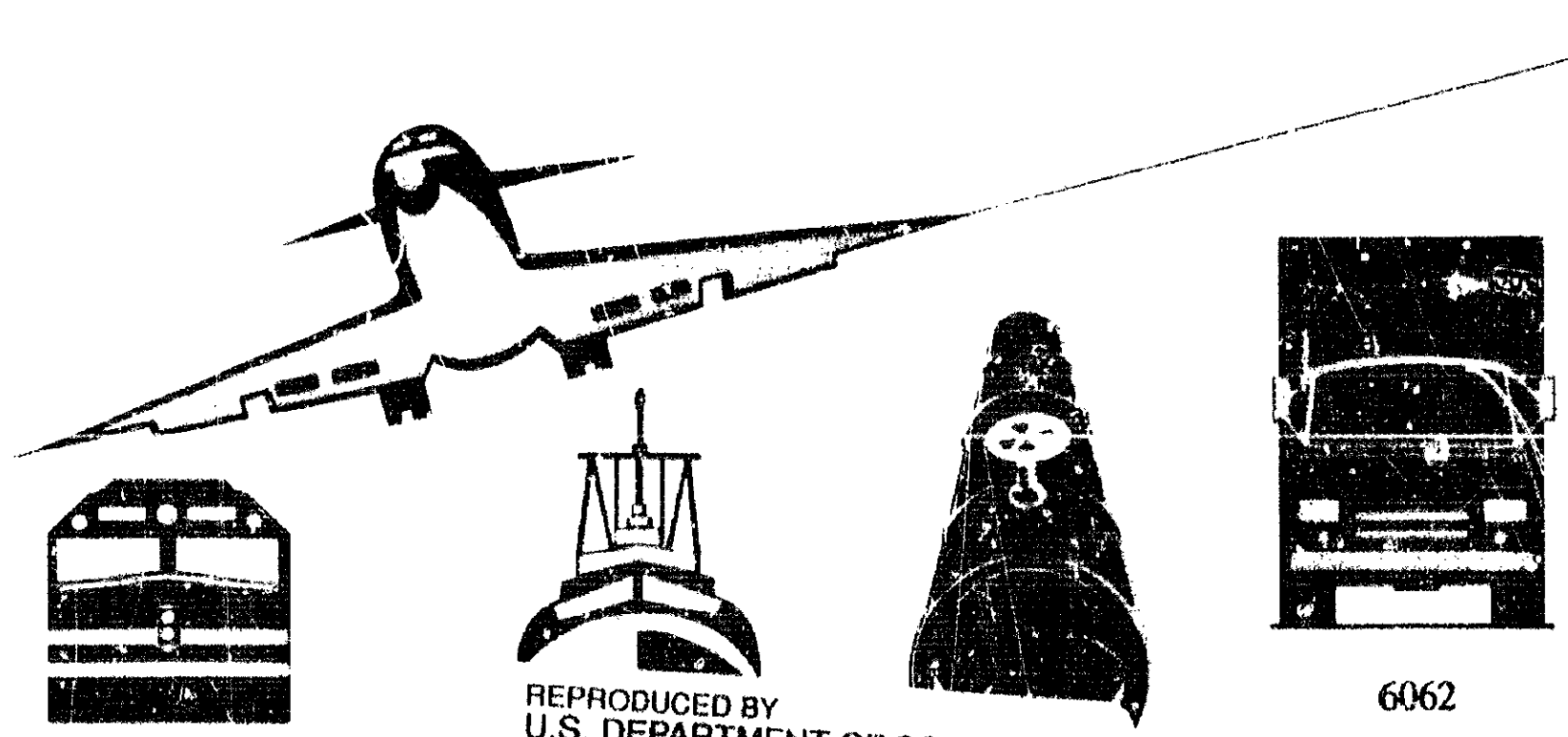
PB93-916301
NTSB/RAR-93/01

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

**HEAD-ON COLLISION
BETWEEN BURLINGTON NORTHERN RAILROAD
FREIGHT TRAINS 602 AND 603
NEAR LEDGER, MONTANA, ON AUGUST 30, 1991**



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NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

ADOPTED: MAY 25, 1993

NOTATION 6062

Abstract: On August 30, 1991, eastbound Burlington Northern Railroad freight train 602 collided head on with westbound Burlington Northern Railroad freight train 603 at milepost 85.55 north of Ledger, Montana. Three crewmen were killed, and four were severely injured.

The safety issues discussed in this report include track warrant delivery and radio procedure, recurrent/refresher dispatcher training, management oversight and dispatcher support, locomotive radio testing, and positive train separation.

As a result of its investigation, the Safety Board issued safety recommendations to the Burlington Northern Railroad, Federal Railroad Administration, Association of American Railroads, and Railway Progress Institute.

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EXECUTIVE SUMMARY

On August 30, 1991, the eastbound Burlington Northern Railroad (BN) freight train 602 departed Shelby, Montana, heading south. Westbound BN freight train 603 departed Great Falls, Montana, proceeding north. Both trains were routed over BN unsignaled single track line between Shelby and Great Falls. A branch line dispatcher in Seattle, Washington, controlled the trains' movements by issuing track warrants through a computerized track warrant control system.

At 5:50 p.m. mountain daylight time at milepost 85.55 north of Ledger, Montana, the two trains collided head on at a closing speed of 87 mph. After impact, fire ensued from spilled locomotive diesel fuel, burning locomotive units, two freight cars, and grass. Nine locomotive units and 22 cars were destroyed; 9 cars were damaged. Track damage, equipment replacement, and clean-up costs were estimated at $19 million. Three crewmen were killed, and four were severely injured.

The National Transportation Safety Board determines that the probable cause of this head-on collision was the poor communication practices of the first-shift dispatcher and the train 603 conductor and BN's failure to establish an adequate management oversight and quality control program in its train control operations. Contributing to the accident was the combined failure of BN and the Federal Railroad Administration (FRA) to follow up on the dispatching concerns and recommendations of the FRA *National Train Dispatcher Safety Assessment 1987-88*.

The safety issues discussed in this report include:

- o track warrant delivery and radio procedure,
- o recurrent/refresher dispatcher training,
- o management oversight and dispatcher support,
- o locomotive radio testing, and
- o positive train separation.

The Safety Board makes recommendations addressing these issues to the Burlington Northern Railroad, Federal Railroad Administration, Association of American Railroads, and Railway Progress Institute.

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, DC 20594

Railroad Accident Report

HEAD-ON COLLISION BETWEEN BURLINGTON NORTHERN RAILROAD FREIGHT TRAINS 602 AND 603 NEAR LEDGER, MONTANA, AUGUST 30, 1991

INVESTIGATION

The Accident

On August 30, 1991, eastbound[1] Burlington Northern Railroad (BN) freight train 602 departed Whitefish, Montana, for Laurel, Montana. At Shelby, Montana, train 602 was reconfigured to consist of 3 locomotive units, 20 loaded cars, and 14 empty cars. On departure from Shelby, it headed south.

Westbound BN freight train 603 originated at Great Falls, Montana, on August 29, 1991, and departed Great Falls at 1:50 p.m.[2] on August 30, 1991. Train 603 proceeded north and stopped at Conrad, Montana, where it was reconfigured to consist of 6 locomotive units, 57 loaded cars, and 28 empty cars.

Both trains were routed over BN unsignaled single track line between Shelby and Great Falls. (See figure 1.) A branch line dispatcher in Seattle, Washington, controlled the trains' movements by issuing track warrants[3] (TWs) and used a computerized track warrant control (CTWC) system, which is designed to prevent conflicting TWs.

At 2:55 p.m., the first-shift branch line dispatcher issued TW 8851 by voice radio to the train 603 conductor at Dutton, Montana. The first-shift dispatcher transmitted the information as she formulated the TW on the formatted computer screen. The TW *to* destination (authority limit) was Ledger, Montana, a railroad siding. The conductor asked his engineer if the first-shift dispatcher had said "west yard limits Shelby," and the engineer replied affirmatively. Repeating the TW to the first-shift dispatcher, the conductor gave west yard limits Shelby as the *to*

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[1]Considered eastbound and westbound trains, train 602 and train 603 traveled, respectively, south and north by compass direction.

[2]All report times given in mountain daylight time.

[3]Train order given via radio by or through a proper railroad official to govern train movements. The Federal Railroad Administration (FRA) interprets TWs as train orders by radio in 49 Code of Federal Regulations (CFR) 220.61.

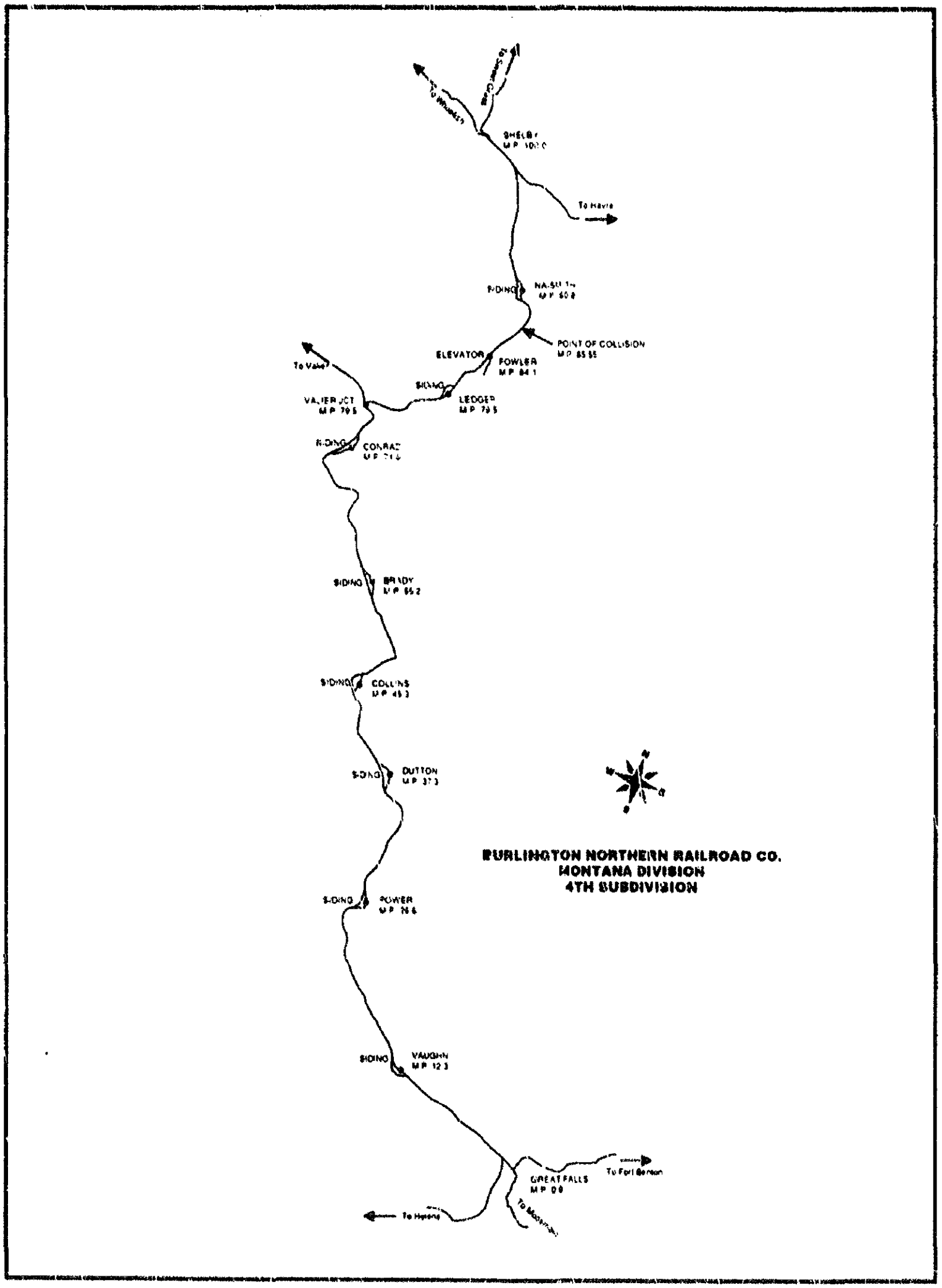

Figure 1.--Route between Shelby and Great Falls.

destination. The first-shift dispatcher "okayed" the TW as repeated by the conductor; however, the computerized TW *to* destination was Ledger.

About 3:45 p.m., the second-shift branch line dispatcher relieved the first-shift dispatcher. At 5:08 p.m., the second-shift dispatcher issued TW 8860 by telephone to the train 602 conductor, giving authority from the east yard limits Shelby to Ledger, about a 20-mile distance. The train 602 conductor stated that he had understood the TW to be from east yard limits Shelby to Ledger and had copied that information on his TW form.

At 5:50 p.m. at milepost (MP) 85.55 north of Ledger, the two trains collided head on at a closing speed about 87 mph. After impact, fire ensued from spilled locomotive diesel fuel, burning the locomotive units, two freight cars, and grass. Nine locomotive units and 22 cars were destroyed; 9 cars were damaged. (See figures 2, 3, and 4.) A functional event recorder tape was recovered from each consist. The train 602 engineer and two train 603 brakemen were killed; the train 602 conductor and two brakemen and the train 603 engineer and conductor were injured.

Injuries

INJURY TABLE[4]

	Train 602	Train 603	Total
Fatal	1	2	3
Serious	2	2	4
Minor	1	0	1
Total	4	4	8

Damages

From information provided by BN, the Safety Board estimated the track damage, equipment replacement, and clean-up costs at $19 million.

BN estimated the depreciated dollar value as:

Train 602	$2,625,000
Train 603	4,220,000
Track	30,000
Cleanup	10,000
Total	$6,885,000

[4]Based on criteria used by the International Civil Aviation Organization.

Figure 2. Aerial view of accident scene.
Photo courtesy of *The Independent Observer*, Central Missouria

Figure 3.--Point of impact.
Photo courtesy of Burlington Northern Railroad.

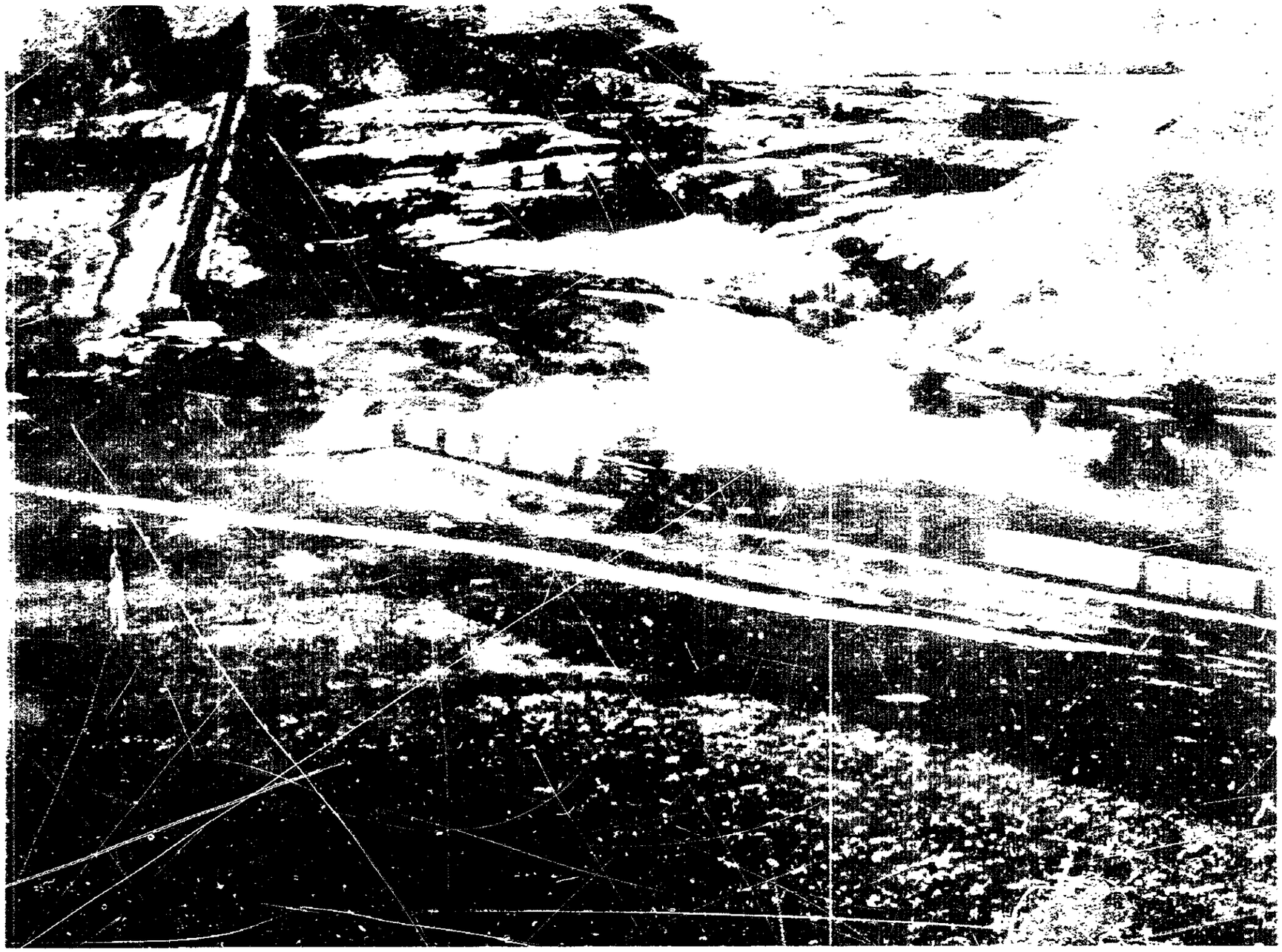

Figure 4.--Aerial view of accident scene, looking west.
Photo courtesy of *The Independent Observer*, Conrad, Montana.

Personnel Information

Train 602 Engineer.--The engineer had worked for BN over 13 years and had been an engineer for 11 years. Since June 1991, he had alternately worked trains 602 and 603.

Train 602 Conductor.--The conductor had worked for BN almost 13 years and had been a brakeman/conductor for 12 years. Since June 1991, he also had alternately worked trains 602 and 603, although not always with the above engineer.

Train 603 Engineer.--The engineer began his railroad career with BN in July 1977 as a brakeman/switchman. In December 1990, he entered the BN engineer training program, was promoted to engineer on July 1, 1991, and worked as an extra board[5] engineer. The engineer had never worked train 603 before the accident; however, he had traveled over the same route on local trains since his promotion and over the same territory as a brakeman/switchman for 14 years.

The engineer said that on Wednesday, August 28, he woke at 10 a.m., went shopping, returned home about 4:30 p.m., ate supper, and was called to report at 6:45 p.m for work. At 3 a.m. on Thursday, he returned home, went to bed, rose about 1 p.m., stayed home, and retired about midnight. On Friday, he rose about 8 a.m., had breakfast, spent the morning with his children, and received a call to report at 12:30 p.m. for work. He reported that he had taken no medications during the 3 days before the accident.

Train 603 Conductor.--The conductor began his railroad career with BN in July 1976 in the maintenance-of-way (track) department. In July 1979, he began working as a brakeman and in September 1981, passed the conductor's test. The conductor had worked as a switch foreman in a yard, as an extra board conductor, and as a brakeman. During the 2 years before the accident, he had worked as a conductor on both trains 602 and 603 on a 6-day week basis.

On Wednesday, August 28, the conductor worked on train 603 and laid over in Cutbank, Montana, as was usual practice. He stated that he observed his usual rest and sleep routine Wednesday night and that he normally retires at 11 p.m. and rises between 8 and 8:30 a.m., whether at home or laying over in Cutbank.

The conductor was home in Great Falls on Thursday evening. On Friday morning, he rose at his normal time, ate breakfast, performed some light yard work, received his work call for train 603 about 11 a.m., and reported to work at 12:30 p.m. He reported that he does not drink alcohol and had taken no medications during the 3 days before the accident.

First-shift Dispatcher.--The first-shift dispatcher began her railroad career with BN in 1977 as a clerk and later became a train order operator.

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[5]An employee who substitutes for an absent assigned employee.

In January 1980, she entered the BN dispatcher school. After finishing her training in July 1980, she was assigned a dispatcher position at Glendive, Montana, where she had received her on-the-job training (OJT) the previous 2 months. According to the now retired Glendive chief dispatcher, the first-shift dispatcher was "let go" after a few days on the job. While monitoring dispatcher communications, the chief dispatcher overheard the first-shift dispatcher issue conflicting train orders for two trains on unsignaled single track. This communication occurred about 6 a.m., and the first-shift dispatcher had been working since midnight. He stated that he explained to her that she needed more experience and better concentration. The chief dispatcher recalled that because the 60-day probationary period had not expired, the first-shift dispatcher did not resist the release, which was reflected in her BN work record as an "administrative reassignment." She returned to work as a clerk and train order operator.

In 1988, the chief dispatcher in Billings, Montana, hired the first-shift dispatcher into the dispatcher program. The first-shift dispatcher told him that she had dispatched at Glendive and had voluntarily withdrawn. He queried other dispatchers and heard that she was a good clerk and operator. According to the Billings chief dispatcher, he found neither a written record of the first-shift dispatcher's release nor any information about her issuing conflicting train orders. From his experience, he believed that dispatchers who had withdrawn from and reentered the dispatcher program made good dispatchers the second time. The first-shift dispatcher reentered the BN dispatcher school and began dispatching in the Billings office in January 1989.

The Billings chief dispatcher stated that during the 60-day probationary period, the first-shift dispatcher showed good work habits and did a good job moving trains. He recalled that although qualified for several positions, she often worked the "busy" District 12 position territory between Glendive and Laurel, which involved automatic block signal[6] (ABS), centralized traffic control[7] (CTC), and TW control[8] territory that included two unsignaled branch lines.

According to the Billings chief dispatcher, the first-shift dispatcher had just completed her probation when BN consolidated dispatching activities in the Seattle office (February-March 1989). The first-shift dispatcher was assigned to the Seattle office, and work records, provided by BN, indicate that from January 1 through August 30, 1991, she worked 174 days[9] there. A breakdown of the positions worked and the days worked on each follows:

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[6]Each track section is governed by an automatic block signal or cab signal, or both.

[7]Train movement over routes and through blocks on designated track directed by signals from a central point.

[8]Train control on unsignaled track using radioed train orders.

[9]Consider each day either a work day or an 8-hour shift.

Dispatcher Position	Days
Assistant Chief Dispatcher[10] (ACD)	107
Wishram East	34
ACD Break In	16
Branch Line	6
Havre East/West	10
Boyer East	1

The first-shift dispatcher stated that on Tuesday and Wednesday, August 27 and 28, she worked the night shift from 10:30 p.m. to 6:30 a. m. She slept about 8 hours on Thursday night. On Friday, she recalled having juice for breakfast and arriving at work about 6 a.m. During her shift, she took one morning break to use the rest room. Her lunch was delivered to the office, and she worked while eating. The first-shift dispatcher reported that she neither drinks alcohol nor smokes. She takes a medication, Choledyl SA 400 mg, twice daily for asthma and stated that she had encountered no side effects.

Train Information

Consist.--At the time of the collision, train 602 consisted of 3 locomotive units, 20 loaded cars, and 14 empty cars and was 1,953 feet long with a trailing tonnage of 2,533. Train 603 consisted of 6 locomotive units, 57 loaded cars, and 28 empty cars and was 4,863 feet long with a trailing tonnage of 8,048.

Locomotives.--General Motors Electro Motive Division manufactured the 65-mph maximum speed locomotive units (models GP38-2 and SD40-2) on both trains. (See appendix B.) Diesel fuel capacity was 2,500 gallons for model GP38-2 and 3,000 gallons for model SD40-2. The model GP38-2 units were not equipped with a collision package.[11] The model SD40-2 units were equipped with a collision package consisting of anticlimbers and collision posts. All locomotive units had type F couplers[12] and 26L brake valves.[13]

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[10]Primarily administrative positions, ACD and ACD break in involve neither train movement nor movement orders, such as TWs and track and time limits.

[11]Consists of collision posts, anticlimbers, and interlocking couplers; however, the features have no set or defined number. Collision posts are two steel beams within the front short hood, designed to attenuate collision forces at the control cab. Anticlimbers are horizontal metal bars, equally spaced on the front and rear sill level, designed to interlock between units on collision and prevent one unit from overriding another. Interlocking couplers keep units aligned during a collision. Collision packages may also include other safety features. Title 49 CFR 229.141 specifies the locomotive body structure design requirements for collision posts and anticlimbers.

[12]The freight version of an interlocking coupler that is designed to maintain vehicle alignment during derailment.

[13]Locomotive valve through which the engineer operates the brakes.

Inspections and Brake Tests.--BN records indicate that both trains had received the required BN and FRA mechanical tests that included predeparture, initial terminal air brake, and equipment tests and inspections. The crews performed FRA air brake tests and checks as locomotive units or cars were changed. At Great Falls, the general mechanical foreman inspected and tested the train 603 locomotive units before attachment to the cars. Daily inspections and the required scheduled maintenance had been performed on the locomotive units, which were maintained at the BN facility in Havre, Montana. According to both train crews, a running air brake test was made as required; neither crew reported any air brake or other mechanical problem.

Track Information

4th Subdivision.--The 4th Subdivision branch line runs directly south from Shelby (MP 100) through the accident site (MP 85.55) to Great Falls (MP 0.9). (See figure 1.) MP 85.55 is 4.97 miles north of the Ledger siding switch. Approaching the accident site as train 603 was traveling, the track descends a 0.6-percent grade and negotiates a 4° 14' right-hand curve through a high hillside cut. Approaching the accident site as train 602 was traveling, the track ascends the 0.6-percent grade and negotiates an S curve, which is a 3° 5' left-hand curve followed by a 4° 18' right-hand curve. The collision occurred as train 602 entered the 4° 18' curve.

Track.--The BN single track line through the accident site is maintained to class 4 track standards with a maximum timetable speed of 49 mph. The track is constructed of 115 pounds-per-yard continuous welded rail, whose surface and alignment are maintained on crushed granite.

On the day of the accident, a BN track inspector had inspected the track from MP 37 to MP 99. The BN roadmaster, who was last over the subdivision track on August 10, 1991, stated that in the accident area, no track work had been performed and no track slow orders had been issued for the last 30 days. Postaccident BN maintenance-of-way department and FRA measurements at the accident site showed no deviations from FRA track safety standards.

Operations Information

Track Warrant System.--The BN TW system began after a 1986 union agreement that allows dispatchers to issue train orders directly to train crews. The system had first consisted of a printed form (see appendix C) with primary headings that were followed by numbered blank lines, each representing a standard operating instruction. A box next to the line number was checked for an applicable instruction, and the appropriate blanks in the line were filled in accordingly. Blanks for secondary copy information, such as initials, were at the bottom. Before computerized TWs, both dispatchers and crews used the TW form.

TWs were usually initiated by a train crew call to the dispatcher requesting authority to proceed farther. The dispatcher evaluated the request, checked for conflicting train movements, filled out a TW form, and read the instructions over the radio to a train crewmember, who filled

out an identical form that was read back to the dispatcher for verification. During the repeat for verification, the dispatcher underlined the information as a communication safety check.

BN has a series of rules applicable to TWs and requires that these be understood by all appropriate operating personnel, such as train crews and dispatchers. BN rule 401 for designated limits states:

> When a station name is used to designate the first named point, authority will extend from and including the last siding switch, or from the station sign if no siding.
>
> At the last named point, authority will extend to but not including the last siding switch when the track warrant specifies "hold main track at last named point."

Since the CTWC system was implemented, the dispatcher has used a formatted computer screen identical to the paper TW form. A train crewmember repeats back the TW to the dispatcher, who confirms the communication by using the keyboard space bar to electronically underline the TW text, word by word or number by number. The dispatcher may print paper copies of TWs issued. All TW authorities are electronically processed through the Information Management System computer in St. Paul, Minnesota.

A CTWC feature is a menu that appears with each function the dispatcher may use to construct a TW. The location menu includes a variety of modification words, such as east, west, switch, or yard limits that are appropriate to a particular destination. These menu words can be arranged in combination, such as east switch or west yard limits. Some menu items are associated with particular destination types. For instance, using a direction with a yard destination is common; however, directions are infrequently used with a siding destination because BN rule 401 makes such use redundant.

The CTWC system advantage is its built-in safety check that is intended to prevent a dispatcher from issuing unauthorized, conflicting, or overlapping instructions.[14] If any word spellings, conflicts, or directions are not computer recognized, the computer will reject the TW. The dispatcher will have to void that TW, which is identified by its unique computer-assigned number, and begin the TW process anew.

(For TW and train control history, see appendix D.)

Dispatching Organization.--The 25,000 miles of BN track are controlled by seven dispatching centers, which BN plans to consolidate into one command/control center. Each dispatching center controls a dispatching district, which deals only with train movement and may

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[14]It may allow overlapping authorities that have been resolved by other rules, such as with work trains. In these situations, the computer automatically adds the rule verbiage to the TW.

control one or more operating divisions or portions thereof. At the time of the accident, BN was divided into eight operating divisions,[15] which pertain to the supervision, the union seniority, and the interchange of crews. Dispatching districts and operating divisions do not necessarily coincide because the dispatching electronic and communication equipment cannot be moved as easily as the operating division boundaries.

The accident occurred on the BN Montana Division, which is controlled by the Seattle dispatching center that also directs train movements on the Pacific Division. The Montana Division encompasses all BN lines in Montana and the BN east-west main line (from Williston, North Dakota, to Sandpoint, Idaho) through northern Montana. A chief dispatcher, three ACDs, and four shift dispatchers control the Montana Division. One ACD and one shift dispatcher are shared with the Pacific Division. Dispatchers are guided by the *General Code of Operating Rules*, second edition, effective October 29, 1989, and the BN *Montana Division Timetable No. 3, April 7, 1991*.

Branch Line Dispatcher.--The branch line dispatcher controls the 4th through 6th, the 8th through 15th, and the 18th subdivisions on the Montana Division and the 8th and the 24th through 26th subdivisions on the Pacific Division. The control systems include CTC (54.7 miles) and CTWC (unsignaled territory as well as 162 miles of ABS track).

The branch line dispatcher sits alone in a small air-conditioned room. The branch line dispatcher may use any of 30 radio channels (16 Pacific Division and 14 Montana Division) and 3 phone lines. Other console equipment includes six video screens, a printer, and three keyboards, which are for the CTWC, CTC, and COMPASS[16] equipment. On the wall are clocks set for mountain and Pacific time.

The branch line dispatcher position has three shifts: day, afternoon, and night. Dispatcher workload varies daily and is dependent on traffic, weather, season, and other business factors. On August 30, the first-shift dispatcher had controlled 33 of the 55 trains operated during the 24-hour period. She issued 3 train destination lineups, 15 CTC track and time limits, and 21 computerized TWs (an additional 7 computerized TWs were voided because of computer rejection). The first-shift dispatcher issued, or attempted to issue, one train control document on average every 10 minutes.

First-shift Dispatcher.--The first-shift dispatcher stated that she had worked the branch line position 14 of the 365 days before the accident: 6 days on first shift, 1/2 day on second shift, and 7 1/2 days on third shift. However, as previously indicated, her work record since January 1, 1991, until the accident shows that she had worked only 3 days as branch line dispatcher and then had worked as an ACD or in other shift dispatching positions, none of which require CTWC equipment use. In August, she worked the branch line position the 2 days before the accident.

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[15]As of March 1993, BN had 27 operating divisions.

[16]A BN computer inquiry system for train movement information, consist lists, and locomotive power status.

She testified that she did not request "break-in time" because another branch line shift dispatcher had been refused this opportunity about 2 weeks earlier and had been "hassled" during the refusal.

The dispatcher who had been refused break-in time told Safety Board investigators that the refusal came from an ACD, who was responsible for assignments. The dispatcher explained that the ACD interpreted her request as evidence that she was not a qualified dispatcher or she would not have requested training. The dispatcher said that she then requested a 2-day break in from a chief dispatcher, who allowed 1 day. She stated that by obtaining the training and working the branch line position, she intended to learn the CTWC equipment as she anticipated that it would be used in other positions on which she wanted to be qualified.

The first-shift dispatcher stated that when she used the CTWC equipment as infrequently as she did, it was as if she had no prior equipment experience. Another dispatcher explained that dispatchers tend to get behind when they have to think about how to issue TWs on the CTWC equipment and at the same time plan how they will control train movements.

The first-shift dispatcher testified that listening and concentrating are necessary dispatching skills and that skilled concentration enables dispatchers to focus on their job despite office distractions. When she returned to shift dispatching work after other job assignments, she was personally more aware of distractions. She added that as an ACD, she did not have to employ the level of listening or concentrating that she had developed as a branch line dispatcher.

The first-shift dispatcher said that when she issued the train 603 TW 8851, she was also operating the CTWC equipment, which is the normal procedure, according to other branch line dispatchers. She also said that the CTWC equipment would at times reject her train movement control decisions, necessitating different inputs and waiting for the outcomes. The chief dispatcher, who reviewed the taped recordings of her TW conversations on August 27, 28, and 30, observed that the first-shift dispatcher sounded as if she was struggling and "frustrated" and was not proficient on the equipment. The chief dispatcher testified that the first-shift dispatcher's difficulty was not with issuing the TWs, but with operating the CTWC equipment. He added that he did not identify the same difficulties when she issued TW 8851 and that it was issued in a normal time length.

The first-shift dispatcher testified that radio communications maintenance work was being performed at Seattle throughout her shift on August 30. She said the tones that alert dispatchers to incoming radio calls occurred throughout her shift during work testing; however, this testing did not affect the remote transceivers on the branch line. Two BN supervisors observed that conditions at that time were unusually quiet. No calls or conversations were recorded for 1 minute before or after TW 8851 issuance, and no CTC activity was logged during the first-shift dispatcher's conversation with the train 603 conductor.

According to the dispatcher training manager, when some dispatchers are issuing TWs under high workload conditions, they tend to move on to their next task before completing all

of the preceding tasks. He also explained that he had observed that same tendency in new dispatchers, who are taught to slow themselves down.

Track Warrant Issuance

Train 603 TW 8851.--On August 30, the first-shift dispatcher issued two TWs (8837 and 8851) to train 603 for westbound movement from Great Falls. The conductor obtained a printed copy of TW 8837 from the Great Falls yard office before leaving. TW 8837 granted authority to occupy the track from Great Falls west yard limits to Dutton.

When train 603 reached Dutton, the conductor called the first-shift dispatcher to request another TW for journey continuance and said, "We'd like to get a warrant to get out of Dutton." (For the TW 8851 CTWC printout and radio transcript, see appendixes E and F, respectively.) The first-shift dispatcher acknowledged the request, established the train's current location as Dutton, and proceeded to initiate another TW on the CTWC terminal. As she entered the proposed authority limit on the computer, "Proceed from Dutton to," her voice trailed off the "to" which faded into a slightly higher tone and ended in a "W" or "Wha" sound ("toooowha"). At the same time, she released the microphone broadcast button, which made a short, quick, hissing "est" sound. Nine seconds later she said Ledger[17] as the *to* destination. She then continued with the TW routine: Item No.7 - "Not in effect until the arrival 7825 East [an opposing train] at Dutton," Item No.8 - "Hold main track at last named point," and Item No.15 - "Protection as prescribed by Rule 99 not required against following trains on the same track."

Approaching Dutton, the train 603 crew had begun their TW request. The conductor said that the usual procedure is to call the dispatcher about 5 miles outside of Dutton. He explained that when the train enters Dutton, the dispatcher has had the time to issue the next TW, and the train does not have to stop before reaching the previous TW authority limit. The conductor could not remember if the train stopped or continued to run slowly through Dutton when TW 8851 was transmitted, or which, if any, cab windows were open.

The train 603 engineer described the TW 8851 transmission as "scratchy." The conductor said he had trouble hearing the TW but could not recall why. Train 7825 East (locomotive units without cars), which restricted the train 603 departure from Dutton, was already waiting on the siding at the east end of Dutton. The train 7825 East engineer had overheard the first-shift dispatcher issue part of TW 8851. According to the train 7825 East engineer, the approaching train 603 crew received the first part of the TW before their locomotives crossed the east switch. He recalled the dispatcher transmission was clear, and he had heard the TW as Dutton to Ledger. However, he could not hear the train 603 crew repeat back the TW information because of the locomotive noise as they passed him.

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[17]According to another branch line dispatcher, Ledger was probably given as the destination because train 603 had been at the elevators beyond the west switch at Conrad. He said that while the crew was setting out and picking up cars beyond the Conrad yard limits, dispatchers could give trains protection using the CTWC equipment only by issuing authority for the main line through to the next station, that is Ledger.

During the TW transmission, the train 603 conductor asked the train 603 engineer, "Did she say West Yard Limits Shelby?" The engineer testified, "It sounded like West Yard Limits Shelby to me." The engineer said that he was occupied with getting the train past the east switch at Dutton when the conductor questioned him. He explained that at Dutton the train descended a grade[18] and was difficult to handle because of his inexperience as an engineer. He also recalled that the radio reception was scratchy at Dutton and at Conrad.

During depositions, the conductor was asked why he queried the engineer and answered, "I don't know. Maybe I wasn't sure, I don't know. I really thought that she had said Shelby. I must have been maybe not a 100 percent sure. I don't know." The conductor was then asked, "If you were not 100 percent sure that you heard west yard limit Shelby or if there was a question in your mind as evidenced by speaking to the engineer about it, why didn't you ask again?" The conductor replied, "I think I was pretty sure she did say Shelby is why I didn't ask again."

Three transcriptions of the TW 8851 radio conversation were prepared from the Seattle office tape recordings. The version that the chief dispatcher prepared indicated the first-shift dispatcher said "west Ledger" as the destination for train 603. A later BN version and the official Safety Board transcription indicated that the first-shift dispatcher had not said "west" when stating the destination. Two Safety Board investigators reviewed the tape recording and confirmed that the first-shift dispatcher said neither "west" nor "extra" as indicated in the initial BN chief dispatcher transcription.

In a hospital interview with the train 603 conductor shortly after the accident, he said:

> So we stopped there and got a track warrant to get out of Dutton and go to Shelby. And we had a little bit of trouble getting the warrant. I couldn't hear him,[19] and I said to the engineer, "What did he say when I was copying?" He [the engineer] said, "I thought he said Shelby." And I said, "Well, that's what I thought he said." I says, "Oh, it don't matter, because I'm going to have to repeat it back and spell it to him."

Under 49 CFR Part 220.45, *Communication Must Be Complete*:

> Any radio communication which is not fully understood or completed in accordance with the requirements of part 220 and the

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[18]As the locomotive and cars begin to brake on a descending grade, the slack in the couplers and draft gear begins to compress against the front of the train. This phenomenon demands the engineer's attention to anticipate and to control train descent.

[19]Although the first-shift dispatcher is female, the conductor referred to her as him.

> operating rules of the railroad shall not be acted upon and shall be treated as though not sent.

Under BN Rule 514, *Not Understood or Completed*:

> Any radio communication which is not understood or completed in accordance with these rules must not be acted upon and must be treated as though not sent.

Both the conductor and the engineer testified that the dispatcher had the ultimate responsibility for TW accuracy. The conductor said:

> My understanding of it was, though, was that the dispatcher was in control of where you had authority to move. They controlled your movement of where your train went. It was my understanding that the dispatcher was in charge of that because they had to okay it. So they had to give you permission to do what you were going to do. They had to okay it and then after they okayed it, give you a time. And then after that, then you had a track warrant.

The engineer stated, "I assume the dispatchers since they're giving us the information and then checking to see if we received it properly."

Asked if he relied on the dispatcher to verify the TW accuracy, the engineer replied:

> Yea. She's -- or the train dispatcher is putting up the information, has the computer in front of their face. And we're, you know, repeating back what we've heard. This happens all the time. If there's a mistake, then the dispatcher tells you what you have incorrect and you correct it. Then you're trying to get an okay after that.

Under BN Rule 403, *Copying*:

> All information and instructions must be entered on track warrant form provided and repeated to train dispatcher who will check and, if correct, will give "OK," the time and his initials.

When the first-shift dispatcher finished the TW 8851 transmission, she said, "and okay to repeat it." The conductor then repeated the TW, however, with the *to* destination of "West Yard Limits Shelby." The first-shift dispatcher used the space bar on the CTWC keyboard to underline the information during the conductor repeat. She then okayed TW 8851 with the time and her initials. The conductor acknowledged the okay, and the first-shift dispatcher said, "All

right, thank you." At that time the CTWC system recognized the authority limit as Ledger, while the train 603 crew believed the authority limit to be Shelby. The TW that the conductor completed was destroyed in the accident.

During depositions, the dispatcher training manager identified 15[20] errors, most involving radio procedure as outlined in 49 CFR Part 220, that the first-shift dispatcher and the conductor made during the radio transcription. Most radio procedure errors involved failure to use the words "over" or "out" to end transmissions. He found no errors on the TW 8851 printout from the CTWC equipment. He also testified that dispatchers issue TWs using a certain cadence and rhythm and are taught during training to pause for 2 or 3 seconds after each line before going to the next item.

The train 603 conductor testified that when he copied TW 8851, he expected train 602 to be either in Shelby or west of Shelby because of a derailment near Shelby. He did not know why he associated the location Shelby when taking TW 8851, except that he thought of west yard limits when he thought he heard the dispatcher say "west."

Another engineer, who regularly operates trains 602 and 603, explained that the only time the word "west" is included in TWs between Dutton and Shelby is for west yard limits Shelby. The dispatcher training manager testified that normally when a TW destination is a yard, a direction is given. The first-shift dispatcher also testified that she did not usually use "west" when naming Ledger as a TW destination.

Train 602 TW 8860.--At the end of the first shift, the second shift branch line dispatcher relieved the first-shift dispatcher. The second shift dispatcher testified that he observed no TW discrepancies on the CTWC terminal during the dispatcher change. He issued TW 8860 by telephone to the train 602 conductor giving authority from the east yard limits at Shelby to Ledger. Using BN computer documentation, Safety Board investigators confirmed this TW issuance. The train 602 conductor stated that he understood the TW to be from east yard limits at Shelby to Ledger and copied that information on his TW, which was destroyed in the accident.

Management Oversight

Dispatcher Quality Control.--The chief dispatcher testified that he and his counterparts are responsible for the Seattle office dispatcher operation, supervising both ACDs and shift dispatchers. Ensuring that shift dispatchers use proper radio procedures is also a chief dispatcher responsibility. The chief dispatcher stated that he visits each work station five to seven times each shift, although not necessarily to monitor dispatcher performance. In addition, ACDs supervise shift dispatchers by giving guidance and by observing their work. Their other duties include assigning locomotives and crews and coordinating work train activities.

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[20]The deposition proceeding radio transcript had several inaccuracies. After correction, the identified errors were reduced from 17 to 15.

The chief dispatcher stated that he was neither trained nor qualified to operate the CTWC equipment and was unaware of any other supervisor who was trained or qualified. The first-shift dispatcher stated that when she returned to the branch line position before the accident, she had not expected any supervisor to be able to assist her with CTWC operation. She had planned to seek help from another shift dispatcher, who worked another position on the same shift.

Dispatcher Tests and Audits.--The chief dispatcher stated that before the accident, he was unaware of any dispatcher "spot checks" being performed, except efficiency testing. All train movement activities are documented on conventional train sheets, and all radio conversations are recorded on reel-to-reel tapes. One day in September 1991, the chief dispatcher used the taping equipment to "spot check" dispatchers issuing TWs. He said that his intention was to listen for inaccurate repeats by train crews and for error corrections by dispatchers.

After the accident, the chief dispatcher audited the August 27 and 28 branch line dispatcher tapes. Four dispatchers had worked and issued 125 TWs during the 48-hour period. The first-shift dispatcher, who worked a total of 9.5 hours, issued 43 TWs. Eighteen of the 125 TWs had a mistake when the train crew repeated back. (Mistakes included incomplete line repeat back, improper dates or times, wrong locomotive unit numbers, and wrong or misspelled locations.) The dispatchers themselves had caught and corrected 11 of the erroneous 18 TWs. Of the seven uncorrected TWs, the first-shift dispatcher had issued five. According to the chief dispatcher, no audits of dispatcher tapes as described above were conducted on a regular basis.

Federal regulations require all railroads to conduct employee tests and inspections to determine operating rule compliance. Title 49 CFR Section 217.9(a) states:

> Each railroad to which this part applies shall periodically conduct operational tests and inspections to determine the extent of compliance with its code of operating rules, timetables, and timetables special instructions in accordance with a program filed with the Federal Railroad Administration.

Revised on January 1, 1987, the BN program requires each employee who is governed by the operating rules to be tested at least once every 6 months and dispatchers to be tested every 90 days. The chief dispatcher testified that the dispatcher efficiency testing program includes checking TWs. He stated that dispatchers could be tested on any rule in the BN *Book of Rules* or in the *Train Dispatcher's Manual* every 180 days; however, only selected rules are used in the testing program. The *BN Guide* for supervisors who conduct employee operating efficiency tests does not identify radio procedures in the applicable rules for dispatcher tests. *BN Guide* instructions state, "the tests included in this booklet identified as 'Qualifying Tests' do not restrict the officer from conducting tests on any applicable rule."

The Safety Board did not identify any efficiency testing for the first-shift dispatcher in 1991. The chief dispatcher explained that the testing absence was because she had worked primarily as an ACD and that only shift dispatchers are required to be tested on qualifying rules.

However, the first-shift dispatcher testified that since January 1991, she had worked 1 night each week as a shift dispatcher, but not in the branch line position. The chief dispatcher noted that chief dispatchers perform efficiency testing in addition to other job responsibilities.

The general manager testified that BN intended to "increase" supervisory monitoring of radio procedures and reviewing of copied TWs submitted at Great Falls. As of March 1993, no monitoring procedure had been established. The general manager added that the dispatcher performance auditing would be in conjunction with the efficiency testing program. The chief dispatcher stated that in addition to existing dispatcher efficiency testing, BN has a new review procedure for monitoring TW quality called "safety sampling." BN provided a list of sampling categories for target dispatcher activities that includes proper radio procedures.

Communications Information

Radio System/Network Coverage.--The dispatcher controls the radio communication system on the branch line track between Great Falls and Shelby. Three base stations transmit 161.100 megahertz for the train radio frequency, as follows:

Location	Effective Radiated Power[21] (watts)	Elevation (feet)
Dutton	142	4637
Conrad	126	3508
Shelby	72	3457

Base radio control[22] and voice communication are over microwave radio channels and leased telephone lines. Each base station has been modified for control over a dedicated four-wire voice/data channel. In July 1991, BN communication technicians placed in service a new Penta PC3 audio station controller to upgrade the area communication system. Other system modifications included reconfigured line circuits and new radio controllers.

All communication system problems (radio or phone) are reported to the BN Communication Network Control Center in St. Paul. The control center conducts tests remotely on the field equipment, determines the problem, and then dispatches a local technician to correct it. Trouble tickets[23] from the control center for the 12 months before the accident showed radio, controller, and line circuit problems. After the system modifications, two trouble calls were received. On August 29, the dispatcher reported that he could not turn on the radio (transmitter) at Conrad. After testing the line, the technician could find no problem, and a train was then

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[21]Transmitter power, less antenna line losses, times the antenna gain.

[22]Remotely turning on the radio base station.

[23]Field reports of communication system malfunctions.

radioed at Conrad. On August 30, the dispatcher reported that he had two trains in the area and could contact neither. These were the accident trains, which had already collided.

Locomotive radio receiver sensitivity is manufacturer-specified at 0.45 micro-volt with 20 decibels quieting. The lowest measured signal strength reading (BN 4th Subdivision radio frequency field strength study, September 12, 1991) was 0.7 micro-volt at MP 16.

Train 603 Radio Communication.--During interviews and depositions, the train 603 conductor and engineer were questioned about radio communication difficulty. The conductor said that he received radio static 25 to 30 percent of the time and that on August 30, "there was a little bit of static." Asked if he had trouble hearing the radio while copying the TW, he replied "yes"; however, he could not remember what was the difficulty. The engineer said, "The radio conditions that we work under are kind of adverse and probably 25 percent of the time it's scratchy in actual working conditions. When we got to Dutton, it was scratchy. And at Conrad, we had difficulty understanding what the dispatcher was saying there, as well."

According to the general manager, BN had purchased headsets for use in the Great Falls area to reduce the interference of locomotive cab noise with radio communication. He indicated that although the accident may have heightened awareness of BN's need to have the best possible communications, the railroad had begun to upgrade radio equipment before the accident.

Predeparture Radio Testing Procedures.--The conductor testified that when train 603 left Great Falls "the normal procedure would be just call and say this is 603 for radio test. Then somebody will usually tell you loud and clear. If you're not loud and clear, they'll tell you."

The FRA radio standards and procedures, 49 CFR Part 220.37, *Voice Test*, requires all locomotive radios be tested before departure from the initial terminal. Both accident train crews tested their radios before departure.

If the radio fails en route, a crew cannot be sure whether the locomotive radio or the base radio has the problem. Radio manufacturers are now installing devices that will indicate whether the locomotive radio is supplying proper transmission power and whether the antenna is radiating effectively. The locomotive radios involved in this accident were not equipped with this option.

The low cost option requires one additional circuit board and a slight front panel modification. It uses a PTT (push to talk) light to indicate a malfunction in the transmitter portion of the transceiver. If radio frequency power output from the transmitter drops to 50 percent or less, the PTT light flashes slowly when transmitting. If a defect in the antenna system occurs, the PTT light flashes rapidly.

Meteorological Information

According to the recorded area weather information for August 30, the temperature was in the mid-90° range with partly cloudy skies, a southwest wind about 10 mph, and visibility of 45 miles.

Medical, Pathological, and Toxicological Information

Survivors.--The five injured crewmembers were transported to Pondera Medical Center in Pondera County, Montana, where one was treated. Three crewmembers were transferred and admitted to the Columbus Hospital in Great Falls. The crewmember who sustained burns from ignited locomotive diesel fuel was first transferred to Deaconess Hospital in Great Falls and later to the Salt Lake City University Burn Center in Salt Lake City, Utah. Injuries consisted of multiple abrasions, lacerations, contusions, fractures, and second degree burns.

Fatalities.--The 23-year-old train 603 brakeman died from extensive internal injuries due to blunt force impact to the head and chest. His burned torso was found near a destroyed locomotive unit on August 30. The 39-year-old train 603 brakeman died from extensive internal injuries due to blunt force and shearing impacts, predominantly to the left side. His body was found under a grain car on August 31. The 48-year-old train 602 engineer died from extensive internal injuries due to blunt force impact, predominantly to the anterior chest, abdomen, and pelvis. His body was buried under loose dirt from the derailed cars and found on September 3. Safety Board investigators could not determine if the fatalities had jumped or been thrown from the trains.

Toxicological Testing.--Postaccident toxicological tissue, blood, and urine samples were collected from the operating train crews and from the accident and branch line dispatchers. Compuchem Laboratories in Triangle Park, North Carolina, analyzed the samples and found the results either negative or "administratively negative." The latter findings resulted from clinically administered medications given after the accident.

Postaccident Inspections

Train 602.--The lead locomotive unit was 2275. The cab was found in front of the train 603 lead unit about two car lengths beyond the impact point. It had been severed from the frame, split into two sections, and completely engulfed in fire, which destroyed the control stand, instruments, seats, and electrical cabinet.

The second unit was 8009. The cab was crushed downward and forward and sustained thermal damage. The electrical cabinet was crushed forward into the cab compartment.

The third unit was 6909. On the engineer side, the cab was crushed even with the long hood car body, and its top was crushed downward on the control stand. The windshield was

broken, the side window glass was broken but in place, and the door was totally crushed. The unit sustained little fire damage, and the cab sustained none.

Train 603.--The lead unit was 6905. The superstructure was displaced to the left side, at which the cab was displaced downward and rearward. The brakeman seat frame and pedestal remained attached to the control compartment's left side, and another seat was found on the cab left side exterior. The cab right side was crushed downward. The unit sustained major thermal damage.

The second unit was 6901. The superstructure, including the cab and engine compartments, was totally sheered off the frame. Only the frame with the couplers and fuel tank survived the collision and was found on unit 6909, which was the train 602 trailing unit. The unit sustained no thermal damage.

The third unit was 2287. The short nose hood, which housed the toilet compartment, was in place but badly mangled. The cab brakeman/conductor side had collapsed and sustained minimal thermal damage. The engineer side was in its original configuration with the control stand and instruments in place and no thermal damage. The back of the engineer seat sustained thermal damage.

The fourth unit was 2283 and sustained major structural damage. The cab top had collapsed downward against the engineer control stand, and the cab sustained thermal damage.

The fifth unit was 2274. The short nose thin gauge metal was torn open and bent, but not totally crushed. The cab roof had collapsed downward in the center between the missing windshields at the headlight area and against the engineer control stand, which, together with the instrument panel, sustained thermal damage. The engineer side was crushed inward, squeezing the door against the car body; on the brakeman/conductor's side, the door was crushed and inoperable.

The sixth unit was 2289. The cab brakeman/conductor side was crushed, and the door was inoperable. The cab top was in position with the windshields present; however, both side windows were missing. The engineer side was bent, the door was sprung open and sustained thermal damage on the outside, and the cab was accessible through the doorway. The door window was two meshed panes: The outer pane sustained thermal damage and separated from the inner pane, which was still in place. The engineer control stand and instruments and the main electrical cabinet were in place with no damage. This unit had minimal fire damage.

Survival Factors

The train 602 conductor, who was in the lead locomotive cab, stated that after seeing the oncoming train headlights, he jumped up, put one hand on the door and the other on the brake valve, and then looked over at the engineer. The engineer put the brakes in emergency, picked up the radio, and told everybody to jump. (He is credited with saving the lives of the two

brakemen in the trailing locomotive units because he stayed at the control stand to broadcast the jump warning.) The conductor went out the fireman side door, toward the left side front to the platform and steps, and then jumped backward. He tumbled and rolled over on the ground. After standing, he saw a box car coming toward him and ran 10 to 15 yards from the train up an embankment. While climbing a fence, he heard a massive explosion and then saw the field afire.

The train 603 engineer stated that before the accident he saw the train 602 headlights, put his brakes in emergency, and shouted that the conductor jump. The engineer then ran out the rear door, hung onto a vertical hand-rail post, placed his feet on the diesel fuel tank, and jumped. Once on the ground, he heard an explosion. He rolled into a ditch and crawled away from the train while watching the freight cars pile into wreckage. He attempted to climb a fence, but did not have the strength. He saw fire around the trains and the "diesel tanks exploding," creating a smoke cloud. When the explosions stopped, the engineer stood and walked to within 100 yards of the car pileup, where it became too hot to go closer.

The train 602 brakeman stated that he was in a trailing locomotive unit when he saw another train approaching. Over the radio, he heard a voice say, "Jump if you can!" He immediately jumped from the cab's fireman side, and the other brakeman in the cab jumped shortly after him. After hitting the ground, the first brakeman stood up, ran down an embankment from the train, and fell. He heard an explosion, saw the fire spreading over the field, crawled until the flames became too hot, and then laid down, covering his head. After several explosions, he then saw the other brakeman running from the fire; both ran, then crawled, down toward the river. They saw the train 603 conductor but believed that he was in shock because he did not know his own identity. The train 602 conductor then appeared and walked with the two brakemen from the crash.

The train 603 conductor stated that as his train came around a curve, he saw train 602. He believed he heard his engineer shout, "Jump!" The conductor ran outside, got down on the platform facing the equipment, looked at the oncoming train, and stepped off the platform; however, he did not remember striking the ground. Then he was on his side and saw a train 602 brakeman on the ground about 50 feet away. He believed the brakeman was in shock because the brakeman was "talking funny, kind of screwed up." The train 603 conductor did not recall what had happened when he jumped.

Emergency Response

Rancher Response.--While herding cattle, a rancher and his family heard the impact of the colliding trains. The rancher saw a "huge ball of blue smoke" in the direction of the collision and climbed to a hill top from where he saw the accident. He saw a man waving his arms, indicating to get help, and knew emergency services were needed. The rancher went to his home about 2 miles away, called 911, and then returned to the accident scene. By then, farmers in three pick ups and a water truck had arrived after seeing smoke; they believed it was a farm fire and called 911. Within 15 minutes, fire and police personnel and ambulances arrived.

Emergency response personnel had difficulty with the terrain and locating an access route to the accident; therefore, the rancher and his relatives directed emergency response personnel to the accident through a path known to them. He later joined in the search for survivors.

Fire Department Response.--The Conrad Volunteer Fire Department chief was notified at 5:51 p.m. and arrived at the accident site at 6:13 p.m. Two fire engines from that fire department and three engines from the Shelby Volunteer Fire Department responded, with at least 35 firefighters participating. Firefighters used a road grader to make a ford across the river so their equipment could be driven closer to the wreckage. The fires were extinguished at 8:17 p.m., except a burning load of lumber, which was still burning at 6 a.m. the next morning. The firefighters prevented the spread of fire, searched for missing crewmembers, and were released from the site at 7 a.m. on September 1.

Sheriff Department Response.--At 5:59 p.m., the Pondera County sheriff was at his residence when he heard sirens and called his office dispatcher, who said "about 10 train cars were on fire" near Ledger. As the sheriff proceeded to the accident, he spoke over the car radio with a deputy, who was also going to the accident. He received a report from the dispatcher about a head-on collision between two freight trains, met the deputy at the site, and drove down a path toward the railroad tracks. As they approached the site, they saw smoke, grass on fire, and fire around the freight trains. Two Toole County, Montana, deputies arrived. The sheriff and deputies assisted the search and rescue team of 30 volunteers to search for missing crewmembers. The search ended at 9:30 p.m. on September 3 after all crewmembers were found.

BN Notification.--At 6:22 p.m., the BN Pacific Division chief dispatcher received a telephone call from the BN Assets Protection Group in St. Paul. Someone had reported that a northbound train out of Conrad was on fire. The BN Montana Division chief dispatcher was then notified and called the Conrad Sheriff's Department, whose dispatcher said that a 911 call had reported 10 cars afire on a train that had passed through Conrad earlier. The sheriff's dispatcher asked if any hazardous material cars were in the consist. The chief dispatcher knew that train 603 was adding cars in Conrad, so he walked into the branch line dispatcher office to contact train 603 by radio. He received no response. The chief dispatcher then called the sheriff's department dispatcher back and said that he did not believe any hazardous material was on board. At that time, the sheriff's department dispatcher was in contact with emergency response personnel, of whom the chief dispatcher asked "if this is a head-on collision?" Someone confirmed that it was a head-on collision at 6:45 p.m.

Medical Response.--At 6:45 p.m., the Pondera Medical Center administrator received a call stating that a train accident had occurred and that the hospital disaster plan was being implemented to treat the injured. He arrived at the hospital a few minutes later and notified the hospital staff of the situation.

In accordance with its ambulance policy, all patients were transported for evaluation and stabilization to the medical center, which is the nearest hospital. (The chief of ambulance

services was the accident incident commander.) Five ambulances transported patients, and three emergency room physicians were waiting to attend the injured when the first ambulance arrived. At 11:30 p.m., hospital staff members were released because no more survivors would be arriving at the facility that night.

Disaster Emergency Services.--Because the accident occurred 1 1/2 miles from the county line, both Toole and Pondera Counties initially responded. (The counties normally provide mutual aid without written agreement.) The accident was determined to be in Pondera County, and its disaster plan was implemented. At 6:05 p.m., the central dispatch in Conrad notified the disaster emergency coordinator, who implemented the county disaster plan from the courthouse emergency operations center. Eleven agencies and local volunteers responded. The Toole County Emergency Services Coordinator and the Montana State Disaster Emergency Services Coordinator provided assistance as needed.

Tests and Research

Sight Distance Tests.--At the accident site on September 4, 1991, a sight distance test was conducted to determine the distance at which the train crews may have seen an opposing train and the reaction and evacuation time that the crews may have had before impact. A GP38-2 locomotive unit and a SD40-2 locomotive unit was used to simulate trains 603 and 602, respectively. This locomotive positioning was opposite the actual locomotive model assignments that lead the accident trains (a GP38-2 lead train 602 and an SD40-2 lead train 603); however, the visual perspectives are the same. Safety Board operating group members, who included representatives from parties to the investigation, acted as crews. After the first two tests, crews were switched to allow for individual visual acuity differences.

Four tests were made:

1 and 2--backing the locomotive units away from each other until the other units could not be seen.

3 and 4--initially backing beyond sight distance and approaching at 5 mph until the other locomotive was seen. 3--with crews straining by positioning their bodies for optimal sight distance, including leaning out the windows. 4--without body movement while sitting in cab seats.

The results from the first sight distance of other train tests were:

Test	In Feet from Point of Impact Train 602	Train 603	In Feet Between Trains
1	1,796	1,955	3,751
2	1,845	2,021	3,866
3	2,553	2,580	5,133
4	1,589	1,583	3,172

Based on an average sight distance from the tests and the event recorder information, trains 602 and 603 could see each other about 1,946 feet and 2,035 feet, respectively, from the point of impact (3/4 mile apart). Given this distance, each train traveled 21 seconds before an emergency brake application and another 8 seconds in emergency until impact. The distance the brakes were applied (in emergency) for trains 602 and 603 was about 540 and 565 feet, respectively.

Stopping Distance Tests.--After the accident, tests to determine the accident trains' approximate stopping distances were performed on a train dynamics analyzer. The tests were conducted using each train consist on tangent track and under ideal conditions. The results follow:

Train	Braking Mode and Braking Distances in Feet Full Service	Emergency
602	2,798	1,848
603	3,907	2,165
Total	6,705	4,013

Based on the sight distance tests, if the crews had immediately applied the emergency brakes, then the speed of the trains may have been significantly reduced before the collision, although the collision was probably unavoidable. The surviving crewmembers' statements indicate that the crews had no expectation of an approaching train and that they displayed disbelief when an opposing train was seen.

Event Recorder Information.--Event recordings were recovered from train 603 locomotive units 2287 and 2289 and from train 602 unit 6909. All other event recorder tapes were incinerated in the postcollision fire. The expanded printouts from the recovered event recorder tapes show that the speed of trains 602 and 603 was 40 mph and 47 mph, respectively, at impact.

Other Information

Dispatcher Selection and Training.--As steady improvements have been made in train control through signal systems, communications, and electronics, BN has consolidated train

control functions into fewer dispatching offices or centers.[24] Consequently, many interlocking and control towers and dispatching offices have been closed, providing a pool of experienced operators as dispatcher candidates. However, as the displaced operator pool was depleted, a significant shortage of experienced dispatcher candidates was created, which, in turn, has created a shortage of dispatchers that continues.[25] To meet its dispatcher needs, BN established a formal training program for candidates from other railroad crafts.

Application for dispatching positions is open to any BN employee. Candidates are interviewed by management and are required to pass two initial tests: a 26-page open book questionnaire covering all aspects of BN train and on-track rules, and within 60 days, a *General Code of Operating Rules* examination. Applicants who successfully pass both tests are entered into the formal training program.

BN has had a dispatcher training program since 1976. Training was conducted in the BN general offices in St. Paul until 1982 and at field offices until 1984. The dispatcher training then became part of the Technical Training Center in Overland Park, Kansas. In 1991, an Illinois Institute of Technology dispatcher simulator, capable of simulating actual train and track car movements on various BN railroad segments, was installed for training. Hardware was installed with simulation software so that training could be provided on CTC and CTWC territories.

The training program begins with 2 weeks at Overland Park to cover rules and regulations, including radio standards and procedures, and culminates in a written exam requiring a 90-percent minimum score. The trainee spends the next week in OJT at the assigned dispatching office, followed by 3 weeks at Overland Park. During this 3-week segment, the trainee works the simulator on all train control methods, including TWs. Final OJT is at the assigned office, where the trainee dispatches, supervised by an experienced dispatcher, and establishes seniority. If the trainee's job performance is acceptable to the chief dispatcher, the trainee receives a regular or extra list assignment; if not acceptable, supervised work continues until the trainee is qualified.

In addition, BN has recruited experienced dispatchers from other railroads and has found this to be the most economical and efficient way to fill its dispatching needs. According to BN, it costs five times more to train a craft transfer candidate than to train an experienced dispatcher. Recruited dispatchers take a month or less to learn BN operating rules; however, a trainee may need 5 months. Also, the quit rate for experienced dispatchers is almost zero, while about 40 percent of training program dispatchers quit dispatching within 2 years.[26]

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[24]BN projects that it will eventually have one centralized dispatching office in Fort Worth, Texas.

[25]The BN dispatcher shortage and its effects were identified in the FRA *National Train Dispatcher Safety Assessment 1987-88*, which is discussed later in this report.

[26]Since 1986 according to the BN dispatcher training manager.

To reduce the high number of trained dispatchers who quit, BN has attempted to develop a personality profile as an instrument for dispatcher selection. Data were gathered by a contracted company in 1986; however, the company went bankrupt, and the data were shelved. In 1988, BN contracted with Dr. Pat Sherry of the University of Denver, who determined that the data could be turned into a selection tool upon validation, which was completed in April 1992. At the time of this report, BN has yet to implement its validated personality profile in the dispatcher selection process.

Safety Board investigators found that although BN does not have a completed dispatcher personality profile, a common image among dispatchers of ideal personality traits does exist. Duane Casey, BN Assistant Director of Rules and Practices, said the person who makes a good dispatcher is "someone who is calm, cool, and can cope with stress; someone who is aggressive, not timid, and doesn't get pushed around or make mountains out of molehills."[27]

FRA National Train Dispatcher Safety Assessment.--In 1987-88, the FRA conducted a national safety assessment of train dispatchers because of the:

- o new technology in train control methods, including computer-assigned dispatching and communications.
- o change in operating rules and methods, including radio-transmitted directives to replace traditional train orders.
- o consolidation of train dispatching offices and positions, resulting in expanded territory responsibility for the dispatcher positions.
- o concern about excessive workloads and increased occupational stress for dispatchers, resulting from the aforementioned factors.

The FRA included the BN railroad in the assessment[28] and examined its staffing and training, rules and procedures, operational testing, office environment and workload, and communications. BN was in the process of consolidating dispatching offices, which reduced the dispatchers needed and expanded each dispatcher's territory. The Seattle dispatching office then had 25 positions.

In 1987, BN reported 19 cases to the FRA in which dispatchers had worked in excess of the Federal hours-of-service law. Of these cases, 14 were related to a qualified dispatcher shortage. BN had 154 shift dispatcher positions at that time.

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[27]Rick Knutson and Karl Rasmussen, "Dispatching BN's Dakota Division," *Trains Magazine*, October 1992.

[28]*National Train Dispatcher Safety Assessment 1987-88*, Chapter 4, Burlington Northern.

All railroads are required by Federal regulations to conduct tests and inspections of employees to determine the operating rule compliance. The FRA requested the documentation used to evaluate and to manage the BN testing program. BN was unable to provide any such reports, and the FRA concluded that "the program is not adequately audited and managed by the carrier."

During the 1987-88 assessment, the FRA found BN dispatchers had not been notified when they had been tested or of the test results. Over a 1-year period, the Seattle office had conducted 551 tests of the 25 dispatchers, with 3 failures. Although this is 22.04 annual tests per dispatcher with a 0.5-percent failure, the FRA took exception to these results. The FRA stated in its assessment:

> The three failures recorded at the Seattle office resulted in verbal reprimands as the corrective action taken. Furthermore, the three failures for an entire year were in glaring conflict with FRA findings in that office. FRA inspectors detected 60 instances of non-compliance with rules, special instructions, or Federal regulations.
>
> During the assessment, FRA inspectors noted that the radio procedures used by dispatchers were generally average while those of employees conversing on the radio with the dispatcher were generally poor. Notable by their absence were the insistence by dispatchers that employees initiating a transmission properly identify themselves (occupation and station) before continuing with a transmission and the use of the applicable words "over" or "out" when ending a transmission.

The FRA expressed its concerns and made several recommendations for BN in its assessment, as follow:

> Concern BN-01: Carrier lacks sufficient qualified dispatching staff to accommodate the needs for replacement of regular dispatchers for illness, vacations, training, familiarization road trips, and other requirements.
>
> Concern BN-02: There is no system standard governing rules examinations for train dispatchers.
>
> Recommendation BN-05: BN should assign supervisors to the dispatching work places to specifically monitor rules compliance of all employees.

Recommendation BN-12: BN should periodically conduct an audit of the workload on each dispatching position. The size of the territory should be adjusted so that the resulting workload will permit the dispatcher to reflect and make rational decisions.

Recommendation BN-17: BN should immediately implement a program to teach and enforce proper radio procedures by the dispatchers so that they will comply with all applicable Federal and carrier radio rules.

Safety Board investigators' follow-up inquiries revealed that although no record of correspondence with BN showed any presentation of the assessment report, its findings, and its recommendations, BN acknowledges possession of the report. BN has no record of any response to the report, and the FRA has no record of any request to respond. According to the FRA, its limited resources do not allow for or require follow-up action, and the report was for informational purposes only, with corrective action performed at carrier discretion.

Positive Train Separation.--BN and Rockwell International developed the Advanced Railroad Electronics System (ARES), which is a train control system based on the Global Positioning Satellite (GPS) system that provides earth surface locations within 1 meter. ARES is one of two proactive train control systems that provide "positive train separation" by safely stopping a train if the engineer fails to do so. The other system, Advanced Train Control System (ATCS), uses in-track transponders, rather than the GPS system, to locate trains and ultra high frequency radio, instead of the ARES very high frequency radio, for data transmission. Both systems' train control concepts are basically the same.

The ARES computer has in its memory a railroad map that includes all the significant physical features that affect train handling, such as road crossings, signal posts, slow orders, speed restrictions, grades, and curves. The computer also gives each train's unique physical makeup: length, weight, and car by car weight distribution (density). The ARES system tracks each train location and every few seconds calculates a new stopping distance in relation to the location and status of other trains. If trains get too close or an authority is violated, the computer takes control and brings the train to a gradual service stop. Current control systems only provide information and rely on the dispatcher and the engineer for appropriate action.

With ARES, the dispatcher can accurately track all train locations and move trains efficiently and safely, based on train performance and environmental conditions. A monitor in each locomotive control cab provides a constant moving track profile and performance information for optimum train handling, even in poor visibility, as well as current TWs and dispatcher information.

ARES is designed for any one of four progressively more sophisticated versions, depending on the functions and features desired. One version monitors 35 locomotive systems and can warn when a system is about to fail or needs maintenance attention.

In 1986, BN began using a prototype ARES on its 230-mile track taconite loop in Minnesota because the captive service equipment and cars would enable maximum control with minimal loss of operating efficiency during development. BN considered the Minnesota ARES use highly successful and expanded it to include locomotive analysis and reporting, as well as train movement authorities and speed restrictions. In 1992, BN ceased the ARES development in favor of ATCS because of the substantial capital investment required for ARES implementation and its incompatibility with other systems. BN indicated that the 4th Subdivision would have been included if ARES had been installed on the BN northern main line.

Postaccident BN Changes.--Since the accident, BN has initiated the following:

1. Predeparture printed TW copies for train crews have been shortened to show only items that are checkmarked by the dispatcher.

2. Separate radio frequencies have been allocated for dispatchers in adjacent territories.

3. Train crews use a double readback or "repeat" to the dispatcher for each TW issued.

Burlington Northern 1992 Dispatcher Initiative.--The Safety Board also learned that after the accident, BN initiated a task force study[29] of all dispatcher activities and training. BN established the task force in September 1991 in response to the longstanding dispatcher shortage; the high turnover rate among dispatchers; and the Ledger, Montana, accident. BN's Executive Vice President of Network Planning and Control headed the group, which included management officials, dispatchers, representatives of the American Train Dispatchers Association, and operations personnel.

The task force developed issue areas or "categories" based on the results of review sessions at all BN dispatching offices. Questionnaires were distributed to all dispatchers, and more than 200 dispatchers were interviewed. Input was received from more than 75 percent of the dispatching work force at the time. Categories identified for investigation and possible recommendations were:

1. Compensation issues, including dispatcher pay in comparison to that of other railroad jobs.

2. Performance standards for shift dispatchers.

3. Dispatcher certification and evaluation.

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[29]Later this effort was called the "Burlington Northern 1992 Dispatcher Initiative."

4. Crew/dispatcher relationship and crew resource management.

5. Sleep deprivation, boredom, short-term memory, monitoring tasks versus acting tasks, and workload.

6. Dispatcher and crew headsets.

7. Dispatcher road trip familiarization.

8. Ongoing training.

9. Stress management and interpersonal skills.

10. Dispatcher selection process.

11. Rewrite of the dispatcher manual.

These issues, approved in July 1992, were to be resolved or agreed on through the collective bargaining process between BN and the American Train Dispatchers Association. As of May 25, 1993, no issue resolution has been agreed on.

ANALYSIS

General

Based on the available evidence, the Safety Board concluded that the weather, the train equipment, the track, and alcohol or illicit drug use neither caused nor contributed to the collision. The operations personnel were qualified to perform their duties in accordance with BN procedures.

On August 30, 1991, the weather was clear and dry; it had no detrimental effect on train operating conditions. Nothing in the train predeparture tests, the postaccident equipment inspection, and the crew testimony or on the recovered event recorders indicated any equipment failure. Pre- and postaccident track inspections and measurements showed no defects or any deviations from FRA standards.

Toxicological test results of the first-shift dispatcher and train crews were negative. The train 602 locomotive crew had received proper TWs and operated the train as prescribed by BN rules. Postaccident examination of the train 602 event recorder tape indicated appropriate train handling. The train 603 engineer and conductor had the necessary training and experience to competently carry out their duties. Both had passed the BN rules tests. Their rest and eating habits in the 3-day period before the accident appeared to be sufficient to maintain alertness. The first-shift dispatcher demonstrated sufficient knowledge of train control procedures and

dispatching duties to carry out her TW issuing responsibilities. She was sufficiently rested and had taken one medication, Choledyl SA, for several months without side effects.[30]

The Accident

At 2:55 p.m. on August 30, TW 8851 was issued to train 603 at Dutton. The train 603 conductor called the first-shift dispatcher and stated, "We'd like to get a warrant to get out of Dutton." The first-shift dispatcher acknowledged the request, established the train 603 location as Dutton, and proceeded to initiate a TW on the CTWC terminal, as routinely done. However, when the first-shift dispatcher transmitted "Proceed from Dutton to-," her voice trailed off the "to" and faded into a slightly higher tone that ended in a "w" or "wha" sound, "toooowha", as she released the broadcast button on the radio microphone, which made a short, quick "est" sound. These sounds combined to sound like "west" and were followed by a 9-second pause.

The crew initiated their TW request as train 603 approached Dutton. The conductor said that the usual procedure is to call the dispatcher for a new TW about 5 miles outside Dutton. As the train enters Dutton, the dispatcher has had the time to issue the next TW, and the train does not have to stop before reaching the first TW westbound limit.

Train 7825 East was on the east end siding at Dutton. According to its engineer, the approaching train 603 crew received the first part of the TW before their locomotives crossed the east switch. He recalled the dispatcher transmission was clear, and he heard the TW as Dutton to Ledger. The engineer also said he could not hear the train 603 crew repeat back the TW information because of the locomotive noise as they passed him.

It was a clear, hot day, and the open windows on the train 603 unair-conditioned lead locomotive cab could have allowed noise from the diesel engines into the cab that made hearing the TW 8851 transmission difficult. Against the noise background, the train 603 conductor heard the first-shift dispatcher say "west" for the *to* destination. During the following 9 seconds, as the first-shift dispatcher paused to enter Ledger into the computer, the conductor was confused about whether he had been given the destination as west *something* and questioned his engineer. From experience, the conductor associated the word "west" with yard locations, and the next yard location was Shelby. At that point, he surmised that the first-shift dispatcher had said west yard limits Shelby, but that he may have not heard it completely. After questioning his engineer, who vaguely recalled that the first-shift dispatcher had said west yard limits Shelby, the conductor assured himself that if he was wrong, the first-shift dispatcher would correct him during the repeat. The conductor believed that under BN Rule 403, it was the dispatcher's responsibility to "check and, if correct, . . . give 'OK'." The Safety Board concludes that the train 603 conductor relied on the readback rather than asking for a repeat of the TW 8851 authority limit.

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[30]Possible side effects are nausea, nervousness, flu-like symptoms, and diarrhea.

The first-shift dispatcher was working her third straight day on the branch line job. Although her skill in operating the CTWC terminal had been improving, she was still struggling. The branch line job was normally busy even for a skilled and experienced dispatcher, and in addition to the frustration of redoing computerized TWs, the first-shift dispatcher was constantly endeavoring to keep the trains moving. She quite likely transmitted "Ledger" to the train 603 crew during the time they were preoccupied in conversation. The Safety Board concludes that the first-shift dispatcher failed to detect and correct the train 603 conductor repeat of the TW 8851 authority limit.

The CTWC system recognized the authority limit as Ledger; however, the train 603 crew believed that they had authority to Shelby, 20 miles beyond Ledger. Consequently, human miscommunication had created the authority conflict that precipitated the head-on collision.

First-shift Dispatcher Aptitude, Selection, and Qualification

After its investigation of a train collision at Motley, Minnesota,[31] the Safety Board recommended that BN:

> R-85-43
>
> Establish and document aptitude and other performance oriented selection criteria which ensure that individuals considered for safety critical positions, such as train dispatchers, are capable of fulfilling the requirements of that position.

Investigation of the Ledger collision showed that the first-shift dispatcher may not have had the aptitude necessary to perform as train dispatcher. Thus, Safety Board investigators are concerned that BN has yet to implement objective selection/screening criteria for train dispatchers. BN indicated in its last response to this recommendation that it was using outside contractors to identify a viable selection/screening tool to assist management in choosing candidates for dispatcher training. Because BN was actively working to meet the intent of this recommendation, the Safety Board classified Safety Recommendation R-85-43 "Open--Acceptable Response" on August 25, 1987. Since BN has now developed a validated personality profile for dispatchers, as previously referred to in this report, BN should implement that developed profile in its dispatcher selection process.

During two separate periods of her railroad service, the first-shift dispatcher had worked controlling trains. Soon after beginning her first service as a shift dispatcher, she was relieved for making an error. She then worked as a clerk and train operator for the next 8 years. She applied for and returned to dispatcher school, completed the training cycle a second time, and worked successfully at various shift dispatching positions in different offices.

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[31]Railroad Accident Report--*Head-On Collision of Burlington Northern Railroad Freight Trains Extra 6760 West and Extra 7907 East Near Motley, Minnesota, June 14, 1984* (NTSB/RAR-85/06).

Although the first-shift dispatcher demonstrated sufficient knowledge of train control procedures and dispatching duties to perform her TW issuing responsibilities, the Safety Board is concerned that her aptitude for such work had not been determined. The Safety Board concludes that BN has yet to implement an employee selection program as stated in Safety Recommendation R-85-43 that would ensure that individuals considered for safety critical positions, such as dispatchers, are capable of fulfilling the position requirements. Therefore, the Safety Board believes that BN should accelerate and implement an objective identification, selection, and screening program for dispatcher candidates to determine their suitability to successfully perform as dispatchers.

Also as a result of the Motley, Minnesota, accident, the Safety Board recommended to the FRA and the Association of American Railroads (AAR), respectively:

R-85-47 and R-85-48

> Initiate a program designed to determine and document aptitude and other performance oriented selection/screening criteria, training, and testing procedures for individuals to be employed in safety critical positions such as train dispatchers.

The FRA responded that in 1974, it had issued the report, *An Analysis of the Job of Railroad Dispatcher*. The FRA asserted that this report provides a data base of job knowledge, skills, training, and other criteria from which safe operations can be derived. It replied that as such, the report meets the requirements set forth in the Safety Board recommendation. The FRA said that carriers have programs of operational tests and instruction, as required by 49 CFR Part 217.9, and that it has promoted training and monitored the results. It found that railroads generally have effective training programs for their train dispatchers and operators and concluded that current dispatcher qualifications and training are adequate to provide safe rail service on a national basis. It saw no need to initiate a national program or duplicate previous efforts involving aptitude, screening, and testing standards for dispatchers or other operating employees.

The Safety Board replied to the FRA that *An Analysis of the Job of Railroad Dispatcher* had been published over 10 years before Safety Recommendation R-85-47 was issued and that the report had been eclipsed by significant changes in dispatcher electronic support technology and techniques. The report was also not intended as a definitive study but as a basis for further development of performance criteria and personnel selection aids. Consequently, the Safety Board classified Safety Recommendation R-85-47 "Closed--Unacceptable Response" on July 30, 1986.

The AAR replied to R-85-48 that while dispatchers must understand the rules, procedures, and organization of the industry, railroads operate in different business environments in unique geographic areas and have different approaches to dispatcher training and staffing. In all cases, prospective candidates are screened through previous employment performance and personal interviews. The AAR reviewed several railroad dispatcher selection and qualification programs

in 1992 to substantiate the difficulties in developing a single screening and training method. It contended that the industry was doing a good job of selection/screening, that the overall record upheld this position, and that the initiation of a national program was not warranted. The Safety Board believed the AAR had adequately supported its contention that a standardized national program of screening and training railroad employees was not warranted and therefore classified Safety Recommendation R-85-48 "Closed--Reconsidered" on December 8, 1992.

After its investigation of a 1986 train derailment in Fall River, Wisconsin,[32] the Safety Board recommended that the FRA:

> R-87-66
>
> Conduct a thorough study of the selection process, training, duties, and responsibilities of train dispatchers to determine if the workload is beyond the normal job stress level and determine what selection and training standards are used for train dispatchers. Establish selection and training standards and limits of workload for dispatchers.

The FRA agreed with the need for such an evaluation and conducted the previously mentioned safety assessment. After publication and presentation of the *National Train Dispatcher Safety Assessment 1987-88* to Congress in 1990, the FRA wrote that the evidence developed did not support the premise that train dispatchers were inappropriately selected or that a statistically significant pattern of accidents was caused by inadequately trained or inexperienced dispatchers. Therefore, the FRA did not pursue the promulgation of standards or establish personnel selection criteria. In September 1991, the FRA administrator wrote that the dispatcher assessment established that technical training appears adequate and that an upcoming study project would cover dispatcher workload, occupational stress, and fatigue; he also requested closure of Safety Recommendation R-87-66. This recommendation has been classified "Open--Acceptable Action."

TW Transmission Transcriptions

Three transcriptions of the TW 8851 radio transmission and repeat were prepared from the Seattle dispatching center tape recording. BN personnel made two transcriptions; Safety Board investigators made one transcription, on which this analysis is based. Immediately after the accident, a Seattle chief dispatcher hastily made the first transcription; about a week later, BN made a more detailed transmission examination that resulted in a second, corrected transcription. Finally, the Safety Board made an official transcription to ensure that a complete, correct transcription was used in its investigation.

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[32]Railroad Accident Report--*Derailment of Amtrak Passenger Train 8, Operating on the Soo Line Railroad, Fall River, Wisconsin, October 9, 1986* (NTSB/RAR-87/06).

In the first transcription, the most significant mistake found was the *to* destination of west Ledger. This mistake demonstrates that even an experienced chief dispatcher thought he heard the word "west" in the transmission. The second BN version and the Safety Board transcription indicate the first-shift dispatcher named the destination station as Ledger and did not include the word "west" in the destination. Multiple aural reviews of the taped transmission also indicated several pauses that could have caused such ambiguity, particularly if outside distraction, engine interference, and machine noise were present. As a result, the Safety Board directed its investigation to the sources of the misunderstanding in TW transmission and repeat.

Misunderstanding Sources

Several factors during the recorded TW transmission and repeat combined to produce the misunderstanding that led to the collision. These follow:

1. Voice intonation used by the first-shift dispatcher.

2. Accepted procedure of simultaneously formulating and transmitting a TW from the computer screen in piecemeal method.

3. Failure to use proper radio procedure, as outlined in 49 CFR Part 220.

4. Failure by the conductor and the engineer to request repeat or clarification of the destination, as outlined in BN operating rules, when they did not clearly hear the destination.

5. Failure by the first-shift dispatcher to recognize and correct wrong destination during crew repeat back.

First-shift Dispatcher Voice Intonation.--The train 603 conductor's mistaken interpretation of the destination was probably from the first-shift dispatcher's extended vocalization of the "w" sound followed by an unexpected and unidentified pause in the transmission that lasted 9 seconds. The vocalized extension that consisted of her prolonging and stressing the word "to" with an upward intonation suggested something was to follow. The extended sound was long enough to overlap the time when the dispatcher would have progressed to the next word, if she was speaking at an even rate. The "tooowha" ended with her keying off the microphone for the 9-second pause about the time a single-syllable word would have concluded at the same speaking rate. After the pause, the first-shift dispatcher named the destination. Several other transmission pauses occurred while she issued TW 8851, and extended vocalizations, based on prolonging the last sound of the word, preceded these pauses. In the first-shift dispatcher's transmission, the longest pause (by several seconds) was during her communication of the destination. These nonverbal cues were sufficiently ambiguous that the Seattle chief dispatcher, who made the first TW transcription, interpreted the destination as "west Ledger." The intermittent pauses resulted from the method commonly used by BN dispatchers to simultaneously formulate and send a computerized TW. The conductor's confusion that resulted from these intermittent transmission

pauses can also be attributed to improper radio procedure. The intermittent pauses, coupled with poor radio procedure, would leave a listener, such as the train 603 conductor, to guess when the transmission has ended and whether the information is complete and correct.

TW Delivery.--The piecemeal method used to simultaneously formulate and transmit a computerized TW can lead to potentially confusing intermittent pauses. The dispatcher keyboards required information onto the formatted computer screen and waits for computer acceptance. The dispatcher then transmits this part of the TW by voice radio before completing the next informational line. This piecemeal method, combined with voice intonation and poor radio procedure, increases the possibility of a dangerous error. The Safety Board concludes that the first-shift dispatcher's piecemeal method of computerized TW formulation and transmission was known to exist by BN management and fostered an environment in which the misunderstanding of the TW 8851 authority limit occurred. When a dispatcher receives a TW request, a "wait out" should be given so the dispatcher can devote full attention to the TW formulation and acceptance on the CTWC screen. Once an acceptable TW has been developed, the dispatcher can call back the requesting train crew and deliver a clearly communicated, fully attended, and uninterrupted TW. A TW developed and communicated in this manner would not only lessen the possibility for a misunderstanding and provide a more lucid delivery of information, but require less radio transmission time. Therefore, the Safety Board believes BN should require dispatchers to complete formulation and entry of a computer-acceptable TW before transmitting it to the train crew.

Radio Procedure.--Proper radio procedure is vital to clear, concise communication and is particularly important in regulating train movement. Consequently, 49 CFR Part 220 is very specific about radio train order transmission, and the FRA monitors railroad radio procedure. The radio procedure of the first-shift dispatcher and the train 603 crew was poor. The BN dispatcher training manager had counted 15 radio procedure errors in the transcript of the TW 8851 radio transmission. After listening to taped dispatcher/crew radio conversations, investigators found that procedural errors were typical of TW transmissions. Had the dispatcher given an "over" or a "wait out" at the start of the 9-second destination pause, the conductor may have recognized that the destination had not yet been given, and the collision may have been avoided.

The BN Seattle chief dispatcher was asked if he believed proper radio procedure was being followed and replied, "I know that in the past, we, as a company, have addressed that issue and it's getting better than it was. I believe there's room for improvement." However, BN neither offered any examples nor presented any testimony that the poor radio procedure practice was corrected. Although the poor procedure was acknowledged by BN management, no plans were made to change it. In a formal radio procedure to control train movement, such as a TW, 15 errors appear to be excessive. After reviewing other TWs, Safety Board investigators found that such procedural errors were common. Even after the FRA dispatcher assessment, BN management failed to take any steps through a formal or informal plan to improve radio procedure. Although no evidence indicated that BN encouraged poor procedure, such procedure was tolerated by being ignored.

The FRA *National Train Dispatcher Safety Assessment 1987-88* states:

> During the assessment, FRA inspectors noted that the radio procedures used by dispatchers were generally average while those of employees conversing on the radio with the dispatcher were generally poor. Notable by their absence were the insistence by dispatchers that employees initiating a transmission properly identify themselves (occupation and station) before continuing with a transmission and the use of the applicable words "over" or "out" when ending a transmission.

The FRA recommended:

> The BN should immediately implement a program to teach and enforce radio procedures by the dispatchers so that they will comply with all applicable federal and carrier radio rules.

Although the FRA recognized that BN had radio procedure problems 3 years before the accident and had so notified BN, it appears that neither the FRA nor BN did anything to significantly improve the situation through stricter regulation enforcement or education. Neither the FRA nor BN could produce any follow-up correspondence or documentation to indicate that corrective action or improvements were made or intended. The Safety Board concludes that the poor radio procedure practices of the first-shift dispatcher and the train 603 crew were not isolated events. Such practices were known to exist by BN management and fostered an environment in which the misunderstanding of the TW 8851 authority limit occurred. Therefore, the Safety Board believes that BN should implement a program to teach and enforce proper radio procedures for dispatchers and train crews so that compliance with applicable Federal and railroad rules will be accomplished.

The Safety Board understands that when the FRA conducts a special railroad evaluation, the carrier and the FRA reach a mutual agreement. The carrier remains open and willing to facilitate an accurate FRA evaluation in lieu of being cited for any carrier violations uncovered during the assessment process. While such an informal agreement may facilitate the FRA assessment, it does not foster public or railroad safety if the findings are not pursued to closure. The Safety Board concludes that had either the FRA or BN adequately followed up the concerns and recommendations about radio procedures from the dispatcher safety assessment, this accident may not have occurred. Therefore, the Safety Board believes that the FRA should follow up on the concerns and recommendations made to railroads in FRA safety assessments and request a response to provide closure on the safety problems uncovered.

Conductor and Engineer Performance.--It is likely that the conductor did not hear the dispatcher say "Ledger" when she resumed transmission. During those moments, the conductor and the engineer were probably discussing their understanding of the destination. Both recalled the conductor questioning the engineer about the station named. Although the Safety Board could

not establish exactly when this discussion took place, it probably took place after the unidentified transmission pause, when the conductor believed he had been given a destination. Because of this, the conductor neither heard nor copied the "Ledger" destination transmitted later.

The conductor's belief that he heard a clearance to Shelby resulted from his interpretation of the word "west." The conductor stated that when he heard "west," he expected the track authority to be west yard limits Shelby. He was familiar with the route between Great Falls and Cutbank and knew the destinations to continue westbound from Dutton. In addition, because a recent derailment in Shelby had delayed train 602 earlier in the week, he expected train 602 would also be delayed that day. The track authority through to Shelby would have been a likely clearance. Therefore, the Safety Board concludes that in the absence of a clearly understood TW 8851 authority limit, the train 603 conductor "heard" what he expected to hear.

National Aeronautics and Space Administration (NASA) researchers have examined similar expectation-based communication problems between aircraft controllers and flight crews. Two human factors studies[33] discuss how flight crews incorrectly hear operational information from controllers consistent with flight crew expectation of wordage. This phenomenon has intuitive validity, as well as support from systematic documentation, and was active when the train 603 conductor recorded the TW.

The Safety Board also considered the TW procedure regulations. Title 49 CFR Part 220.45 and BN Rule 514 require that when any radio communication is not fully understood, employees must treat that communication as if never received. The strict interpretation of either rule requires crew to question dispatchers directly to ensure clear communication and not to continue beyond the preceding TW authority. When the conductor questioned his engineer, it indicated that he was unsure of what he had heard for the destination. He did not question the first-shift dispatcher but waited to verify the station during the repeat. The conductor testified that he expected the first-shift dispatcher to correct him, as required by BN Rule 403, if he had made an error. He did not comply with either 49 CFR 220.45 or BN Rule 514 because he relied on the repeat procedure for clarification and permitted train 603 to proceed beyond Dutton without that clarification. Had he strictly interpreted BN Rule 514 and requested an authority limit repeat, the accident may not have occurred.

The Safety Board is concerned that the conductor's reliance on the first-shift dispatcher to correct the TW interpretation may not be a single incidence. According to one engineer, some crewmembers are reluctant to question dispatchers about TWs because it can be interpreted as challenging a dispatcher decision. He indicated that many crewmembers rely on the repeat procedure and BN Rule 403 rather than directly asking for clarification when information is unclear. Deposition testimony about the operating employee responsibility for TW accuracy is

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[33]Charles E. Billings and John K. Lauber, *NASA Aviation Safety Reporting System: Third Quarterly Report*, NASA Technical Memorandum, NASA TM X-3546 (Washington, D.C.: National Aeronautics and Space Administration, May 1977), p. 22. William P. Monan, *Human Factors in Aviation Operations: The Hearback Problem*, NASA Contractor Report 177398 (Moffet Field, CA: March 1986), p. 11.

consistent with this practice. Interviewed crewmembers uniformly agreed that the final responsibility for TW accuracy rests with the dispatchers. Dispatchers and BN management testified that TW accuracy is a shared responsibility of crew and dispatchers.

Relying on dispatchers to clarify TW information during repeat is not the intent of the procedure or BN Rule 403. The repeat procedure was devised to verify train orders and was adopted as a safety feature to supplement the CTWC system. According to BN management, the repeat verifies that the track occupancy authority carried by the crew is the same as that issued by the dispatchers. The Safety Board is concerned that if the repeat procedure is used to clarify uncertain TW information, then the verification and safety redundancy functions decrease.

After the accident, BN revised the repeat procedure so that two crewmembers, usually the conductor and the engineer, repeat TWs to the issuing dispatcher. Relying on aural radio or telephone communication for track occupancy authorities underutilizes existing technology. A visual display and/or information printer in the control locomotive cab is the method of communication most likely to minimize misunderstanding.

Radio printers/fax machines, which might be used for train control information, are used in police cars, taxis, trucks, and delivery vehicles. However, the railroad industry has yet to find a printer that can reliably take the vibration in and environment of a locomotive cab. As described in the ARES train control, monitors have visually displayed train control information. Either on screen or on paper printout, a display reduces the chance of misunderstanding and, therefore, is preferable to memory and to hearing in a noisy locomotive cab.

Dispatcher Performance.--The Safety Board could not determine for certain why the first-shift dispatcher did not correct the error during the destination repeat. The TW tape recording indicated that the conductor clearly read back the words "west yard limits Shelby," but the first-shift dispatcher could offer no explanation for her error.

The first-shift dispatcher's suitability for her dispatcher position was considered. She had dispatched trains and issued TWs successfully for several months in the Billings office before transferring to the Seattle office. Based on that background, the first-shift dispatcher had sufficient TW control knowledge and experience to perform train control duties.

Evidence did suggest that over the previous 11 months during her assignment predominantly as an ACD, some dispatcher skills may have deteriorated from normal performance levels. The ACD positions are administrative in nature and do not directly involve train movement or the associated listening skills. The first-shift dispatcher testified that listening and attention skills deteriorate when dispatchers do not regularly work shift dispatching positions. She had been working once a week at another shift position, which did not involve CTWC, as well as the ACD assignments. Safety Board investigators could not evaluate the extent of the first-shift dispatcher's listening skill loss; however, some degree of listening and attention skill degradation had probably taken place over the previous 11 months.

BN supervisors acceded that it is likely listening and attention skills deteriorate with nonuse. Nonetheless, no evidence was found that BN management recognized a possible problem of skill deterioration during assignments not involving computerized TWs or radio listening skills. Moreover, when dispatchers returned to a position requiring CTWC operating and radio listening skills and requested refresher training, supervisors discouraged these requests. The Safety Board concludes that BN had no recurrent CTWC operating training and radio skills program for shift dispatchers. Therefore, the Safety Board believes that BN should establish within its qualification program a formal requalification program for dispatchers and supervisors who intermittently work such positions.

The Safety Board attempted to determine whether the first-shift dispatcher had been distracted and her attention diverted during the TW repeat. No unusual sounds were recorded on the taped TW transmission, and no other dispatching tasks were logged on the computerized track control data recorder. The first-shift dispatcher stated that she could not recall any distraction during the TW 8851 repeat. It is probable that if a distraction would have been sufficient to cause her to overlook the destination repeat error, she would have recalled it or audible evidence of it would have existed on the transmission tape.

The Seattle office tape recording indicated that the first-shift dispatcher had been experiencing difficulty while using the CTWC machine during the 3 days on the job and that she was frustrated with its operation. According to the chief dispatcher, the earlier recorded radio transmissions revealed that the first-shift dispatcher was "fighting the machine." Several other dispatchers described CTWC activities (planning train movements, translating plans into computerized TWs, and cancelling and reentering a computer-rejected TW) as "demanding." One dispatcher, who had worked the branch line position, stated that her experience was "terrifying" because of the CTWC equipment operating characteristics. When asked if the first-shift dispatcher's efforts to enter a computer-accepted TW overshadowed her attention to the TW repeat, the Seattle chief dispatcher, who was not qualified or familiar with the CTWC equipment, testified that he was not aware of such a situation.

The first-shift dispatcher's failure to correct the train 603 conductor's repeat probably resulted from a combination of several factors. Some factors were related to her admitted lack of proficiency on the CTWC equipment that, in turn, made her dispatching tasks more demanding. Another dispatcher testified that if dispatchers need extra time to operate the computer, they get behind in their train control activities. The first-shift dispatcher was not keeping up with her work that afternoon as evidenced by her testimony that she was unable to finish lunch or to take a rest room break. She probably attempted to recover the time she had lost reformulating TWs on the CTWC equipment by transitioning to her next task before the train 603 conductor read back the TW. This premature task transition divided her attention. The dispatcher training manager stated that under high workload conditions, dispatchers sometimes initiate their next task before concluding TW repeat. The Safety Board could not verify the first-shift dispatcher's susceptibility to this tendency; however, premature task transition would have circumvented the purpose of the readback procedure.

The skills and attention needed by train dispatchers are much like those required by air traffic controllers. In the NASA research on communication errors between air traffic controllers and flight crews, controllers reported that moderate to heavy air traffic conditions had frequently been present when overlooked incorrect readbacks occurred. Neither the NASA research on the hearback problem nor this investigation could establish a causal relationship between hearing incorrect information and workload conditions. However, considerable generic evidence exists that demanding workload conditions reduce attention and that stressful operating circumstances may exacerbate this problem when self-induced operating errors are included.[34]

The first-shift dispatcher issued TW 8851 about an hour before her shift ended at a time when she might be more fatigue prone. Asked if it was any busier near the end of the shift than the beginning, she replied:

> At that point in the afternoon, I believe that things were a little hectic in there. There were operators -- I guess, last minute things before everybody is at the end of their shift -- everybody else wants to get their work done too. So basically there was -- I would say there was quite a bit of activity at that point.

According to the first-shift dispatcher, because of the railroad traffic volume and her inexperience on the CTWC equipment, she could only have a sandwich at her desk and make "a quick trip to the bathroom" on her shift. Neither her testimony nor other evidence indicates that she was physiologically stressed; however, more frequent variations in her intonations were heard later in her shift on the transmission tape. The change in her verbal delivery to a more conversational style suggests a decline in her capacity to maintain the disciplined monotonic delivery preferred by experienced dispatchers. The Safety Board concludes that her one comfort break during her shift may not have been sufficient to maintain the required mental ability for a complete shift, and BN made no effort to periodically schedule relief or extra dispatchers on positions. Therefore, the Safety Board believes that BN should evaluate each dispatcher position to determine the number of adequate breaks necessary to maintain optimum mental ability.

After its investigation of the Fall River, Wisconsin, train derailment, the Safety Board recommended that the Soo Line Railroad:

> R-87-63
>
> Provide train dispatchers and operators at a minimum one off-duty period of 24 hours during any 7-day consecutive work period, a mandatory lunch break, and an additional break in the first half of the shift and one break in the second half of the shift in any 8-hour tour duty.

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[34]Sandra G. Hart and Michael R. Bortolussi, "Pilot Errors as a Source of Workload," *Human Factors*, 26, 1984, p. 555.

The Soo Line responded:

> Dispatchers and operators are not restricted to their desks and, as the opportunities present themselves, the dispatchers have the freedom to move in and about the immediate vicinity of their work area in order to go to the restrooms, or obtain coffee and food from vending machines provided.

It further stated that it was actively training new dispatchers, rearranging dispatcher territory, and installing computer-assisted traffic control systems, which it believed would reduce the individual dispatcher workload. The Safety Board contended that "as the opportunities present themselves" would not ensure a regular break, if any, and considered the response inadequate to fullfill the recommendation. Therefore, the Safety Board classified Safety Recommendation R-87-63 "Closed--Unacceptable Action" on July 12, 1989.

At the time of the Ledger accident, this "catch as catch can" philosophy about dispatcher breaks was in place at the BN Seattle office and is evidenced by the first-shift dispatcher's inability to leave her desk because of workload. In the haste to consolidate dispatching operations, the Safety Board has found a management tendency to overlook a dispatcher workload evaluation of human needs by including reasonable regular breaks.

Also as a result of the Fall River train derailment, the Safety Board recommended that the FRA:

> R-87-65
>
> Revise the hours of service regulations for train dispatchers and operators to provide at a minimum one off duty period of 24 hours during any 7-day consecutive work period, a mandatory lunch break, and an additional break in the first half of the shift and one break in the second half of the shift in any 8-hour tour of duty.

The FRA responded that the provisions of the Hours of Service Act, which is FRA-enforced, and not FRA regulation, control the number of hours railroad employees may work. The act does not authorize the issuance of implementing regulations, and the FRA has no authority to alter statutory provisions. However, the FRA administrator stated his support for legislative reform and cited instances when he had spoken in support of revision. Consequently, Safety Recommendation R-87-65 was classified "Closed--Reconsidered."

After a 1988 head-on collision between two freight trains at Thompsontown, Pennsylvania,[35] the Safety Board recommended that the Consolidated Rail Corporation (Conrail):

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[35]Railroad Accident Report--*Head-On Collision of Conrail Freight Trains UBT-506 and TV-61 at Thompsontown, Pennsylvania, January 14, 1988* (NTSB/RAR-89/02).

R-89-17

Provide train dispatcher breaks on all shifts with qualified backup relief, a mandatory lunch break, and at least one additional break in each half of any 8-hour tour of duty.

Conrail replied that its dispatcher offices had promoted dispatchers to chief dispatchers and ACDs who would be qualified to provide backup relief for each dispatcher. Dispatchers desiring to eat their lunch or to take short breaks away from their desks may do so by asking the ACD to "sit in." A private lunch room is available in most dispatching offices for this purpose. Dispatchers can and do routinely leave their desks for 10- to 15- minute breaks. The chief dispatcher or ACD can then monitor the on-break dispatcher's control territory from an adjoining desk or through the radio system[36] until the dispatcher returns. Safety Recommendation R-89-17 has been classified "Closed--Acceptable Action."

The Safety Board concludes that the first-shift dispatcher's error in not correcting the train 603 conductor's readback resulted from several problems that combined to reduce her attention when TW 8851 was issued. These included the effort required for her to operate the CTWC equipment at a pace that did not delay train movements, the likely deterioration of her listening and concentration skills because her primary duties were administrative rather than operational, and the decline of her capacity to allocate strict attention to all tasks during the major part of the shift without a break.

Dispatcher Break In

The first-shift dispatcher testified that because of the time lapse between assignments and the equipment usage, it was like starting over each time she returned to the branch line position. She expected problems on the equipment and planned to use the expertise of another shift dispatcher who was working at the same time. The first-shift dispatcher explained that she had not requested break-in training because another dispatcher had been refused the training and then subjected to supervisory disapproval for making the request. BN management expected the Seattle office shift dispatchers to be fully qualified and proficient when they changed positions, regardless of the time lapse between assignments. Therefore, the Safety Board concludes that the first-shift dispatcher had recognized her need for refresher training on the CTWC equipment before commencing the branch line position on August 27; however, BN supervisors discouraged such requests.

After the Motley, Minnesota, train collision, the Safety Board recommended that BN:

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[36]BN dispatchers also employed this system, which allows the dispatcher to talk on the radio through a microwave system or through direct phone line.

R-85-44

Revise the training and testing procedures for individuals to be employed in safety critical positions, such as train dispatchers, to better ensure the safety requirements of those positions are fulfilled.

BN provided a comprehensive description of curriculum changes for the initial dispatcher training and qualification, which met the intent of this recommendation. Safety Recommendation R-85-44 has been classified "Closed--Acceptable Action." However, the Ledger accident shows the need for an encompassing qualification program that would also cover dispatchers once assigned to an office.

Training and testing not only includes initial qualification but extends to a comprehensive, continuing skills maintenance and enhancement program for management and employees. The Safety Board is concerned that the carrier has not implemented a skills maintenance program for all positions on which a dispatcher is qualified to work and that it has no system for shift dispatchers to retain their familiarity with the equipment and workload. Investigators determined that BN was not implementing a skills maintenance program for dispatchers assigned to positions in which they did not frequently use listening and concentration skills or specific equipment operating skills.

In their book *Human Error: Cause, Prediction, and Reduction*,[37] Senders and Moray state that specific skills required for a job should be identified. The employer should ensure that the required skill performance levels are maintained. If the tasks employing those skills cannot be performed with sufficient frequency to enable the employee to retain the required performance levels, additional training should be provided.

Carrier management should not depend on dispatchers who recognize personal knowledge or skill deficiencies to request break-in training. An evaluation and refamiliarization program for dispatcher positions should be initiated that includes train control performance duties. In addition, whoever determines the dispatcher proficiency after break-in or on-the-job training should be someone experienced in all aspects of the subject train control position. In the BN Seattle office, a chief dispatcher who may never have worked a position as equipped observes qualifying dispatchers perform their duties.

Management Oversight and Dispatcher Support

During the accident investigation, the Safety Board reviewed the management oversight of the first-shift dispatcher. The chief dispatcher's testimony showed that BN management was

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[37]J. W. Senders and N. P. Moray, *Human Error: Cause, Prediction, and Reduction*, (Lawrence Erlbaum Associates, Publishers, 1991), pp. 124-125, 129.

aware of the first-shift dispatcher's difficulty. He testified that ACDs and chief dispatchers had direct oversight of shift dispatchers; however, no evidence substantiates that the claimed oversight was actually performed. During depositions, the first-shift dispatcher was asked, "What kind of supervision did you receive when you were working that position: the branch line position?" She replied:

> Basically it's a pretty much ignored job as far as supervisors. If a person has problems, they will ask somebody, but it's not generally that somebody is going to come in and watch over what you're doing. It's basically a job that's busy enough that most people stay out of there and pretty much leave you to what you've got to do. But if there are questions, you find someone who can answer it for you.

Although Safety Board investigators considered the first-shift dispatcher's statement self-serving, BN management neither challenged nor contradicted it. The chief dispatcher was asked, "Do you have guidelines as to how to perform your supervisory duties?" and responded, "Not that I'm aware of; nothing that is writing set, no." When questioned if he monitored dispatchers on a regular basis, he said that he made "contact" or got "in there" five to seven times a shift. However, when asked if this was to monitor their performance, he replied, "Not always, no, but it does play into it, yes."

The second-shift dispatcher, who relieved the first-shift dispatcher and issued TW 8860 to train 602, was asked to describe the supervision received when working the branch line position. He said that sometimes the ACD provides a work lineup for cars to be picked up or dropped off, but he was unaware of anyone monitoring his work. When asked if the quality of his work was ever mentioned, he replied that occasionally a train crew did so if a move or trip went well. He was aware that a chief dispatcher might be able to monitor his work by a recording device, but did not know if that had ever been done.

After the Motley, Minnesota, train accident investigation, the Safety Board recommended that BN:

> R-85-45
>
> Review and revise, as necessary, supervisory procedures for individuals employed in safety critical positions, such as train dispatchers and especially newly promoted employees, to better ensure the safety requirements of those positions are fulfilled.

In April 1987, BN responded:

> Burlington Northern has instituted closer monitoring of neophyte train dispatchers. An exempt supervisor, usually a chief

> dispatcher, or other designated officer, is required to sit with the dispatcher during his/her first work alone on shift to closely monitor and supervise. The next eight shifts are monitored by an exempt chief dispatcher and/or assistant chief dispatcher for the same purposes. On the new dispatcher's tenth shift, an exempt supervisor again sits in to monitor, supervise and evaluate the dispatcher's work.

Safety Recommendation R-85-45 was classified "Closed--Acceptable Action" on August 25, 1987.

During the Ledger accident investigation, no evidence surfaced that BN dispatcher supervisors used or even knew of this monitoring procedure. The Safety Board can only surmise that such a procedure was forgotten or no longer in effect. Because no BN dispatcher supervisors were qualified on the CTWC equipment at the time of the accident, they would have been unable to help a new dispatcher or another dispatcher requalify on the branch line position.

The postaccident BN audit of branch line dispatcher tapes proved an effective way to detect uncorrected train crew readback errors and to identify the first-shift dispatcher's lack of CTWC equipment operating proficiency. The daily voided TW tally showed the first-shift dispatcher's progressive improvement on the CTWC equipment. Neither the tape audit nor the TW tally was a standard quality control or oversight procedure, and they were only performed because of the accident. If management had given this scrutiny before the accident, the first-shift dispatcher's difficulties on the CTWC equipment would have been apparent and appropriate break-in training could have been authorized. In addition, casual radio procedures between the branch line dispatchers and the train crews could have been identified and corrected to conform to intended Federal and carrier rules.

Unlike many management positions, dispatcher supervisors, such as chief dispatchers and ACDs, are first-line supervisors who may be required to substitute for shift dispatchers who have unscheduled absences because of sudden illness or labor strike. This is particularly important when a shortage of dispatcher personnel is already evident, as at the BN Seattle office, and becomes crucial in consolidated offices, where a limited number of dispatchers control the entire railroad. Consequently, it is critical that supervisors have the necessary skills to operate electronic equipment, such as CTWC, which are the tools of the dispatcher's trade and an integral part of the dispatcher's job. Equipment proficiency is also a factor in the ability to properly supervise dispatchers. Therefore, the ability to effectively evaluate, monitor, test, or assist a shift dispatcher is directly related to the supervisor's understanding of and skill on the electronic tools that directly or indirectly control the trains.

The chief dispatchers and other supervisory personnel did not have proficiency on all shift dispatching computer equipment. The chief dispatcher testified that he could not operate the CTWC equipment and did not know any chief dispatcher who had received training on it. The Safety Board recognizes that chief dispatchers are promoted from the shift dispatcher positions

to ensure that office oversight reflects the specialized technical expertise required for train control activities. Without basic skills on the major dispatching equipment, chief dispatchers lose some ability to effectively enforce high standards of dispatcher performance and cannot provide direct assistance if needed. Chief dispatchers and hift dispatchers now resolve technical operating problems by dependence on other employees who have special computer expertise and may, by chance, be working on the same shift. The Safety Board concludes that BN management neither provided personnel specifically to relieve, help, or monitor dispatchers nor adequately trained supervisors in the use of computer equipment. Therefore, the Safety Board believes that BN should provide adequate personnel and equipment resources to effectively monitor, test, evaluate, help, and relieve shift dispatchers.

BN Efficiency Testing Program

The BN efficiency testing program consisted of testing dispatchers every 180 days. However, when questioned whether he was able to take time from immediate job demands to devote to efficiency testing, the chief dispatcher said no. He was asked whether it was "viewed as an extra duty, something that was perhaps important to be done but there was [sic] other pressing duties that might have tended to take precedent" and replied, "I would agree with that." This attitude casts doubt on supervisors' ability to conduct an effective efficiency testing program and makes suspect recorded tests.

In addition, the BN testing program in effect at the time of the accident was misunderstood and not applied according to the BN plan. Regulated railroads must submit to the FRA a testing plan to ensure employees understand and comply with the carrier operating rules (49 CFR Part 217.9). The BN plan required operating employees and dispatchers to be tested every 180 days and every 90 days, respectively. According to the chief dispatcher, dispatchers were not tested every 90 days, as required by the BN plan, but every 180 days. Furthermore, the first-shift dispatcher had not been tested in 1991, although she had been working dispatching positions at least a night a week. Except for the irregular testing, no dispatcher monitoring or oversight by BN supervision was evident.

The BN efficiency testing program had not included the first-shift dispatcher because dispatchers working positions that do not directly control train movement are exempt from the testing program requirements. BN management explained that the first-shift dispatcher's work assignment as an ACD (no train control responsibilities) had caused the testing discrepancy; however, the first-shift dispatcher had worked periodically at train control positions. Also, BN allowed dispatchers "temporarily" exempted from the testing program to work shift dispatching jobs and, as the first-shift dispatcher did, to periodically work positions.

If the testing program remains the only system monitor of shift dispatcher performance, BN should establish rigorous record controls for tested employees, and supervisors should have available documentation on the performance strengths and weaknesses of each dispatcher. In addition, untested dispatchers should be withheld from shift dispatching positions until the required testing is performed and/or break-in training with qualification on the positions is

completed. The Safety Board concludes that BN had an inadequate dispatcher quality control program and an ineffective dispatcher testing program. Therefore, the Safety Board believes that BN should establish a dispatcher audit/quality control program and implement an effective periodic dispatcher testing program.

Locomotive Radio Testing Adequacy

The untested locomotive radio is the radio system's weak link. A faulty locomotive radio and/or antenna will negate the best radio communication network. In the TW system, the railroad radio system and the locomotive radio, in particular, are used as communication tools to regulate train movement. The locomotive radio should be tested to ensure the communication link is completely clear before train departure and where applicable en route. BN locomotive crews neither are required to effectively test the locomotive radio system over the distance the system is expected to operate nor have the capability to determine the locomotive radio is functioning as designed.

Developments since 1986 have allowed radio manufacturers to build in devices that indicate whether the locomotive radio is supplying proper transmission power and whether the antenna is radiating effectively. TW issuance has increased radio use to control trains and, thus, a properly operating radio is critical to safe train movement.

After its investigation of the Fall River, Wisconsin, train derailment, the Safety Board recommended that the FRA:

> R-87-64
>
> Modify the regulations for the testing of radios used in operations to be tested at each crew change location to determine that the radio will transmit and receive over a distance equal to the longest distance between base stations on the route the train is to travel.

The FRA asserted that its inspection and monitoring activities revealed the railroad industry had eliminated the problems that initiated this recommendation. It stated that "any radio communication problems that warrant additional regulatory action" were not evident. The FRA added that advances in technology had overtaken the recommendation and asked that it be closed because of the improved quality of radio communications. On May 7, 1991, the Safety Board closed the recommendation as no longer applicable.

This accident demonstrates the critical relationship between the radio communication system and the TW system. Although no evidence is conclusive that the locomotive radio of train 603 malfunctioned, testimony suggests that it may have.

Locomotive Anticlimbers and Fuel Tanks

Because of the mix of collision-equipped locomotive units, the magnitude of dynamic forces, and the locomotive damage, the Safety Board could not determine the locomotive cab crashworthiness. The Safety Board will continue to monitor locomotive cab performance in accidents.

Positive Train Separation

The principle of safely and successfully operating more than one train on a given railroad segment is predicated on the establishment of a system that will keep trains separated. A system to ensure positive train separation has for many years been a Safety Board concern and has always been on its "Most Wanted List." With either ARES or ATCS in effect, the TW would have appeared on a cab mounted screen, and a fully implemented system would have automatically limited train 603 from advancing beyond Ledger. Therefore, the Safety Board concludes that had an ATCS been installed and working in the accident area, the accident probably would have been prevented.

After its investigation of a May 1986 rear-end train collision at Brighton, Massachusetts,[38] the Safety Board recommended that the FRA:

> R-87-16
>
> Promulgate Federal standards to require the installation and operation of a train control system on main line tracks which will provide for positive separation of all trains.

On May 31, 1991, the FRA wrote:

> The Railroad Safety Improvement Act of 1988 required the FRA to assess the feasibility of requiring ATC (automatic train control) on all rail corridors that handle passengers or hazardous materials. The FRA analysis concludes that mandatory ATC would cost between $8 and $16 billion and that is not feasible. I have enclosed a copy of our report for your use. The conclusion of this report reflects our analysis at this time. However, as I stated at our March 26, 1991 meeting on the "Most Wanted List," the FRA is highly concerned about this issue. We are actively monitoring industry developments associated with implementing a less costly system than is currently available. We are also moving to identify appropriate corridors that may be prime candidates for an ATC

[38]Railroad Accident Report--*Rear-End Collision Between Boston and Maine Corporation Commuter Train 5324 and Consolidated Rail Corporation Train TV-14, Brighton, Massachusetts, May 7, 1986* (NTSB/RAR-87/02).

system. While we cannot solve the ATC dilemma, it is a pertinent subject that we expect to address in the years ahead based on new analysis and technology.

Safety Recommendation R-87-16 has been classified "Open--Acceptable Response."

After its investigation of a train accident at Sugar Valley, Georgia,[39] the Safety Board issued recommendations to the FRA (R-91-25), to the AAR (R-91-31), and to the Railway Progress Institute (RPI) (R-91-32). It recommended that in conjunction with each other, they expand the effort being made to develop and install ATCS for the purpose of positive train separation.

In December 1991, the AAR president stated that the AAR and its member railroads actively support the ATCS design and development and that in the past year, significant progress had been made refining the system logic and control flow specifications, which would improve the ATCS capability to perform the intended train control application. He added that the AAR and the RPI are working closely with the FRA to ensure that all concerns are addressed as the system logic is further developed and refined. Safety Recommendations R-91-25, -31, and -32 have been classified "Open--Acceptable Response."

AAR member railroads have been testing components of ATCS since 1991. The National Railroad Passenger Corporation (Amtrak), for example, has installed transponders at selected locations on the Northeast Corridor that have the ability to slow trains (using the current cab signal system) for permanent speed restrictions. Amtrak plans to update the signal system on the Northeast Corridor to include nine speed commands up to 150 mph. The application of onboard computers to Northeast Corridor locomotives may eventually provide true positive train separation. The AAR, however, has yet to demonstrate a fully implemented ATCS that provides positive train separation. Although the activities of Amtrak and other AAR member railroads in developing and testing ATCS components are laudable, the Safety Board concludes that the development of a practical positive train separation system has not progressed as quickly as it should have.

Until 1992, BN had ARES, a working positive train separation system. The Safety Board was greatly disappointed when BN abandoned ARES. The ARES approach for wayside, locomotive, and dispatcher control was very similar to the AAR-proposed ATCS; however, ARES used continuous GPS signals instead of in-track transponders. Through these signals, an onboard computer calculated the specific location of the train, which was transmitted by very high frequency 160 megahertz data radio to a central office. Based on Rockwell International receivers, train locations could be determined within a 150-foot accuracy.

Whether ARES or ATCS, a fully implemented positive train separation system will supply information to the dispatcher's computer monitor to indicate whether the engineer has train

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[39]Railroad Accident Report--*Collision and Derailment of Norfolk Southern Train 188 with Norfolk Southern Train G-38 at Sugar Valley, Georgia, August 9, 1990* (NTSB/RAR-91/02).

control. If the engineer fails to adhere to a speed restriction or to obey a signal, the locomotive computer can stop the train.

The Safety Board is greatly interested in systems such as ARES and ATCS and knows that system technology exists because its staff had the opportunity to see the ARES demonstration program. However, the only active program, the ATCS project, is limited to work order reporting, track warrants, and installation of ultrahigh frequency radio systems. These activities have no bearing on positive train separation or its benefits. More emphasis should be placed on positive train separation, particularly since FRA records indicate that from 1987 through 1991, 1,483 head-end, rear-end, and side collisions have occurred.

ARES made a lasting impression on many carriers in the railroad industry. Amtrak requested that ARES be installed on BN track where Amtrak passenger trains operate. Amtrak also requested that ARES be installed on its own track between Porter, Indiana, and Kalamazoo, Michigan. BN indicated that the area in the Ledger accident, the 4th Subdivision, would have been included if ARES had been adopted. The advanced, field tested and demonstrated ARES technology has been abandoned in favor of ATCS, which has not been field proven.

The Safety Board believes that the FRA, in conjunction with the AAR and the RPI, should establish a firm timetable that includes, at a minimum, dates for final development of required ATCS hardware, dates for implementation of a fully developed ATCS, and a commitment to a date for having the ATCS ready for installation on the general railroad system.

CONCLUSIONS

Findings

1. The weather, the train equipment, the track, and alcohol or illicit drug use neither caused nor contributed to the collision. The operations personnel were qualified to perform their duties in accordance with BN procedures.

2. The train 603 conductor relied on the readback rather than asking for a repeat of the track warrant 8851 authority limit.

3. The first-shift dispatcher failed to detect and correct the train 603 conductor repeat of the track warrant 8851 authority limit.

4. Burlington Northern Railroad has yet to implement an employee selection program as stated in Safety Recommendation R-85-43 that would ensure that individuals considered for safety-critical positions, such as dispatchers, are capable of fulfilling the position requirements.

5. The first-shift dispatcher's piecemeal method of computerized track warrant formulation and transmission, as well as the dispatcher's and the train 603 crew's

poor radio procedure practices, were not isolated events. Such practices were known to exist by Burlington Northern Railroad management and fostered an environment in which the misunderstanding of the track warrant 8851 authority limit occurred.

6. Had either the Federal Railroad Administration or Burlington Northern Railroad followed up the concerns and recommendations about radio procedures from the National Train Dispatcher Safety Assessment 1987-88, this accident may not have occurred.

7. In the absence of a clearly understood track warrant 8851 authority limit, the train 603 conductor "heard" what he expected to hear.

8. The first-shift dispatcher's error in not correcting the train 603 conductor's readback resulted from several problems that combined to reduce her attention when track warrant 8851 was issued.

9. The first-shift dispatcher had recognized her need for refresher training on the computerized track warrant control equipment before commencing the branch line position on August 27; however, Burlington Northern Railroad supervisors discouraged such requests. Burlington Northern Railroad had no recurrent computerized track warrant control operating training and radios skills program for shift dispatchers.

10. The first-shift dispatcher's one comfort break during her shift may not have been sufficient to maintain the required mental ability for a complete shift, and Burlington Northern Railroad made no effort to periodically schedule relief or extra dispatchers on positions.

11. Burlington Northern Railroad management neither provided personnel specifically to relieve, help, or monitor dispatchers nor adequately trained supervisors in the use of computer equipment.

12. Burlington Northern Railroad had an inadequate dispatcher quality control program and an ineffective dispatcher testing program.

13. Had an advanced train control system been installed and working in the accident area, the accident probably would have been prevented.

14. The development of a practical positive train separation system has not progressed as quickly as it should have.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this head-on collision was the poor communication practices of the first-shift dispatcher and the train 603 conductor and the Burlington Northern Railroad's failure to establish an adequate management oversight and quality control program in its train control operations. Contributing to the accident was the combined failure of Burlington Northern Railroad and the Federal Railroad Administration to follow up on the dispatching concerns and recommendations of the Federal Railroad Administration *National Train Dispatcher Safety Assessment 1987-88*.

RECOMMENDATIONS

--to the Burlington Northern Railroad:

Accelerate and implement an objective identification, selection, and screening program for dispatcher candidates to determine their suitability to successfully perform as dispatchers. (Class II, Priority Action) (R-93-5)

Require dispatchers to complete formulation and entry of a computer-acceptable track warrant before transmitting it to the train crew. (Class II, Priority Action) (R-93-6)

Implement a program to teach and enforce proper radio procedures for dispatchers and train crews so that compliance with applicable Federal and railroad rules will be met. (Class II, Priority Action) (R-93-7)

Establish within your qualification program a formal requalification program for dispatchers and supervisors who intermittently work such positions. (Class II, Priority Action) (R-93-8)

Evaluate each dispatcher position to determine the adequate number of breaks necessary to maintain optimum mental ability; provide adequate personnel and equipment resources to effectively monitor, test, evaluate, help, and relieve shift dispatchers. (Class II, Priority Action) (R-93-9)

Establish a dispatcher audit/quality control program and implement an effective periodic dispatcher testing program. (Class II, Priority Action) (R-93-10)

--to the Federal Railroad Administration:

Follow up on the concerns and recommendations made to railroads in your safety assessments and request a response to provide closure on the safety problems uncovered. (Class II, Priority Action) (R-93-11)

In conjunction with the Association of American Railroads and the Railway Progress Institute, establish a firm timetable that includes, at a minimum, dates for final development of required Advanced Train Control System hardware, dates for implementation of a fully developed Advanced Train Control System, and a commitment to a date for having the Advanced Train Control System ready for installation on the general railroad system. (Class II, Priority Action) (R-93-12)

--to the Association of American Railroads:

In conjunction with the Federal Railroad Administration and the Railway Progress Institute, establish a firm timetable that includes, at a minimum, dates for final development of required Advanced Train Control System hardware, dates for implementation of a fully developed Advanced Train Control System, and a commitment to a date for having the Advanced Train Control System ready for installation on the general railroad system. (Class II, Priority Action) (R-93-13)

Advise your membership of the facts and circumstances of this accident and encourage them to implement and install an Advanced Train Control System. (Class II, Priority Action) (R-93-14)

--to the Railway Progress Institute:

In conjunction with the Federal Railroad Administration and the Association of American Railroads, establish a firm timetable that includes, at a minimum, dates for final development of required Advanced Train Control System hardware, dates for implementation of a fully developed Advanced Train Control System, and a commitment to a date for having the Advanced Train Control System ready for installation on the general railroad system. (Class II, Priority Action) (R-93-15)

APPENDIXES

APPENDIX A

INVESTIGATION AND DEPOSITION

Investigation

After accident notification on August 30, 1991, the National Transportation Safety Board immediately dispatched a western regional office investigator to the accident scene. Safety Board headquarters dispatched a Member, the investigator-in-charge, and the investigative team, who formed operational, track, mechanical, human performance, and survival factors investigative groups.

The Federal Railroad Administration, Burlington Northern Railroad, American Train Dispatchers Association, Brotherhood of Locomotive Engineers, and United Transportation Union assisted in the investigation.

Deposition

On March 10 and 11, 1992, the Safety Board held a deposition proceeding in Seattle, Washington. The deposition participants included the Federal Railroad Administration, Burlington Northern Railroad, American Train Dispatchers Association, Brotherhood of Locomotive Engineers, and United Transportation Union. Nine witnesses testified.

APPENDIX B

LOCOMOTIVE CONSIST LISTS

Train 602

Unit	Model	Built	Origin	Anticlimber
2275	GP38-2	1973	SLSF 420	No
8009	SD40-2	1977	BN	Yes
6909	SD40-2	1973	BN	Yes

Train 603

Unit	Model	Built	Origin	Anticlimber
6905	SD40-2	1973	BN	Yes
6901	SD40-2	1973	BN	Yes
2287	GP38-2	1974	SLSF 432	No
2283	GP38-2	1974	SLSF 428	No
2274	GP38-2	1973	SLSF 419	No
2289	GP38-2	1974	SLSF 434	No

APPENDIX C

BN TW FORM

TRACK WARRANT BURLINGTON NORTHERN RAILROAD

No _____ _____ _____ 19 _____

To: _____ At: _____

1. ☐ Track warrant number _____ is void.
2. ☐ Proceed from _____ To _____ On _____ track.
3. ☐ Proceed from _____ To _____ On _____ track.
4. ☐ Work between _____ And _____ On _____ track.
5. ☐ Not in effect until _____ M.
6. ☐ This authority expires at _____ M.
7. ☐ Not in effect until after arrival of _____ _____ at _____ .
8. ☐ Hold main track at last named point.
9. ☐ Do not foul limits ahead of _____ .
10. ☐ Clear main track at last named point.
11. ☐ Between _____ _____ and _____

    make all movements at restricted speed. Limits occupied by train or engine.
12. ☐ Between _____ and _____

    make all movements at restricted speed and stop short of men or machines fouling track.
13. ☐ Do not exceed _____ MPH between _____ and _____.
14. ☐ Do not exceed _____ MPH between _____ and _____.
15. ☐ Protection as prescribed by Rule 99 not required.
16. ☐ Track bulletins in effect _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____ .
17. ☐ Other specific instructions: _____

OK _____ M Dispatcher _____

Relayed to _____ Copied by _____

Limits reported clear at _____ M By _____

(Mark X in box for each item instructed.)

FORM 15974 4-86 Printed in U. S. A.

APPENDIX D

TRACK WARRANT AND TRAIN CONTROL HISTORY

Much of the following information is from a June 1992 *Trains* article by William L. Gwyer, Assistant Chief Dispatcher, Burlington Northern Railroad.

In the early to mid-1800's, opposing trains were governed by a timetable. Meets were prescribed, and one train simply waited on the other. As traffic increased so did the level of sophistication, culminating in a timetable containing schedules of various classes and establishing priority. With no way to supersede the timetable, single track operation was slow, haphazard, and dangerous.

By the Civil War, train movements were controlled by a dispatcher who used telegraph agents to deliver orders through operators or station agents to affected trains. The system remained essentially unchanged for more than a century. The dispatcher issued train orders, which superseded the timetable. The orders were used to advance one or more trains past other trains, establish positive meeting points, create extra trains (those not in the timetable) and sections (another train following under the same name and schedule as the first), annul schedules, authorize work trains, and warn of track conditions and/or speed limitations.

Most railroads required a copy of the train order for the locomotive (engineer), the caboose (conductor), and the issuing station's records. Two train order forms, 31 and 19, were used. A train crewmember had to sign for a form 31, and it was used when the dispatcher needed to confirm that the affected train actually had the order. A form 19 required no signature and was used when the dispatcher needed no confirmation. With the orders came a clearance card that listed all the orders a train was to receive at a station en route or at origin. This ensured that all train orders intended for the train crew were accounted for.

A train order transmission was a strict ritual. The station names were pronounced and spelled out letter by letter, as were numbers and time. The dispatcher always addressed an order to the train being restricted firsthand, then each operator repeated the order back to him in the succession in which they were addressed. With the telegraph, the dispatcher wrote the order in the train order book from the first repetition; with the telephone, it was written as it was transmitted. In all cases, it was underlined as each station repeated the order. Once it was repeated correctly, it was made "complete," and the time given. An order was never in effect until it was completed. If it had been repeated but not made complete, it became a holding order. Once effective, the train order remained in effect until superseded by another order, fulfilled, or annulled.

APPENDIX D

Train stations had signals to slow the train through the station so that the station agent could "hoop up" the orders to the engineer and conductor without stopping the train. Agents used a large forked device to hold the orders suspended by string tied in a slip knot. The train crewman simply slipped his arm through the fork as the train went by and snagged the orders. Delivering orders was not pleasant and was sometimes dangerous, particularly during inclimate weather. Another drawback was signed copies had to be returned by the crew, who simply threw them along the right of way beyond the station.

CTC eliminated the need for train orders because trains ran by signal indication under dispatcher control. However, this control system is very expensive and is used only in high traffic areas where the cost could be justified. On branch lines, train orders were still effectively used.

The train order's demise was in 1986 when a national agreement between the railroads and the Transportation Communication Employees Union gave dispatchers the authority to issue movement instructions directly to train crews in direct train control (DTC) territory. Throughout the 1980's, railroads adopted either DTC, which uses verbal instructions only (radio), or TW control, which uses a preprinted form copied by the crew.

APPENDIX E

TW 8851 CTWC PRINTOUT

EN
RAILROAD

TRACK WARRANT FORM

NO. 8851
TO: 0905 WEST

Aur
AT: DUTTON

1. [ ] Trail warrant number ___ is void

2. [X] Proceed from DUTTON
to LEDGER
on MAIN

3. [ ] Proceed from
to
on

4. [ ] Work between
and
on

5. [ ] Not in effect until

6. [ ] This authority expires at

7. [X] Not in effect until after arrival of:
7825 EAST
at DUTTON

8. [X] Hold main track at last named point

9. [ ] Do not foul limits ahead of:

10. [ ] Clear main track at last named point

11. [ ] Between
and
make all movements
restricted speed. Limit: occupied by train or engine

12. [ ] Between
and
make all movements
restricted speed and stop short of men or machines fouling

13. [ ] Do not exceed __ MPH between and

14. [ ] Do not exceed __ MPH between and

15. [X] Protection as prescribed by Rule 99 not required against following trains on the same track

16. [ ] Track bulletins in effect:

17. [ ] Other specific instructions

OK 1335
Relayed to
Limits reported clear at

Dispatcher MKJ
Copied by MEYERS
By

APPENDIX F

TW 8851 RADIO TRANSCRIPT

TW 8851 transcript issued from the branch line dispatcher (Nancy K. Jaeger), Montana Division, Seattle Region, Burlington Northern Railroad, to train 603 (6905 West, conductor Meyers) about 2:20 p.m. MDT, August 30, 1991.

Safety Board investigators Russell G. Quimby, Mechanical Group Chairman, and Eric Sager, Human Performance Group Chairman, made this transcript at the Washington, D.C., NTSB laboratory at 1 p.m. on August 26, 1992. It was made from a cassette recording that BN provided shortly after the accident.

Dispatcher: Seattle Branch Dispatcher answering.

Train 603: Dispatcher, this is 603. We'd like to get a warrant to get out of Dutton.

Dispatcher: Okay, let's make it TW number 8851, eight-eight-five-one, to 6905, six-nine-naught-five, West, w-e-s-t. You're at Dutton now?

Train 603: Roger, we've stopped at the east end of Dutton, or the west end of Dutton, I mean.

Dispatcher: Dutton, Dutton, D-u-t-t-o-n,

Item number 2, t-w-o, Proceed from Dutton, D-o-t-t-o-n-D-u-t-t-o-n to (nine second pause) Ledger, L-e-d-g-e-r, on main, m-a-i-n, track.

Item number 7, s-e-v-e-n, Not in effect until after arrival of 7825, seven-eight-two-five, East, e-a-s-t, at Dutton, D-u-t-t-o- n.

Item number 8, e-i-g-h-t, Hold main track last named point.

Item number 15, one-five, Protection as prescribed by Rule 99 not required against following trains on the same track, and okay to repeat.

Train 603: TW number 8851, dated August 30th, 1991, to 6905, six-nine-oh-five, West, w-e-s-t, at Dutton, D-u-t-t-o-n,

Item 2, t-w-o, Proceed from Dutton, D-u-t-t-o-n, to west, w-e-s-t, yard limits Shelby, S-h-e-l-b-y, on main track.

Item 7, s-e-v-e-n, Not in effect until after arrival of 7825, seven-eight-two-five, East, e-a-s-t, at Dutton, D-u-t-t-o-n.

Item 8, e-i-g-h-t, Hold main track at last named point.

Item 15, one-five, Protection as prescribed by Rule 99, nine-nine, not required against following trains on the same track.

Dispatcher: 8851 is okay 13, B-K, 1455, one-four-five-five, Dispatcher N-K-J.

Train 603: TW 8851, eight-eight-five-one, is okay at 1455, one-four-five-five. Dispatcher NKJ.

Dispatcher: All right, thank you.

END

* U.S. G.P.O.:1993-341-835:82062