Collision of Two Burlington Northern Santa Fe Freight Trains Near Clarendon, Texas May 28, 2002

Railroad Accident Report

NTSB/RAR-03/01

PB2003-916301
Notation 7558

National Transportation Safety Board
Washington, D.C.

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National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2003. ***Collision of Two Burlington Northern Santa Fe Freight Trains Near Clarendon, Texas May 28, 2002.*** **Railroad Accident Report NTSB/RAR-03/01. Washington, DC.**

Abstract: At 8:57 a.m., central daylight time, on May 28, 2002, an eastbound Burlington Northern Santa Fe (BNSF) coal train collided head on with a westbound BNSF intermodal train near Clarendon, Texas. Both trains had a crew of two, and all crewmembers jumped from their trains before the impact. The conductor and engineer of the coal train were critically injured. The conductor of the intermodal train received minor injuries; the engineer of the intermodal train was fatally injured. The collision resulted in a subsequent fire that damaged or destroyed several of the locomotives and other railroad equipment. Damages exceeded $8 million.

As a result of its investigation of this accident, the Safety Board identified the following safety issues: the use of cell phones by railroad operating crews; the issuance to moving trains of track warrant authority that contains an "after-arrival" stipulation; and the lack of positive train control.

As a result of its investigation of this accident, the National Transportation Safety Board makes recommendations to the Federal Railroad Administration and the General Code of Operating Rules Committee.

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Executive Summary

At 8:57 a.m., central daylight time, on May 28, 2002, an eastbound Burlington Northern Santa Fe (BNSF) coal train collided head on with a westbound BNSF intermodal train near Clarendon, Texas. Both trains had a crew of two, and all crewmembers jumped from their trains before the impact. The conductor and engineer of the coal train were critically injured. The conductor of the intermodal train received minor injuries; the engineer of the intermodal train was fatally injured. The collision resulted in a subsequent fire that damaged or destroyed several of the locomotives and other railroad equipment. Damages exceeded $8 million.

The National Transportation Safety Board determines that the probable cause of the May 28, 2002, collision at Clarendon, Texas, was (1) the coal train engineer's use of a cell phone during the time he should have been attending to the requirements of the track warrant his train was operating under and (2) the unexplained failure of the conductor to ensure that the engineer complied with the track warrant restrictions. Contributing to the accident was the absence of a positive train control system that would have automatically stopped the coal train before it exceeded its authorized limits.

As a result of its investigation of this accident, the Safety Board identified the following safety issues:

- The use of cell phones by railroad operating crews;
- The issuance to moving trains of track warrant authority that contains an "after-arrival" stipulation; and
- The lack of positive train control.

As a result of its investigation of this accident, the National Transportation Safety Board makes recommendations to the Federal Railroad Administration and the General Code of Operating Rules Committee.

Factual Information

Accident Synopsis

At 8:57 a.m., central daylight time, on May 28, 2002, an eastbound Burlington Northern Santa Fe (BNSF) coal train collided head on with a westbound BNSF intermodal train near Clarendon, Texas. (See figure 1.) Both trains had a crew of two, and all crewmembers jumped from their trains before the impact. The conductor and engineer of the coal train received critical injuries. The conductor of the intermodal train received minor injuries; the engineer of the intermodal train was fatally injured. The collision resulted in a subsequent fire that damaged or destroyed several of the locomotives and other railroad equipment. Damages exceeded $8 million.

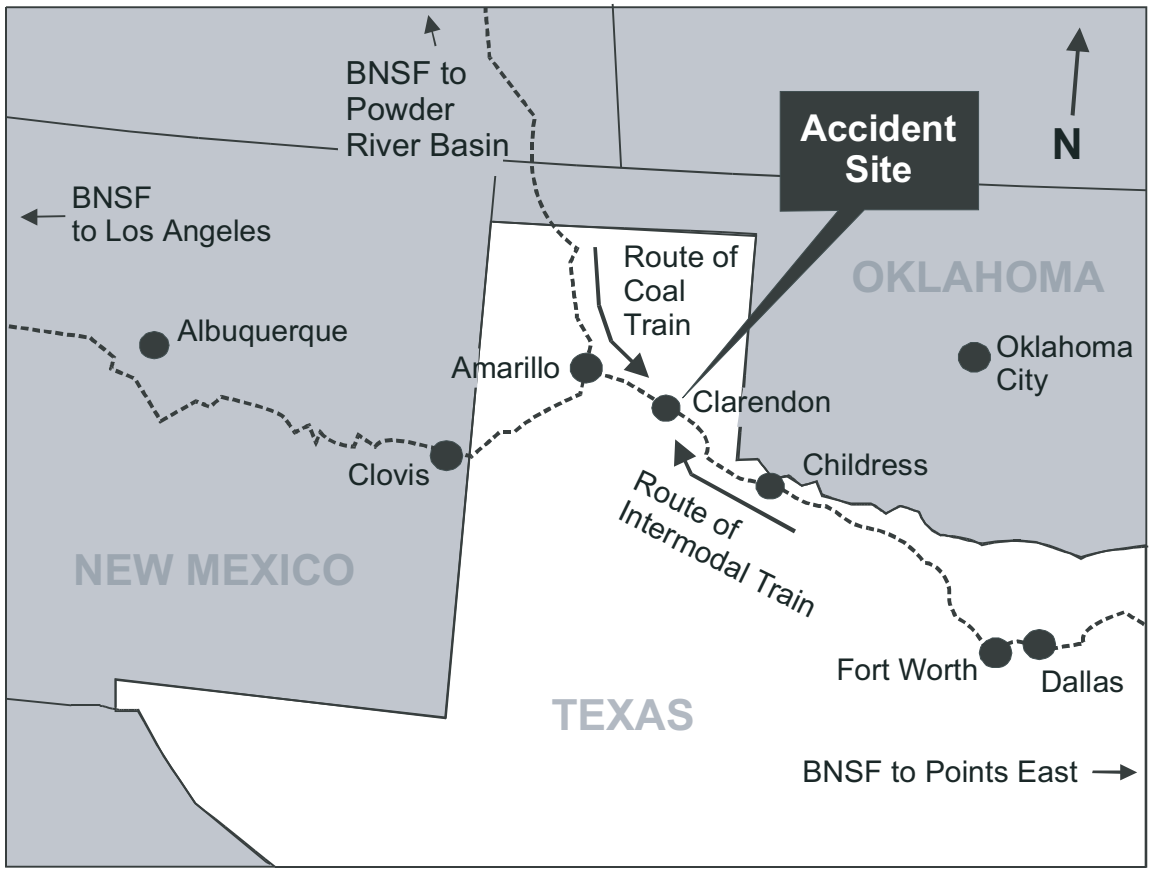

Figure 1. Accident location.

Accident Narrative

Preaccident Events

The engineer and conductor of the intermodal train[1] went on duty at 6:45 a.m. in Childress, Texas, about 60 miles east of the accident location.[2] The engineer and conductor of the coal train went on duty at 6:00 a.m. in Amarillo, Texas, about 55 miles west of the accident location.

The coal train, with 116 cars of coal and headed by lead locomotive BNSF 8876,[3] departed Amarillo at 7:40 a.m. The train operated eastward, entering track warrant control (TWC)[4] territory several miles east of the yard area. Track warrant records indicate that the coal train received a track warrant to enter TWC territory at 7:47 a.m. The crew's first track warrant was quickly followed by a second track warrant, which was issued[5] to the coal train at 7:49 a.m. The second track warrant was an "after-arrival" warrant, which stipulated that the coal train was to wait at Malden Siding for the arrival of a specified train before proceeding beyond that point. As was common BNSF practice when heavy coal trains were to meet other, lighter, trains on this portion of the railroad, the coal train was to remain on the main track while the lighter train was diverted onto the siding. The coal train met the opposing westbound train at Malden Siding, as required. The meet took place from about 8:30 until 8:35, after which, in accordance with its track warrant, the coal train proceeded toward the east end of Ashtola Siding.

Meanwhile, the westbound intermodal train (Engine BNSF 4385 West) was granted track warrant authority at 8:26 a.m. This track warrant was also an after-arrival warrant. The train was to proceed to Hedley Siding (see figure 2) where it was to await the arrival of Engine UP 5827 East. Once that train had passed on the adjacent track, the intermodal train's track warrant authorized it to move on the main track from Hedley Siding to Ashtola Siding. At Ashtola, the intermodal train was to divert onto the siding to allow the coal train to pass on the main track. As instructed by the track warrant, the intermodal train waited for the passage of Engine UP 5827 East, after which the requirement of the track warrant was complete, and the intermodal train began moving westward toward Ashtola.

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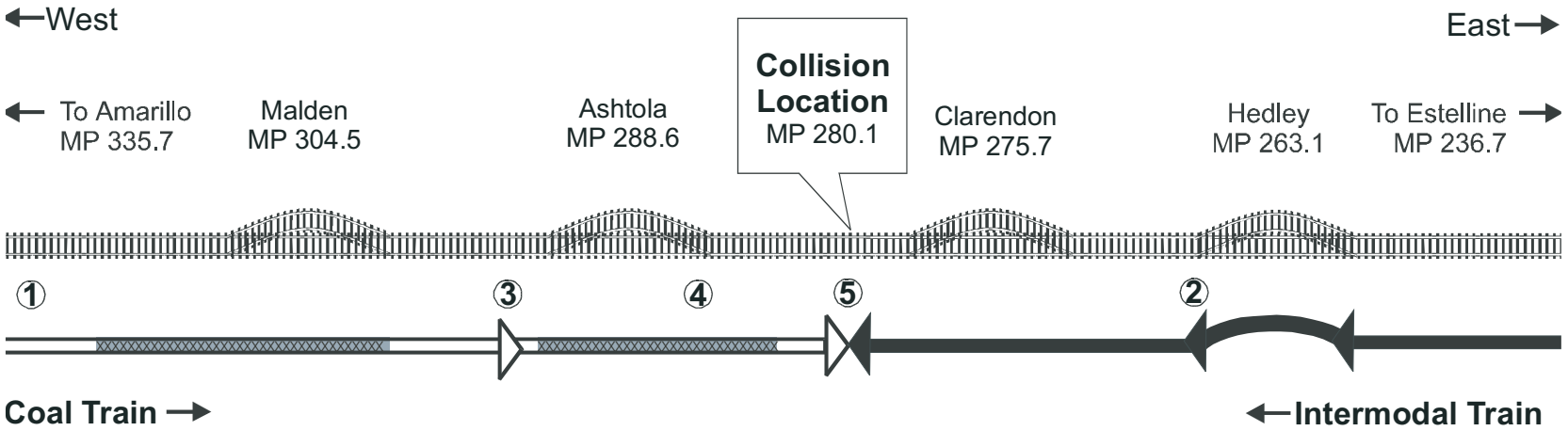
[1] *Intermodal* trains have rail cars that are designed to handle piggyback trailers or containers.

[2] See appendix B for a complete time line of accident events.

[3] The *General Code of Operating Rules* uses the identification of the lead locomotive to formally identify a train for the purpose of issuing authority to occupy main tracks. The train identification also includes the train's direction. Thus, the official identification of the coal train on track warrants (see note below) was "Engine BNSF 8876 East."

[4] In *track warrant territory*, train dispatchers control train movements by issuing track warrants, which authorize trains to occupy the section or sections of track covered by the warrant. (See the "Method of Operation" section of this report for more information.)

[5] All of the train dispatcher's communications of track warrants to the coal train were radioed to the conductor who, as required by operating rules, confirmed the information by reading back the warrant to the dispatcher.



Time Of Events

① 07:49 - Coal train authorized by Track Warrant 16 to the east switch at Ashtola.
② 08:35 - Intermodal Train departed Hedley Siding with Track Warrant 19 authorizing it to operate to Ashtola Siding and to enter the siding at the east switch.
③ 08:43 - Coal Train authorized by Track Warrant 22 to proceed from Ashtola to Hedley, with the stipulation that the authorization was not in effect until after the arrival of the Intermodal Train at Ashtola Siding.
④ 08:47 - Coal Train passed the east switch at Ashtola Siding without stoping.
⑤ 08:57 - Collision occurred.

Cell Phone Use XXXXX

Schematic view only-Not to scale

Figure 2. Operational diagram.

As the coal train neared Ashtola, at 8:43 a.m., the final track warrant, Track Warrant 22, was issued. This was also an after-arrival track warrant that covered the coal train's movement between Ashtola Siding and Hedley Siding, about 25 miles away. This track warrant specified that the coal train was to hold short of the east end of Ashtola Siding until the arrival in the siding of Engine BNSF 4385 West (the intermodal train). The track warrant would become effective at that point. A review of the audiotapes of the dispatcher's radio communications confirmed the content of the track warrant, which the conductor read back accurately to the dispatcher, including the stipulation that the track warrant was not in effect until after the arrival of Engine BNSF 4385 West at Ashtola. At the time this warrant was issued, the coal train was approximately 3.2 miles from the point at which it was to stop and wait and was traveling, according to event recorder data, about 48 mph.

The Collision

The investigation revealed that about the time the final track warrant was radioed to the coal train and read back by the conductor, the coal train engineer placed a call on his cell phone. The engineer was still on this call several minutes later as his train passed the east end of Ashtola Siding. The train should have stopped at this point to await the arrival of the intermodal train, in accordance with the train's track warrant. Event recorder data indicated that the train was traveling about 48 mph at that time.

Most of the BNSF Red River Valley Subdivision, where this accident occurred, is tangent track on modest cuts and fills through undulating territory. In many places, the visibility along tangent stretches of track can be measured in miles. There are curves, however, one of which is a 1°7' left-hand curve[6] about 8 miles past the east end of the siding where the coal train should have stopped. After the coal train had traveled for about 9 1/2 minutes after passing the east end of the siding, the train's conductor saw and alerted the engineer to the oncoming train as the intermodal train rounded the curve ahead. The engineer stated that he exited the rear door of the locomotive, followed by the conductor, and that he jumped from the rear steps. The conductor and engineer of the intermodal train also exited their locomotive and jumped from the walkway.

Event recorder information indicates that both trains' brakes were placed in emergency before the collision. At the time the coal train was placed in emergency, it was moving at 49 mph. The intermodal train was placed in emergency as it was moving at 42 mph with the throttle in the 8th notch (maximum power). An engineering survey commissioned by the BNSF indicates that the coal train went into emergency 1,093 feet before the collision point and that the intermodal train went into emergency 1,064 feet before the collision point. At the point of the collision, the coal train had traveled for almost 10 minutes and about 7.8 miles from the point where it should have waited for the arrival of the intermodal train. (See figures 3 and 4.)

[6] This was a right-hand curve when viewed from the coal train.

Figure 3. Wreckage of coal train.

Figure 4. Wreckage of intermodal train.

Emergency Response

A witness who lived directly across from the point of the collision stated that she called 911 on her cell phone and that the 911 operator was apparently not aware of the accident. She noted that the time was 8:57. She said that a few minutes after the collision, she saw an "engineer guy"[7] walking around and that he said that he was on the train that was going toward Amarillo. The individual appeared to be in shock, and he had been calling for someone else; the witness said she thought that he was probably calling for another crewmember.

Records indicate that the first emergency call to Clarendon emergency medical services was placed at 8:57 a.m. and that the first rescue workers reached the scene at 9:03 a.m. Another ambulance was called at 9:03 and was on scene at 9:06. The engineer of the intermodal train was found dead at the scene. All of the injured employees were taken to Northwest Texas Healthcare System, a hospital in Amarillo. Lifestar, a medical helicopter based at Northwest Texas Healthcare System, was used to transport the conductor of the coal train. The engineer of the coal train and the conductor of the intermodal train were transported by ambulance a short time later.

The Clarendon Fire Department is staffed by 37 volunteers. The assistant chief of the Clarendon Fire Department indicated that multiple 911 calls and other non-911 calls alerted firefighters to the accident. The first call to the fire department was at 8:59 a.m. The first two fire department units to arrive were on scene at 9:05 and 9:06 a.m. The assistant chief stated that the fire was large and was concentrated in the area of fuel that had spilled from the locomotives. Other fire department units arrived from surrounding communities, and a foam truck arrived from Pampa, Texas, a city about 47 miles away. Rescue workers found the body of the intermodal train engineer adjacent to the track on the north side of the wreckage beneath wreckage debris. The first BNSF supervisor to reach the scene arrived about 10:30 a.m.

A highway worker said he was about 1 mile west of the point of the collision and was looking at the coal train as it passed him. He said he heard the train go into emergency, and as he watched, he saw a fireball rise into the sky. He and a coworker rushed to the scene and took part in the rescue efforts. His highway maintenance truck carried shovels that rescue workers used to dig out the coal train conductor, who was partially buried in coal near the fire.

The assistant fire chief stated that the BNSF had trained with his department about 2 months before the accident and that he considered the BNSF's training to be helpful. The BNSF's safety program instructed firefighters on the basic safety concerns at a railroad accident scene, including the location of personnel aboard trains, railroad nomenclature, and hazards that may be found near a railroad accident. The assistant chief said that his department drills twice a month and that 50 percent of his volunteers are certified, as required by the State.

[7] This employee was the conductor of the intermodal train.

Injuries

The coal train engineer received critical injuries. The conductor of the coal train was struck by the debris of the derailing equipment of his train and partially buried in coal. He received critical injuries and required extensive hospitalization and rehabilitation. Although the intermodal train conductor received minor injuries, the engineer of the intermodal train was fatally injured when he was struck by the derailing equipment.

Damage

The postcollision fire consumed most of the combustible material in both locomotive cabs. The first six platforms of the intermodal train were also damaged by fire.[8] Both locomotives at the head end of the coal train were derailed. The coal train's lead locomotive was destroyed. In addition to being damaged by fire, the cab section was separated from the frame and crushed into an unrecognizable shape. The second locomotive was also severely damaged. The first 23 cars of the coal train were derailed and destroyed. The distributed power locomotive at the rear of the coal train was not damaged. The two locomotives of the intermodal train were derailed; the lead locomotive was destroyed. The first four intermodal cars, a total of 12 double-stack platforms, were also derailed. The first 3 intermodal cars, each with 3 double-stack platforms, were destroyed, along with the 18 loaded containers that were carried on these cars.

The cost of the collision included:

Equipment	$6,401,192
Lading	427,000
Track	331,189
Environmental cleanup	202,765
Wreck clearing	763,506
Total	**$8,125,652**

Personnel Information

Coal Train Engineer

The coal train engineer, 51, was hired by the Fort Worth & Denver Railroad on April 10, 1973, in Amarillo as a clerk-operator. In August 1975, he became a staff assistant to the general manager and moved to Fort Worth. He returned to Amarillo to begin training as a locomotive engineer in April 1976 and has an engineer's seniority date

[8] Each railcar can provide one to five platforms. Depending on the size and configuration, each platform can hold one to four containers.

of November 8, 1976. He was certified as a locomotive engineer and was listed as having attended a rules examination on October 16, 2001, and a prior rules examination on March 2, 1999. His record includes numerous training and rules classes since 1992.

Coal Train Conductor

The coal train conductor, 57, began his railroad career on May 26, 1966. His entire railroad career has been with the BNSF or predecessor roads. His last rules class was in 2001, and he had attended a safety meeting on the Wednesday before the accident.

Intermodal Train Engineer

The intermodal train engineer, 61, was fatally injured as a result of the collision. He had been hired by the railroad as a trainman on June 3, 1959, and had resigned on May 7, 1974. He was reemployed as a trainman on January 31, 1975, and that date is shown as his official hire date. He entered engine service on May 1, 1997.

The engineer was listed as having attended a rules examination on December 2, 2001, and a prior rules examination on October 10, 1998. He was certified as a locomotive engineer. His record includes numerous training and rules classes since 1992.

Intermodal Train Conductor

The conductor of the intermodal train began his railroad career on July 1, 1996. Records show steady employment. The conductor had attended locomotive engineer training in 1998. His last rules class was on April 19, 2001, and he had attended a prior rules class on September 18, 1998.

Train Dispatcher

The train dispatcher, 57, began his railroad career in June 1970 when he was hired by the Fort Worth & Denver Railroad as a telegrapher. He began working as a clerk-operator in August 1971 and has been a train dispatcher since 1974. The dispatcher had worked as a dispatcher on the Red River Subdivision about 20 of the 28 years that he had worked as a dispatcher. His most recent rules class was on September 15, 2001. His territory includes the TWC territory from Estelline, Texas, to Amarillo as well as some centralized traffic control (CTC) territory north of Amarillo.

Train Information

The coal train was designated C-RWMOKO0-68A and was a typical coal train that the BNSF originates from the Powder River Basin. The train consisted of 116 cars of bituminous coal that were consigned to a power plant in Oklaunion, Texas. The gross weight of the train was 15,483 tons, giving an average of 133.5 tons per car. All cars were

made of aluminum and were designed to be emptied in a rotary dumper. Including the locomotives, the train was 6,380 feet long and had 482 axles.

Three locomotives powered the coal train, two on the head end and one on the rear. Rear locomotives, operated by distributed power from the lead locomotive, are used to improve train handling and reduce in-train forces. Records indicate that all locomotives had received their 92-day inspections. The crew noted no problems with the locomotives.

Federal regulations require that railroad freight equipment be inspected a minimum of every 1,000 miles. Amarillo is a common inspection point for coal trains that originate in the Powder River Basin and move eastward across Texas. After the coal train arrived and before the accident crew departed, the coal train received the 1,000-mile inspection. During the inspection, a mechanical defect was discovered on one car, which was set out of the train by the accident crew before departure.

The intermodal train was made up of double stack container equipment. It had a gross weight of 5,545 tons and was powered by two locomotives. Both locomotives had received their 92-day inspections in April 2002. The train was made up of 34 railcars with 77 platforms and carried 169 containers and 11 truck trailers. Four containers were listed as carrying hazardous materials. The total train length was 7,033 feet.

Track and Site Information

The collision occurred about 3 miles west of Clarendon, a farming and ranching town about 58 miles east of Amarillo. The single-track Red River Valley Subdivision passes through town in an east-west direction. In 1887, the Fort Worth and Denver City Railroad began constructing track in the area that would become Clarendon. This railroad evolved into the Fort Worth & Denver, then the Chicago Burlington & Quincy. A subsequent merger with the Northern Pacific and the Great Northern produced the Burlington Northern in 1970. In 1995, the Burlington Northern and the Santa Fe merged to form the BNSF Railway.

The Red River Valley Subdivision stretches westward from Valley Junction, near Wichita Falls, Texas, to Amarillo, a distance of 217.3 miles. Milepost numbers increase westward. With slight and variable grades, the railroad rises from an elevation of about 1,000 feet near Wichita Falls to more than 3,600 feet in Amarillo. Railroad officials stated that the west end of the Red River Valley Subdivision was the busiest section of single-track non-signaled TWC railroad on the BNSF system. About 30 trains pass over this portion of the subdivision on an average day. The Union Pacific has trackage rights over the subdivision and operates two trains per day each way. No regularly scheduled passenger trains operate on the Red River Valley Subdivision.

The collision occurred at milepost 280.1 on tangent track with an ascending grade of 1.05 percent eastward. At the point of the collision, the approximate first half of the eastbound coal train was ascending the 1.05-percent grade; the rear portion was on level

track. The head end of the intermodal train had begun to descend the grade as the middle and rear portions were moving uphill on a grade that varied between 1.0 and 0.38 percent. The intermodal train had just rounded a left-hand curve that extended from milepost 279.91 to milepost 280.09.

The single track was owned and maintained by the BNSF and had a maximum allowable operating speed of 49 mph for freight trains, a speed that requires the track structure to meet Federal Railroad Administration (FRA) standards for class 4 track. Postaccident inspection of the undamaged track in the area of the collision revealed no track conditions that would prohibit the track from meeting the requirements of class 4 track.

There were two trackside warning detectors (TWD) near the accident area.[9] The last TWD passed by the eastbound coal train was near Ashtola at milepost 294.0. The last TWD passed by the westbound intermodal train was near Clarendon at milepost 273.2. Event recorder systems in those TWDs recorded nothing unusual about either train.

Method of Operation

Movement of Trains

The Red River Valley Subdivision is controlled from the BNSF operations center in Fort Worth. The eastern half of the subdivision, from Valley Junction to Estelline, is operated by CTC. In CTC territory, the train dispatcher controls wayside signals to authorize or restrict the movement of trains. Trains of the same direction are permitted to follow one another and are spaced automatically by the signal system. The train dispatcher arranges for trains operating in opposite directions to meet at sidings, where one train is routed onto the siding to allow the opposing train to pass.

The western half of the subdivision, 99 miles from Estelline to Amarillo, is non-signaled TWC territory.[10] The timetable speed for all trains is 60 mph in CTC territory and 49 mph in TWC territory. In TWC territory, track warrants are issued by the train dispatcher to authorize a train to occupy the main track within designated limits. Track warrant limits must be designated by exact points, such as switches, mileposts, and stations.

[9] *Trackside warning detectors* are installed at various trackside locations to detect and report some or all of the following conditions: overheated journals, dragging equipment, excess dimensions, shifted loads, high water, and slides.

[10] Some sections of the BNSF have signaled TWC, primarily in areas of double track. In such areas, it is common to have automatic block signals space trains that are moving in the same direction. The train dispatcher has no control over such signals, however, and a track warrant is required for trains to occupy the track.

The BNSF uses the *General Code of Operating Rules*, Fourth Edition.[11] The special instructions that were in effect at the time of the accident were BNSF System General Special Instructions No. 7, effective January 20, 2002. The most current timetable for the Red River Valley Subdivision at the time of the accident was the Texas Division Timetable No. 5, effective January 20, 2002.

At the time of the accident, the sidings in the TWC portion of the Red River Valley Subdivision were equipped with power switches that were operated by train crews. In the fall of 2002, the BNSF began a conversion program to transfer control of the switches, and the signals guarding them, to the train dispatcher. In effect, this created "CTC islands" at each end of the designated sidings.

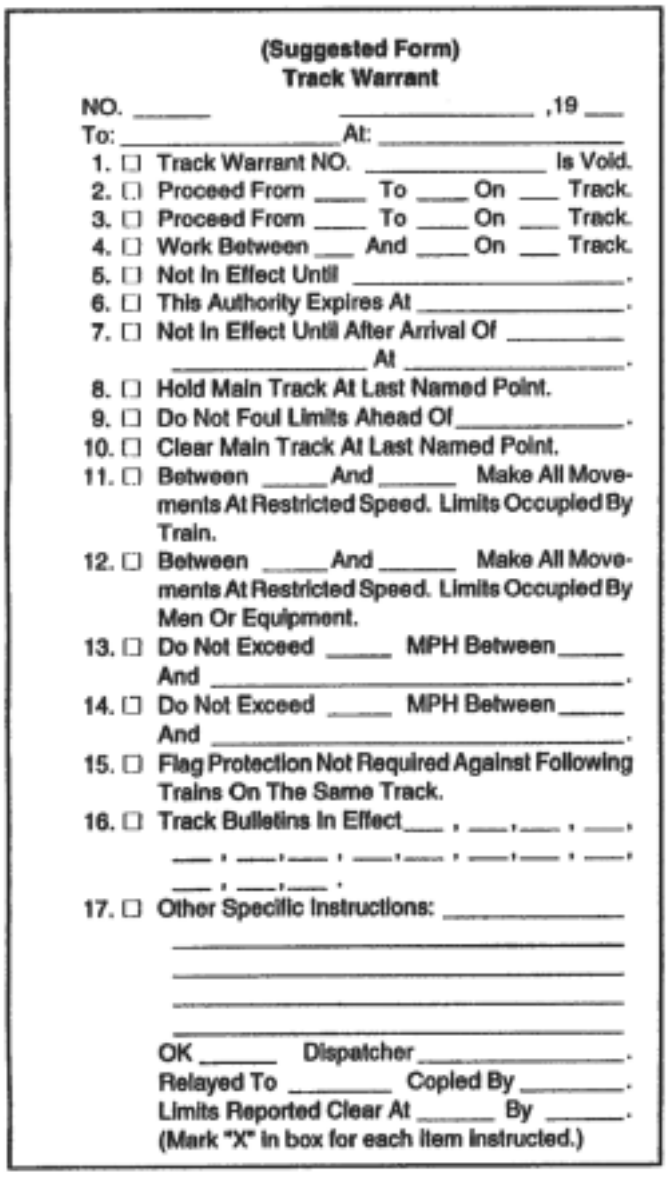
Track Warrants

The train dispatcher issues the authority to occupy tracks and gives other instructions to trains in TWC territory by the use of track warrants. The dispatcher issues track warrants to the conductor of an en-route freight train by radio. This transmission is normally audible to all crewmembers in the locomotive cab and to other trains within radio range. After receiving and recording the track warrant, the conductor must confirm that he has copied it correctly by reading it back to the dispatcher. He typically does this using the locomotive radio's microphone or, if the unit is so equipped, with a telephone-style handset. The read-back may or may not be heard by the engineer.

The track warrant form in use by the BNSF is a preprinted form with 17 lines from which a dispatcher can select particular instructions to authorize and/or restrict train movements. (See figure 5.) When one train is permitted to follow another on the same track, the first train is authorized to proceed[12] from one location to another, and a following train is authorized to occupy the same track only after the first train has reported clear of a certain point. When trains traveling in opposite directions are operated on a single track, the dispatcher must arrange for them to meet one another at a siding; one train is permitted to "hold the main track" while the other train is instructed to "leave the main track" (take the siding).

[11] While many eastern railroads use the Northeast Operating Rules Advisory Committee (NORAC) rules; western class I railroads, including the BNSF, use the *General Code of Operating Rules*, as do many regional railroads and smaller railroads. The General Code of Operating Rules Committee meets twice per year, at which time committee members may make additions or otherwise modify the operating rules.

[12] A train that is operating on "proceed" authority cannot make a reverse move.



(Suggested Form)
Track Warrant

NO. _____ _____ ,19 ___
To: _____ At: _____

1. ☐ Track Warrant NO. _____ Is Void.
2. ☐ Proceed From ____ To ____ On ___ Track.
3. ☐ Proceed From ____ To ____ On ___ Track.
4. ☐ Work Between ___ And ____ On ___ Track.
5. ☐ Not In Effect Until _____.
6. ☐ This Authority Expires At _____.
7. ☐ Not In Effect Until After Arrival Of _____ _____ At _____.
8. ☐ Hold Main Track At Last Named Point.
9. ☐ Do Not Foul Limits Ahead Of _____.
10. ☐ Clear Main Track At Last Named Point.
11. ☐ Between _____ And _____ Make All Movements At Restricted Speed. Limits Occupied By Train.
12. ☐ Between _____ And _____ Make All Movements At Restricted Speed. Limits Occupied By Men Or Equipment.
13. ☐ Do Not Exceed _____ MPH Between _____ And _____.
14. ☐ Do Not Exceed _____ MPH Between _____ And _____.
15. ☐ Flag Protection Not Required Against Following Trains On The Same Track.
16. ☐ Track Bulletins In Effect___ , ___,___ , ___, ___ , ___,___ , ___,___ , ___, ___ , ___,___ .
17. ☐ Other Specific Instructions: _____ _____ _____ _____ _____

OK _____ Dispatcher _____.
Relayed To _____ Copied By _____.
Limits Reported Clear At _____ By _____.
(Mark "X" in box for each item instructed.)

Figure 5. Track warrant form used by the General Code of Operating Rules.

Using this track warrant form, a train can be authorized to proceed from one location to another with the issuance of authority, referred to as a "Box 2," that is contained on line 2 of the track warrant. The crew is instructed to mark an "X" in the box for line 2 and fill in the locations "from" and "to." Upon a proper read-back of all of the instructions and the track warrant being put into effect by the train dispatcher, the train is authorized to proceed from one location to another. The end point of the train's authorized segment of track is referred to as the track warrant "limit."

When trains of opposing directions are intended to meet at a siding so that one train may pass the other, the train that is to "hold the main track" will not be permitted to pass beyond the siding switch that will be used by the other train to leave the main track and enter the siding. In this case, the opposing train would be given a "Box 2" to operate from one location to another, then would also be given "Box 10" instructions to "clear main track at last named point." In other words, the opposing train is required to take the siding.

In the real-world application of track authority, trains are often given track warrants for many miles of track at a time, and they may be given track warrants long before they arrive at the location(s) where the track warrants are in effect. Because it is desirable to keep trains moving, track warrants are given in advance of the anticipated arrival of a train at the "limit" of a prior track warrant. The result is that trains often simultaneously hold more than one valid track warrant.

All track warrants are issued with BNSF's computerized track warrant system and are entered in the dispatcher's computer with a standardized screen template. The preprinted form the train crewmember uses to copy the track warrant has lines and items that match the train dispatcher's computer screen.

In some cases, a train crew is given authority to proceed but is instructed that such authority is not in effect until another train arrives and clears the main track. Such a track warrant is known in the industry as an "after-arrival" track warrant because it stipulates that it is not in effect until after the arrival of a specified train.

An after-arrival warrant is accomplished with a "Box 7," whereby the dispatcher instructs a crew to place an "X" in the box for line 7, the line of instruction that stipulates that the track warrant is "not in effect until after the arrival of ____." The dispatcher then informs the crew of the opposing train's engine number (including the initials of the owning road) and direction. In some cases, the train for which a train has been instructed to wait will not be the first opposing train that is encountered.

After the Clarendon collision, the BNSF issued instructions requiring that a train be stopped at the location where another train is to be met before the train is given a track warrant that contains an "after-arrival." These instructions[13] read:

> Effective May 31, 2002, at 0700 CDT, track warrant authority containing a Box 7 (not in effect until after the arrival of…) is permitted in non-signaled TWC territory only after the train to receive the track warrant containing the Box 7 is stopped at the meeting point where the opposing train will be met.

[13] These instructions were initially issued to heighten awareness of issues related to track warrant operations and were expected to be in effect until all employees were contacted in safety briefings. These instructions were later extended.

Meteorological Information

There was no fog or other weather-related restrictions to visibility at the time of the collision. A weather observation station in Clarendon indicated that the temperature was 56° F. A witness who reported on conditions at the time of the accident told investigators that it was sunny with just a few clouds in the sky. The engineer of the coal train stated that it was clear and sunny, and he did not indicate that the position of the sun compromised his ability to observe the track ahead. During sight distance testing 48 hours after the accident, the position of the sun was not a factor.

Toxicological Information

Subpart C of Part 219 of 49 *Code of Federal Regulations* (CFR) governs postaccident toxicological testing of operating crewmembers and train dispatchers involved in an accident. Both crewmembers of the coal train were tested for drugs and alcohol. The conductor of the intermodal train and the fatally injured engineer of the intermodal train were also tested. Tests of all operating crewmembers and the train dispatcher were negative for the presence of alcohol or drugs.

Tests and Research

About an hour and a half after the accident, an inspection was begun on the non-derailed cars of the coal train where they had come to rest. Inspection records indicate that all brakes had applied on these cars. The non-derailed cars of the intermodal train were similarly inspected, and all brakes were found to have applied.

Two days after the accident, on May 30, 2002, the Safety Board arranged for a sight distance test at the collision site. The test was conducted at the same hour and in about the same weather conditions that existed at the time of the accident. The BNSF supplied the same model locomotives from the same manufacturer to represent the lead locomotive of each accident train.

After staging the two test locomotives at the point of collision, each locomotive unit was operated in reverse to establish the distance at which the other locomotive became visible. Because the coal train was operating on tangent track for several miles before the point of collision, the actual location at which the intermodal train became visible was not determined. The intermodal train was operating on curved track when the coal train first became visible, and the point at which the crew would have been able to first observe the coal train[14] was 1,202 feet east of the point of collision.

[14] These tests indicated that the topography in the accident area would likely allow the crew of the intermodal train to see the cars behind the locomotives of the coal train before they could see the lead unit or the headlight.

Investigators examined the computer-generated track warrant copies that were issued from the train dispatcher's desk in the BNSF's operation center and noted that the track warrants were correct, complete, and in compliance with the operating rules.

Event recorder data indicated that the coal train engineer made no control inputs that would have reduced his train speed below normal operating speed from the time the last track warrant was issued until he placed the train in emergency upon sighting the oncoming intermodal train.

Actions of Coal Train Crew

The engineer of the coal train told investigators that he did remember leaving Amarillo and the events of the trip up to a point, but he did not remember events as the train was approaching the siding at Ashtola or the events just before the collision.

The engineer said he usually let the conductor copy a track warrant and that he usually had a copy of the track warrant in front of him on the control panel. He did not remember the last track warrant, and he did not remember having it in front of him. When interviewed a second time, some 5 months after the collision, he said that from everything that he had been told and heard from others, "we ran the meet." He said he had no idea why he had passed the point where he should have waited.

The conductor said he did not remember anything about his last tour of duty, including the last track warrant and the events that led up to the collision.[15] Regarding the issuance of track warrants to trains on the Red River Valley Subdivision, the conductor said he thought it was easy to make a mistake: "It is easy to make a mistake or a miss-mark.…If the ink pen didn't write or if you didn't have a carbon copy, who's to say that you don't 'X' the box and just read it back, something could distract you and you don't know it." He talked about the Box 7 being "just one mark." The conductor also stated: "That one little mark means the difference between life and death."

According to Rule 6.10 of the *General Code of Operating Rules*, the conductor must remind the engineer that the train is approaching an area restricted by limits of authority, track warrant, or track bulletin, and this reminder must take place at least 2 miles from the restriction. The rule states that if the engineer fails to comply with the restriction, the conductor must stop the train. BNSF special instructions state that the conductor and engineer are jointly responsible, through job briefing, to ascertain and agree on their train's exact location before reporting past a specific point or clearing their track warrant.

[15] Although the conductor willingly participated in postaccident interviews, the injuries he had received seriously impaired his ability to assist investigators in reconstructing the accident.

Cell Phone Use

All four crewmembers involved in this accident had personal cell phones. According to cell phone records obtained by the Safety Board, the conductor of the coal train used his cell phone for brief calls before the train departed Amarillo. The cell phone belonging to the engineer of the coal train was used for two calls during the morning of the accident.

At 8:05 a.m., a 23-minute[16] call originated from the engineer's cell phone. After the completion of this call, and after about 16 minutes of non-use, another call originated from the engineer's phone at 8:44 a.m. This time corresponds to the end of the last track warrant, which was given to the coal train at 8:43 a.m.[17] This call, which lasted about 10 minutes, was to the same number as the previous call. The engineer said, and telephone company records confirm, that the number called was that of a family member. The engineer said that he could not recall the substance of the telephone calls that day. He added that he usually called this family member, who was in failing health, each morning.

The coal train passed the east end of Ashtola Siding, the location at which it should have waited for the arrival of the intermodal train, at about 8:47 a.m. The engineer said he did not remember specifically being on the phone at the time his train passed the east end of Ashtola Siding.

Use of Cell Phones by Operating Employees

Title 49 CFR Part 220 governs railroad communications. Subpart "B" of Part 220, "Railroad and Wireless Communication Procedures," defines the use of radio and wireless communication and governs the use of these methods of communication. Per Federal regulations, a locomotive engineer is not permitted to copy a track warrant while at the controls of a moving train. Federal regulations do not prohibit a locomotive engineer from using a cell phone while at the controls of a moving train.

The *General Code of Operating Rules* restricts the use of cell phones by operating employees under the general interpretation of Operating Rule 1.10, which prohibits employees from using unauthorized electronic devices while on duty. As a result of an unrelated collision[18] on a different BNSF subdivision, the railroad issued instructions to operating employees on June 18, 2002, that specifically restricted cell phone use. The instructions prohibited the use of cell phones and laptop computers while on duty, with certain exceptions. Per these instructions, locomotive engineers "are prohibited from using cell phones/laptop computers while operating the controls of a locomotive."

[16] A security analyst with the telephone company told investigators that the length of the phone call is "rounded up" to the next higher minute for any part of a minute that is used.

[17] According to telephone company and BNSF personnel, cell phone and track warrant times are synchronized with coordinated universal time (UTC).

[18] This collision was not investigated by the Safety Board.

Use of After-Arrival Track Warrants

Over a period of time, some railroads, including the Union Pacific (as noted below), have discontinued issuing after-arrival track warrants to moving trains. Rules promulgated by the Northeast Operating Rules Advisory Committee (NORAC), under which some railroads operate, have not allowed the use of after-arrival track warrants for at least 15 years. After this accident, the BNSF changed its operating rules to require that dispatchers not issue after-arrival track warrants until after the affected train is stopped at the location where it is to meet the opposing train.

After the Safety Board investigated a head-on collision of two Union Pacific trains at Devine, Texas, in June 1997,[19] the Safety Board recommended that the Union Pacific Railroad:

> R-98-25
>
> Discontinue permanently the use of after-arrival orders in dark (nonsignalized) territory.

This recommendation was classified "Closed—Acceptable Action" on July 23, 2001, after the Union Pacific indicated that it would stop using after-arrivals in non-signaled TWC territory. In May 2002, the railroad issued instructions to operating employees that would allow the use of after-arrival track warrants after the train that was issued these instructions had stopped at the point at which it was to wait for the arrival of the opposing train. The Union Pacific's instructions read:

> Track Warrant Box 7: A track warrant authority containing a Box 7 (not in effect until after the arrival of…) is permitted in non-signaled TWC territory only after the train to receive the track warrant containing the Box 7 is stopped at the location where the opposing train will be met.

The portions of 49 CFR that address train movement mention "mandatory directives" and "train orders" but do not address the information that is contained in these authorities or other similar methods of train control.

Also as a result of the Devine collision, the Safety Board made the following safety recommendations to the FRA:

> R-98-26
>
> Revise 49 *Code of Federal Regulations* Part 220 to address track warrants and other current railroad operating practices.

[19] For more information, see National Transportation Safety Board, *Collision and Derailment of Union Pacific Railroad Freight Trains 5981 North and 9186 South in Devine, Texas, June 22, 1997.* Railroad Accident Report NTSB/RAR-98/02 (Washington, D.C.: NTSB, 1998).

R-98-27

Require railroads to discontinue permanently the use of after-arrival orders in dark (nonsignalized) territory.

In a February 4, 1999, letter in response to Safety Recommendation R-98-26, the FRA told the Safety Board that it had issued a final rule, effective January 4, 1999, modifying 49 CFR Part 220 as requested. Accordingly, the Safety Board classified Safety Recommendation R-98-26 "Closed—Acceptable Action" on June 29, 1999.

In the same February 1999 letter, the FRA stated that it had issued a safety directive addressing safety practices in direct train control territory. The directive recommended that in those instances in which a train movement instruction includes a train meet, the dispatcher specifically state in the movement authority that "this track warrant includes a requirement to meet another train." The second recommendation in the directive required that railroads review their operating rules and practices pertaining to operations in non-signaled territory to determine what further enhancements were warranted to improve safety, including the elimination of the use of after-arrival orders. The letter further stated that FRA audits had determined that "the overwhelming majority" of railroads had eliminated the use of these orders in non-signaled direct train control territory. While the letter stated that the FRA would continue to review these safety-critical procedures during future dispatcher audits, the agency stopped short of prohibiting the use of after-arrival orders. Based on this response, the Safety Board classified Safety Recommendation R-98-27 "Closed—Unacceptable Action" on June 29, 1999.

Analysis

Exclusions

The engineer and conductor of the coal train had been on duty less than 3 hours and had traveled about 56 miles before the accident. The engineer and conductor of the intermodal train went on duty about 2 hours 12 minutes before the accident and had traveled about 60 miles before reaching the site of the collision. All of the surviving operating employees were interviewed, and no factors indicating fatigue or illness were identified. All operating employees were tested for the presence of drugs or alcohol after the accident, and all results were negative. The Safety Board therefore concludes that no evidence was found to indicate that crewmember fatigue or the use of alcohol or drugs by crewmembers caused or contributed to the accident.

All crewmembers were qualified on this territory. The coal train engineer, with 29 years of service, and the conductor, with 36 years of service, were seasoned employees. The intermodal train conductor had almost 6 years of experience, and the engineer had 42 years of railroad service, including 5 years as an engineer. The weather was clear, with no fog or other restrictions to visibility. The coal train engineer indicated that the position of the sun was not a factor. The time and location of each train's emergency brake application and the relative speed of the trains indicate that at least one crewmember of each train likely saw the opposing train at about the same time.

The railroad's mechanical department had inspected the coal train before it departed Amarillo. The coal train engineer told investigators that the locomotives were functioning well and that he was comfortable in the cab. The event recorder data from the distributed-power locomotive at the rear of the coal train indicates that it was placed in emergency braking by a radio signal from the head end, as designed. Wayside train defect detectors did not detect a problem with either train and did not sound an alarm. Shortly after the accident, an inspection was begun on the non-derailed cars of both trains where they came to rest. All brakes applied on the equipment that was not derailed.

The track in the area of the collision was found to meet the requirements for class 4 track. There were no speed restrictions in the area of the collision, and discussions with crewmembers and other employees revealed no track-related problems. The Safety Board therefore concludes that the following did not cause or contribute to the accident: weather, crew qualifications, and the mechanical condition of the equipment and track.

Investigators examined the computer-generated track warrant copies that were issued from the train dispatcher's desk in the BNSF's operation center and noted that the track warrants were correct, complete, and in compliance with the operating rules. The audiotapes of the train dispatcher's communications of the accident track warrant reflected an exact reproduction of the instructions that were contained on the track warrant. The Safety Board concludes that the track warrant instructions were complete and correct; the

transmission of these instructions and the coal train conductor's repetition of the instructions back to the train dispatcher were also complete and correct.

The Intermodal Train

The intermodal train was operating with an "after-arrival" track warrant that gave the intermodal train authority to proceed from Hedley Siding to Ashtola Siding. With the coal train on the main track at Ashtola, the intermodal train would have taken the siding so that the two trains could pass one another. The last track warrant given to the intermodal train was complete and correct. As instructed by the track warrant, the intermodal train waited for Engine UP 5827 East to arrive at Hedley and to pass by on the adjacent track.

With the arrival of Engine UP 5827 East, the "after-arrival" requirement of the track warrant was complete, and the intermodal train, Engine BNSF 4385 West, began moving westward toward Ashtola. At the time and location of the collision, the intermodal train was authorized to occupy the main track and was operating below the maximum allowable timetable speed. Given the available sight distance, the crew of the intermodal train initiated an emergency brake application in a timely manner. The Safety Board concludes that the operation of the intermodal train did not cause or contribute to the severity of the collision.

The Coal Train

Investigators reviewed audiotapes and confirmed that communications between the dispatcher and the coal train crew were similar for both of the last two track warrants given to the train. The conductor accurately repeated the instructions for the last track warrant, including the "Box 7" stipulation that the track warrant was not in effect until after the arrival of BNSF 4385 West (the westbound intermodal train) at the east siding switch at Ashtola. Both the engineer and conductor said they could not remember anything about the track warrant. They could not, therefore, confirm that the engineer had a copy of the track warrant or, if the conductor did give a copy to the engineer, that it reflected the after-arrival instructions. (The track warrant could not be found after the operating cab was destroyed by the impact and fire.)

The grade toward Ashtola was descending in the direction in which the coal train was traveling. Normal train handling of a 14,483-ton coal train preparing to stop on a descending grade would include controlling train speed with airbrakes and/or significant dynamic braking. Because the train was moving about 48 mph, the engineer would have needed to begin slowing his train within about 2 minutes of receiving the track warrant in order to bring the train to a smooth, controlled stop before passing the east end of Ashtola Siding. Investigators reviewed event recorder data and found no evidence that the engineer had initiated control inputs that would have stopped, or even slowed, the train before it passed the holding point. Thus, the crew of the coal train essentially ignored the

after-arrival stipulation of Track Warrant 22 and continued at a relatively steady speed as if the after-arrival stipulation had not been issued.

While investigators were given no explanations by the engineer for why he did not act on the after-arrival information, it is not likely that he would have forgotten about the meet with the intermodal train because only a minute or two would have elapsed from the time the warrant was issued until he would have had to begin preparing for it by beginning to slow his train. The only known departure from what must have been a routine conveyance of track warrant information between the conductor and the engineer was the engineer's placing of a cell phone call. The call was initiated at about the same time the track warrant was received, possibly producing a significant dual-task diversion of the engineer's attention during the time he would have been expected to read the track warrant. The cell phone call ended several minutes before the collision. During the several minutes after the cell phone call and before the collision, the coal train continued to travel eastward at timetable speed.

The engineer's cell phone use may have diverted enough attention from his track warrant reading that the "Box 7" information was seen but not actually comprehended. Because he could have looked at the track warrant again or checked with the conductor if he had any afterthoughts or uncertainties, it is likely that he proceeded beyond Ashtola with absolutely no knowledge of the oversight. The Safety Board concludes that the engineer's cell phone use likely distracted him to the extent that he did not take proper note of the after-arrival stipulation imposed by Track Warrant 22 and thus was unaware of the need to prepare to bring his train to a stop.

The irregularities of the conductor's performance after copying Track Warrant 22 may be the result of two factors. First, the task of copying track warrants is a repetitive one, subject to a few variants of the same information every working day. The conductor was well practiced with this routine and was familiar with the territory, and he could undoubtedly perform this task with little mental effort.[20]

Likely because of the timing of the engineer's phone call, the conductor probably did not discuss the track warrant with the engineer. Nor is it likely that he would have felt it necessary to do so, because the track warrant involved routine and predictable arrangements that the engineer would be expected to perform. But this expectation would not explain the conductor's apparent inattention to the operation of the train after receipt of the track warrant. The conductor had himself taken the track warrant information, had copied it down, and had read it back accurately and completely to the dispatcher. There could have been no question in his mind about what was required. He was also familiar with the territory and would have known how close the train was to the required holding point and how quickly it was approaching that point. He would have expected the engineer to begin to slow the train within a minute or two of getting the track warrant information.

[20] A fundamental of human error prediction is that accomplished proficiency may increase the risk of employees' paying less attention to the routine tasks at hand. It has been termed a mechanism of error production. See J.W. Senders and N.P. Moray, *Human Error: Cause, Prediction, and Reduction*, Hillsdale, New Jersey, Lawrence Erlbaum Associates, 1981, p. 78.

Further, Operating Rule 6.1 required that the conductor remind the engineer that the train was approaching the end of track warrant authority and even authorized him to stop the train if the engineer failed to take action.

Because of the requirements of the operating rule and the fact that the conductor would have known that violating the track warrant instructions could lead to a collision with another train, his failure to communicate with the engineer when it became apparent that the engineer was not preparing to stop suggests that the conductor was not properly attentive to the operation of the train. Also because of the substantial risk involved, he would not likely have been deterred from communicating with the engineer simply because the engineer was on the telephone at the time. Although it cannot be known why the backup system—in this case, the conductor—failed to take action when the primary system—the engineer—did not perform as expected, this accident highlights once again that human performance alone cannot be relied upon to provide true safety redundancy in a transportation system.

Certain information was not available that may have helped investigators determine why neither the engineer nor the conductor acted in accordance with the provisions of the Track Warrant 22. Had recordings of the in-cab conversations between the crewmembers been available for postaccident review, investigators may have been able to assess the crew interactions in the cab during the period for which neither the engineer nor conductor could provide detailed information. But locomotives are not required to be equipped with locomotive cab audio recorders, and these were not.

For several years, the Safety Board has been a proponent of installing and using locomotive cab audio recorders to help determine the cause of accidents. Safety Recommendation R-97-9 was issued to the FRA as a result of the Safety Board's investigation of the collision between a Maryland rail commuter train and an Amtrak passenger train on February 16, 1996, near Silver Spring, Maryland:[21]

> R-97-9
>
> Amend 49 *Code of Federal Regulations* Part 229 to require the recording of train crewmembers' voice communications for exclusive use in accident investigations and with appropriate limitations on the public release of such recordings.

[21] National Transportation Safety Board, *Collision and Derailment of Maryland Rail Commuter MARC Train 286 and National Railroad Passenger Corporation (Amtrak) Train 29 Near Silver Spring, Maryland, February 16, 1996*, Railroad Accident Report NTSB/RAR-97/02 (Washington, D.C.: NTSB, 1997).

The recommendation, which is on the Safety Board's list of "Most Wanted" transportation safety improvements, was reiterated in the Board's report of a collision involving three Consolidated Rail Corporation freight trains near Bryan, Ohio, on January 17, 1999.[22]

Based on the initial responses of the FRA, the Safety Board classified Safety Recommendation R-97-9 "Open—Unacceptable Response." On April 17, 2003, the Safety Board asked for an update on the status of the implementation of this recommendation. In a May 5, 2003, letter in response to the request for an update, the FRA, citing the absence of "a clear showing that safety benefits will outweigh the costs," stated that it "has reluctantly come to the conclusion that this recommendation should not be implemented at the present time."

Use of Cell Phones by Operating Employees

Locomotive engineers commonly use the locomotive radio to communicate with the dispatcher or other railroad employees. At the same time, cell phones are becoming more prevalent, and all four crewmembers involved in this accident had personal cell phones with them.

Cell phone use in controlled research situations has been shown to interfere with the perception process during the performance of operational tasks. The scientific understanding of this impairment is that visual perception is disrupted to the extent that a person does not implicitly attend to the information or physical cues available.[23] Such an impairment obviously has implications for operating train crews because use of a cell phone during train operations can call a crewmember's attention away from the task at hand. Moreover, a crewmember who is on a cell phone may miss information that is broadcast on the locomotive radio. Wayside defect detectors broadcast defect information and axle counts to the crews of passing trains. Similarly, train crews and other employees are required to inspect passing trains and report defects or the improper display of the rear marker. To improve safety, many railroads require that train crews announce their train's presence on the radio as they approach a meeting point in non-signaled territory and the indication of wayside signals in signaled territory. An employee who is using a cell phone may not hear or perceive such information.

[22] National Transportation Safety Board, *Collision Involving Three Consolidated Rail Corporation Freight Trains Operating in Fog at Bryan, Ohio, January 17, 1999*, Railroad Accident Report NTSB/RAR-01/01 (Washington, D.C.: NTSB, 2001).

[23] Strayer, D.L., Drews, F.A., and Johnston, W.A. Cell Phone-Induced Failures of Visual Attention during Simulated Driving, *Journal of Experimental Psychology: Applied*. Vol. 9, No. 1, 2003: pp. 23-32. The term "inattentional blindness" was given by earlier researchers to findings where persons were unable to perceive certain controlled presentations in the visual field that they would have seen if they had been attentive to them. Mack, A. and Rock, I., *Inattentional Blindness.* Cambridge, MA: The MIT Press, 1998. pp. 13-15, 227-250.

When used by either the engineer or conductor, a cell phone may distract the other crewmember or terminate the normal interaction between the two. Perhaps one employee may wish to ask a question or offer a reminder but chooses to not disturb the employee who is using the phone. An incoming phone call may be a significant distraction to a person who is engaged in a critical task at that particular moment.

It is conceivable that both the conductor and the engineer could be on their cell phones at the same time. In this case, neither employee is fully concentrating on the safe operation of the train. In other situations, particularly in passenger operations, an engineer may be alone in the cab. In this case, the sole occupant of the locomotive may be impaired by the demands of a cell phone call. In the Clarendon accident, as noted previously, the engineer placed a cell phone call and continued the conversation during the time he should have been preparing his train to stop, providing convincing evidence that cell phone use by train operating crews can interfere with crewmember attention and communications and can therefore degrade the safety of train operations.

Both the *General Code of Operating Rules* and BNSF operating instructions restrict the use of cell phones by operating employees. The BNSF instructions prohibit locomotive engineers from using cell phones/laptop computers while operating a locomotive. Federal regulations contained in 49 CFR Part 220 do not prohibit an engineer from using a cell phone while at the controls of a moving locomotive. As noted, however, the use of a cell phone by an engineer at the controls of a moving locomotive will likely dilute the engineer's full awareness and attention, which are required for safe operation. To improve safety, the Safety Board believes that the FRA should promulgate new or amended regulations that will control the use of cellular telephones and similar wireless communication devices by railroad operating employees while on duty so that such use does not affect operational safety.

Use of After-Arrival Authority

The issuance of after-arrival track warrants is useful in keeping traffic moving because the train that is holding the after-arrival track warrant can depart immediately once the opposing train has cleared. Often, a train crew can reduce the speed of the train and synchronize the time of its arrival at the waiting point so the train does not have to stop, thus saving fuel. There is no need to contact the dispatcher, report the opposing train in the clear, and copy a new track warrant. The authority is valid once the opposing train arrives and clears the main track. However, if the train holding the after-arrival leaves the waiting point too soon or, as in this accident, does not wait at all, the result is likely to be a head-on collision.

The eastern half of the Red River Valley Subdivision is signalized with a CTC system. In this territory, signal indications inform crews of routing and required speed changes or the limits of track authority. A train approaching the limits of its track authority will receive, at a minimum, an approach signal instructing the crew to reduce train speed to 30 mph and be prepared to stop at the next signal. If a crew should mistakenly pass a

stop signal, the train dispatcher will receive an indication of track occupancy by the offending train. In addition, the "fail-safe" signal system will display red (stop) signals to all trains involved. Should a train exceed its authority in dark territory, however, as did the coal train in this accident, nothing is in place to alert others of the incident.

As can be expected on the busiest section of BNSF single-track TWC territory, there is typically a high level of radio traffic. The dispatcher is busy, and the crews are constantly waiting for their trains to be contacted by the dispatcher. With hundreds of track warrants written each day, and with track warrant read-backs and crews calling in to cancel the track warrants or report clear of locations, radio traffic can saturate the dispatcher's frequency.

Giving after-arrivals to moving trains is easier for the train dispatchers, but it increases the responsibility of train crews. The territory and the corresponding number of trains that the dispatchers must monitor and control may place a demanding load on the dispatcher. However, the dispatcher's desk is equipped with computer software that is designed to prevent a dispatcher from delivering an incorrect track warrant. Train crews have no such backup.

After the Clarendon collision, the BNSF issued instructions requiring that a train be stopped at the location where another train is to be met before the crew is given a track warrant that contains an after-arrival. This restriction eliminates instances in which a train has a track warrant that instructs the crew to proceed or to keep proceeding, but to remember to stop the train before passing a specific point within the territory. A disoriented or distracted crew may not stop at the designated location.

In this accident, had the crew not received their final track warrant, they might have stopped at the limit of their previous warrant; that is, at the east end of Ashtola. The engineer may have heard the radio transmission of at least the beginning of the final track warrant and mistakenly determined that, since he had a track warrant, he did not have to be concerned about stopping in the next several miles. The timing of the engineer's initiation of the final phone call clearly suggests that he did not believe he had to stop at Ashtola.

The Safety Board concludes that the issuance, to moving trains, of track warrants containing after-arrival provisions creates an unacceptable and unnecessary risk of a head-on train collision. The Safety Board believes that the FRA should, in territory not equipped with a positive train control system (discussed below), restrict the issuance of track warrant authority that contains an after-arrival requirement to trains that have stopped at the location at which they will meet the opposing train. In the meantime, the Safety Board believes that the General Code of Operating Rules Committee should add language to the track warrant rules to ensure that in territory not equipped with a positive train control system, track warrant authority that contains an after-arrival requirement is issued only to trains that have stopped at the location at which they will meet the opposing train.

Positive Train Control Systems

Technology does exist to automatically enforce the operating parameters of trains and thus prevent train collisions. Over the past 3 decades, the Safety Board has investigated a long list of train collisions that could have been prevented through the use of a positive train control system[24] that incorporated collision avoidance. The Safety Board has addressed this issue through the issuance of a series of safety recommendations. In fact, positive train control has been on the Safety Board's list of "Most Wanted" transportation safety improvements since 1990. The most recent safety recommendation relating to positive train control was issued as a result of the Board's previously referenced investigation of the 1999 fatal train collision in Bryan, Ohio:

> R-01-6
>
> Facilitate actions necessary for development and implementation of positive train control systems that include collision avoidance, and require implementation of positive train control systems on main line tracks, establishing priority requirements for high-risk corridors such as those where commuter and intercity passenger railroads operate.

Based on a March 27, 2002, letter in which the FRA outlined steps it had taken toward "achieving the proper atmosphere in the rail industry to allow for the development and implementation of [positive train control]," the Safety Board classified Safety Recommendation R-01-6 "Open—Acceptable Response."

In answer to an April 17, 2003, letter from the Safety Board asking for an update on actions regarding this safety recommendation, the FRA responded, in a May 5, 2003, letter, that it was "moving forward across a broad front to create the conditions under which [positive train control] systems can be more widely deployed on the national rail system." In the letter, the FRA detailed some of the steps the agency was taking in the following areas:

- Providing a radio-navigation infrastructure and ensuring adequate spectrum;
- Facilitating positive train control through regulatory change;
- Supporting the demonstration and deployment of candidate technologies; and
- Analyzing costs and benefits.

The FRA stated that the agency was "doing everything within its power to prepare the way for [positive train control] and encourage its rapid deployment." In the meantime, the majority of railroad operations occur in territory without any automatic means of preventing train collisions.

[24] Various names have been given to these types of systems, but one component of all true positive train control systems is a system designed to prevent train collisions.

The BNSF is developing a system of train separation that would prevent trains from operating beyond the limits of track warrant authority. BNSF's train collision avoidance system is designed as an "overlay system" that enforces the track warrant limits or signal indications and the operating rules that are in place. The system is designed to inform the engineer of conditions that require him to act. If the engineer does not take the proper actions, the system will automatically stop the train. The BNSF plans to begin a pilot collision avoidance program for trains in the summer of 2003 on about 100 miles of track in western Illinois.

The BNSF system will use such information as train position (provided by the global positioning system), switch position (provided by switch sensors), signal indication, locomotive speed and control inputs, and track authority as given by the train dispatcher. This information will be combined with a train and track database to enforce operating parameters. The system will be designed to prevent the overrun of track authority in both signaled and track warrant territory. In addition to the absolute limits of track authority, the system will be able to enforce track speed and permanent and temporary speed restrictions. The Safety Board concludes that had a positive train control system with collision avoidance capabilities been in place and operational on the Red River Valley Subdivision at the time of the accident, the collision probably would not have occurred.

Conclusions

Findings

1. No evidence was found to indicate that crewmember fatigue or the use of alcohol or drugs by crewmembers caused or contributed to the accident.

2. The following did not cause or contribute to the accident: weather, crew qualifications, and the mechanical condition of the equipment and track.

3. The track warrant instructions were complete and correct; the transmission of these instructions and the coal train conductor's repetition of the instructions back to the train dispatcher were also complete and correct.

4. The operation of the intermodal train did not cause or contribute to the severity of the collision.

5. The engineer's cell phone use likely distracted him to the extent that he did not take proper note of the after-arrival stipulation imposed by Track Warrant 22 and thus was unaware of the need to prepare to bring his train to a stop.

6. The issuance, to moving trains, of track warrants containing after-arrival provisions creates an unacceptable and unnecessary risk of a head-on train collision.

7. Had a positive train control system with collision avoidance capabilities been in place and operational on the Red River Valley Subdivision at the time of the accident, the collision probably would not have occurred.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the May 28, 2002, collision at Clarendon, Texas, was (1) the coal train engineer's use of a cell phone during the time he should have been attending to the requirements of the track warrant his train was operating under and (2) the unexplained failure of the conductor to ensure that the engineer complied with the track warrant restrictions. Contributing to the accident was the absence of a positive train control system that would have automatically stopped the coal train before it exceeded its authorized limits.

Recommendations

As a result of its investigation of the May 28, 2002, collision at Clarendon, Texas, the National Transportation Safety Board makes the following safety recommendations:

To the Federal Railroad Administration:

Promulgate new or amended regulations that will control the use of cellular telephones and similar wireless communication devices by railroad operating employees while on duty so that such use does not affect operational safety. (R-03-1)

In territory not equipped with a positive train control system, restrict the issuance of track warrant authority that contains an after-arrival requirement to trains that have stopped at the location at which they will meet the opposing train. (R-03-2)

To the General Code of Operating Rules Committee:

Add language to the track warrant rules to ensure that in territory not equipped with a positive train control system, track warrant authority that contains an after-arrival requirement is issued only to trains that have stopped at the location at which they will meet the opposing train. (R-03-3)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

Ellen G. Engleman
Chairman

Mark V. Rosenker
Vice Chairman

John J. Goglia
Member

Carol J. Carmody
Member

Richard F. Healing
Member

Adopted: June 3, 2003

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Appendix A

Investigation

The National Transportation Safety Board was notified about noon, eastern standard time, on May 28, 2002, that two BNSF freight trains had collided near Clarendon, Texas. The Board launched an investigator in charge from the Atlanta Regional Office and a railroad signal investigator from the Safety Board's Washington, D.C., headquarters. In addition, a human performance investigator assisted during the subsequent interviews of operating employees. Locomotive event recorder data were processed by the Safety Board's Office of Research and Engineering.

The Safety Board held 2 days of interviews as part of its investigation. The first interviews were held at Amarillo, Texas, on July 1, 2002. Additional interviews were held at the BNSF's network operations center in Fort Worth, Texas, on July 2, 2002.

The Safety Board was assisted in its investigation by the Federal Railroad Administration, the Texas Railroad Commission, the BNSF Railway, the Brotherhood of Locomotive Engineers, and the United Transportation Union.

Appendix B

Time Line of Events

6:00 a.m.	Coal train crew begins tour of duty at the BNSF Amarillo yard office
6:45 a.m.	Intermodal train called on duty at Childress, Texas
7:01 a.m.	Coal train conductor places 2-minute cell phone call to his home number
7:14 a.m.	Coal train conductor places 2-minute cell phone call to an unknown number
7:18 a.m.	Intermodal train Track Warrant 12 in effect, Estelline to Hedley
7:40 a.m.	After setting out one defective car, coal train crew departs Amarillo
7:47 a.m.	Track Warrant 15 is in effect for the coal train from "Restricted limits Amarillo" to "East Siding Switch Malden."
7:49 a.m.	Track Warrant 16 is in effect for the coal train from "Malden to East Siding Switch Ashtola"
8:05 a.m.	Coal train engineer originates a 23-minute cell phone call
8:26 a.m.	Intermodal train Track Warrant 19 in effect, Hedley to Ashtola, instructions to take siding at Ashtola
8:27 a.m.	Coal train engineer cell phone call ends
8:28 a.m.	Coal train reports clear of milepost 305
8:29 a.m.	Coal train is clear of the limits of Track Warrant 15
8:39 a.m.	Intermodal train clears track warrant 12, indicates that the limits were clear at 8:30
8:41 a.m.	Coal train clears the wayside detector at milepost 294; the head end of the train is about milepost 292.8
8:41 a.m.	Coal train reports clear of Track Warrant 15 to dispatcher and that the train is east of milepost 294
8:43 a.m.	Coal train receives last track warrant: From "East Siding Switch Ashtola" to "East Siding Switch Hedley after the arrival of BNSF 4385 at Ashtola." Radio transmission between coal train and dispatcher ends at about 8:43:55.

8:44 a.m.	Engineer originates a 10-minute cell phone call
8:44 a.m.	Coal train passes west siding switch Ashtola
8:47 a.m.	Coal train passes east siding switch Ashtola
8:48 a.m.	Intermodal train clears the detector at milepost 273.2. Head end of the train is at approximately milepost 274.6
8:49 a.m.	Intermodal train passes the east end of Clarendon siding at milepost 274.89
8:51 a.m.	Intermodal train passes the west end of Clarendon siding at 276.57, about 3.53 miles before the point of collision.
8:53 a.m.	Coal train engineer cell phone call ends
8:57 a.m.	Collision occurs at milepost 280.1

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