National Transportation Safety Board

Office of Railroad, Pipeline, and Hazardous Materials Investigations
Washington, D.C. 20594

IIC Factual Report

Accident No.:	DCA-12-FR-007
Location:	Barton County, Missouri
Date:	July 21, 2012
Time:	3:30 PM, Central Daylight Time (CDT)
Railroads:	Kansas City Southern Railway & BNSF Railway
Fatalities:	None
Injuries:	2
Type of Accident:	Side Collision

Synopsis

On July 21, 2012 at about 1530 hours CDT a Kansas City Southern Railway (KCS) freight train No. QSHKC20, consisting of 5 locomotives and 81 cars of mixed freight, collided with the side of BNSF Railway (BNSF) freight train No. EMHSEBM088 consisting of 2 locomotives (one was a Distributed Power Unit[1]) and 124 freight cars (all empty coal cars) at a railroad crossing at grade (diamond) near Arcadia, Kansas. The BNSF train was operating northbound[2] on the BNSF main track under signal indications of a traffic control system. It had previously received a diverging approach signal from the BNSF train dispatcher (located in Ft. Worth, TX), to proceed west through the crossing and into the controlled BNSF Arcadia siding. The BNSF train was estimated to be moving at a speed of 31 miles per hour at the time of

[1] Distributed Power Unit (DPU)– is a locomotive coupled to the rear of a train to provide additional tractive effort. The DPU is controlled by the locomotive engineer on the lead locomotive of the train.

[2] BNSF timetable direction is North, geographic direction is northwest

the collision. The KCS train was operating northbound[3] on the KCS main track of the Pittsburg Subdivision. The KCS train was operating under signal indications of a traffic control system. The KCS train had just recently changed train crews at Pittsburg, KS, located approximately 15 miles south of the location of the collision.

Figure No. 1 – Kansas City Southern locomotive No. 4667 derailed as a result of side collision with BNSF train near Arcadia, KS.

The KCS train approached the crossing at a recorded speed of 45 miles per hour. The collision occurred at milepost 114.6 of the Pittsburg Subdivision. The diamond is known as the BNSF / KCS crossing.

There were two KCS employee injuries as a result of the collision. Both KCS employees jumped from the lead locomotive prior to the collision. One employee was treated and released from the hospital. The second employee was kept in the hospital under observation, as a result of possible head injuries. The second employee was released from the hospital the following day.

Weather at the time of the accident was clear. The temperature was 92 degrees.

Derailed equipment included 5 locomotives and 5 cars on the head end of the KCS train.

[3] KCS timetable direction is North, geographic direction is north

15 cars of the BNSF train were derailed.

Total damages were estimated to be $7.75 million.

Figure No 2. – Overview of accident site. KCS train operating right to left. BNSF train operating from upper right to bottom left (arrow indicates north).

Accident Investigation

Accident Location

The accident occurred at railroad milepost 118.4 on the Fort Scott Subdivision of the BNSF, and at railroad milepost 114.6 on the KCS Pittsburg Subdivision.

Geographically the accident location is approximately 10 miles northwest of Pittsburg, KS, approximately 80 miles south of Kansas City, MO and 60 miles west of Springfield, MO. The accident location is less than one mile from the Kansas / Missouri state boundary, at a location where the KCS main line crosses briefly from the state of Missouri into Crawford County Kansas.

The sight of the accident is located in a lightly populated area and in an area with limited public road access.

BNSF / KCS Railroad Crossing

The BNSF and KCS track arrangement at the location of the derailment consists of a railroad crossing of 58 degrees. Rail at this location is 136 pound rail attached to wooden crossties with steel tie plates, secured by spikes and track clips. The rails of the actual are maintained by the KCS Railway. The sub-roadbed consists of crushed limestone. Water drainage ditches are located on all four sides of the track diamond.

BNSF / KCS Crossing (Interlocking Signals)

BNSF

The BNSF Fort Scott Subdivision runs in a timetable north / south direction. The Fort Scott Subdivision which is located on the Springfield Division begins at Kansas City, Missouri, mile post (MP) 0.0 and continues southward to Nichols, MO. MP 198.6. The accident occurred at Arcadia Interlocking, railroad crossing at grade, with the KCS located at MP 118.4. The BNSF track structure in the vicinity of the interlocking consists of a main track and passing siding converging within the limits of the absolute signals, just west of the crossing, and a single main track crossing the KCS continuing eastward to Springfield, Missouri. The maximum timetable speed approaching the interlocking is 45 mph.

The BNSF method of operation in the area of the accident is a traffic control system operated by BNSF dispatchers stationed in Ft. Worth, Texas. The railroad crossing is automatically[1] controlled by BNSF through their route and automatically controlled on the KCS route. BNSF signal equipment at the interlocking consists of color light type signals, a Union Switch and Signal (US&S) M23 dual controlled power-operated switch machine, and electronically controlled track circuits, each controlled through the use of a General Electric Transportation System (GETS) Vital Harmon Logic Controller (VHLC).

The operation of the railroad crossing is achieved by the BNSF dispatcher requesting a desired route through the railroad crossing. The route is stored and only executed once a BNSF train occupies the approach circuit. The approach circuits extend out from the crossing to the intermediate signal located at MP 120.2 on the south side and North Arcadia Controlled Point MP 116.9 on the north side.

[1] The BNSF timetable refers to the interlocking (railroad crossing) as automatic, however when the BNSF dispatcher lines a train into the BNSF controlled siding north of the railroad crossing, a red signal will be displayed in both directions for the KCS track.

KCS

The KCS Pittsburg Subdivision runs in a timetable north/south direction. The Pittsburg Subdivision which is on the Midwest Division begins at Pittsburg, Kansas, MP 128.2 and continues north to Kansas City, MO., MP 3.7. The KCS denotes the accident location as the Arcadia Automatic Interlocking located at MP 114.6. The KCS track structure in the vicinity of the interlocking consists of a single main track. The maximum timetable speed on the Subdivision is 55 mph, with a permanent 40 mph speed restriction through the interlocking.

The KCS method of operation on the Pittsburg Subdivision is a traffic control system controlled by the KCS dispatchers stationed in Kansas City, MO. The Arcadia railroad crossing is automatically controlled on the KCS route. The KCS signal equipment at the railroad crossing consists of searchlight type home[4] signals, electronically controlled track circuits, and a relay based control system. The signal equipment at North Mulberry (NB approach signal), consists of color light type signals, electronically controlled track circuits, General Railway Signal (GRS) Model 5H dual controlled power-operated switch machine, each controlled through the use of a GETS Electro-Logic controller.

The operation of the railroad crossing is achieved when a KCS train occupies the approach circuit. The approach circuits extend to MP 117.61 on the south side and MP 111.71 on the north side. Once a train enters the approach circuit, the route is lined for their movement if no conflicting routes have been established.

Train Crews

The BNSF train crew was called at Springfield, MO at 11:25 AM. The crew consisted of a locomotive engineer and conductor. The crew was instructed to operate their train from Springfield, MO to Fort Scott, Kansas, where it would be handed over to another BNSF train crew. The BNSF train departed Springfield at about 12:45 PM.

The KCS train crew was called at Pittsburg, KS, at 1:40 PM. The train crew consisted of a locomotive engineer and conductor. The crew was instructed to operate their train from Pittsburg, KS to Kansas City, MO, where the train terminated. The KCS train departed Pittsburg at about 3:10 PM.

[4] Home signal – refers to the last signal before the crossing

Equipment

Struck Train – BNSF EMHSEBM088

The BNSF train had two locomotive units; one on the head end and one on the rear. The rear unit was designated a distributed power unit, located on the rear of the train, controlled from the lead locomotive unit. There were 124 empty cars in the train, consisting entirely of empty coal cars, and the train weighed 3086 tons. The combined cars in the train were 6750 feet in length, and the total length, with locomotive units was 6971 feet. BNSF records indicate that the train had a speed restriction of 55 miles per hour. Table 1 provides information on the locomotives.

Table 1: EMHSEBM088 locomotive information

Locomotive Unit	Position	Model	Horsepower
BNSF 9797	Lead	SD70MAC	4000
BNSF 6187	DPU	ES44AC	4400

Striking Train – KCS QSHKC20

The KCS train had five locomotive units; all five were located on the head end of the train. The third and fifth locomotives were not operating, and were shut down. There were 81 cars of mixed freight on the train. This included 61 loaded cars and 20 empty cars, weighing 8024 tons. The combined cars were 6645 feet in length, and the total length, with locomotive units was 7012 feet. There were 5 loaded and 13 empty, properly placarded Hazardous Materials cars in the train. The train was equipped with an operating End-of-Train device, number KCS 957868. Hazardous Materials cars were located throughout the train starting with the 23rd car. KCS records indicate that there were no restrictions to the handling of the train.

Table 2: QSHKC20 locomotive information

Locomotive Unit	Position	Model	Horsepower
KCS 4667	Lead	ES44AC	4400
KCS 3913	Second Unit	SD70MAC	4000
KCS 4581	Third Unit	AC4400	0
KCS 4580	Fourth Unit	AC4400	4400
TFM 1609	Fifth Unit	SD70MAC	0

Mechanical Inspection

Both trains had proper air brake test documentation.

A Federal Railroad Administration mechanical inspector examined both the damaged and undamaged locomotives and cars on both trains. On the BNSF train, both locomotives were inspected for current daily and 92 day inspection records (no exceptions were noted). Air brake tests were also conducted on the undamaged BNSF locomotives and cars (no exceptions were noted in the operation of the air brake system).

All locomotives were damaged on the KCS train. All KCS locomotives were inspected for current daily, 92 day inspection and recent repair records (no exceptions were noted).The undamaged freight cars of the KCS train were fully examined. Air brake tests were also conducted on the undamaged KCS freight cars (no exceptions were noted in the operation of the air brake system).

Operating Rules in Effect

KCS

Train operations on this portion of the KCS were governed and authorized by a traffic control system signal and indications under the control of a KCS train dispatcher located Kansas City, MO. The train dispatchers at the KCS Control Center set routes at each control point that establish the priorities for, and control, train movements. Typically, intermediate signals are positioned between control points that govern the use of discrete signal blocks. At the accident site there was a railroad crossing at grade with the BNSF railroad. The home signal for the KCS at the railroad crossing is automatically controlled by the railroad crossing signal system. The railroad crossing checks automatically for the presence of a BNSF train near the interlocking. If no BNSF train is detected, a proceed signal is given to the approaching KCS train.

The crews were governed by the General Code of Operating Rules (GCOR), Sixth Edition, effective April 7, 2010. The territory was designated the KCS Pittsburg Subdivision, Midwest Division. At the time of the accident, the current timetable was System Timetable No. 9, effective November 1, 2010.

BNSF

Train operations on this portion of the BNSF were governed and authorized by traffic control system signal indications under the control of a train dispatcher located at the Network Operations Center (NOC) in Fort Worth, Texas. Train dispatchers at the NOC set routes at each control point that establish the priorities for, and control, train movements. Typically, intermediate signals are positioned between control points that govern the use of discrete signal blocks. At the accident site there is a railroad crossing (diamond) with the KCS railroad and an adjacent control point north of the crossing that allows access to the south end of the BNSF Arcadia siding.

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Train crews were governed by the General Code of Operating Rules (GCOR), Sixth Edition, effective April 7, 2010. The territory was designated the BNSF Springfield Division, Fort Scott Subdivision. At the time of the accident, the current timetable was Springfield Division Timetable No. 7, effective July 22, 2009.

Time Line of KCS Train Progression to Accident Location

The following data points document the progression of the KCS train leaving Pittsburg, KS and its progress to the accident location. The data was determined from the locomotive download of the event recorder of the lead KCS locomotive as well as, signal system data logs.

Table 3: QSHKC20 time progression

Time	Milepost	Signal	Signal Indication
1510 Hours	126.8	Dispatcher controlled signal, N. Pittsburg	Train passes Green Clear Signal indication
1518 Hours	124.7	Automatic Signal, MP124.7	Train passes Green Clear Signal indication
1523 Hours	120.6	Automatic Signal, MP 120.6	Train passes Green Clear Signal Indication
1525 Hours	118.4	Dispatcher controlled	Train passes Flashing Yellow
		Signal, S. Mulberry	Medium Approach Signal Indication

1528 Hours	116	Dispatcher controlled Signal, N. Mulberry	Train passes Yellow Approach Signal Indication
1529 Hours	114.7	Arcadia X-ing Interlocking Automatic Signal	Train passes Red Stop Signal

Sleep / Wake / Work History

Based on personnel records and interviews with investigators, the sleep/wake/work histories of the crewmembers involved in the accident were gathered. The information for the engineer and conductor of the KCS train are included in the tables (below).

Table 3: QSHKC20 Engineer Sleep / Wake / Work History

DATE	TIME	ACTIVITIES OF THE KCS ENGINEER
7/13/2012	0130 - 0725 hours	On duty / Operate train
7/14	0300 - 1030 hours	On duty / Operate train
7/15-7/17	N/A	Off duty
7/18	1520 – 2340 hours	On duty / Operate train
7/19-7/20	2200 – 0752 hours	On duty / Operate train to Pittsburg
7/20	0800 hours	Arrive home
7/20	0900 -1200 hours	3-hour nap
	1200 -2300 hours	Spent the day at home
7/20	2300 hours	Went to bed and fell asleep quickly
7/21	0900 hours	Awoke
	0900 - 1210 hours	Remained at home
7/21	1210 hours	Received call from KCS to report for duty in 90 minutes
	1300 hours (approx.)	Departed house for train yard in Pittsburg
7/21	1340 – 1530 hours	On duty in Pittsburg - accident

Additional information: The KCS engineer's drive time from his residence to his

home terminal was about five minutes. His normal call time before going on duty was 90 minutes. He normally slept between six and seven hours (the amount he needed to feel rested). He indicated that if he did not work (e.g., if he were on vacation) he would sleep

from about 2200 to 0400 or 0500 hours. He did not normally take naps unless he was very tired. He told investigators that prior to the accident he his quality of rest was "excellent" and he felt "very alert."

Table 4: QSHKC20 Conductor Sleep / Wake / Work History

DATE	TIME	ACTIVITIES OF THE KCS CONDUCTOR
7/12	0930 - 1950 hours	On duty
7/13	09:30 – 18:30 hours	On duty
7/14	N/A	Off duty
7/15	0830 - 1411 hours	On duty
7/16	1100 - 2115 hours	On duty
7/17	N/A	Off duty
7/18	12:01 – 20:30 hours	On duty
7/18–7/19	2300 - 0625 hours	Sleep
7/19-7/20	1600 - 0310 hours	On duty
7/20	0400 - 0900 hours	Sleep
7/20	Day	Off duty
7/20	2300 - 0630 hours	Sleep
7/21	1340 - 1530 hours	On duty in Pittsburg - accident

Additional information: The KCS conductor's drive time from his residence to his home terminal was about 40 minutes. His normal call time before going on duty was 90 minutes. He normally went to bed at 2300 hours. He typically slept between 6 and 7 hours. He told investigators that prior to the accident his quality of rest was "excellent" and he felt "very alert."

BNSF train crew

The BNSF engineer was not able to provide investigators a detailed work/rest routine of his activities 72 hours before the accident. He told investigators that he normally went to bed about 2230 hours, and slept between 7-8 hours. He occasionally took naps that lasted 1-1 ½ hours, although he did not nap prior to going on duty. He indicated that his quality of rest prior to the accident was excellent and he felt "very alert." On the day of the accident he had been notified of his assignment about 0955 hours. His commute time from his residence to the train yard was about 20 minutes. On the day of the accident he went on duty at 1125 hours.

The BNSF conductor also was not able to provide details of his work/rest routine 72 hours before the accident. On the day of the accident he went on duty at 1125 hours.

Medical Factors

KCS train crew

The KCS engineer passed his last physical in July 2010. He wore prescriptive glasses for reading. He indicated that his overall health was good. Occasionally he took oxycodone[2] for back pain. He took Prilosec[3] daily for heartburn. He had not been diagnosed with any sleep disorders. As a result of him jumping from the train moments before the accident, he was sent to the hospital for treatment. He suffered broken ribs, a broken collar bone, and a gash on his head that required staples. He was treated and released from the hospital that same day.

The KCS conductor passed his last physical in April 2012. He had no operating restrictions based on his vision or hearing. He wore corrective glasses for reading, and had some hearing loss. He had no chronic medical conditions, and had not been taking any prescription or non-prescription medications prior to the accident. He regularly took multivitamins. He snored on occasion, but had never been diagnosed with any sleep disorders.

BNSF train crew

The BNSF engineer told investigators that his overall health was good, although he had some chronic pain due to an automobile accident years earlier. He passed his last physical

in 2009. He has not been diagnosed with any sleep disorders. Prior to the accident he indicated that he felt very alert.

The BNSF conductor told investigators that he was in "pretty good" health, although he had some chronic pains from a non-work accident years earlier. He took a prescription medication (for digestion purposes) as a result of that prior accident, as well as Imodium (non-prescription) 2-4 times per day. He wore corrective lenses for distance vision. He had not been diagnosed for a sleep disorder, and indicated that he slept well. He told investigators that he felt very alert prior to the accident.

Post-Accident Toxicological Tests

In accordance with federal regulations, following the accident all four crewmembers from both trains involved in the accident provided blood and urine specimens for post-accident toxicological testing. The KCS engineer provided a blood specimen at 2249 hours, and a urine specimen at 2319 hours at a hospital in Joplin, Missouri. The KCS conductor provided a blood specimen at 2009 hours and a urine specimen at 2030 hours at a facility in Pittsburg, KS. The results were negative for illicit drugs and alcohol for all four crewmembers involved in the accident.

Operational Factors

Hired dates / Disciplinary Actions

The KCS engineer was hired on April 17, 1995 and worked as a conductor for two years. He later became a certified engineer and had been working in that capacity for about 14 years. He had operated over the accident territory for about 16 years. He worked a regular assignment.

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[2] Oxycodone is an opioid narcotic pain reliever similar to morphine. An opioid is sometimes called a narcotic. It is used to treat moderate to severe pain.

[3] Prilosec (omeprazole) belongs to a group of drugs called proton pump inhibitors. Omeprazole decreases the amount of acid produced in the stomach. It is used to treat symptoms of gastroesophageal reflux disease (GERD) and other conditions caused by excess stomach acid. It is also used to promote healing of erosive esophagitis (damage to your esophagus caused by stomach acid).

The KCS conductor was hired on August 28, 1995. Prior to that he had worked in the railroad industry for 19 years in various capacities. He was involved in a previous accident/incident in January 2012. While working as a conductor, his train proceeded past a stop signal in a Kansas City train yard. He was disciplined by the railroad and returned to service in April 2012.

The BNSF engineer's seniority date is June 2, 1998, and he had been a certified engineer for 9 years. He had been off work for over a year while recovering from a non work-related injury.

The BNSF conductor's seniority date is March 22, 1973. He had been operating as a conductor for 39 years.

Crew Interviews

BNSF Train

Based on the train crew interview, the BNSF train crew was called at Springfield, Missouri at 1125 hours. The crew consisted of a locomotive engineer and a conductor. They were instructed to operate their train from Springfield to Fort Scott, Kansas, where it would be handed over to another BNSF train crew.

The BNSF train departed Springfield at about 1245 hours. Their trip had been uneventful and the workload was normal. Minutes before the accident the engineer was operating the train just under the 45 mph speed restriction for that area. The crew observed the approach signal to the south end of Arcadia[4] displaying double yellow (approach diverging). This indicated that the crew would be taking the siding at Arcadia. The crew continued to operate their train around a curve and then more tangent track where they observed the signal at the railroad crossing (diverging approach).

The engineer slowed the train to about 35 mph and the train began to enter the siding near the location of the interlocking signal. The train was about two car lengths into the siding when the crew felt a "jerking" motion. Soon after the train went into emergency. The engineer then activated the toggle switch to activate the two-way end of train (EOT) device. Moments later the train had stopped. The conductor called out "Emergency" and identified his location using his radio. The engineer hit 911 on the radio and received a very quick response from the train dispatcher. The crew then identified the other train involved in the accident as a KCS freight train. Both BNSF crewmembers left their train to find and provide assistance to the KCS crewmembers.

[4] Arcadia is the name of the BNSF siding located just west of the KCS railroad crossing.

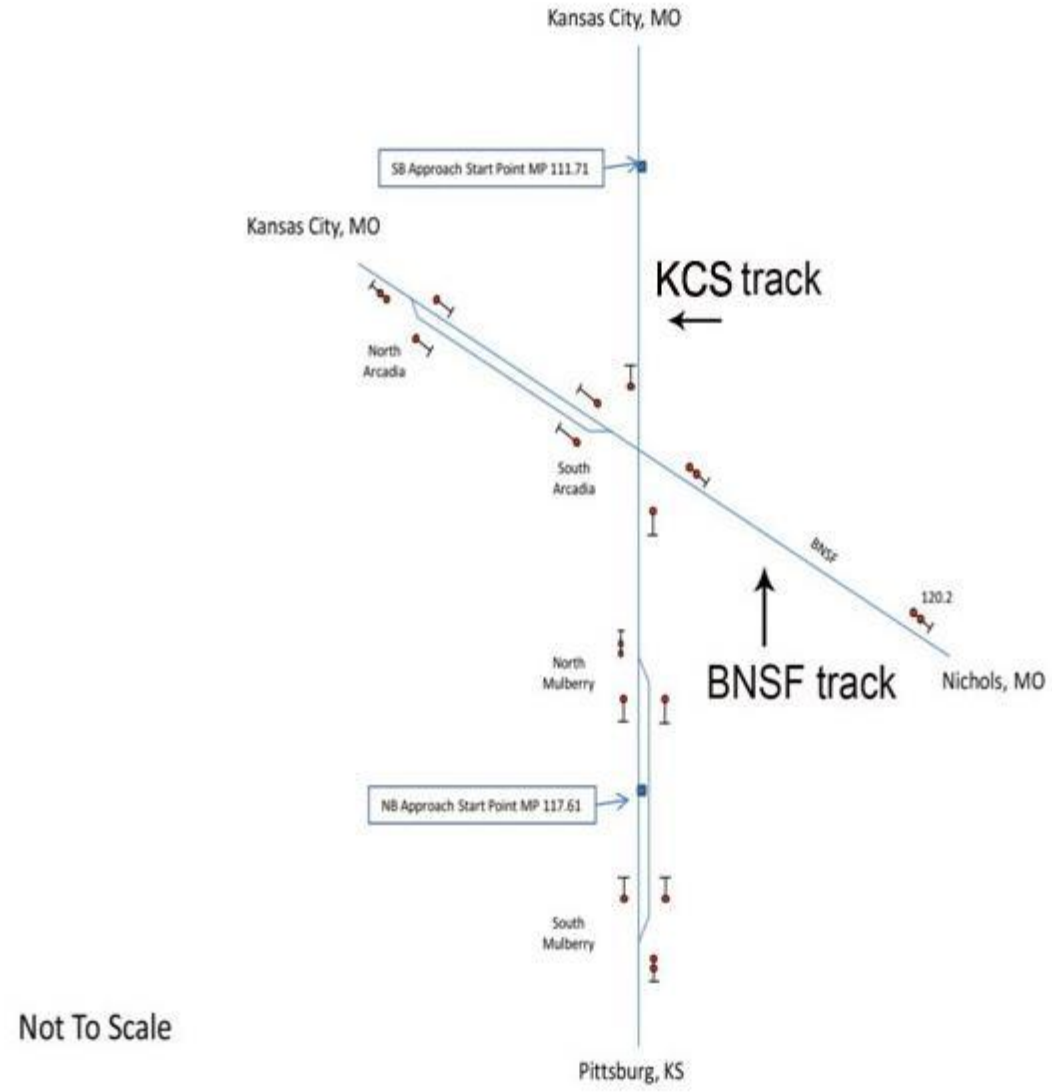


Figure No 3. *This diagram identifies several signals on both the KCS and BNSF tracks leading up to the interlocking. (The diagram was developed by investigators from the Signal Group).*

KCS Train

Based on interviews with the locomotive engineer and conductor of the KCS train, they went on duty at 1340 hours at the yard in Pittsburg, Kansas. They had to wait about 80 minutes for the train they would be operating to arrive at the train yard.

The KCS crew departed the yard about 1510 hours and headed north.[5] Shortly thereafter, the KCS train dispatcher communicated to the crew via radio that they would probably meet a train in Hume (about 55 miles from Pittsburg). The maximum authorized speed for their train was 55 mph.

Early in the trip the conductor first realized that the operating compartment radio did not have a microphone. (The conductor told investigators that without a microphone one cannot call out signals over the radio). The crew later operated past a defect detector at milepost 124.9, and no problems were reported with the train.

The KCS train arrived at South Mulberry and received a medium approach signal (displaying a flashing yellow aspect). The crew continued to operate their train to North Mulberry. Both crewmembers told investigators that they each observed a clear (green) signal indication at North Mulberry. (Post accident testing indicated that the signal at North Mulberry was an Approach signal displaying a yellow aspect).

After passing the signal at North Mulberry the train traveled around a slight curve. According to the conductor, at a distance of approximately 25 car-lengths, (being approximately 1500 feet) he observed a red signal at the crossing "Home" signal, the last signal before the railroad crossing. The engineer told investigators that he observed the red signal at a distance of 40 to 45 car-lengths (being approximately 2000 to 2250 feet) immediately afterwards, the crew saw the BNSF train entering and crossing over the railroad crossing. The crew told investigators that the engineer immediately applied emergency braking.

The crew then made the decision to evacuate the operating compartment and jump off the train. The engineer went out the back door, followed by the conductor. Each crewmember went to the back of the locomotive and down the steps and jumped from the bottom step. Both jumped off the train about 70 to 80 feet before the collision. Both crewmembers were injured after they jumped. The engineer was sent to the hospital for treatment. He suffered broken ribs, a broken collar bone, and a gash on his head that required staples. The conductor also hit his head and sustained other minor injuries. He was transported by ambulance to a hospital in Pittsburg where he was treated and released the next day.

[5]There were six signals between the train yard in Pittsburg and the railroad crossing where the accident occurred.

Figure 4. *This photograph was taken by the KCS freight train's outward facing camera positioned on the lead locomotive. The railroad crossing Home signal can be seen ahead of the train on the right side of the tracks. The KCS train is likely less than 10 seconds before impact with the BNSF train, which is now traversing the railroad crossing. It is estimated that this was the point where the KCS crew jumped from the lead locomotive.*

Workload

The engineers and the conductors of both the KCS and the BNSF freight trains told investigators that their overall workload during the accident trip was normal and routine. None of the crewmembers reported seeing any environmental factor (e.g., fog, haze, or rain) that would adversely affected their vision of the signals. The crew told investigators that the sun was "beating on" the Home signal at the interlocking. Neither crewmember indicated that the sun was a factor on their visibility of the signal at North Mulberry.

Personal Electronic Devices

Cell phone records of the crewmembers involved in the accident were acquired and reviewed. The records show no calls or text messages were sent or received by crewmembers of either train during the time when each train was being operated.

Radio Communications

The lead locomotive of the KCS train (KCS 4667) was equipped with a working radio, departing Pittsburg, KS. However, upon departing Pittsburg, the KCS crew discovered that the hand set that was normally located on the conductor's side of the locomotive cab, was missing[8].

The KCS train crew had no radio communications with other KCS employees at Pittsburg after departing the Pittsburg Yard. The KCS engineer stated that he called out each signal indication on the radio, however, no radio recordings were made by the KCS until approximately 1522 hours.

At approximately 1522 hours the KCS train dispatcher, located in Kansas City, MO, issued a radio relayed, speed restriction, to the conductor of the KCS train. The speed restriction was for a 40 mph speed restriction, at a location beyond the accident (located between milepost 92.8 and 93.0). This radio transmission was initiated at about milepost 121.5. Based on a review of the radio recording made of the KCS train dispatcher, the conductor correctly repeated the restriction back to the KCS train dispatcher at approximately1523 hours. This radio conversation between the KCS train dispatcher and the KCS train crew was the only radio transmission recorded prior to the accident. Following the repeat of the speed restriction, the KCS train dispatcher did not communicate further with the KCS train crew.

Sight Distance Test

A sight distance test (signal sight distance) was performed on July 25, 2012 under similar weather conditions to those, on the day of the accident, clear sky, with a temperature in the upper 90's. All distances were made using the footage counter on the locomotives used.

The same signal aspects that were displayed the day of the incident were used. These were verified using the signal records obtained after the incident. Parties to the investigation boarded the locomotives at the interlocking.

As described below, a color light signal is of the "traffic light" design utilizing multiple vertical bulbs to provide the desired aspect, whereas a searchlight signal uses a single bulb with multiple movable color lenses to display the desired aspect.

BNSF supplied the locomotive (BNSF 9797), an EMD SD70MAC, that was on the train the day of the incident for the tests. KCS supplied locomotive (KCS 4788) a GE ES44AC, of the same type and class as the locomotive involved.

[8] The lead KCS locomotive (KCS 4667) was normally equipped with 2 hand sets, one on the engineer's side of the cab, and one on the conductor's side of the cab.

BNSF Results

The BNSF locomotive used, was backed up east to Iantha, MO (the first control point east of the interlocking). It then proceeded west until the approach signal to the interlocking located at milepost 120.2, became visible.

This signal is a right hand, double head, color light signal. There were no overgrown vegetation issues associated with this signal. It clearly displayed a yellow on the top head and a yellow on the bottom head. It was clearly visible to all those in the cab. The sight distance to the signal was 3924 feet at 13:41 CDT.

The locomotive then proceeded west until the reaching the Home signal at the South Arcadia Interlocking (KCS railroad crossing) located at milepost 118.3 became visible. The signal is a right hand, double head, color light signal. There is no overgrown vegetation issues associated with this signal. It clearly displayed a red on the top aspect and a yellow on the bottom aspect. It was clearly visible to all those in the cab. The sight distance to the signal was 4643 feet at 13:57 CDT. The distance from the signal to the KCS main track is 98 feet.

KCS Results

The locomotive was backed up to the approach signal to South Mulberry, located at M.P. 120.6. This is a single head, color light, left hand signal. There were no overgrown vegetation issues associated with this signal. It displayed a green aspect, clearly visible to all those in the cab. Neither the visibility of this signal, nor its aspect, was in question, so the sight distance to it was not measured.

The locomotive proceeded north until the signal at South Mulberry became visible. This signal is located around a 1degree, 0 minute, right hand curve, with trees on both sides as well as an overhead highway bridge in the area. These conditions limit the sight distance to this signal. This is a right hand, double head, color light signal. The sight distance was measured for both the conductor seated on the left side of the cab and the engineer seated on the right side. The distance for the conductor was measured at 1365 feet and 1335 feet for the engineer. The signal was clearly visible at these distances to all present. The signal displayed a flashing yellow on the top head and a solid red on the bottom. This was observed at 16:40 CDT.

Mulberry is a controlled siding extending 12,331 feet (per timetable) in length. Both the main track and siding are tangent for the entire distance. The Northbound signal for the siding was constantly lit up for comparison with the main track signal. This is also a right hand, color light signal. This signal was clearly visible to all in the cab, as soon as the signal at South Mulberry was passed. It showed a solid red aspect.

Once passing South Mulberry, the locomotive then proceeded North on tangent track toward the signal located at North Mulberry. This is a left hand, single head, color light signal. There is no overgrown vegetation issues associated with this signal. There are approximately 12,500 feet between the northbound signals at each end of Mulberry. The Northbound signal is approach lit, meaning that a train must enter a track circuit in advance of the signal for it to light up. This signal became clearly visible to all in the cab at a distance of 9,010 feet displaying a solid yellow aspect. While the locomotive was stopped at this location, the signal supervisor manually manipulated this signal to show a green signal which was also clearly visible to all. The signal for the siding remained a solid red aspect during this time.

The locomotive then proceeded north until the home signal for the interlocking became visible. This signal is located around a 1 degree 30 minute left hand curve and is a single head searchlight type signal. There is no overgrown vegetation issues associated with this signal. The distance traveled between the signal at North Mulberry and when this signal came into view was 4143 feet for the engineer and 5255 feet for the conductor. This resulted in a sight distance to the home signal of 3144 feet for the engineer and 1939 feet for the conductor. The signal displayed a solid red aspect and was clearly visible to all at these distances. This was at 1704 hours CDT. The distance between the home signal and the BNSF mainline is 177 feet.

As this test was being performed, a Westbound BNSF train entered the railroad crossing and was visible from a distance of approximately 3000 feet.

Table 5: The cumulative results of the sight-distance test.

Signal	**Indication or Aspect**	**Distance Aspect was Identified**	**Time of Day Observed**
South Mulberry	Medium Approach (Flashing Yellow)	Engineer: 1365 feet Conductor: 1335 feet	1640 hours
North Mulberry	Approach (Yellow)	Engineer: 9010 feet Conductor: 9010 feet	1649 hours
Home (@ Interlocking)	Red	Engineer's side: 3144 feet Conductor's side: 1939 feet	1705 hours

Locomotive Event Recorder

KCS lead locomotive 4667 was equipped with a working event recorder. Data from the lead locomotive was downloaded at the accident scene.

The data showed that the person operating the lead locomotive manipulated the locomotive controls consistent with proper KCS train handling departing Pittsburg, KS. The locomotive operator also used the locomotive horn several times, for public highway rail grade crossings after departing Pittsburg.

In brief, the locomotive event recorder data from KCS 4667 indicated the following:

- At 15:28:24 CDT, the bell and horn both transitioned from "Off" to "On". At this time, the electronic air brake-equalizing reservoir pressure (EAB ER) and the electronic air brake-brake pressure (EAB BP) were 88 psi, the speed was 51 mph, and the throttle position was T2. During the next 18 seconds until 15:28:42 CDT, the horn transitioned from "Off" to "On" a few more times.
- At 15:28:35 CDT, the throttle position transitioned to T1 while the EAB ER, EAB BP, and speed remained unchanged.
- At 15:28:42 CDT, both the bell and horn transitioned "Off" and remained "Off" for the remainder of the event. At this time, the speed decreased slightly to 50 mph.
- At 15:29:25 CDT, the EAB ER and EAB BP reduced to 84 psi and 86 psi, respectively and the speed decreased to 46.
- At 15:29:26 CDT, the engineer induced emergency (EIE) and the emergency brake transitioned from "Off" to "On" and remained "On" for the rest of the event. Also at this time, the EAB ER and EAB BP decreased to 78 psi and 84 psi, respectively, and the throttle positioned transitioned to Idle and remained Idle for the rest of the event. The speed remained at 46 mph.
- At 15:29:27 CDT, the PCS transitioned to "Open" and remained "Open" for the rest of the event. Additionally, the EAB ER and EAB BP decreased to 53 psi and 18 psi, respectively, and the speed remained at 46 mph.
- At 15:29:28 CDT, the EAB ER decreased to 32 psi and EAB BP decreased to 0 psi and remained at 0 psi for the rest of the event. At this time, the speed decreased to 45 mph.
- At 15:29:33 CDT, the EAB ER decreased to 0 psi and the speed decreased to 42 mph.
- Twenty three seconds later at 15:29:56 CDT, the speed decreased to 0 mph.

In brief, the locomotive event recorder data from BNSF 9797 indicated the following:

- At 15:27:49 CDT, the bell and horn both transitioned from “Off” to “On”. At this time, the EAB BP was 90 psi, the speed was 39 mph, and the throttle position was T6. During the next 21 seconds until 15:28:10 CDT, the horn transitioned from “Off” to “On” a few more times.
- At 15:28:10 CDT, both the bell and horn transitioned “Off” and remained “Off” for the remainder of the event.
- From 15:29:05 CDT to 15:29:44 CDT, the throttle position changed from T6 to T1 and the speed to 34 mph.
- At 15:29:49 CDT, the EAB BP decreased to 47 psi and the speed decreased to 29 mph.
- At 15:29:50 CDT, the EAB BP decreased to 5 psi, throttle position transitioned to HI and remained at HI for the rest of the event, and the speed decreased to 26 mph.
- At 15:29:51 CDT, the PCS transitioned to “Open” and remained “Open” for the rest of the event. At this time, the EAB BP decreased to 0 psi and the speed decreased to 23 mph.
- At 15:29:52 CDT, the EIE transitioned to “On” and remained “On” for the rest of the event and the speed decreased to 20 mph.
- At 15:29:58 CDT, the speed decreased to 0 mph.

Lead Locomotive Forward Facing Video Recorder

The lead KCS locomotive, number KCS 4667, was equipped with a working forward facing video recorder. The following images are still photos taken from the KCS 4667 forward facing video recorder approaching the accident sight.

At 15:25:17 CDT, the locomotive approached the start of the double track at South Mulberry, receiving a flashing yellow signal, as shown in figure 5.

Figure 5. KCS 4667 approaching South Mulberry.

At 15:25:24 CDT, the locomotive was on the west track of the double track between South Mulberry and North Mulberry, as shown in figure 6.

Figure 6. KCS 4667 between South Mulberry and North Mulberry.

At 15:28:00 CDT, the locomotive approached the end of the double track near North Mulberry, receiving a steady yellow signal, as shown in figure 7.

Figure 7. KCS 4667 near North Mulberry.

At 15:29:32 CDT, the BNSF train first came into view of the locomotive, as shown in figure 8.

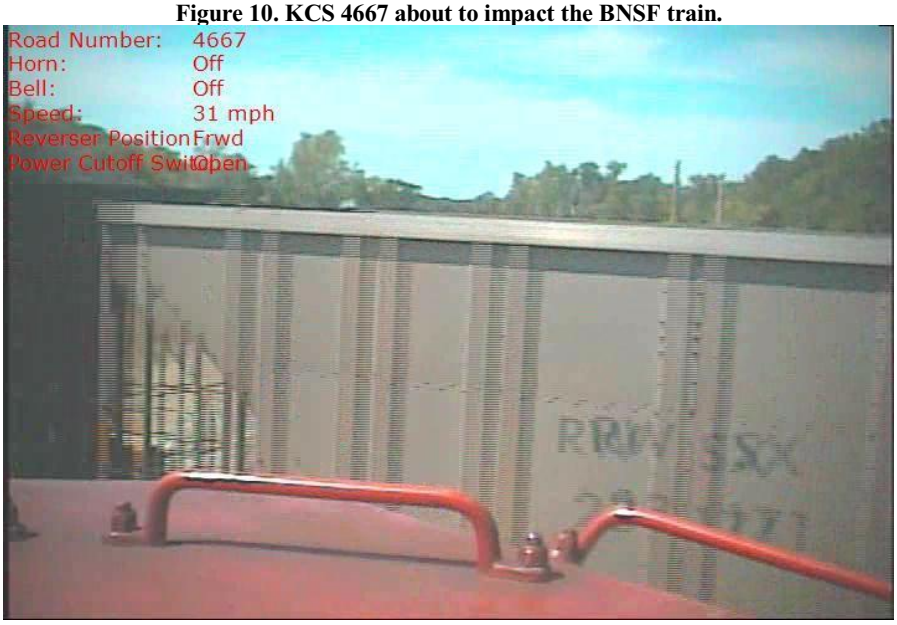
Figure 8. KCS 4667 with BNSF 9797 first in view.

At 15:29:44 CDT, the locomotive passed the signal just prior to the collision.

Figure 9. KCS 4667 passing signal before collision.

At 15:29:48 CDT, the locomotive was just about to strike the BNSF train. The car passing in front of the locomotive was labeled "RW SX 23 171," as shown in figure 10.

Figure 10. KCS 4667 about to impact the BNSF train.



After the collision, at 15:31:36 CDT, the dust had cleared enough to regain forward visibility. The stationary train image is shown in figure 11.

Figure 11. View from KCS 4667 recorder after collision.

Emergency Response

Immediately after the accident, the BNSF train crew called in the occurrence of the derailment to the BNSF train dispatcher located in Fort Worth, TX via radio. It took several minutes for the dust to clear at the accident sight, before it was determined that a KCS train was involved in the accident. Upon being informed of the collision, the BNSF train dispatcher then notified the KCS train dispatcher located in Kansas City, MO. The KCS train dispatching office immediately upon being notified of the accident began to notify local responders.

The BNSF train crew, as well as railroad signal contractors who were working close to the accident site, attended to the injured KCS train crew.

Multiple surrounding emergency response units responded to the accident. Initial access to the accident site was along a railroad access road, which ran parallel to the KCS track. Additional road access was later granted by a land owner with a private road near the

accident site.

Both KCS train crew members were transported to medical facilities in Pittsburg, KS for treatment of their injuries.

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