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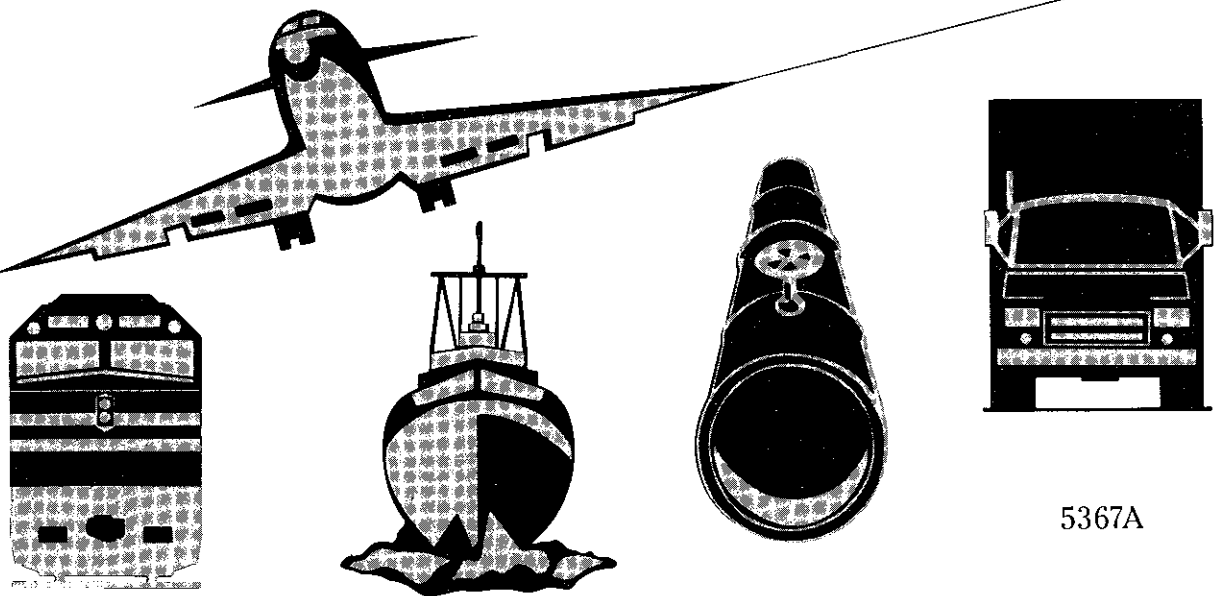
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

COLLISION AND DERAILMENT
OF NORFOLK SOUTHERN TRAIN 188
WITH NORFOLK SOUTHERN TRAIN G-38
AT SUGAR VALLEY, GEORGIA
AUGUST 9, 1990

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**ADOPTED: JULY 9, 1991
NOTATION 5367A**

Abstract: This report explains the 1990 collision of two Norfolk Southern freight trains near Sugar Valley, Georgia. Among the safety issues discussed are the following: effect of work and rest cycles, effectiveness of the alerter system, monitoring of employees who are taking prescription drugs, crashworthiness of locomotive cabs, need for locomotive diagnostic computer checking, and need to achieve positive train separation through the use of an advance train control system.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable cause of accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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EXECUTIVE SUMMARY

About 3:13 a.m. eastern daylight time, on August 9, 1990, northbound Norfolk Southern (NS) freight train 188 collided with southbound NS local freight train G-38 at control point DAVIS near Sugar Valley, Georgia. The conductor on train 188 and the conductor and engineer on train G-38 were fatally injured. The trainmen on both trains and the engineer on train 188 received minor injuries. Damage was estimated at \$1,268,680.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the engineer of train 188 to stop at the stop signal because he was asleep, distracted, or inattentive. Contributing to the accident were the failure of the conductor to monitor the engineer's performance and the failure of the brakeman and flagman to carry out their responsibilities to notify the engineer to stop the train.

Safety recommendations pertaining to these safety issues were addressed to the Norfolk Southern Corporation, the Association of American Railroads, the Railway Progress Institute, and the Federal Railroad Administration.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

COLLISION AND DERAILMENT OF NORFOLK SOUTHERN TRAIN 188
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AUGUST 9, 1990

INVESTIGATION

Accident

On August 8, 1990, about 9.30 p.m.,¹ a four-man crew that had been off duty in accordance with the Federal Hours of Service law reported for duty at Norfolk Southern's (NS) Inman Yard in Atlanta, Georgia. The crew consisted of an engineer, a conductor, a brakeman, and a flagman. It was to operate NS train 188 from Atlanta to Chattanooga, Tennessee, a distance of 148 miles. (See appendix D.) After removing a car, the traincrew coupled the train, completed the initial terminal brake test,² and left Inman Yard at 10:45 p.m. Train 188 was a caboosless train with 25 loaded cars and 45 empties. It weighed 4,720 tons and was 5,197 feet long.

The distance from Inman Yard (MP³ 148.2) to the accident location, Davis (MP 53.3) was about 95 miles (See figure 1.) The railroad between Atlanta and Chattanooga was mostly single main track, except for about 6 miles of double track at the Atlanta end and 13 miles at the Chattanooga end. The territory contained undulating track with gradients of about 0.01 percent; the maximum gradient was 1.05 percent. The curvatures ranged up to 6 degrees, although most were 4 degrees or less.

The engineer said he stopped at sidings to meet opposing trains at Austell (MP 135), Oak (MP 122.5), and Smith (MP 81.5). According to the crew's testimony, the brakeman and flagman were on the ground at all three meet points to inspect the passing trains. The engineer testified that he used the automatic air brake system three times during the trip, going down Braswell mountain (MP 109.0), going into Lindale siding (MP 83.9), and going into Sugar Valley siding (MP 55.3). On all three occasions, he used it to supplement the dynamic brakes.⁴

¹All times are eastern daylight saving time

²Title 49, Code of Federal Regulations, Part 232.12 (49CFR 232.12) "Initial Terminal Road Train Airbrake Tests," requires that each train be inspected as specified by a qualified person at the place where the train is originally made (initial terminal).

³MP stands for mile post

⁴Dynamic braking is a method of train braking whereby the kinetic energy of a moving train is used to generate electric current at the locomotive traction motors that is dissipated through banks of resistor grids in the locomotive body, providing a retarding force

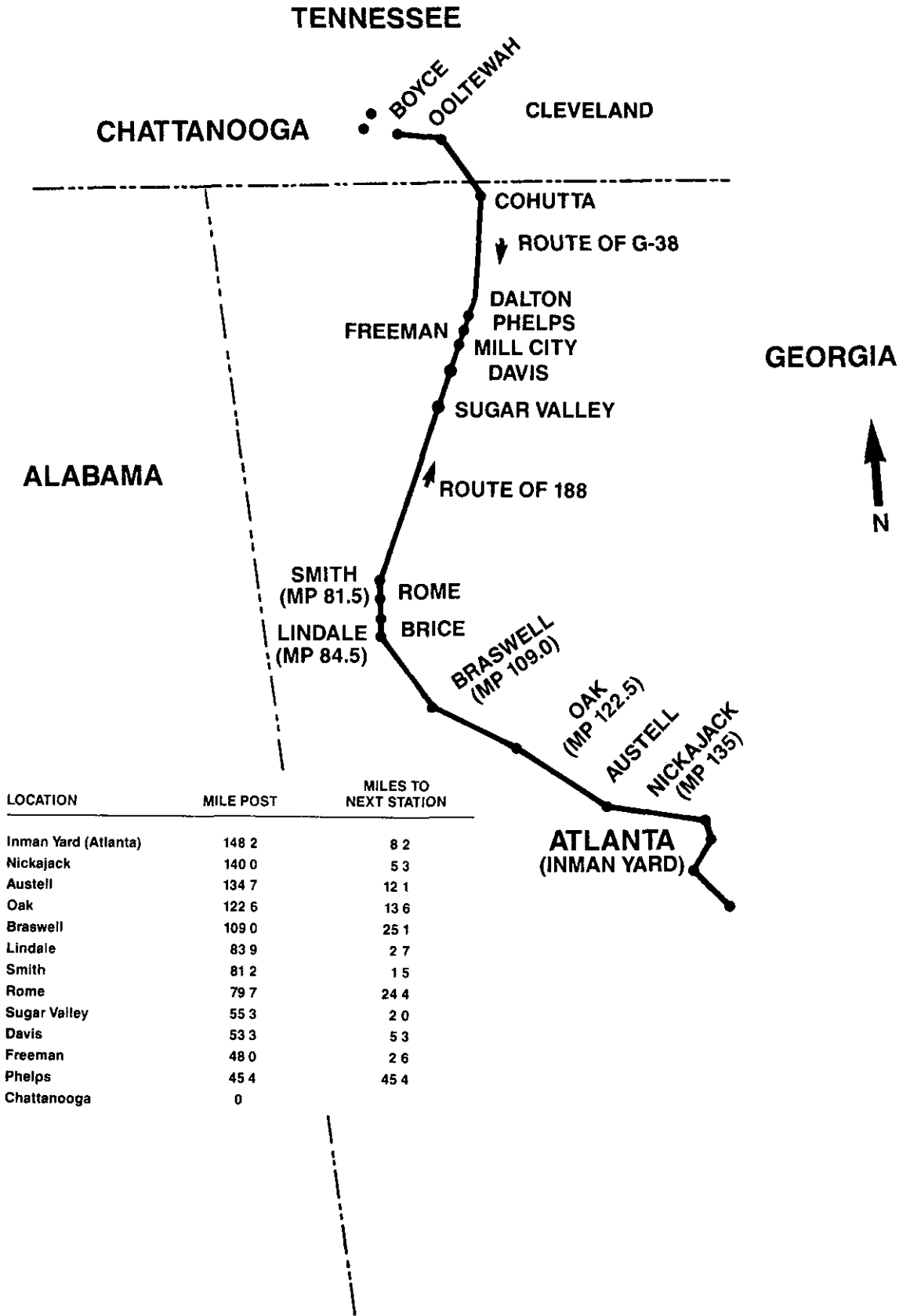


Figure 1.--The routes of train 188 and train G-38

The brakeman, who was in the second unit,⁵ stated that the diagnostic display panel indicated a problem in dynamic braking several times and each time had to be reset. He notified the engineer of the problem at Nickajack (MP 140 0), and the engineer replied, "There is nothing you can do but go ahead and reset it." After the last failure, just before entering Sugar Valley, the brakeman did not reset the control

The engineer testified that signal 57.8, the approach signal to the Sugar Valley siding,⁶ displayed an approach diverging aspect⁷ and that the northbound home signal⁸ at CP⁹ SUGAR VALLEY displayed a diverging route approach¹⁰. He stated that he entered the siding at 27 mph and that he thought he had drawn off air since the dynamic braking did not slow the train. He said, "Normally with two locomotives and the load I was pulling, I would not have had any problem controlling the train with dynamic braking alone if the dynamic braking was working properly." He stated he proceeded to pull his train into the siding, when he approached the home signal (see figure 2) at CP DAVIS, he called the signal "all stop"¹¹ to the conductor, and the conductor called back, "all stop." The next thing the engineer remembered was seeing the home signal and headlight of another train, and he reached up and "shot the air"¹².

I remember shouting to my conductor to hold on, that we wasn't going to stop. Then I remember holding on to the brake handle and throwing my legs up and then the explosion of the impact; and the next thing I remember, I came to. I realize that it's just not the normal way I come in there, and I just cannot remember or recall what I did between those two points. I've thought a thousand times, and the only thing I can think of is that I had to have nodded off between that point of calling an all stop signal and looking up and seeing the stop signal and headlight and shooting the air.

⁵Train 188 had two engines, or locomotives. In this report, the first engine, 8641, is referred to as the leading unit, or the first unit. The second engine, 8621, is referred to as the trailing unit, or second unit.

⁶The control point at the south end of this siding is referred to as SUGAR VALLEY, the north end is called DAVIS.

⁷Rule 302 "Approach Diverging. Proceed, approaching next signal prepared to take diverging route."

⁸Home signal. A fixed signal at the entrance of a route or block to govern trains or engines entering and using that route or block. (Standard Code)

⁹CP stands for control point.

¹⁰Rule 308 "Diverging Route Approach. Proceed through diverging route, observing authorized speed through turnout(s) or crossover(s), preparing to stop at next signal. Train or engine exceeding medium speed must at once reduce to that speed."

¹¹"All stop" means all the signal lights on the mast were red or stop indication.

¹²"Shot the air" means to place the train braking system into emergency.

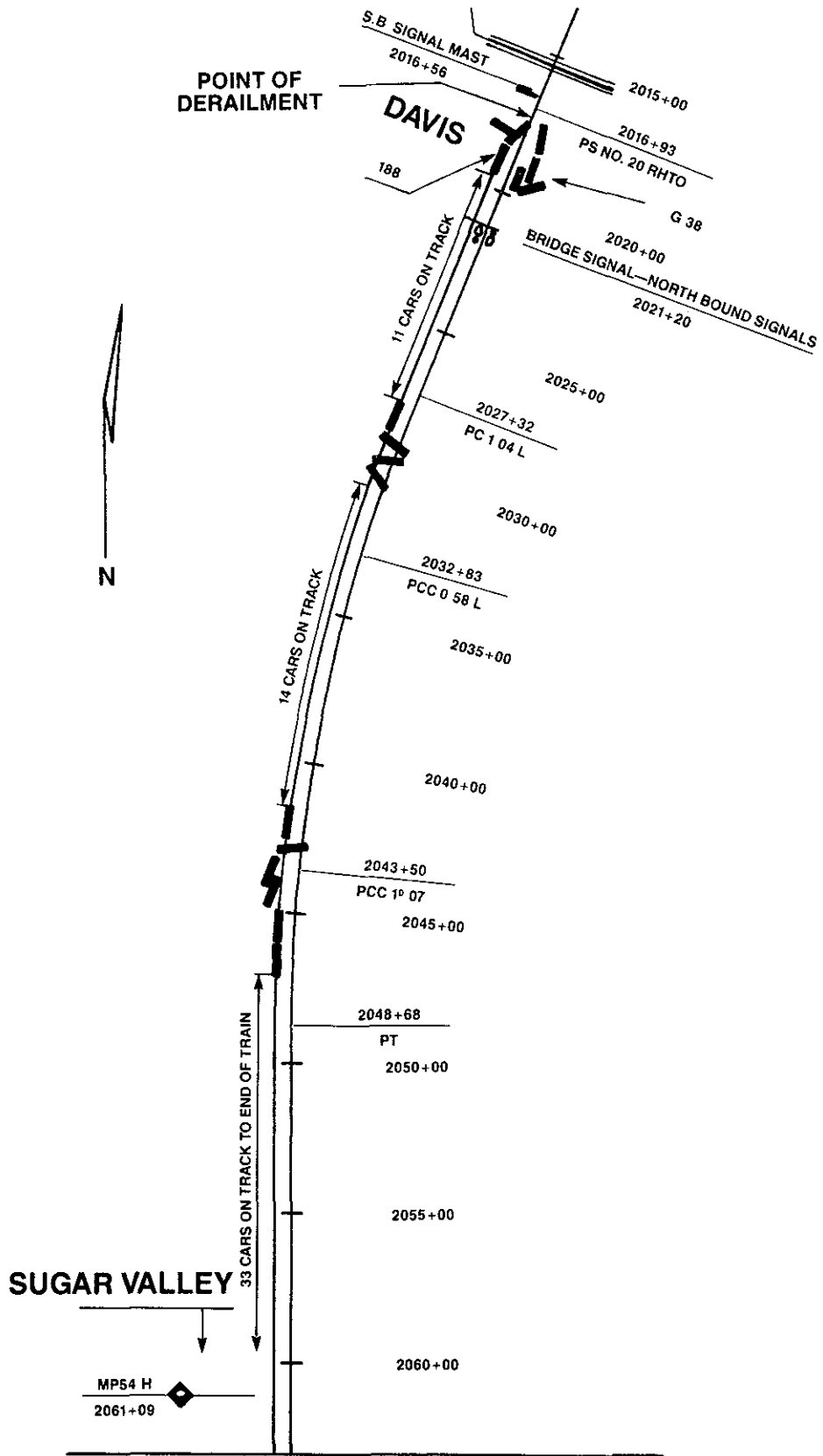


Figure 2.--Accident site CP SUGAR Valley to CP DAVIS.

The brakeman and the flagman, who were in the trailing unit, testified that neither of them observed the home signal aspect at CP DAVIS at any time. The brakeman's view of the signal was blocked by the long hood of the second unit and by the lead engine; he was seated on the west side of the unit. The brakeman also testified that as the train approached CP DAVIS, he might have been resetting the display panel. At another point in his testimony, he said that he might have been bending down to retrieve his lantern because he and the flagman were going to inspect the passing train. The flagman, who was seated on the east side of the second unit, said that he had left his seat to get some water so that he could take his diabetes medicine.

The crew of the NS local freight G-38 went on duty at Rome, Georgia, at 6 p.m. on August 8. The crew consisted of an engineer, a conductor, and a helper (trainman). They were to operate the regular run from Rome to Chattanooga northbound and back again in continuous service, a total distance of about 158 miles. Train G-38 left Chattanooga southbound at 10:55 p.m. with 17 cars. The helper, who was in the second locomotive,¹³ stated that nothing unusual occurred during the trip. The last place G-38 had worked was the chip yard at MP 46, and it left with six loaded cars and no empties. The helper remembered a radio conversation between the dispatcher and the engineer, but he could not remember exactly what was said (see appendix I). The last signal he saw was when the train left the siding at Freeman (MP 48). The signal displayed a diverging route clear.¹⁴ He said he did not observe the intermediate signal at MP 50, the approach signal to CP DAVIS. He was on the east side of the locomotive when he observed that the home signal at CP DAVIS was red and when the engineer started the "massive horn blowing." He also saw the conductor, who was seated on the east side of the lead locomotive, stand up facing the engineer as if the engineer had said something that startled the conductor. The helper believed that the brakes were applied at or almost at the moment of impact.

About 3.13 a.m. on August 9, train 188 and G-38 collided at MP 53.4. The engineer of train 188 stated that after the collision, "he was laying down in a hole and it was dark inside (referring to his position in the cab)." He saw flames and fire all around, and he felt around until he found the conductor. He removed the debris covering the man and began pulling on his arm. He heard "some gurgling sounds" from the conductor. Diesel fuel was pouring onto the ground, so he climbed up on the console, centered the reverser handle, placed all switches in the off position, and put the throttle in emergency stop,¹⁵ hoping to shut the engine down so it would not blow up. He then crawled out of his window (the locomotive was lying on its right side) and started screaming for help. He said he could see the brakeman and flagman walking down the track toward the signal instrument house. He crawled down the locomotive and went around to the front and looked underneath. He could reach up and touch the conductor's leg but could not free him. The engineer by then was standing in diesel fuel, and it was getting so hot he could not stay there any longer. He walked into the woods to avoid the fire and then to the track.

¹³Train G-38 had two engines, or locomotives. The first engine, 2799, is also referred to as the leading unit, or the first unit. The second engine, 3994, is referred to as the trailing unit, or the second unit.

¹⁴Rule 304, Diverging Route Clear. "Proceed through diverging route, observing authorized speed through turnouts or crossover." The timetable maximum authorized speed through the turnout is 40 mph.

¹⁵The engine was already in idle because the engineer had applied the emergency brakes. Moving the throttle to emergency stop shut down the engine's fuel pump.

The brakeman and flagman, who were in the second unit of train 188, checked with each other to determine the extent of their injuries. After deciding that their injuries were minor, they tried to escape through the door on the west side of the cab, it was blocked by fire, so they went out the door on the east side. They met the helper from train G-38 about three car lengths north of train 188's second unit.

The helper said he immediately tried to protect himself by getting out of his seat and onto the floor when he realized that a collision was imminent. When his locomotive stopped, it was lying east of the tracks on its left side. He had to crawl out of the cab because the unit had a narrow door and was lying on the ground. He met the brakeman and flagman from train 188 and helped them break the lock on the signal instrument house, from which they contacted the dispatcher. The conductor on train 188 and both the engineer and conductor on train G-38 died as a result of the collision.

Both trains were equipped with radio transceivers, neither engineer communicated with the other. The engineer of train G-38 did communicate twice with the dispatcher, once between midnight and 12:45 a.m. and once at 3:02 a.m, when the train left Phelps, Georgia (MP 46.1). The dispatcher initiated the communication at 3:02 a.m.: "How long before you're ready to leave Freeman? Over." G-38: "We're ready to leave Freeman now. We're coming over Lawyer's crossing now, over." Dispatcher: "OK, dispatcher out."

Injuries¹⁶

<u>Injuries</u>	<u>Crew 188</u>	<u>Crew G-38</u>	<u>Total</u>
Fatal	1	2	3
Serious	0	0	0
Minor	3	1	4
None	0	0	0
Total	4	3	7

Train Damage

Equipment	-	\$1,150,000
Track	-	45,000
Signal	-	0
Lading	-	55,000
Clean-up	-	10,680
Total Cost of Damage		\$1,260,680

¹⁶The injury table is based on the injury criteria used by the International Civil Aviation Organization (ICAO). The Safety Board uses these criteria in all of its accident reports.

On train 188, the two locomotive units, the 1st car (loaded with lumber), the 14th through the 17th cars, and the 32nd through the 37th cars derailed. On train G-38, the two locomotive units and the 1st through the 4th head cars derailed. The NS estimated the damage as follows:

Personnel Information

Train 188 --The engineer had gone off duty about 5 a.m., Sunday, August 5, and did not work Sunday, Monday, or Tuesday. On both Sunday and Monday nights he slept 8 or more hours. On Tuesday he did some shopping for his baseball team and took his family to a double header baseball game in Atlanta. He came home at midnight and was in bed by 1.30 a.m. On Wednesday morning he awoke at about 9:30 a.m. He left for work at 8.45 p.m., after eating supper. He said that he felt rested when he reported for duty at 9:45 p.m. At the time of the accident, he had been on duty for about 6 hours and had been without sleep for about 17 1/2 hours.

The engineer had been hired by the Southern Railway in 1976. He had been a trainman, a hostler, and a fireman before becoming an engineer on June 14, 1978. In the past 5 years, he had been cited once for a violation and suspended for failing to comply with rule 19: "Each train will display a marker on the rear to indicate the end of train." He had not had a medical or an ocular examination since 1985, when he was required to because he was returning to duty after disciplinary action had been taken against him as a result of the above violation.

The conductor had been hired by the Southern Railway in 1968. He became a conductor on September 21, 1971. The Safety Board was unable to find out what he had been doing during the 72 hours before the accident as the family refused to be interviewed. He had reported for duty about 9:30 p.m. and at the time of the accident had been on duty for about 6 hours. His last medical examination was in 1978.

The brakeman started work on Monday, August 6, and went off duty at 3:40 a.m. on Tuesday. He had 9 1/2 hours rest and worked from 1.30 p.m. to 7 p.m. He went home and worked on his wife's car, watched a movie on TV, and went to bed about 1 a.m. On Wednesday morning he awoke about 10 a.m., went shopping at 11 a.m., and had lunch at 1:30 p.m. He played with his children and his dog that afternoon, visited his wife at her place of work, and reported for work at 9.30 p.m. At the time of the accident, he had been on duty for about 6 hours and had been without sleep for about 17 1/2 hours.

The brakeman had been hired by Southern Railway in 1971. He was both a flagman and a brakeman and was functioning as a brakeman at the time of the accident. In the past 5 years, he had been cited once for violating rule GR9, which states, in part: "All employees must, as far as practicable, observe passing trains for their entire length for defects such as brakes sticking, hot journal, broken or loose wheel, brake rigging down, load shifted, or other trouble."

The flagman worked Monday, August 6, and Tuesday, August 7. He went off duty at 7 p.m. on Tuesday and went to bed at 11 p.m. He arose about 7 a.m. on Wednesday and remained home that day until about 8 p.m. He had had some rest that afternoon while watching TV from his couch but had not consciously sought to sleep. He reported for duty at 9.45 p.m. His schedule from then on was the same as that of the engineer. He had been on duty about 6 hours at the time of the accident and had been without sleep for 20 hours.

The flagman had been hired by the Southern Railway in 1970. He had been a brakeman, but was a flagman at the time of the accident.

Train G-38.--The engineer did not work on August 5. He worked the night of Monday, August 6, and came home early Tuesday morning. He stayed home on Tuesday. He shopped for groceries on Wednesday morning, went to bed for 4 or 5 hours, had dinner, and left for work at 4:30 p.m. He went on duty about 6 p.m.; and at the time of the accident, he had been on duty for 9 1/2 hours and had been without sleep for about 11 1/2 hours.

The engineer had been hired by the Southern Railway in 1968. He became an engineer on June 1, 1970. In 1987, he was suspended for violating Rule 109, which states: "A train or engine must not run faster than the maximum speed authorized in the timetable." His violation resulted in the train uncoupling. He was restored to service, and in 1988 he was suspended for 7 days for failing to secure a clearance card before he left the terminal.

On each of the 3 days before the accident, the conductor had come home about 3 or 4 a.m., slept till 1 or 2 p.m., and left between 4:30 and 4:45 p.m.. According to his wife, he arrived home at 4 a.m. on Wednesday, August 8. They talked until about 6 a.m., when he went to bed. He slept until 2 or 2:15 p.m.. He and his wife talked over breakfast until 4:30 p.m., when he left for work. His wife stated that he had been tired and had experienced a "rough week" because he had been working 6 days a week. However, he was in good health and enjoyed working with this particular crew. At the time of the accident, he had been on duty about 9 1/2 hours and had been without sleep for almost 13 1/2-hours.

The conductor had been hired as a trainman by the Southern Railway in 1971. He became a conductor on May 6, 1976.

The helper came on duty on Wednesday, August 8, at 6 p.m. He had worked a similar schedule on Monday and Tuesday and had gone off duty at 3.00 a.m., Wednesday morning. He had slept until 9:30 a.m. and then had gone to a cattle sale and a flea market in town. He had gone home at 1 p.m., had gone to bed until 3 p.m., and had had lunch before leaving for work. He stated that he had kept pretty much to the work and rest cycle described above and that he felt well rested when he reported for work. When he reported, he met the other two crewmembers and saw nothing unusual in their appearance or behavior.

The helper had been hired by Southern Railway in 1972. He had worked as a brakeman and as a flagman at various times and, at the time of the accident, was a helper. He had received a letter of reprimand for violating Rule 104, which pertained to damage to a switch. At the time of the accident, he had been on duty about 9 1/2 hours and had been without sleep about 12 1/2 hours.

Dispatcher.--The dispatcher had been hired by the Southern Railway in February 1970 as a student agent-operator. He had become a clerk-operator in April 1970 and a train dispatcher in March 1973. He worked a 5-day work week. On Monday, August 6, and Tuesday, August 7, he worked second shift, 3 p.m. to 11 p.m. He worked from 11 p.m. on Wednesday to 7 a.m. on Thursday. He said that on Wednesday he had slept from 2 a.m. to about 7 a.m. and again from 4 p.m. to 7 p.m. He remained home that day and did various chores. He stated that he usually got about 8 hours of sleep each day and that he felt well rested on Wednesday night. At

the time of the accident, he had been on duty about 4 1/2 hours and had been without sleep about 8 1/2 hours.

Work Shift and Rest.--According to work records supplied by the NS, the engineer of train 188 had worked the trip from Atlanta to Chattanooga and back steadily since he had returned from sick leave on July 7. From July 7 through August 5 (30 days), he had made 23 round trips.

The records received from the NS were not complete. They showed when the engineer left Atlanta, when he returned to Atlanta, and how much time he spent on duty between Atlanta and Chattanooga. They did not show when he arrived at Chattanooga, when he left Chattanooga, or how much time he spent on duty between Chattanooga and Atlanta.

The engineer's average daily on-duty time, excluding deadhead hours, was 7 hours 25 minutes. On the average, he went on duty at Atlanta about 9:45 p.m. and off duty at Atlanta about 3:45 a.m.

Table 1 shows the engineer's work record for the 20 days from July 17 through August 5, including the times at which he reported for work at Inman Yard, his on-duty times for the trips to Chattanooga, and the times he went off duty after returning from Chattanooga.

The conductor had a similar schedule. He had been on vacation from July 15 through July 30. He signed up to be on call July 31 but did not start work that day. Table 2 shows his work record from August 1 through August 7.

In spring 1990, the dispatcher and all of the crewmembers of trains 188 and G-38 had passed examinations of their knowledge of the NS "Operating Book of Rules."

A search of the National Driver Register (NDR) and a 50-State license check did not reveal a history of driver license suspension, revocation, or other judicial action against the personnel involved in this accident.

Train Information

Train 188.--The train had two General Electric (GE) units, Model C-398, each developing 3,900 horse power; the two units were connected such that the ends of the long hoods met, with the short end of the hood of the lead unit in front. During the entire trip, the engineer sat at the control stand¹⁷ (console) on the west (left) side of the lead unit, and the conductor sat on the east (right) side. Two crewmen rode in the trailing unit, the flagman in the seat at the console on the east side and the brakeman in the west side seat. Both units were equipped with Pulse 48-hour MTR event recorders. The event recorder data pack from the trailing unit was internally damaged before the accident and contained no data pertinent to the accident; the event recorder data pack from the lead unit was intact and was read

¹⁷The units were dual control. The design direction of running is with the long hood in the lead, at which time the engineer is on the right side of the locomotive. Before the accident, the locomotive was running with the short hood forward. Therefore, the engineer was on the left side.

Table 1

<u>Date</u>	<u>Left Atlanta</u>	<u>Time on Duty (hours--minutes)</u>	<u>Returned to Atlanta</u>
7-17	10:00 p.m.	7 45	
7-19			3.00 a.m.
7-19	11:45 p.m.	8 30	
7-21			5 20 a.m.
7-23	11:30 a.m.	2 20 (deadheading)	
7-24			7:30 a.m.
7-25	10:45 p.m.	7 20	
7-27			3:15 a.m.
7-27	10:45 p.m.	6 00	
7-29			2:15 a.m.
7-30	11:56 p.m.	3 15 (deadheading)	
7-31			2.30 a.m.
8-1	8:15 p.m.	7 15	
8-3			12.30 a.m.
8-3	1:45 a.m.	7 45	
8-5			5 10 a.m.
8-8	9:45 p.m.	(Accident)	

Table 2

<u>Date</u>	<u>Left Atlanta</u>	<u>Time on Duty (hours--minutes)</u>	<u>Returned to Atlanta</u>
8-1	8:45 p m	6 45	12.30 a.m.
8-3			
8-3	1:45 p.m.	8 15	5:10 a.m.
8-4			
8-5	Off		
806	1:01 a m	2 59 (deadheading)	4:30 a m
807			
8-8	9:30 p m	Accident	

at the Safety Board's laboratory. The lead unit had a Pulse Sentry II Alerter System¹⁸. The maintenance base for both units was in Roanoke, Virginia.

Train G-38 --The train had two units; the lead unit, with the long hood forward, was an EMD GP-38 model, four-axle, 2,000-horse power diesel electric locomotive; and the second unit, with the long hood trailing, was a GE model B-23-7, four-axle, 2,250-horse power diesel electric locomotive. The event recorder data pack from the lead unit was destroyed. The data pack from the trailing unit was retrieved, however, that event recorder was a NS-designed recorder capable of recording for only 8 hours. The Safety Board's laboratory did not have an NS 8-hour read-out station; therefore, the Safety Board staff supervised the operation of the NS read-out station. The Safety Board staff determined that a portion of the accident data was unrecoverable. It was the data that were collected after the train was 0.35 of a track mile from the accident. (A track mile is 5,280 feet long.) The train was hauling six loaded cars and no empties.

Track Structure and Signal System

Track--The main track was constructed with 136-pound (per yard) continuous welded rail (CWR), which was manufactured in 1979 and laid in 1981. The track was maintained to meet Federal Railroad Administration (FRA) class 4 Track Safety Standards. Freight trains on class 4 track are allowed a maximum speed of 60 mph. NS Division Superintendent Bulletin #0-11, dated January 9, 1990, directed that the speed of all freight trains be reduced to 50 mph, except rail-highway trains consisting entirely of TTX, Triple Crown Service, double-stack (container, highway trailers, or combination rail-highway trailers), or passenger equipment, unless otherwise restricted.

The siding was constructed with 132-pound (per yard) CWR. The carrier had a 25-mph operating speed on the siding.

The track grade and alignment southbound on the single main track at the accident site was 0.7 percent descending grade and straight. Approaching from the north on the main track, about 1 mile before the point of the accident, there were, in succession, straight track for 1,447 feet, a 3-degree 3-minute curve to the left for 558 feet, straight track for 1,393 feet, a 55-minute curve to the right for 878 feet, and straight track for 1,017 feet to the point of the accident and for 939 feet beyond. The gradient from the north on the main track was practically level for 3,700 feet; then, from a point 1,493 feet away from the point of the accident, the descending grade was 1.2 percent. (See appendix C.)

From the south on the signaled siding for northbound movement, the track was straight for 7,892 feet; it had a compound curve of 1 degree and 7 minutes to the right for 518 feet, 1 degree 58 minutes for 1,067 feet, and 1 degree and 4 minutes for 551 feet; and then it was straight for 939 feet to the point of the accident on the north end turnout of the signaled siding. The gradient from the south on the siding for northbound movement was 0.8 percent ascending for 3,500 feet, 0.3 percent ascending for 3,000 feet, 0.8 percent ascending for 1,700 feet, and 1.4 percent ascending for 800 feet to the point of the accident.

¹⁸An alerter system is an electronic device that automatically cuts off locomotive power and applies the brakes if the engineer is incapacitated.

The track inspections were in compliance with the frequency requirements set forth by the FRA.¹⁹ Because of hot weather, the carrier's maintenance-of-way department had been inspecting the track daily for 2 months before the accident. A relief track inspector had inspected the track the day before the accident. He found one broken track bolt in the area of the accident site, and remedial action was taken.

The carrier ran the Sperry Rail Service test car over the territory on June 13. No rail defects were reported or found in the vicinity of the accident. The NS operated its geometry car over the territory on May 1. One track safety standard variation was found in the vicinity of the accident site and was corrected 6 days later.

Signal System.--The signal system in the area of the accident was a single-track traffic control that used a General Railway Signal Co. (GRS) type 4000 control machine that was operated from Atlanta, Georgia, by means of cable and microwave radio transmission.

The accident happened at CP DAVIS, MP 53.3. CP DAVIS was the north end of a 10,232-foot signaled siding, of which the south end was CP SUGAR VALLEY. The approach signal, MP 57.8, governing northward train movement to CP SUGAR VALLEY, was about 13,088 feet south of CP SUGAR VALLEY. The approach signal, MP 50.7, governing southward train movement to CP DAVIS, was about 12,451 feet north of CP DAVIS.

Track circuits were GRS rate code.²⁰ The wayside signal locations used GRS plug-in relays. Switch machines controlling the switch points at CP SUGAR VALLEY and DAVIS were GRS 5-H dual control. The signals were GRS type D colorlight with Phillips lamp bulbs.

Upon arriving at the accident scene, the NS signal employees and a representative of the FRA observed that the power switch at CP DAVIS was lined and locked for a main track move. They also recorded the relay positions (energized, deenergized, or code rate) in the CP DAVIS instrument house. After comparing this information with the circuit plans, the NS and the FRA verified that the southbound controlled main track signals at CP DAVIS and CP SUGAR VALLEY were cleared (proceed) for the southward movement of train G-38. They also verified that all northbound signals had to be at "STOP." The computer dispatch system report showed that all train movements were governed by signal indication up to the time of the accident. The signal inspections complied with the frequency requirements set forth by the FRA.²¹

¹⁹Title 49, Code of Federal Regulations, (49CFR213) Part 213, "Track Safety Standards "

²⁰A "rate code" track circuit is one in which the steady rail current is interrupted a predetermined number of times per minute (75, 120, or 180) in order to form a code consisting of uniform impulses per minute. The direction of the coded pulses is reversed to facilitate changes in train traffic direction, in turn providing the correct signal aspect for that train movement.

²¹Title 49, Code of Federal Regulations, (49CFR236), Part 236--"Rules, Standards, and Instructions, Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Appliances "

Operations Information

The NS Georgia Division Timetable No 4, effective Sunday, May 21, 1989, which was in effect at the time of the accident, designated territory between Atlanta and Chattanooga as Traffic Control (TC) Territory in which trains were operated on the bases of wayside signal indications. The timetable stated that the maximum speed through the turnout at CP SUGAR VALLEY was 40 mph. The maximum speed in the siding between CP SUGAR VALLEY and CP DAVIS was 25 mph. According to the NS operating officers, the lower of the two (25 mph) also governed the speed through the turnout. Train dispatchers in Atlanta manipulated the remote control switches and signals at the control points by operating the TC console. No special instruction or train orders were issued for the area of the accident.

No regularly scheduled passenger trains operated on this segment of railroad. The NS operated about 20 to 25 freight trains daily over the segment.

The NS had a policy of requiring operating and division officers to administer a predetermined number of efficiency tests each month. The rules required a quota of tests equal to the average number of trains operated on the division each day. In addition, each operating officer was required to make a minimum of 25 checks monthly for adherence to other rules.

According to the NS, between January 1989 and June 1990, the seven crewmembers involved in the accident were each given from 43 to 126 tests; in all, the seven took 500 tests covering all aspects of the carrier's operating rules. During that period, none of the seven was cited for rule violation.

At the time of the accident, the April 15, 1990, Norfolk Southern Operating Rule Book governed the conduct of transportation on the NS and its subsidiaries and defined signal indications, speeds, and other operating requirements.

The following rules applied to the operation of train 188 as it progressed through the siding towards CP DAVIS:

Rule 240.

A train or engine approaching a signal displaying a STOP indication must stop before any part of the equipment passes the signal.

Rule 34:

The engineer must comply with the indication of each block, interlocking and other signal that affects the movement.

Crew members located in the compartment must occupy a window seat when available, and must maintain a vigilant lookout for signals and conditions along the track that affect movement. Crew members located in the operating compartment who cannot avail themselves of a window seat must maintain a vigilant lookout for signals and conditions along the track, within their view, that affect the movement.

Employees located in the operating compartment of an engine must communicate to each other in an audible and clear manner by its name the indication of each signal affecting movement of their train or engine as soon as the signal is clearly visible or audible. Each signal must be called (1) as soon as is clearly visible or audible and (2) again, if other than a stop signal, just before the signal is passed. It is the responsibility of the engineer to have each employee comply with these requirements

When crew members ride in trailing units their first duty is to observe signals affecting the movement. If other crew members are present, they must communicate to each other by its name the indication of each signal.

If the engineer fails to control movement in accordance with signals or other conditions, crew members must communicate with him at once. If he then fails to immediately control speed properly they must take necessary action to stop the train.

Rule 106

The conductor, engineer and pilot are jointly responsible for safety of the train and engine and for observance of the rules. Under conditions not provided for by rules, they must take every precaution for protection. When necessary, they must instruct members of their crew as to proper performance of duties.

Other members of the crew must call attention of conductor or engineer immediately to any apparent failure to observe requirements of rules, timetable, train orders, messages or other instruction.

When conditions require stopping the train or reducing speed and the engineer or conductor fails to take proper action to do so, or should the engineer become incapacitated, other crew members must take necessary action to stop the train.

According to the carrier's operating book, each crewmember is responsible for stopping the train should he or she believe the engineer is incapable of controlling it. The NS-issued Bulletin 0-108, dated October 4, 1990, which superseded a similar bulletin (0-97, dated September 4, 1990), for the Georgia Division states.

Crew members riding trailing units must transmit via radio to the engineer the indication of each control signal as it comes into view, and must be acknowledged by the engineer. [See appendices E and F.]

Meteorological Information

According to the NS dispatcher, at the time of the accident the temperature was 68 °F.; it was dark, clear, and windless.

Medical, Pathological, and Toxicological Information

Injuries.--The engineer and conductor of train 188 were riding in the lead locomotive. The engineer, who was seated on the left side of the locomotive, suffered multiple contusions and abrasions and temporary loss of consciousness secondary to trauma. The conductor, who was riding on the right side (striking side) of the locomotive, suffered smoke inhalation, burns, and massive injuries. Both the flagman and the brakeman, who were seated, respectively, on the left side and on the right side of the second unit, suffered multiple abrasions and contusions.

The engineer of G-38 was riding on the right side, and the conductor was on the left side of the lead unit. Both men suffered smoke inhalation, burns, and massive injuries. The helper, who was seated on the left side of the second unit, suffered a lacerated scalp.

Toxicology.--Samples of blood and urine were taken from all the surviving crewmembers and the dispatcher. Tissue samples consisting of liver and muscle were taken from the fatally injured crewmembers. All samples were taken at Gordon Hospital in Gordon County, Georgia, within 8 hours of the accident. Compuchem Laboratories in North Carolina tested the samples on August 21, 1990. All results were negative for drugs and alcohol.

Medical.--Four of the seven crewmembers were being treated for hypertension, one crewmember and the dispatcher were being treated for diabetes. The following table shows what drugs they were taking.

<u>Employee</u>	<u>Drug</u>	<u>Reason</u>
Engineer (188)	Prinzide Diuretic	hypertension high blood pressure
Flagman (188)	Micronase Capoten Disulfiram Fluoxymesterone Procardi	diabetes hypertension alcoholism hormone therapy angina/hypertension
Brakeman (188)	Inderal Minipress Naqua Doxycyline	hypertension/angina high blood pressure high blood pressure antibiotic
Engineer (G-35)	Methyclothiazide	high blood pressure
Dispatcher	Tolazamide	diabetes

The NS policy for medical examinations for train and engine crewmembers was as follows:

<u>Under age 50 years</u>	Every two years the employee will be tested for visual acuity, color and auditory perception, urinalysis and a drug screen
<u>Age 50 to 59 years</u>	Every two years the employee will be tested for the same items as employees under 50 years of age in addition to a physical examination.
<u>Age 60 and over</u>	Examinations are the same as those for age 50 to 59 years except they are on an annual basis.

Alcohol and Drug Program --The NS's drug policy and its Drug and Alcohol Rehabilitation Service (DARS) program for hours-of-service employees were described in its booklet "Safety and General Conduct Rules." The booklet described the penalties employees were subject to if they possessed or used alcohol or other intoxicants, cannabis in any form, amphetamines, narcotic and hallucinogenic drugs, any controlled substance (as defined by Federal law), or any derivative or combination of any of the drugs mentioned.

Fire

The fuel tank on the lead unit of train G-38 was torn loose and ruptured, resulting in a fire that engulfed the operating cab and damaged the long hood of the trailing unit. The fuel tank on the second unit was punctured.

The fuel tank on the lead unit of train 188 was punctured. The control cab and the long hood were damaged extensively by fire. A bulkhead flat car loaded with lumber also caught fire and burned until the early afternoon of August 9

Postaccident Damage Examination

Train 188 --The lead locomotive unit derailed and came to rest about 90 feet to the west of and at a 90-degree angle to the track. It lay on its right side with the short hood pointed toward the west. Both trucks were separated from the unit, and its fuel tank was dented and ruptured. Fire had damaged the short hood and the part of the long hood that was over the fuel tank. The right side of the control cab was severely crushed inward, and no survivable space remained between the conductor's console and the right exterior wall. The interior of the cab was extensively damaged by heat (see figure 3). The grab rails along the exterior right side had collapsed inward. The power switch was on, and the dynamic braking switch was off.

The second unit remained upright with its lead truck derailed. The sheet metal surrounding the right front of the unit was collapsed inward about 4 feet. The inside of the cab was not visibly damaged.

Train G-38--The lead locomotive unit derailed to the east of the main track; it lay on its right side with the long hood pointed south. All the sheet metal that had surrounded the engine was torn away. The locomotive was off its trucks, and its fuel

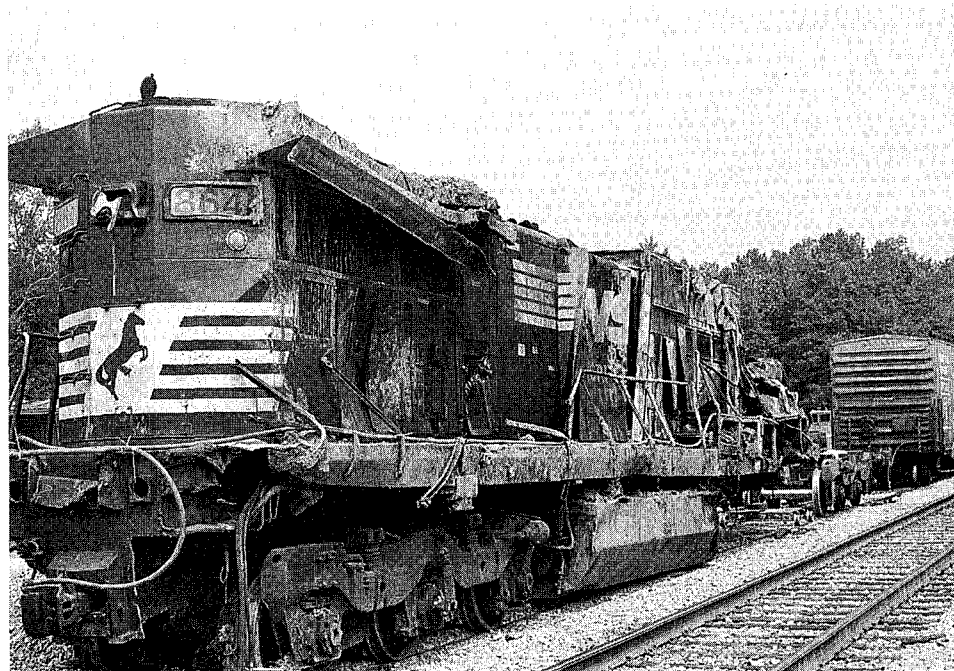
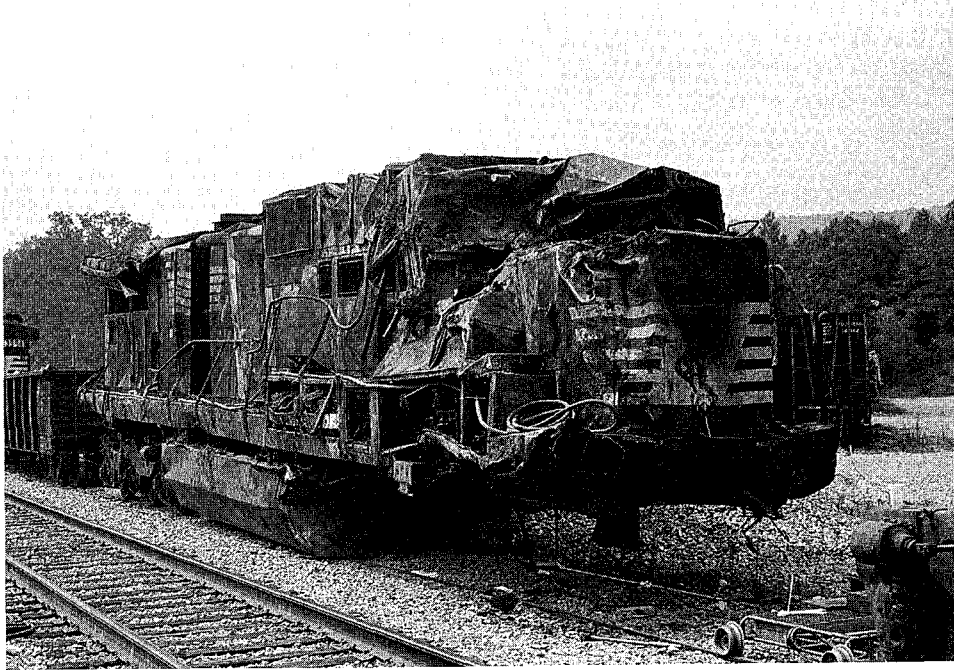


Figure 3.--Two photos of damage to the lead unit, NS 8641, of train 188.

tank was torn off. The cab interior was intact and had no apparent structural damage, but thermal damage was extensive. (See figure 4.)

The sheet metal and grab rails of the right front of the second locomotive unit were damaged thermally and structurally. (See figure 4.) The fuel tanks were punctured, and the locomotive was on its right side. The interior of the cab was not visibly damaged.

Four trailing cars derailed to the east of the track, but remained upright.

Survival Aspects

The Gordon County sheriff and the fire chief shared responsibility for command at the accident scene. No incident command or command post was established. No triage area was necessary because the four crewmembers identified themselves to emergency medical service (EMS) personnel upon the arrival of the ambulance and were transported to the hospital about 4:17 a.m.

According to the county's Director of Emergency Services, Gordon County's disaster plan had been in effect since August 1983. Because the plan had not been exercised for the past several years, the Gordon County Hospital, the sheriff, the EMS, and the fire department operated their own plans independently. No 911 emergency telephone number was available. The sheriff's dispatcher was responsible for notifying the police, fire, and EMS departments through regular telephone communication.

The brakeman and the flagman, who had escaped the second unit of train 188, tried to notify the dispatcher of the collision. The brakeman did not receive a response to his emergency call on his portable radio, so he used a hammer to break the lock on the signal instrument house at the accident site, where he knew there was a telephone. After telephoning the dispatcher and describing what had happened, he left the instrument house and heard the dispatcher calling train 188 over his portable radio.

About 3:25 a.m. the NS notified the Gordon County sheriff's office that a train collision had occurred just south of highway 136 between Sugar Valley and Hill City. At approximately 3:40 a.m., Gordon County fire department's Rescue One and Engine One arrived on the scene. Personnel from both units attacked the fire surrounding the lead unit of train 188, which lay on the west side of the track. Subsequently, engine No. 5 attacked the fire on the east side of the track, and engine No. 7 attacked the fire from the woods.

At 3:50 a.m., the sheriff's deputies found the four surviving crewmembers just south of the burning locomotive.

At 4:20 a.m., a U.S. Forest Service pickup truck arrived and was able to clear a footpath through the woods along the east side of the tracks.

At 5 a.m., the fire inside the lead unit of train 188 was extinguished. Workers used hydraulic cutters and a sledge hammer to extricate the body of the conductor through the window.

At 5:30 a.m., the fire on the east side of the lead locomotive unit of train G-38 was extinguished. The bodies of the two victims were removed at daylight.

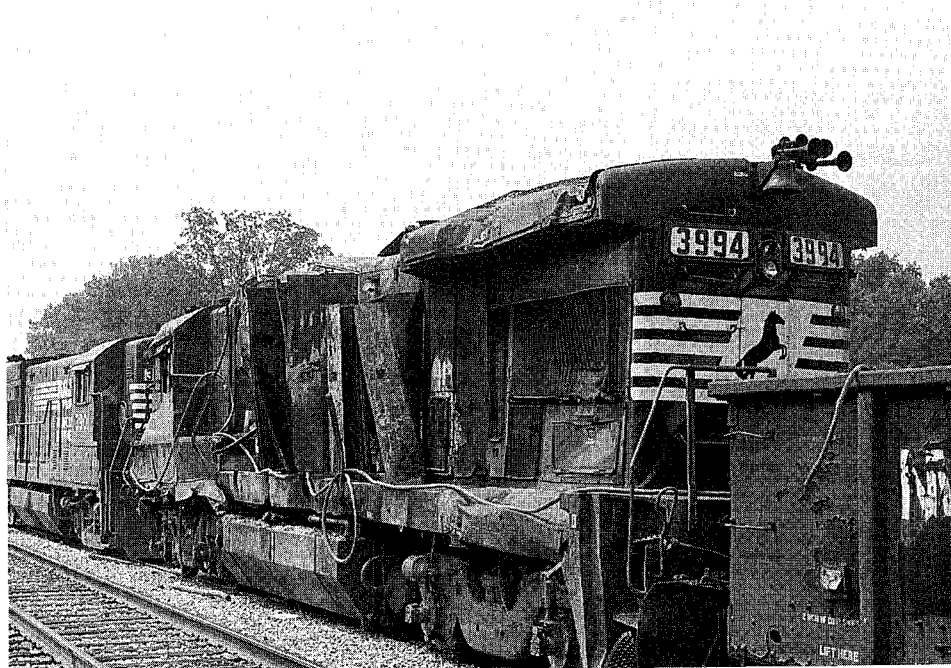


Figure 4.--Two photos of damage to the locomotive of train G-38.

Firefighters were not able to extinguish the burning lumber on the freight cars until cleanup crews had removed it from the cars.

Tests and Research

Event Recorder on Train 188--The data from the event recorder showed that the dynamic brakes had been the primary brake system used to slow the train. The automatic air brake system had been used twice throughout the trip from Atlanta; on both occasions, it was used to supplement the dynamic brakes

The NS Computer Dispatch System Report showed that the dispatcher had lined the switch and signal for train 188 to enter the south end of the siding, CP SUGAR VALLEY, at approximately 3:02 a.m. The train entered the siding about 3:08 a.m. at a speed of 38 mph according to the data retrieved from the event recorder. The engineer had applied the dynamic brakes.

The data from the event recorder showed that the engineer made the following locomotive command changes: When the head end was about 2,000 feet into the siding, he released the dynamic brake and placed the throttle²² in the idle/1/2 position. The train was moving about 28 mph. It slowed to about 27 mph, at which time he moved the throttle to position 4. The train's speed continued to decrease to about 20 mph.

He moved the throttle to position 6 and, when the train was about 4,500 feet from the accident, to position 8. The train's speed increased to about 24 mph when he moved the throttle to position 7. He moved it to position 6 when the train was about 2,500 feet from the accident site and traveling about 26 mph.

When the train was 361 feet and 9.51 seconds from the collision point, he put the automatic air brake in emergency, which in turn operated the engine brake and opened the pneumatic control switch, (PCS),²³ placing the engine throttle in the idle/1/2 position. When the brakes were applied, the train had already reached the "STOP" signal, and it struck the lead engine of train G-38 in the turnout of the siding

Event Recorder on Train G-38 --The dispatcher's incident report (see appendix J) yielded the following description of activities: The crew performed work at Ooltewah, Tennessee, MP 17.2 and 18.2, and at Cohutta, Georgia, MP 26.7 and 29.8, when southbound train NS 243 passed (1:15 a.m.) and northbound train NS 230 passed (1:34 a.m.). The next stop was Dalton, Georgia, MP 42.0, where train NS 360 passed while the crew was working. Train G-38 then proceeded to MP 46.1 near Phelps, Georgia, working a wood chip yard. Leaving this location shortly after the engineer had a radio conversation with the dispatcher, the train proceeded toward Davis, Georgia, the accident site.

²²The throttle is the regulating handle and connections that determine the amount of fuel entering an engine, thereby determining the engine and locomotive speed

²³The PCS is operated from the air brake system. During a safety control penalty or emergency brake application, this switch opens, causing the engine control to drop to the idle position

According to the dispatcher's computer log, the train left Freeman, Georgia, clearing the controlled siding (MP 48) at 3:06 a.m., about 5.1 miles from Davis, with six loads and no empties. Event recorder data indicate that just before the accident, the train was traveling 42 mph, with the throttle in idle, the reverser off, a load of 0 amperes, the dynamic brake on, and the automatic brake indicating a major reduction. The second locomotive unit decelerated rapidly from 42 mph, and the reverser, dynamic brake, throttle, independent brake, and automatic brake positions changed to on, off, idle/1, on, and emergency, respectively. Whether these final throttle and brake positions were the result of the accident or of the train operator's actions is uncertain.

Alerter System --The locomotive of train 188 was equipped with a Pulse Sentry II Alerter System. The system monitors actions taken by the engineer to detect whether he is incapacitated by sleep, unconsciousness, or death. If the engineer does not reset the system by manipulating the various controls, such as the throttle, the three brake systems, the horn, the bell, the reverser, and the manual sander, or by touching the console-mounted reset switch, the alerter activates its warning lights and whistle until a predetermined amount of time has passed, after which a penalty brake application occurs.

After the accident, NS personnel removed the alerter control box and safety control magnet valve from the lead unit of train 188 and sent them to the Roanoke, Virginia, locomotive maintenance facility, where they were tested and reported to function as designed.

According to testimony from an NS mechanical department officer, when a train's speed is below 3 mph, about 20 seconds elapse between the time that an alerter is reset and the time that the lights start to ramp up²⁴. After about 10 seconds of lamp ramp up, the whistle activates for 10 seconds, followed by 7 to 10 seconds to bleed the air off the safety control magnet valve, after which a penalty brake application is initiated.

If the train's speed is between 3 and 40 mph, the time between reset and the ramping of the light is 60 seconds. The time between activation of the whistle and bleed-off of the air remains the same. Thus, about 87 to 90 seconds elapse between the time that the alerter is reset and the time that a penalty brake application is initiated.

If the train's speed is more than 40 mph, the dormant time in seconds is determined by dividing 2,400 by the speed in mph. (See appendix G.)

Diagnostic Display Panel (DID)

According to the data stored in the diagnostic display panel (DID) of train 188's second unit, the unit's dynamic braking was in the failed mode on three occasions, the last being about 25 minutes before the accident. The fault message, which is designated on the DID panel, was 04A3, "NO SPEED FROM BRAKING GRID BLOWER 1." The same fault showed up six other times before the accident trip run. (See appendix H.)

²⁴"Ramp up" refers to a steady rise in the flash rate of the alerter warning light.

Sight Distance Tests

The day after the accident, sight distances were tested at the accident site. The weather and time frame for the tests were comparable to those at the time of the accident. Four locomotive units were used for the tests. Two units of the same type as those on train G-38 were coupled in the same configuration as that of the accident train and occupied the main track north of CP DAVIS. The other two units were of the same type as those on train 188; they were coupled in the same configuration as that of train 188 and occupied the siding south of CP DAVIS.

Heading north from CP DAVIS, the track curves 1 degree to the left. Heading south from CP DAVIS, it curves 1 degree to the left. The tests measured various locations and distances from which personnel in each set of units could see the headlights (not reflection) of the other set of units.

The tests also attempted to determine the distance from which personnel in the locomotive consist on the siding could see the northward signals at CP DAVIS.

The farthest that members of the two operating crews could see each other clearly was the point at which the units on the siding were 1,075 feet south of the northward home signal at CP DAVIS and the units on the main track were 1,860 feet north of that signal, for a total separation distance of 2,935 feet. The crewmembers on the units simulating train 188 could see the northward home signal for CP DAVIS siding at 1,385 feet.

Stopping Distance Tests

Three days after the accident, the NS tested a train that was similar to train 188 to find out how its stopping distance at CP DAVIS was affected by its brakes. The test train consisted of two of the same kind of locomotive units that were on train 188, 22 loads, and 40 empties; it weighed 4,174 tons. On one of the tests, the engineer used the dynamic brakes to slow the train to enter the siding at CP SUGAR VALLEY. After the train entered the siding, the engineer released the dynamic brake and used the throttle to restore power. He reduced the throttle to position 1, and the train continued to slow until it stopped about four car lengths (approximately 200 feet) from the home signal. The engineer did not use dynamic or air braking to stop the train.

To study the braking pattern of engineers entering CP SUGAR VALLEY, the NS removed an event recorder tape from train 711, a revenue train similar to train 188, at CP DAVIS on August 22. The train carried no loads and consisted of four locomotive units and 110 empties, it weighed 3,636 tons and was 6,398 feet long. The engineer used dynamic braking entering the siding and subsequently reduced the throttle; he did not use dynamic or air braking to slow or stop the train. The train stopped about 300 feet from the signal. The crewmembers were unaware that the stopping of their train was being observed as part of this braking study and that the event recorder tapes were to be read.

Other Information

In the late 1970s, several Canadian railroads began to study the potential for using new technology in computers and communication for a new train control system. Several U.S. railroads joined them in 1983. The union was formalized in 1984 through an agreement between the Association of American Railroads (AAR)

and the Railway Association of Canada. The AAR currently manages the project. The new system is called the advanced train control system (ATCS)

In 1985, the AAR retained a technical consulting firm in Annapolis, Maryland, to design the system architecture. System specifications have been written, approved by the ATCS oversight committees, and released to the railroads for implementation. The specifications are written in such a way that the system can be built in stages and components can be furnished by several different suppliers.

The ATCS has five major components

1. The dispatching system controls train movement; provides information through the management information system (MIS) about work orders, train schedules, and other features, and receives information from the field and distributes it to the proper departments.
2. The communication system is made up of two distinct systems: a voice radio that uses the current VHF frequencies and a data radio that uses one of the six 4,800 bytes per second (bps) UHF radio frequencies in the 900 Mhz band. The Federal Communication Commission allocated the channels to the ATCS as a functional data interface between the dispatchers, engineers, and track maintenance personnel.
3. The locomotive system computer consists of the mobile communication unit, the control and display package, the on-board locomotive computer, the transponder/interrogator, odometers, enforcement interface, locomotive diagnostics, and any other sensor device that a user may employ.

The on-board computer (OBC) is the heart of the locomotive. It responds to messages from the dispatcher computer, wayside elements, track forces, and other external devices that operate through the mobile communication unit.

The track transponder, which is one of the wayside elements, establishes positions at specified locations and provides odometer readings between those locations. The information is updated by the OBC and reported to the dispatcher's computer.

4. The track-force data terminal, like the locomotive system, has a UHF radio frequency data link. Each railroad will decide how to use the track force data terminal. Its basic uses are to determine train line up for track work without the need for voice communication, to schedule track work that will not interfere extensively with traffic, and to report work performed at day's end.
5. The field systems consist of a wayside interface unit (WIU) and a communication package. The WIU has two basic functions: it provides control for and monitoring of switches for route integrity, and it provides the interface between other devices or subsystems, such as hot box detectors. The ATCS data link

communicates with the WIU, locomotives systems, the dispatcher system, and the ATCS data network.

The ATCS system is being tested on AAR member roads in the United States and Canada.

One U.S. railroad, the Burlington Northern, decided to try a different approach to train control. Its system is the advanced railroad electronic system (ARES). The ARES approach regarding wayside, locomotive, and dispatcher control is very similar to the ATCS. Instead of transponders, ARES uses continuous signals received from several NAVSTAR global positioning satellites (GPS). An on-board computer uses the signals to calculate the specific location; the information is transmitted by the railroad's voice (VHF) radio system to a central office. The location is accurate to within 150 feet. The voice radio frequency is used instead of the UHF 960 Mhz frequencies assigned to the ATCS. The locomotive does not have a keypad. Instead, it has a cathode-ray tube with a menu-driven program and seven touch-screen keys.

Regardless of the system employed, ARES or ATCS, information is provided to the dispatcher's computer monitors above whether the engineer has control of his train. If the engineer fails to adhere to a particular authority or becomes incapacitated, the dispatcher's computer can determine from the train's speed that the engineer is not going to stop. The computer can then enforce the stopping of the train by a command.

ANALYSIS

General

The track structure did not have any anomalies or deficiencies, and the wayside signal system functioned as designed. Train 188 was inspected before it left Atlanta, and according to the surviving crewmembers, no mechanical problems were reported. The weather was not a causal factor in the accident.

Accident

Train 188 proceeded through the siding and failed to stop at the northward home signal at the north end of the siding, CP DAVIS. It continued on to the turnout, striking train G-38 nearly head on. Train G-38 had been given clear signals to operate southward on the main track over the normal switch at CP DAVIS and on to CP SUGAR VALLEY and beyond. To find out why the engineer of train 188 did not stop his train and why the conductor, flagman, and brakeman did not intervene, the Safety Board examined the work and rest cycle of the traincrew, their physical condition, NS operating rules 34 and 106, the effectiveness of the alerter system, and the influence that positive train separation provided by the ATCS could have had on this accident. Another area investigated was the locomotive diagnostic computer checking.

Human Performance

Work and Rest Cycle.--The engineer of train 188 normally worked at night. He usually reported for duty between 9 and 11 p.m., took a train to Chattanooga, took his required rest during the day at a motel, and then returned by train to Atlanta, where he usually arrived between 2 and 7 a.m. On the average, he worked about 82 hours per shift and had 12 to 15 hours rest time after he returned home.

The train engineer's schedule had been reasonably consistent since July 7, and he had regularly worked 6 days a week. His habit, he said, was to go to bed after he got home, sleep through the remainder of the morning, do chores and shop in the afternoon, and try to nap before the time he expected to be called. A change had taken place in his routine, however, just before the accident. On Sunday, August 5, he went off duty about 5:10 a.m., and he took Monday, as well as his usual day, Tuesday, off. Thus, he had reverted to a day and night routine for 3 nights after having been on his normal night-work and day-rest routine for over 3 weeks

Sleep research has shown that shift workers never fully adapt to an irregular night shift routine.²⁵ Other research²⁶ has shown that people in general are particularly vulnerable to falling asleep between 2 and 7 a.m. and between 2 and 5 p.m. People who have slept briefly during these times are likely to suffer from diminished capacity in their functioning, and people who have not had enough sleep are likely to be particularly vulnerable to episodes of microsleep during those same periods.

Microsleep is defined as a period of sleep lasting from a few seconds to minutes from which a person awakens spontaneously. During a public hearing on a similar railroad accident, Dr. Donald Tepas, an expert on sleep loss, testified²⁷ before the Safety Board that the frequency and duration of such events increase with the increase in sleep deprivation. He said that the individual often is unaware of either the onset or the end of a microsleep and even may be entirely unaware that any lapse of consciousness has occurred. He may perform quite well just before and after the lapse, during the lapse, however, he will respond only to external stimuli that are very intense, very unusual, or particularly meaningful.

The decision of the engineer of train 188 to interrupt his work and rest cycle made him more susceptible to falling asleep. On the previous 3 nights, he had slept a full 8 hours or more. He had not tried to obtain additional rest before he went on duty on Wednesday night; and thus at the time of the accident, he had been awake for more than 17 hours. The need for sleep would recur again after about 15 or 16 hours of wakefulness. Furthermore, this pressure for sleep probably was increased because he had entered into the early zone (2 to 7 a.m.) of increased sleep vulnerability.

The Safety Board believes that despite the engineer's testimony to the contrary, he was already experiencing some alertness problems when the train entered the siding at CP SUGAR VALLEY. The event recorder data recovered from the leading unit shows that the engineer's performance had deteriorated; that is, he did not control his train so as to arrive at the turnout at CP SUGAR VALLEY at the proper speed. He subsequently allowed the speed to drop well below the 25 mph

²⁵Dinges, David F., "The Nature of Sleepiness: Causes, Context and Consequences", in Baum, A., Stunkard, A. eds., Perspectives in Behavioral Medicine, New Jersey: Erlbaum, 1988

²⁶Mitler, Merrill M., et al. "Catastrophes, Sleep, and Public Policy. Consensus Report", in Sleep, 11(1) 100-109, Raven Press Ltd, New York, 1988

²⁷Tepas, Donald I., in railroad accident report, "Head-end Collision of Consolidated Rail Corporation Freight Trains UBT-506 and TV-61 near Thompsettown, PA, January 14, 1988"; National Transportation Safety Board, NTSB/RAR-89/02, Washington, D.C. 20594, February 14, 1989 Government Assessment No. PB89-916302

limit for the siding and needed to go to full throttle (position 8) to regain speed. Since a willful disregard for track speed and train handling technique was out of character for him, the Safety Board believes that he was having trouble staying awake even before he entered the siding.

The event recorder data showed that he reduced the throttle setting from 8 to 7 and finally to 6 in an apparent effort to maintain a speed of 25 mph as he topped the crest of the grade. An alert and proficient engineer would have brought the throttle back to the idle position at this point so that the train could coast to a stop before it reached the signal. Nevertheless, the Safety Board is not able to say definitely that the engineer fell asleep at this point, and there are other possible reasons for his inattention; however, none were apparent to the Safety Board.

The conductor, who was seated on the right side of the locomotive cab, had also worked a steady 6-day week throughout June and the first half of July, after which he went on a 2-week vacation. The majority of his trips were round trips between Atlanta and Chattanooga, and most were at night. It could not be conclusively established why he did not warn the engineer when the train did not slow down in preparation for a stop at the signal. It seems unlikely that the conductor would have consciously allowed the engineer to pass the stop signal and cause an accident. Therefore, the Safety Board believes that the conductor was either distracted or asleep.

The brakeman and the flagman, who were in the trailing unit, had work and rest cycles that were similar to those of the other two train crewmembers. The Safety Board could not conclusively determine why the trainmen did not see the home signal at CP DAVIS. Their testimony indicates that they were alert and that they were aware that they were responsible for warning the engineer or taking other action to avoid an accident if he did not stop the train in response to the signal at CP DAVIS. The Safety Board realizes that since the trainmen were in the trailing unit, it was not easy for them to see signals because their view was partially blocked by the lead unit and by the long hood of the trailing unit. Nevertheless, these trainmen were equally responsible for ensuring the safety of the train to the best of their ability.

On May 12, 1989, the Safety Board issued Safety Recommendations I-89-1 through 3 to the Secretary of the Department of Transportation (DOT) about human fatigue in transportation. The Secretary responded on August 11, 1989, citing ongoing human-factors research in the various modal administrations of DOT. The Office of the Secretary briefed the Safety Board staff on September 12, 1990. Each modal administration discussed its ongoing studies and how they would relate to the overall DOT policy.

On June 21, 1991, the Chairman of the National Transportation Safety Board addressed Congress and discussed work and rest problems and how the FRA is being hampered by antiquated railroad work laws. The Safety Board is hopeful that the FRA will soon provide guidelines to help the railroad industry reduce or eliminate accidents caused by fatigue.

Effectiveness of the Alerter System.--The engineer on train 188 testified that when the train was about midway through the siding, the alerter activated and he reset it, thus, the system was functioning normally. Enough time had elapsed between his resetting the alerter by placing the throttle in position 6 and the accident to trip the alerter system. Since the event recorder indicates that no further

events occurred after he set the throttle at position 6, the alerter system should have activated about 60 seconds later. He also said that he had placed the train into emergency after having seen the headlight of train G-38. But the train did not come to a stop at the signal. This suggests that he must have reacted to the alerter, a reasonable assumption if the distance between the point where he made the last throttle movement and the point where the accident happened was at least 2,376 feet.²⁸ However, even if he did react, he may not have been alert.

As Dr. Tepas has described, a sleeping person can discriminate sounds (and also lights) and perform reflex actions in response to a well known stimulus. The light on the alerters used on the NS locomotives flicker at a high frequency about 10 seconds before the alerter produces an auditory signal. The light is intense enough, especially in a darkened locomotive cab, for a sleeper to perceive it even though his eyes are shut. Since that light was a very well known warning signal to the engineer, as was the required response, the light may have triggered a simple response from him without fully awakening him. For example, he could have touched the wiper switch on the console, which would have reset the alerter timer.

In the past, railroads used various kinds of alerters. All of them had the same deficiency: they required the engineer to perform in ways that were either intrusive or interfered with his duties. Consequently, engineers often tampered with the alerters, making them ineffective. The alerter system on the accident locomotive was an improved one; however, it was so easily reset that it could be done by reflex action without conscious thought. The Safety Board believes that alerters should be made in such a way that they cannot be reset by an engineer who is merely performing a reflex action. The Safety Board recommends that the railroad industry research the feasibility of a locomotive alerter system that requires cognitive responses from the engineer to cancel or reset the system.

Physical Condition of the Train Crewmembers.--A number of the trains' crewmembers had hypertension, diabetes, and other medical conditions for which they were taking various prescription drugs. Although most of these prescription drugs are relatively harmless, sensitive users could develop side effects, such as headaches and dizziness. Moreover, Disulfiram may cause drowsiness. The surviving crewmembers denied experiencing any of these symptoms. However, while the side effects of individual drugs are well known, very little is known about the possible interaction of drugs when they are taken in combination, such as was done by at least one of the crewmembers.

Although the medicines taken by the crewmembers were reported by them and noted by the contract physician on the medical forms that were forwarded to the carrier after the crewmembers' physical examinations, the Safety Board is concerned that the medical condition of crewmembers and the drugs prescribed for these conditions by their private physicians were not being monitored by the carrier. As was noted previously, the NS does not require an employee to undergo a physical examination other than for vision and hearing until he turns 50. The only exception is the employee who is returning to duty after an extended absence caused by sickness or disciplinary action. Thus, serious illness and prescriptions required for such conditions by safety-sensitive personnel easily could go unnoticed by the carrier for extended periods of time. The engineer, for instance, had not been examined medically since 1985, a violation of company rules, which required a medical

²⁸The train was traveling at an average speed of 27 mph, or 39.6 feet/second

examination every 2 years. The Safety Board believes that the carrier's medical department should set up a system for monitoring its personnel in safety-sensitive positions for ailments that require them to take prescription drugs.

The FRA recently adopted Notice No. 1, RIN 2130-- AA 51, "Qualification For Locomotive Engineer."²⁹ The regulation requires that engineers be licensed and pass an examination of their hearing and visual acuity. Unfortunately, the regulation does not require engineers to have any other medical qualifications, other than that of being drug free. The Safety Board has supported requiring employees in safety-sensitive positions to periodically demonstrate minimum medical qualifications. Although individual carriers may have their own medical policies, there is no evidence that such policies are enforced, at least not at Norfolk Southern. The Safety Board believes the FRA should require standard periodic medical examinations of train crewmembers.

Train Operation and Oversight

Carrier's Operating Rules 34 and 106.--These rules made all crewmembers, regardless of which unit they were in, responsible for observing signals and, if necessary, for stopping the train. The operating department enforcement officer had no way to determine when crewmembers were fulfilling their obligations under rules 34 and 106.

Bulletin 0-108 stated that crewmembers were instructed to transmit via radio to the engineer the indication of each controlled signal as it came into view. The bulletin was issued in October 1990 by the Superintendent of the Georgia Division and governed only that division of the carrier. The Safety Board believes that the bulletin should be included in the carrier's operating rule book, particularly under rules 34 and 106. Its inclusion there would provide oversight for the operating department because each radio transmission on the road channel³⁰ could be recorded on the dispatcher's audio tapes. Safety would improve because each crewmember would be responsible for reporting controlled signal aspects to the engineer and for receiving a response from him verifying the conversation. Any crewmember who did not receive a response would be responsible for halting the train. Crewmembers in the trailing units would conduct their conversations with the engineer by radio.

Positive Train Separation --The Safety Board realizes much remains to be done before a complete ATCS can be implemented. Nonetheless, this is another accident that could have been averted had the ATCS system been available and installed. With transponders to monitor the train's location and speed and to provide moving braking distance parameters and information about how the train was being handled, the dispatch computer would have recognized that the train was not going to stop at the signal. The dispatch computer, through the data radio link, would have ordered the locomotive's computer to stop the train, thus preventing

²⁹Federal Register, Vol 56, No 118, June 18, 1991, "Qualifications for Locomotive Engineers", Docket Mp RSOR-9, Notice No 5, RIN 2130-AA51

³⁰Norfolk Southern uses frequency 160.950 megahertz for its road channel. On the former Southern Railway System, no dispatcher signaling is used. However, on the former Norfolk Western Railroad, dispatcher signaling is used. A modification in the radio system could be made to permit recording of all radio messages on the dispatcher's audio tape even though signaling is required to talk to the dispatcher.

the collision. The Safety Board urges the industry and the FRA to expedite the development and use of the ATCS. The Safety Board issued Safety Recommendation R-87-16 in May 1987, requesting FRA to promulgate Federal standards to require the installation and operation of an ATCS in order to provide positive train separation. The FRA is continuing in its position that the railroads are developing an ATCS that will meet the intent of this safety recommendation. The FRA is "monitoring" the research and development process. The Board is holding to the position that the FRA should become actively involved in the development of the system, providing funding incentives and program direction to ensure a uniform implementation of a positive train separation feature of the ATCS. The status of Safety Recommendation R-87-16 is "Open--Response Received."

Locomotive Diagnostic Computer Checking.--The dynamic braking of train 188's second unit was working intermittently. On three occasions during the trip, the brakeman reset the unit's diagnostic display panel because it was reporting the following fault: "No Speed From Braking Grid Blower," meaning that the dynamic braking capability had been eliminated. The last time the display came on, the brakeman did not reset the panel. The lack of dynamic braking capability was not a cause of the accident because the train's primary brake system was working. However, the engineer, as his testimony shows, "was concerned about the inconsistency in the braking system."

It was two incidents I recall, coming down the mountain at Braswell and heading in at Lindale. I had to give considerable amount of air because it just wasn't slowing down. Normally with those two units, if they were working properly, I would not have had to get any air. I could come in there and slowed it down with dynamic in both places.

According to the unit's computer, the dynamic brakes had not functioned well on the previous trip also. At the time of the accident, no one knew about the previous problem because the unit had not yet been returned to its maintenance base where the computer-stored information would have been retrieved. The Safety Board believes that the carrier should make a practice of retrieving a computer's stored information at away-from-home maintenance facilities, as well as at home maintenance facilities, to ensure that any problems the locomotive units are having will be corrected as soon as possible.

Event Recorder Information.--The Safety Board's laboratory successfully generated a read-out from the data pack of train 188's lead locomotive (8641). When the Safety Board generated a read-out from G-38's surviving data pack at the NS's Alexandria laboratory, it was discovered that the data that should have been recorded when the train was about 0.35 track miles away from the accident site was not recorded because of a splice in the tape; therefore, an unknown amount of data was not recorded.

Crashworthiness.--The Safety Board continues to investigate head-on collisions between trains to evaluate the crashworthiness of locomotive cabs. Manufacturers build their locomotives to different sill heights.³¹ In a head-on collision, the

³¹Sill height Distance from the track to the main longitudinal member of the locomotive underframe

locomotives may override each other and crush the cabs and their occupants. The Safety Board has made recommendations in the past to correct this problem. In this accident, the lead locomotive of train 188 was a General Electric Model C-39-8, and the lead locomotive on train G-38 was an EMD Model GP-38. The locomotives had different sill heights. This report is not about a direct head-on collision. The right front of train 188's lead unit struck the near right front of train G-38's lead unit; each locomotive was deflected in a different direction. The right cab of train 188 was crushed, so there was no survivable space for the conductor, who was seated in that area. The fuel tank on both locomotives of train G-38 ruptured, and the resulting fire destroyed both cabs. The conductor and engineer of train G-38 suffered smoke inhalation, burns, and massive injuries.

CONCLUSIONS

Findings

1. The engineer of train 188 had changed his work and rest routine just before the accident.
2. The engineer's failure to bring the train to a stop at the signal probably was caused by a microsleep or inattention due to distraction.
3. The conductor of train 188 was either distracted or fell asleep sometime after verifying the signal status at CP DAVIS.
4. The engineer of train 188 could have canceled the alerter system while he was asleep by a simple reflex action that he performed without conscious thought.
5. If the brakeman and flagman of train 188 had complied with operating rules 34 and 106, the accident might not have occurred. The NS lacked management oversight of these rules.
6. The engineer of train 188 had not been medically examined since 1985, some train crewmembers were being treated for hypertension and diabetes, diseases that were not being monitored by the railroad's medical department.
7. This accident would have been prevented had the trains been separated by a fully implemented advanced train control system.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the engineer of train 188 to stop at the stop signal because he was asleep, distracted, or inattentive. Contributing to the accident were the failure of the conductor to monitor the engineer's performance and the failure of the brakeman and flagman to carry out their responsibilities to notify the engineer to stop the train.

RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board made the following Safety Recommendations.

--to the Federal Railroad Administration

Establish a requirement for minimum medical standards for locomotive engineers in the rule for "Qualifications for Locomotive Engineers " (Class II, Priority Action) (R-91-23)

Establish uniform medical requirements for train crewmembers that are based on reasonable standards consistent with current medical practices, and require carriers to provide their train crewmembers with periodic medical examinations based on these standards. (Class II, Priority Action) (R-91-24)

In conjunction with the Association of American Railroads and the Railway Progress Institute, expand the effort now being made to develop and install advanced train control systems for the purpose of positive train separation. (Class II, Priority Action) (R-91-25)

In conjunction with the study of fatigue of train crewmembers, explore the parameters of an optimum alerter system for locomotives. (Class II, Priority Action) (R-91-26)

--to the Norfolk Southern Corporation.

In conjunction with the operating unions, conduct an educational and counseling program designed to improve train crewmembers' knowledge of health and diet regimens and of methods of avoiding sleep deficits and sleep deprivation (Class II, Priority Action) (R-91-27)

Revise the company's medical program to ensure that train crewmembers are examined periodically and monitored for ailments and the taking of associated prescription drugs (Class II, Priority Action) (R-91-28)

Check the locomotive diagnostic computer "LOG" at away-from-home terminals to determine and promptly correct faults that occurred during a trip. (Class II, Priority Action) (R-91-29)

Revise the Carrier's Operating Rules 34 and 106 to incorporate system wide the language of the Georgia Division Superintendent's Bulletin 0-108, dated October 4, 1990, which requires all crewmembers to acknowledge the indication of each control signal to the engineer (Class II, Priority Action) (R-91-30)

--to the Association of American Railroads:

In conjunction with the Railway Progress Institute and the Federal Railroad Administration, expand the effort now being made to develop and install advanced train control systems for the purpose of positive train separation (Class II, Priority Action) (R-91-31)

--to the Railway Progress Institute:

In conjunction with the Federal Railroad Administration and the Association of American Railroads, expand the effort now being made to develop and install advanced train control systems for the purpose of positive train separation. (Class II, Priority Action) (R-91-32)

As a result of its investigation, the Safety Board also reiterated the following safety recommendation:

--to the Federal Railroad Administration:

R-87-16

Promulgate Federal standards to require the installation and operation of a train control system on mainline tracks which will provide for positive separation of trains.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ James L. Kolstad
Chairman

/s/ Susan M. Coughlin
Vice Chairman

/s/ John K. Lauber
Member

/s/ Christopher A. Hart
Member

/s/ John A. Hammerschmidt
Member

July 9, 1991

APPENDIXES**APPENDIX A****INVESTIGATION AND HEARING****Investigation**

The Safety Board was notified of the accident shortly after it occurred, and it immediately dispatched an investigator from the Atlanta field office. The investigator-in-charge and other members of the Safety Board investigative team were dispatched from Washington, D.C., and from the New York field office. Investigative groups were established to study operations, track, mechanical, signals, survival factors, and human performance.

The Safety Board was assisted in the investigation by the Federal Railroad Administration and the Norfolk Southern Corporation.

Hearing/Deposition

The Safety Board staff conducted a deposition proceeding as part of its investigation of this accident on October 17, 1990, at Atlanta, Georgia. Seven witnesses testified.

APPENDIX B
PERSONNEL INFORMATION

Train 188

a. G L. Fisher

Mr Fisher was hired by the Southern Railway in 1976. He had been a trainman, a hostler helper, and a fireman until he became an engineer on June 14, 1978. At the time of the accident he was 43 years old. His last medical examination was completed on May 29, 1985. It included a periodic physical examination, a triennial ocular examination, and an audiogram. He weighed 203 pounds and was 5'10" tall. His blood pressure was 140/90, his far vision in the right eye was 20/20 and in the left eye, 20/22, his near vision was J-1, and his color vision and depth perception were normal. His drug screen was negative. Mr. Fisher reported that he was being treated for hypertension and that he was taking Primazide, an anti-hypertension medicine for the treatment of high blood pressure. He was also taking a diuretic for this condition.

b. M Beal, Jr.

Mr Beal was hired by the Southern Railway in 1968. He became a conductor on September 21, 1971. Mr Beal's activities during the last 72 hours before the accident are not known. Mr. Beal was 44 years old at the time of the accident. His last medical examination was completed on March 14, 1978, after he had returned to work from an extended absence. At that time, his weight was 202 pounds and his blood pressure was 150/80. A drug screen was negative. He had his last ocular examination on October 30, 1985, at which time he reported no major illness. His vision was 20/20 uncorrected, and his near vision was J-2.

c. G. L. Blessitt

Mr. Blessitt was hired by the Southern Railway in 1970. He became a brakeman and was a flagman at the time of the accident. Mr Blessitt was 43 years old. He received his latest medical evaluation on April 24, 1990. He was 5'9" tall and weighed 220 pounds. His blood pressure was 160/110. His far vision was 20/22 in the right eye and 20/20 in the left eye. His near vision was as J-4. His color vision and hearing were normal. The examining physician found him to be overweight and hypertensive. He was also a borderline diabetic. The drug screen was negative. Mr Blessitt said that he was taking a variety of medicines, including Micronase, Capoten, Disulfiram, Fluoxymesterone, and Procardia. Most of the medicines were related to his diabetes and hypertension.

d. R G Hall

Mr. Hall had been hired by the Southern Railway in 1971. He was a flagman and a brakeman. At the time of the accident, he was 41 and functioning as a brakeman. He was 5'11" tall and weighed 235 pounds. His blood pressure was 130/90. His far vision was 20/20 in both eyes, and his near vision was J-1. His color vision and hearing were normal. He suffered from high blood pressure and was diagnosed as hypertensive. He was taking Inderal, a beta blocker for high blood

pressure, Minipress, an anti-hypertensive, Naqua, a diuretic, and Doxycycline, an antibiotic. His drug screen was negative.

Train G-38

a. A. A. Forrister

Mr. Forrister was hired by the railroad in 1968. He became a locomotive engineer on June 1, 1970. At the time of the accident, he was 49 years old. He was medically evaluated on February 21, 1989. The evaluation showed that he was basically healthy, but overweight and suffering from high blood pressure, for which he took Methycz (methycloiazide), a diuretic used in the treatment of hypertension. His blood pressure was 130/90. His far vision was 20/20 in the right eye and 20/30 in the left eye, his near vision was J-8 binocularly without correction. The drug screen was negative.

b. L. R. Cowart

Mr. Cowart was hired by the Southern Railway in 1971. He became a conductor on May 6, 1976. Mr. Cowart was 43 years old when the accident occurred. His last medical examination was performed on June 29, 1989. The examination showed that he was a healthy male with a blood pressure of 122/70 and normal color vision and depth perception. His far vision was 20/25 in the right eye and 20/20 in the left eye, corrected, his near vision was J-4. His audiogram results were acceptable, and the drug screen was negative.

c. J. R. McDaniel

Mr. McDaniel was hired by the Southern Railway in 1972. He had worked as a brakeman and as a flagman. At the time of the accident, he was 45 years old and a helper. His last medical examination was on September 11, 1989. The examination showed him to be a healthy male with blood pressure of 130/78 and normal color vision and hearing. His far vision was 20/25 uncorrected, and his near vision was J-30 corrected. His drug screen was negative.

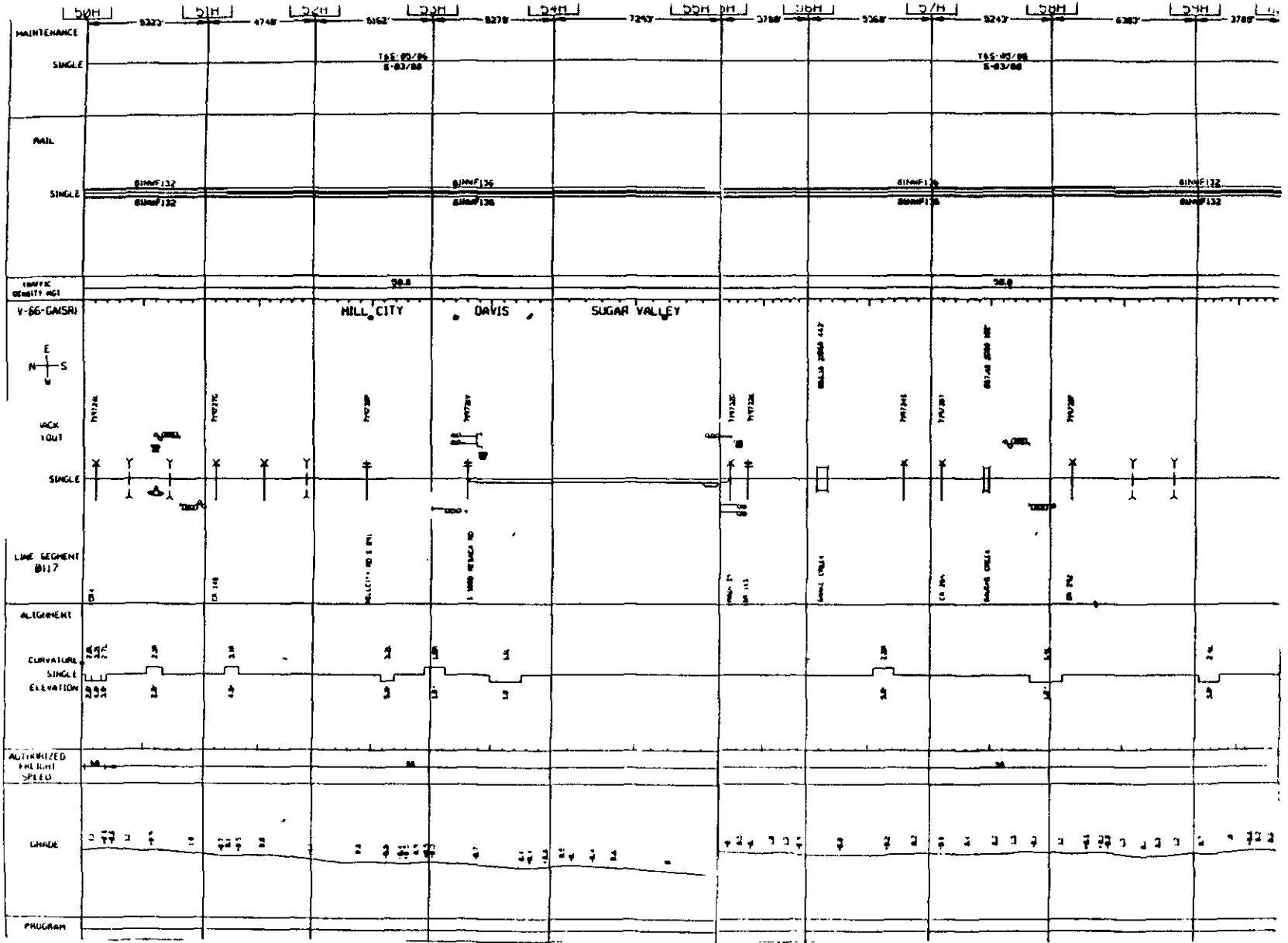
Dispatcher

a. R. R. Kennedy

Mr. Kennedy had been hired by the Southern Railway in February 1970 as a student agent-operator. He became a clerk-operator in April 1970 and a train dispatcher in March 1973. At the time of the accident, Mr. Kennedy was 47 years old. He was not required to take a physical examination for continued employment and had not taken one since his initial employment. Also, he had not been asked to submit to a drug screen before the accident. Mr. Kennedy stated that he had consulted a doctor about 2 years ago and was diagnosed as a diabetic. He was taking 250 mg of Tolazamide, a hypoglycemic, a day to control his condition. He also wore glasses for far and near vision correction.

APPENDIX C

NORFOLK SOUTHERN TRACK CHART FOR AREA OF ACCIDENT



APPENDIX D

CHATTANOOGA AND ATLANTA TIMETABLE NO. 4

CHATTANOOGA AND ATLANTA—SOUTHBOUND

Capacity of Tracks		STATION	MILE MARK	CHATTANOOGA	TIMETABLE NO. 4 Effective May 21, 1989 STATIONS	MILE MARK	STATION
Other Tracks In Cars	Sidings In Feet						
				2 6H	C. T. Tower		C
				1 8H	Pratt		
		242A		0 0H	Chattanooga		
Yard		240A		2 1H Y	deButts Yard DN		
				2 3H	Webb		
				3 4H	Pierce		
				3 9H	Citico Jct.		C
				4 8H	Brown		
				5 5H	Spell		
				6 1H	Williams		
				7 1H	Jersey		
				11 9H	Summit		
25		22"A		15 2H	Ooltewah, Tn. (So End Two Tracks)		C
50	158+0	2"H		26 "H	Cohutta, Ga.		C
	11550			29 8H	Still		
				33 "H	Hixon		
				36 0H	Waring		
Yard				37 "H	Norton		
Yard		40H		40 1H	Hair		C
Yard				40 3H	Daron		
				42 4H	Walnut		
	158+8			45 4H	Phelps		
				48 0H	Freeman		
				53 3H	Davis		
22	10232	55H		55 3H	Sugar Valley		
				67 8H	Reeves		
	89+6			69 6H	Pinson		
				75 1H	Berwin		
Yard	15416	75H		77 0H Y	Forrestville		
				78 1H	Fox		C
		80H		79 "H	Rome		
				81 2H	Smith		
	1245"			83 9H	Lindale		
				90 1H	Brice		
2	9036			92 0H	Green		C
				98 3H	Arson		
20	14025			101 2H	Perkins		
98		102H		101 8H	Rockmart		
				107 1H	Finch		
	11885			109 0H	Brazwell		
				111 1H	Koy		
10	10993			113 4H	McPherson		
88		119H		118 8H	Dallas		
				122 6H	Oak		
	14330			125 6H	Clark		
100				134 "H	Austell (No End Two Tracks)		C
				137 2H	Low		
				140 0H	Nickajack		
				145 5H	Bolton (So End Two Tracks)		
				146 "H	Perry		
Yard		148H		148 2H Y	Inman Yard DN		

Tennessee Division Timetable governs between Jersey and Chattanooga

APPENDIX E

SUPERINTENDENT'S BULLETIN 0-97, SEPTEMBER 4, 1990

DELIVER TO ATLANTA-GA/D

MESSAGE-03726689
FROM ATLANTA-GA/D
09/04/90 02:25P

NORFOLK SOUTHERN CORPORATION
GEORGIA DIVISION
OPERATIONS BULLETIN

ATLANTA - SEPTEMBER 4, 1990 2/DMJ
FILE: 2-55
CY-2-10

BULLETIN NO. 0 - 97

TO: ALL CONCERNED (DIVISION WIDE)

CREW MEMBERS RIDING TRAILING UNITS MUST TRANSMIT VIA RADIO TO THE ENGINEER THE INDICATION OF EACH CONTROL SIGNAL AS IT COMES INTO VIEW.

D. N. ZUREICH
SUPERINTENDENT

POST BULLETIN BOOKS

POSTED: -----

DATE: ----- TIME: -----

ECM @ H#OX3LP 09/04/90 02:25:59P FOR #AN 13 458

APPENDIX F

SUPERINTENDENT'S BULLETIN 0-102, OCTOBER 4, 1990

DELIVER TO ATLANTA-GA/D

MESSAGE-02918147
FROM ATLANTA-GA/D
10/04/90 02:51P

NORFOLK SOUTHERN CORPORATION
GEORGIA DIVISION
OPERATIONS BULLETIN

ATLANTA - OCTOBER 4, 1990 *DMJ
FILE: 2-55
CY-2-10

BULLETIN NO. 0 - 102

TO: ALL CONCERNED (DIVISION WIDE)

SUPERSEDES BULLETIN 0-97, DATED SEPTEMBER 4, 1990

OPERATORS RIDING TRAILING UNITS MUST TRANSMIT VIA RADIO TO THE ENGINEER THE INDICATION OF EACH CONTROL SIGNAL AS IT COMES INTO VIEW, AND MUST BE ACKNOWLEDGED BY ENGINEER.

D. N. ZUREICH
SUPERINTENDENT

POSTED BY: [unclear]

POSTED: -----

DATE: ----- TIME: -----

EOY 3 # [unclear] 10/04/90 02:51:29P FOR # [unclear] 13 078

APPENDIX G
ALERTER SYSTEM TIME SETTINGS

The time required for the system to request acknowledgment is factory programmed in accordance to customer specifications. Figure 1 presents a specific example of the timing functions.

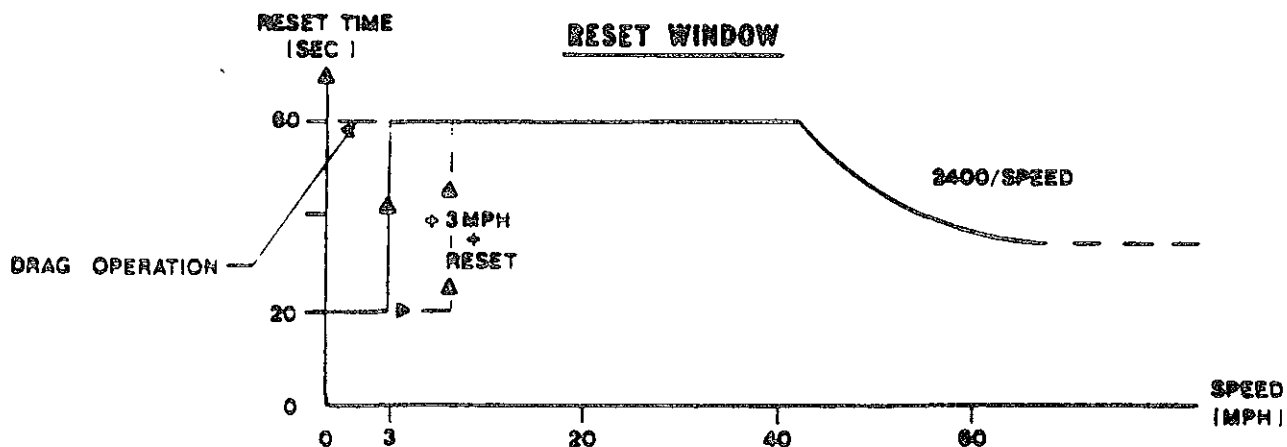


Fig. 1

The time sequence Reset Window (RW) in seconds, is determined by following formula:

$$\begin{aligned}
 RW &= k^1 \text{ if } S < S^1 \\
 &= k^2 \text{ if } S^1 < S < S^2 \\
 &= 2400/S \text{ if } S > S^2
 \end{aligned}$$

$$\begin{aligned}
 \text{Where } k^1 &= 20 \text{ Sec} & S^2 &= 40 \text{ MPH} \\
 k^2 &= 60 \text{ Sec} & S &= \text{Train Speed (MPH)} \\
 S^1 &= 3 \text{ MPH}
 \end{aligned}$$

Case I Train Start Up

$$RW = 20$$

Case II After the first reset has been received and the speed is above 3 mph

$$\begin{aligned}
 RW &= 60 \text{ (for speeds between 3 and 40 mph)} \\
 &= 2400/\text{speed} \text{ (for speeds above 40 mph)}
 \end{aligned}$$

NORTHFOLK SOUTHERN RAILROAD

Road Number: 8621

Date: 08/12/90

Time: 17:45:15

Location: CALHOUN GA.

Electrical Control Faults

Fault	Occur	Reset	Fault Message
08F2	35989.13	35992.75	BJ+ Fault. Run SelfTest 021
08F8	35989.13	35992.75	BJ- Fault. Run SelfTest 021
022E	35992.75	35992.85	Fault Reset While In Level 1
0497	36163.71	36163.71	SCM #1 Module Is Bad
0498	36163.71	36164.25	SCM #2 Module Is Bad
0499	36163.71	36164.25	SCM #3 Module Is Bad
049A	36163.71	36164.25	SCM #4 Module Is Bad
049B	36163.71	36164.25	SCM #5 Module Is Bad
049C	36163.71	36164.25	SCM #6 Module Is Bad
022E	36164.25	0.00	Fault Reset While In Level 1
002D	36654.56	36654.58	EXC - Automatic Reset In Progress
04A3	36927.98	36938.56	No Speed From Braking Grid Blower 1
04A3	36942.00	36942.63	No Speed From Braking Grid Blower 1
04A3	36943.23	36943.86	No Speed From Braking Grid Blower 1
04A3	36944.26	36946.23	No Speed From Braking Grid Blower 1
04A3	36946.45	36952.40	No Speed From Braking Grid Blower 1
04A3	36954.01	36954.75	No Speed From Braking Grid Blower 1
#1 04A3	36956.68	36956.76	No Speed From Braking Grid Blower 1
#2 04A3	36956.90	36957.60	No Speed From Braking Grid Blower 1
#3 04A3	36958.81	0.00	No Speed From Braking Grid Blower 1
0917	36959.10	0.00	LOT (Lube Oil Temp) Sensor Bad
0838	36959.10	0.00	AUXLINE Fault. Run SelfTest 024
083A	36959.10	0.00	AUXLINE Fault. Run SelfTest 024
045A	36959.10	0.00	SHUTDOWN - Crankcase Over-Press.
0839	36959.10	0.00	AUXLINE Fault. Run SelfTest 024
0009	36959.10	0.00	Load Limited: Dirty Engine Air Filt
0919	36960.06	0.00	EWT (Water Temp) Sensor Bad
Current Time Is		36960.33	
27 Faults Since		33000.00	

EXCERPT OF ELECTRICAL CONTROL FAULTS NS 8621

APPENDIX H

APPENDIX I

COPY OF DISPATCHER RADIO COMMUNICATIONS

DELIVER TO ATLANTA-GA/DSUPT

MESSAGE-03637944
 FROM ATLANTA-GA/CAD
 08/18/90 05:53P

EXCERPTS FROM DISPATCHER AUDIO TAPES
 ATLANTA, GA.

*between 6:00 P.M. Aug 8, 1990
 and 4:00 A.M. Aug 9, 1990*

APPROX 1208 AM 8/9/90

G38 FORRISTER: G38 CALLING THE DISPATCHER, OVER.

DI-KENNEDY: NS DISPATCHER, OVER.

G38-FORRISTER: (GARbled)..CAN'T GET THE TIME OFF UP HERE AT
 NO 1 BAKERY, OVER.

DI-KENNEDY: LOOKS LIKE IT WILL BE STILL, 38.

G38-FORRISTER: ALRIGHT.

DI-KENNEDY: HOW MUCH MORE DO YOU THINK YOU HAVE TO DO THERE?

G38-FORRISTER: WELL, IF YOU WOULD GET SOMEBODY TO FIX THESE SWITCHES
 UP HERE WE WOULD ALREADY BE THROUGH WITH IT.

DI-KENNEDY: WHEN YOU GET THE TIME OFF, HOW MUCH LONGER WILL YOU
 BE THERE?

G38-FORRISTER: PROBABLY 35. IF WE HAD A GOOD RADIO NOW AND THEN IT
 WOULD HELP.

DI-KENNEDY: THIS IS THE FIRST TIME I'VE HEARD YOU.

G38-FORRISTER: WE'VE BEEN CALLING YOU ABOUT 20 MINUTES.

APPROX: 1245 AM

G38-FORRISTER: NS G38 ATLANTA DISPATCHER, OVER.

DI-KENNEDY: NS DISPATCHER ATLANTA, OVER.

G38-FORRISTER: WE'VE LEFT THE BAKERY JUST A FLYING, OVER.

DI-KENNEDY: OK. THANK-YOU. OUT.

APPROX: 302 AM

DI-KENNEDY: NS DISPATCHER ATLANTA G38, OVER.

G38-FORRISTER: 38

DI-KENNEDY: HOW LONG BEFORE YOU'RE READY TO LEAVE FREEMAN, OVER?

G38-FORRISTER: WE'RE READY TO LEAVE FREEMAN NOW. WE'RE COMING OVER
 LAWYER'S CROSSING NOW, OVER.

DI-KENNEDY: OK. DISPATCHER OUT.

APPROX: 319 AM

SEE NEXT ATTACHED.....

(Mr. E. G. Tuenge: This is a recording from the Chief Dispatcher's tape for August 9, 1990. Began listening to the tape at 3:05 A. M. The first transmissions regarding the incident at Davis begins at 3:19 and 15 seconds.)

Unidentified: (Unintelligible) Atlanta Dispatcher, over.

Dispatcher: Dispatcher, Atlanta, over.

Unidentified: (Unintelligible).

Dispatcher: Try that again, over.

(Here follows a brief conversation between two unknown parties, where one asks the other about the number of cars and the reply is "86").

Dispatcher: G38, did you call me?

Unidentified: Yes sir, yes sir....(unintelligible).

Dispatcher: Alright, try it again.

Dispatcher: 188, can you understand them?

No. 188: Yes sir, 188 is involved in this head-on, this head-on with 38.

Dispatcher: You say you got a head-on?

No. 188: Yes sir, G38 and 188 got a head-on up here.

Dispatcher: Alright, is anybody hurt, over?

No. 188: Yes sir, yes sir, there's people hurt. There's people hollering and trapped in here/

Dispatcher: Alright, there's people on the way.

(Mr. Tuenge: This transmission ended at 3:21 and 20 seconds).

(Mr. Tuenge: This transmission begins at 3:26 and 5 seconds).

(Unidentified background conversation about Constitution).

No. 188: This is the Brakeman on 188 there, Chief Dispatcher.

Chief Dispatcher: Channel 2, over.

No. 188: Alright there, Dispatcher, Channel 2.

Chief Dispatcher: What did y'all do, get by the signal there at Davis, over?

No. 188: Well, uh, we're by the signal, and they, they looked like they were heading in the siding. We can't get up

No. 188 (cont): toward the crossing, there, uh, everything's burning so bad, one's already exploded. It's blocked back down here on the other end.

(Mr. Tuenge: Next transmission begins at 3:31 and 7 seconds).

Chief Dispatcher: Chief Dispatcher's Office, Atlanta, to 188, over.

No. 188: Brakeman on 188.

Chief Dispatcher: Can you tell me anything about how bad anybody's hurt, over?

No. 188: I've got McDaniel here, and he's got a bump or fracture on his head, and he's bleeding, but the rest of the crew, we can't locate. Blessitt and R. G. Hall and McDaniel is barely okay. As far as the rest of the crew, we can't find them.

Chief Dispatcher: How about, have you seen or talked to anybody on 38's crew, over?

No. 188: We have McDaniel, he's with, he's with us.

Chief Dispatcher: No. 188, were you still moving when y'all hit in the siding, over?

Chief Dispatcher: Chief Dispatcher's Office, Atlanta, to Brakeman on 188, over.

No. 188: Alright, this is the Brakeman on 188.

Chief Dispatcher: Were you still moving when y'all hit, over?

No. 188: Yes.

Chief Dispatcher: You said the local was lined to come into the siding there also, over?

Chief Dispatcher: Brakeman on 188, over.

Chief Dispatcher: Chief Dispatcher's Office in Atlanta to Brakeman on 188, over.

No. 188: Yes sir, we found another crew member, the Engineer on 188, and we're trying to calm him down.

(Mr. Tuenge: Tape was monitored until 3:45 with no further conversation).

APPENDIX J

DISPATCHER LOG ON G-38 ACTIVITIES

DELIVER TO ATLANTA-GA/DSUPT

MESSAGE-03637877
FROM ATLANTA-GA/CAD
08/18/90 05:29P

TRAIN NUMBER G38

THIS TRAIN IS A LOCAL FREIGHT THAT ORIGINATES AT FORRESTVILLE YARD, ROME, GA, MP 77.0-H, OPERATES TO DEBUTTS YARD, CHATTANOOGA, TN., APPROXIMATELY 79 MILES, AND RETURNS TO ROME. ITS MAIN PURPOSE IS TO EXPEDITE PIGGYBACK TRAFFIC ORIGINATING AT DALTON, MP 42.6-H TO CHATTANOOGA FOR CONNECTION TRAINS.

THE 3 MAN CREW REPORTED FOR DUTY AT FORRESVILLE AT 6 PM AND MADE A REGULAR NORMAL RUN TO CHATTANOOGA.

~~THE TRAIN DEPARTED CHATTANOOGA AT 1055 PM WITH 8 LOADS, 9 EMPTIES, 1427 TONS AND 2 LOCOMOTIVES. THE 2799 WAS IN THE LEAD WITH THE LONG HOOD FORWARD PUTTING THE ENGINEER ON THE WEST OR RIGHT SIDE. THE 3994 WAS TRAILING WITH THE SHORT HOOD FORWARD. A STOP WAS MADE AT COLLEGEDALE, TN TO WORK MCKEE BAKING'S TWO PLANTS, MP 17.2-H AND MP 18.2-H.~~

G38 THEN PROCEEDED TO COHUTTA, MP 26.7-H, ENTERED THE SIDING AND PROCEEDED TO STILL, MP 29.8-H. SOUTHBOUND TRAIN 243 PASSED AT 115 AM AND NORTH BOUND TRAIN 230 PASSED AT 130AM. G38 DEPARTED STILL AT 134 AM.

THE NEXT STOP WAS DALTON, MP 42.0-H WHERE ENTIRE TRAIN WAS SET OUT AND 4 EMPTIES AND 3 LOADS WERE PICKED UP WHILE TRAIN 360 PASSED.

G38 THEN PROCEEDED TO MP 46.1-H, PULLED 3 LOADS AND PLACED HIS 4 EMPTIES AT THE CHIP YARD.

LEAVING THIS LOCATION WITH 6 LOADS, G38 PROCEEDED SOUTH TO DAVIS, MP 53.3-H, MEETING NO OTHER TRAINS. THE INCIDENT THEN OCCURRED ABOUT 315 AM AT DAVIS.

EOM @ H#0X3LP 08/18/90 05:43:08P FOR 132 13 339