains will receive cab speed 80 code between MP 59.2 and 61.4.

Status:

Scheduled for cutover on 9/10/15

Milestones:

Issue changes to field 08/13/2015.

Complete changes in field and cut over.

Curve 701 (Curve west of Middletown) 80 mph with an approach speed of 110 mph.

Mitigation:

Eastbound signals 964-1 and 964-2 will display Cab Speed instead of Clear and trains will receive cab speed 80 code to the home signals at Roy interlocking.

Westbound trains will receive cab approach medium code approaching the westbound home signals at Roy interlocking which will display Approach Limited as their most favorable aspect. Westbound trains will then upgrade to cab speed 80 code between Roy and MP 95.3.

Status:

Scheduled for cutover on 9/19/15.

Milestones:

Issue changes to field 08/13/2015.

Complete changes in field and cut over.

4.8 Signal Damages

There was no damage to any signal equipment or appurtances. The Amtrak engineering personnel concluded that the total signal and switch damages was zero.

Signal Attachments

1. 82.9 Loc (4) 236.102A, 105, 106 Tests
2. 83.4 Loc (4) 236.102A, 105, 106 Tests
3. 188 Equipment 5-12-2015
4. Arnic Officer AIM Historical Shore Report
5. CETC Electrification Train Control Gerad-Holmes Even History 2100 HRS to 2125 HRS 5-12-2015
6. DED Loc West of Shore (4) 236.102A, 105, 106 Tests
7. Shore 98 SW Lock Relays (4) 236.102A, 105, 106 Tests
8. Shore Delair Relays (4) 236.102A, 105, 106 Tests
9. Shore Fouling Circuits and Shunt Wires (19) pre 236.104 Tests
10. Shore Ground Tests (18) pre 236.107.
11. Shore Insulating Rail Joints and Switch Insulation (27) pre 236.59
12. Shore Interlocking Control Lines Eastward
13. Shore Interlocking Scan Sheet
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42. Shore WBA Insulation Resistance (2) 236.108
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44. Shore WBB Insulation Resistance (2) 236.108
45. Shore WBB Relays (4) 236.102A, 105, 106
46. Signal Aspect Unit Identification
47. Dispatcher Screen Playback 2115 HRS 5-12-2015
48. FRA, NTSB and Amtrak Photographs. Seventy-four total photographs.

Party to the Investigation - Acknowledgment Signatures

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

_____ Date 9/21/15
Timothy J. DePaepe, NTSB /s/

_____ Date 9/21/15
Wayne Stafford, Amtrak /s/

_____ Date 9/21/15
Charles (Chuck) Sumoski, Federal Railroad Administration /s/