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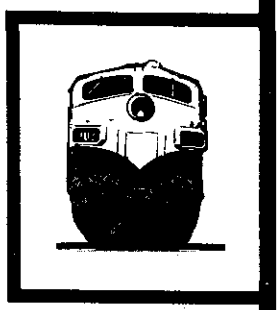

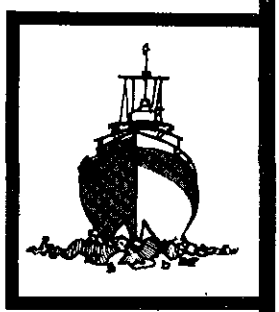

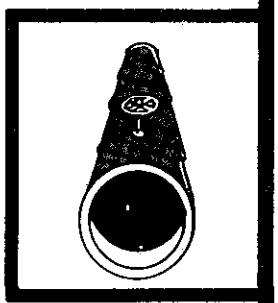

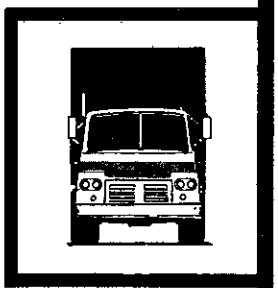

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

HEAD-END COLLISION
OF CONSOLIDATED RAIL CORPORATION
FREIGHT TRAINS UBT-506 AND TV-61
NEAR THOMPSONTOWN, PENNSYLVANIA
JANUARY 14, 1988

NTSB/RAR-89/02

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15 Supplementary Notes

16 Abstract

About 7.54 a m , e s t , on January 14, 1988, westbound Consolidated Rail Corporation (Conrail) "trail van" freight train TV-61 collided with eastbound Conrail freight train UBT-506 near Control Point Thompson, at Thompsontown, Pennsylvania The engineers and brakemen on both trains were fatally injured The conductors on both trains received minor injuries Damage to the trains was estimated at $6,015,000

The safety issues discussed in the report include the train crew's fitness for duty and the effect of irregular and unpredictable shift and night work, irregularity and unpredictability of present-day trian operations on Conrail and other railroads; dispatcher stress and lack of backup relief for dispatchers; the adequacy of safety backup devices on Conrail's locomotive, and Conrail's management and supervision policies

17 Key Words irregular/unpredictable work schedule, computer-based traffic control system; locomotive backup system; restricting cab signals		18 Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
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EXECUTIVE SUMMARY

About 7.54 a m , e s t , on January 14, 1988, westbound Consolidated Rail Corporation (Conrail) "trailer van" freight train TV-61 collided with eastbound Conrail freight train UBT-506 near Control Point Thompson, at Thompsontown, Pennsylvania The engineers and brakemen on both trains were fatally injured The conductors on both trains received minor injuries Damage to the trains was estimated at $6,015,000

The National Transportation Safety Board determines that the probable cause of this accident was the sleep-deprived condition of the engineer and other crewmembers of train UBT-506, which resulted in their inability to stay awake and alert, and their consequent failure to comply with restrictive signal aspects Contributing to the failure of the crewmembers were their unpredictable work/rest cycles, their voluntary lack of proper rest before going on duty, and the inadequate alertness and acknowledging devices of the locomotive safety backup systems Contributing to the severity of the accident was the failure of the engineer of train TV-61 to adequately reduce the speed of his train in conformance with a restricting cab signal and the inability of the dispatcher to recognize the emergency because of the inadequacies in the computer-based traffic control system

The safety issues discussed in the report include

- the train crew's fitness for duty and the effect of irregular and unpredictable shift and night work,
- the irregularity and unpredictability of present-day train operations on Conrail and other railroads,
- dispatcher stress and lack of backup relief for dispatchers,
- the adequacy of safety backup devices on Conrail's locomotive, and
- Conrail's management and supervision policies

Safety recommendations pertaining to these safety issues were issued to Conrail, the Association of American Railroads, the Brotherhood of Locomotive Engineers, and the United Transportation Union Two safety recommendations relating to dispatcher's hours of service and workload are reiterated to the Federal Railroad Administration

RAILROAD ACCIDENT REPORT

HEAD-ON COLLISION OF CONSOLIDATED RAIL CORPORATION FREIGHT TRAINS UBT-506 AND TV-61 NEAR THOMPSONTOWN, PENNSYLVANIA JANUARY 14, 1988

INVESTIGATION

The Accident

Freight Train TV-61 --About 6·36 a m , on January 14, 1988, westbound Consolidated Rail Corporation (Conrail) "trail van" freight train TV-61 departed Harrisburg, Pennsylvania, en route to Chicago, Illinois It consisted of 3 diesel-electric locomotive units and 61 flat cars loaded with 104 piggyback highway trailers and containers The train was manned by an engineer and brakeman on the lead locomotive unit and a conductor on the third locomotive unit TV-61 entered Conrail's double-track, Allegheny Division Harrisburg-Pittsburgh main line at the control point (CP) Banks interlocking about 7:18 a m , 1/2 hour behind westbound freight train LMPI-3 and 15 minutes ahead of westbound freight train OIIN-3 It was then routed over main track 2 to CP Port, an interlocking at Newport, Pennsylvania The next interlocking, CP Thompson, was located near Thompsontown, Pennsylvania, 10 9 miles west of CP Port (See figure 1)

About 6.23 a m , the dispatcher handling the Altoona to CP Banks section observed a train occupancy indication light (TOL) for track 2 east of CP Thompson displayed on the computer-assisted train dispatching system (CATD) color video display monitor cathode ray tube (CRT) screens for CP Thompson and CP Port interlockings (For a more detailed discussion, see Computerized Dispatching System, page 9) It was subsequently determined that this occupancy indication was caused by the shunting of the track 2 signal circuitry as a result of a cold-induced contraction and separation of a continuous-welded rail (CWR) [1] At the time, train LMPI-3 was running on track 2 west of CP Banks and it was necessary to divert this train to track 1 through the crossover track at CP Port so that it could run around the affected section of track 2, the train could be returned to track 2 by way of the west crossover track at CP Thompson (See figure 2) The same route would have to be taken by trains TV-61 and OIIN-3 This routine maneuver could be accomplished through the remote reversing of the appropriate crossover switches and could be quickly arranged by a request from the dispatcher through the CBTCS system

The route and the reversing of the crossover switches at CP Port and CP Thompson were later requested by the dispatcher, and at 7.18 a m , train LMPI-3 cleared the interlocking at CP Port, having been crossed over to track 1 At 7:32 a m , the train cleared CP Thompson, again moving west on track 2, and at 7.33 a m , the dispatcher rerequested the track 1 route for TV-61 According to the CATD system computer log, at 7:33 53 a m , the switches for the west crossover at CP Thompson

[1] A rail "pull-apart" at a weld, a broken rail, failure of an insulated joint between adjoining rails, or an open switch will shunt the signal circuitry just as a train does and causes the appropriate wayside signals to display restrictive aspects and the CATD system to display a TOL at the corresponding location of the dispatcher's CRT screen

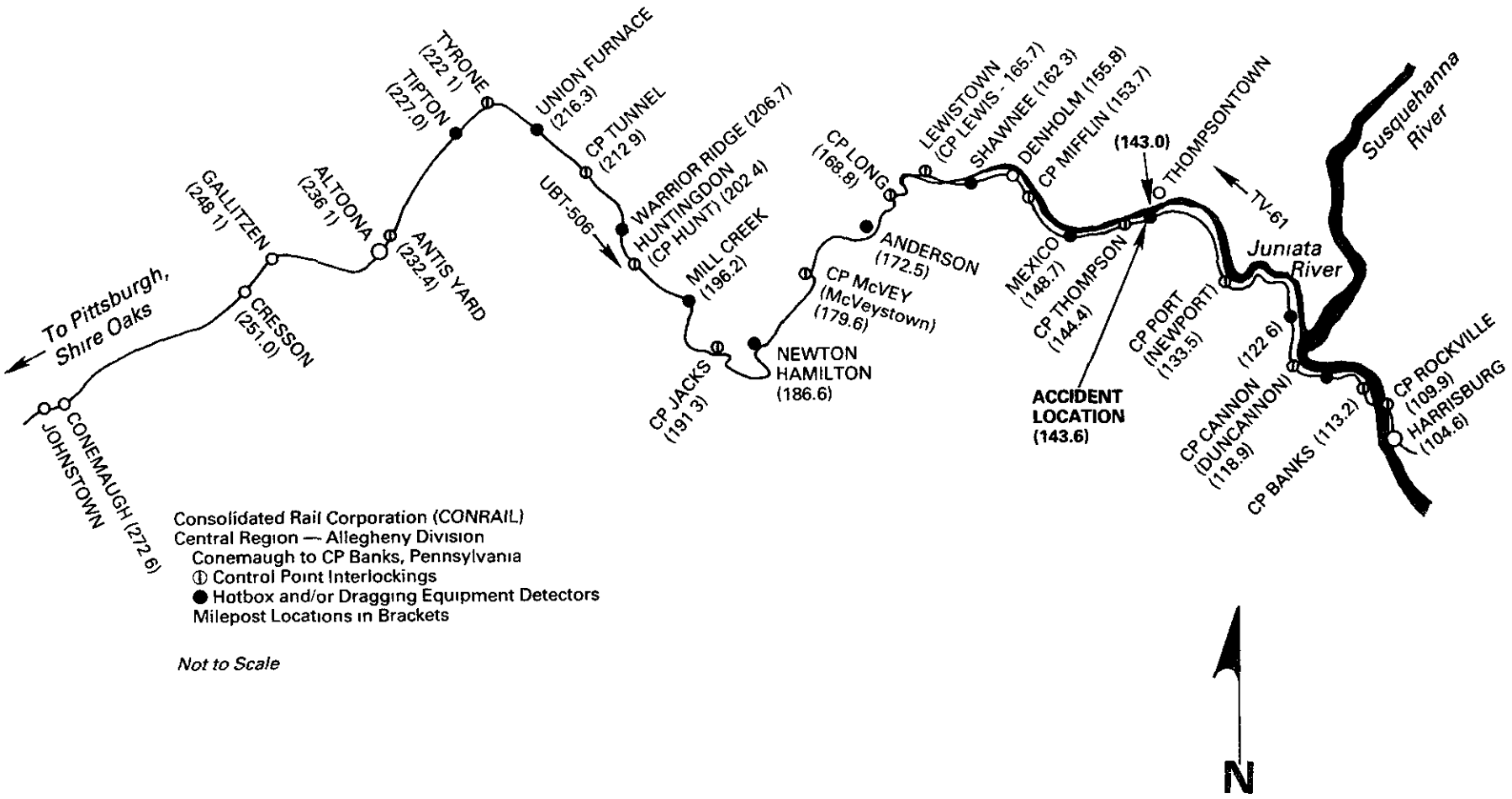

Figure 1.--Conrail's Allegheny Division between Conemaugh, Altoona, and Harrisburg, Pennsylvania

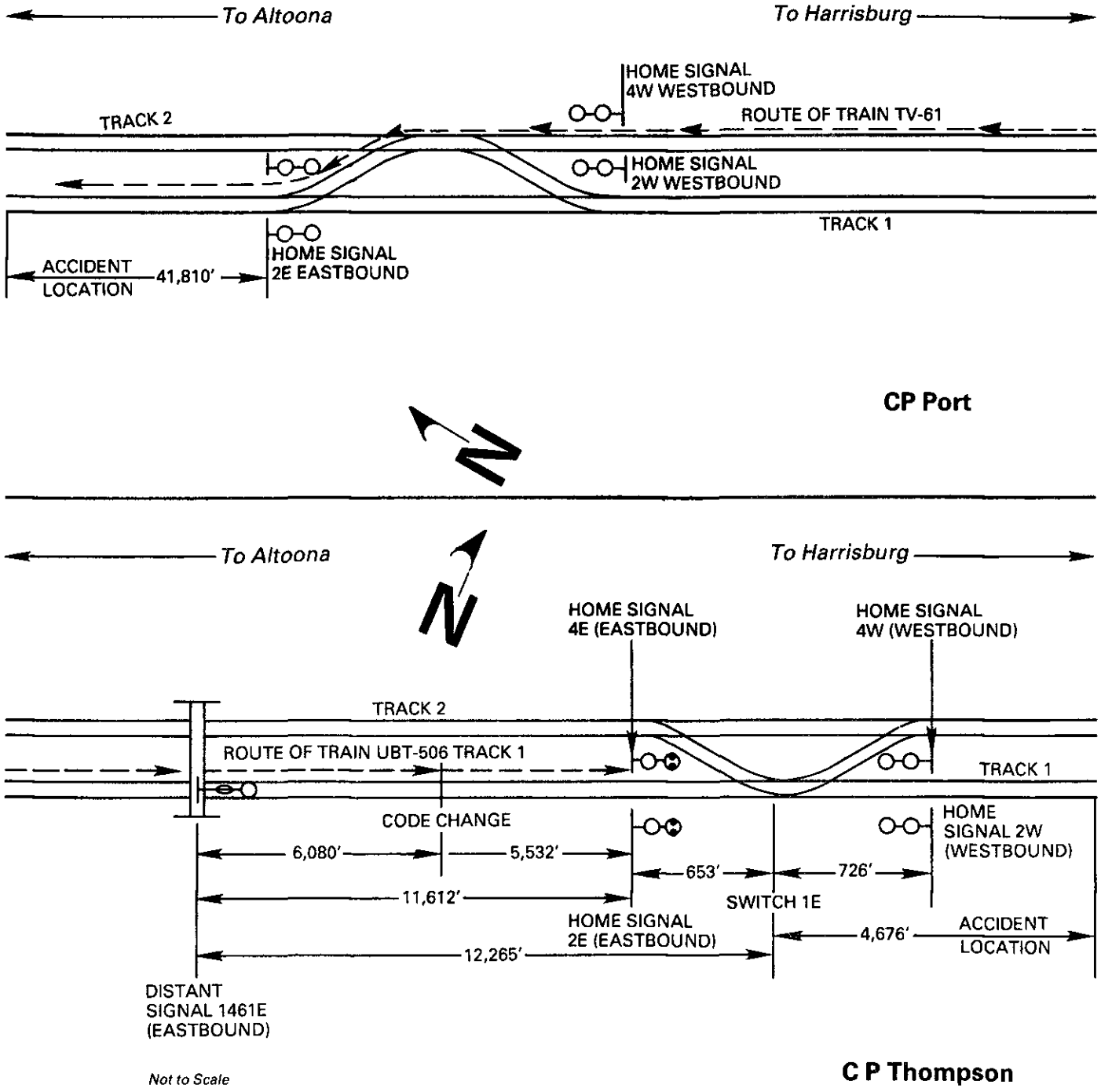

Figure 2 --Configuration of signals, switches, and tracks
at CP Port and CP Thompson Interlockings

corresponded in reverse position and were locked and indicating, and the route was otherwise properly set up for TV-61 [2] This information was reconfirmed in the computer log at 7·37:43 a m , 7.47:26 a m , and 7:50.34 a m.

The dispatcher intended for train OIIN-3 to follow TV-61 over the track 1 route between CP Port and CP Thompson before he would request that the crossover switches be returned to normal As a consequence, it would be necessary for any eastbound train on track 1 to stop short of CP Thompson interlocking and wait until the two westbound trains passed, the crossover switches were returned to normal, and the eastbound home signal[3] changed from "stop" to "clear" permitting the train to proceed

Freight Train UBT-506 --Earlier, about 5:45 a m , eastbound Conrail freight train UBT-506 had departed Altoona, Pennsylvania, en route to Baltimore, Maryland, by way of Conrail's Enola Yard near Harrisburg, Pennsylvania The train consisted of two diesel-electric locomotive units and 105 hopper cars loaded with coal It was manned by an engineer and brakeman located on the lead locomotive unit and by a conductor on the trailing unit After leaving Altoona, UBT-506 was operated continuously over track 1 of the Allegheny Division main line It reached CP Thompson about 7 53 a m , having traveled the 88 miles from Altoona without stopping at an average speed of 40 mph

Eight hotbox and/or dragging equipment detectors, spaced 9 1/2 to 14 miles apart, are located between Altoona and CP Thompson These detectors broadcast a radio transmission to each passing train advising whether or not a defective condition has been detected in the train The designed range of transmission is 25 to 50 miles, although actual effective range may be less Train crews are required to acknowledge the detector transmissions by radio, and all radio transmissions are recorded on continuously operated tapes at the dispatchers' office and at the detector sites A review of these tapes indicated that the engineer of UBT-506 responded to the first six detector transmissions within 8 seconds following each transmission The engineer's last response was transmitted at 7 14:17 a m , 4 seconds after a "no dragging equipment" transmission to UBT-506 from the detector at Anderson, 27 6 miles west of CP Thompson

The next detector, at Shawnee (17 9 miles west of CP Thompson), transmitted a "no defects" message to UBT-506 at 7:29:05 a m , there was no clearly identifiable response detectable on the recording tapes However, one tape contained a garbled transmission from an unidentifiable source at 7:29:25 a m The last detector passed by UBT-506 was at Mexico, 4 3 miles west of CP Thompson, a "no dragging equipment" transmission from the detector to UBT-506 was recorded at 7.48 22 a.m There was no recorded response from the train The conductor of UBT-506 stated that he heard the engineer respond to the first four detectors, but not to the last four detectors because he had moved to the opposite side of the operating compartment from the radio speaker and noise from the heater blower drowned out the sound of radio transmissions

About 5 minutes and 2 3 miles before reaching the Shawnee detector, UBT-506 slowed from 40 to 30 mph for about 1 1/2 miles just east of CP Lewis (Lewistown, Pennsylvania) The timetable restricted mineral trains, such as UBT-506, to 35 mph through a 0 2-mile curve at this location A review of the event recorder tape indicated that the train entered the restricted section before it began to decelerate While approaching and entering the curve, the entire train was on a 0 46-percent descending grade

[2]In this configuration, the west crossover switch on track 1, which was a right-hand facing point switch westbound and was identified by Conrail as switch 1E, was in the reverse position

[3]Conrail defines a home signal as "A fixed signal governing the entrance to an interlocking "

After clearing the 35-mph curve at CP Lewis, UBT-506 accelerated to 46 mph over a 10-mile section ending at CP Mifflin (Mifflintown, Pennsylvania) where the train was restricted by the timetable to 35-mph for 1 mile The restriction ended at milepost (MP) 153, 8 6 miles west of CP Thompson The grade was descending through most of the restricted section and for more than 2 miles to the west of it UBT-506 began decelerating about 1/2 mile before reaching the speed restriction and had reduced to 37 mph by the time the train's head end had reached the end of it at MP 153 Speed was further reduced to about 34 mph over the next 1 3 miles, and for 2 miles beyond that, the speed was maintained at 34-35 mph Thereafter, UBT-506 accelerated gradually to 37 mph at the Mexico detector, from a point about 1/2 mile west of CP Thompson and beyond, the train maintained a speed of 39-40 mph

The locomotives of trains LMPI-3 and UBT-506 passed about 7 41 a m about 1 mile east of CP Mifflin The engineer of LMPI-3 said he could not see into the lead unit's operating compartment because of the glare of sunlight on the UBT-506 unit's windows The brakeman, who was seated on the left, or south side, stated he thought he saw the silhouette of someone move from the left side to the center of the lead unit of UBT-506 There was no radio communication between the trains, although Conrail's operating rules require train crews to observe passing trains for defects and to communicate with their crews [4]

With the route for the westbound trains aligned for crossover movement from track 2 to track 1 at CP Port and from track 1 to track 2 at CP Thompson, eastbound home signal 2E for track 1 at CP Thompson should have displayed a "stop" aspect Distant signal 1461E,[5] located 11,612 feet west of signal 2E, should have displayed an "approach" aspect These wayside signals governed the movement of train UBT-506 as it approached CP Thompson on track 1 The "approach" aspect of signal 1461E required a reduction to medium speed (not exceeding 30 mph), and the "stop" aspect of home signal 2E required the train to stop short of the signal which was located 653 feet west of west crossover switch 1E at CP Thompson (See figure 3)

According to the conductor of UBT-506, the last wayside signal he observed was a "clear" aspect displayed by the home signal at CP Mifflin; he did not observe the aspects successively displayed by two intermediate signals, distant signal 1461E, or home signal 2E at CP Thompson The conductor also stated that the train's brakes were not applied before or after passing CP Thompson

The Collision --Approaching CP Port on track 2, TV-61 should have received an "approach limited" aspect on the distant signal and a "limited clear" aspect on the home signal Successively, these aspects required the engineer to approach the home signal at limited speed (40 mph) and to proceed through the interlocking at that speed

About 3 1/2 miles east of the home signal, TV-61 began to gradually decelerate from 58 mph, and it entered the interlocking at 40 mph According to the locomotive event recorder, the deceleration was accomplished by reducing power from full throttle to idle without braking Having cleared the interlocking on track 1 at 7·44 a m , the train began accelerating from 40 mph about 1 1/4 miles west of the interlocking About 2 miles farther west, TV-61 reached a speed of 52 mph and it maintained speed between 50 and 53 mph for the next 5 miles

With the track 1 route set up with crossover switches reversed at CP Thompson, "clear" aspects should have been displayed for TV-61 by the three intermediate wayside signals west of CP Port

[4]The rules do not specifically require communication if no defect is observed (See appendix C) However, Conrail rules supervisors state that it is a near-universal practice for crews to make an "O K " or "no-defects" transmission after inspecting a passing train

[5]Conrail defines a distant signal as, "A fixed signal used to govern the approach to a home signal "

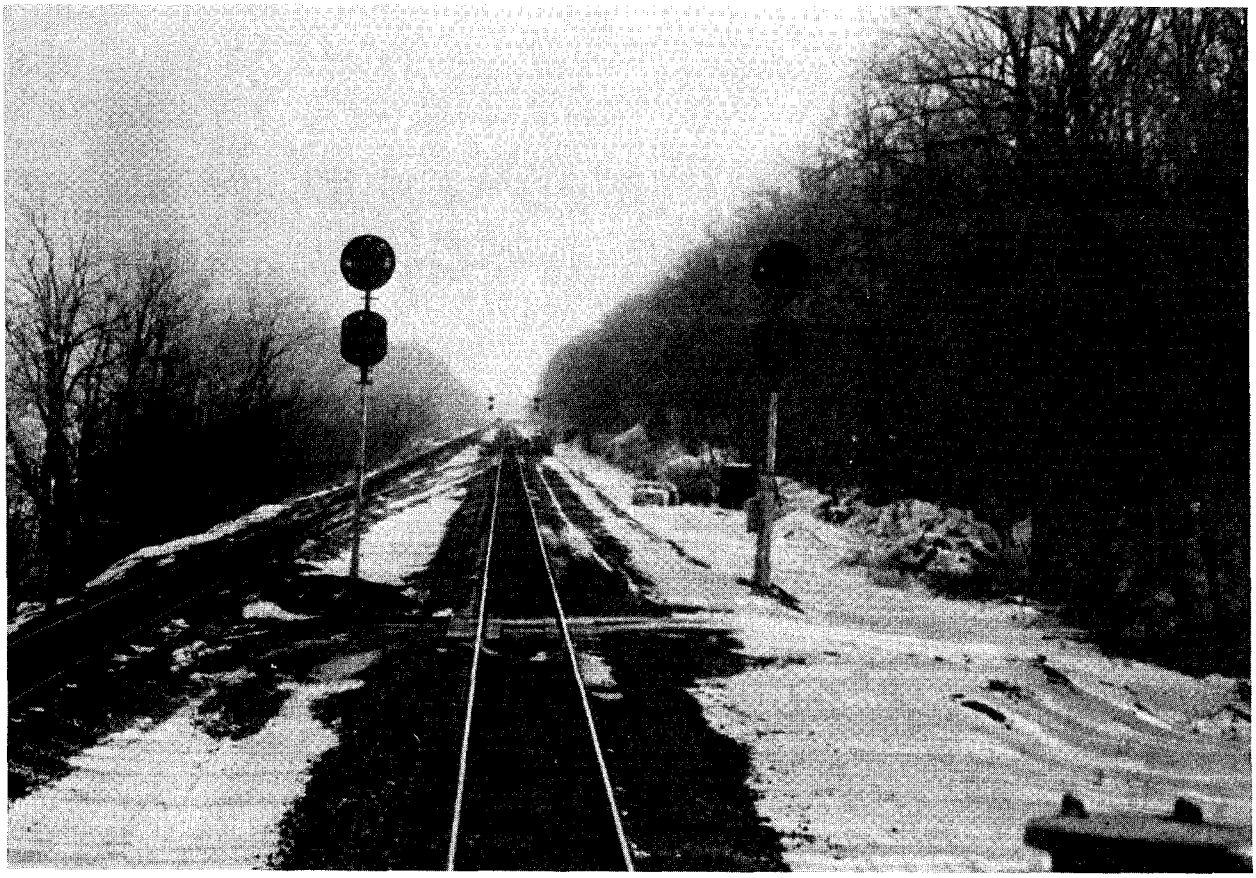

Figure 3.--CP Thompson interlocking with signal 2E in foreground and switch 1E beyond, as viewed from an eastbound train on track 1

Distant signal 1421W, 11,573 feet east of switch 1E at CP Thompson, should have displayed "approach limited," and home signal 2W at CP Thompson should have displayed "limited clear." As at CP Port, TV-61 was restricted to a maximum of 40 mph through the interlocking. (See figure 4.)

About 0.3 mile east of signal 1421W, the engineer of TV-61 began reducing throttle from the No. 7 position.[6] At the time, the train's speed was 52 to 53 mph. Just before reaching signal 1421W about 7:53:25 a.m., the engineer placed the throttle in the "idle" position. During this sequence of action, TV-61 was on a descending grade and there was no significant reduction in speed.

At 7:53:37 a.m., UBT-506 ran through switch 1E at CP Thompson; its speed at the time was about 40 mph, and there was no reduction in speed before or after the train ran through the switch. At the time, TV-61 had reached a point about 950 feet west of signal 1421W. The two trains were then about 10,700 feet apart, on the same track, and closing at a speed of about 91 mph.

About 7:54 a.m., the engineer of TV-61 began a series of actions to decelerate the train by successively changing from power to dynamic braking and initiating application of the train air brakes by making an initial 6-pound brakepipe reduction. About 7:54:30 a.m., he placed the brake

[6]The locomotive throttle has eight graduated power positions, 1 through 8, with position No. 8 being the fully-open, maximum power position.

Figure 4.--Westbound distant signal 1421W, located 11,573 feet east of switch 1E at CP Thompson, as viewed from a westbound train on track 1

valve in emergency. By this time, the train's speed had been reduced to about 45 mph. About 30 seconds later, the two trains collided with TV-61 moving at 31 mph and UBT-506 moving about 40 mph at a point 4,676 feet east of switch 1E at CP Thompson. When UBT-506 stopped, its rear end was about 32 feet east of westbound home signal 2W at CP Thompson.

Injuries

The engineers and brakemen of both trains were fatally injured. Pathological examination of the engineer and brakeman of train UBT-506 established that they died from head trauma with multiple fractures and multiple trauma, respectively. Multiple trauma also was given as the cause of death for the engineer of TV-61. The examining coroner determined that the brakeman of TV-61 had died of suffocation. The conductor of train TV-61 was hospitalized for a fractured finger and lesser injuries; the conductor of train UBT-506 received outpatient treatment for minor injuries.

Injuries	Train UBT-506	Train TV-61	Total
Fatal	2	2	4
Serious	0	1	1
Minor	1	0	1
None	0	0	0
Total	3	3	6

Damage

The locomotive units of both trains, 31 coal hopper cars of train UBT-506, and two flatcars and 4 piggyback highway trailers of train TV-61 were destroyed Some of the coal in the hopper cars was lost as was the contents of the trailers. Diesel fuel oil leaking from the tanks of the locomotive units ignited following the collision About 14,000 gallons of fuel oil was consumed by fire or spilled onto the right of way and contaminated the surrounding area

About 350 feet of track was destroyed, and there was severe damage to crossover switch 1E at CP Thompson as a result of its being run through by train UBT-506

Damage was estimated by the Safety Board as follows:

Locomotives	$4,400,000
Cars	1,267,000
Track	28,500*
Signals	8,500*
Lading	30,000*
Clearing wreckage	125,000
Containing oil spill	156,000 +
Total	$6,015,000 +

*Estimates furnished by Conrail

Method of Operation

The Allegheny Division between Altoona and Harrisburg has two main tracks running generally east to west; track 1 is located to the south of track 2 Trains are operated in both directions over both tracks by signal indications of the CATD under Conrail operating rule 261. (See appendix C) Double crossover tracks with remotely controlled power switch machines are located at 14 CP interlockings between Altoona and CP Banks The distance between these interlockings varies from 3.1 to 14 6 miles Operations over the 119 2-mile section are under the control of the "A" desk dispatcher located at Altoona Typically, about 60 trains are operated daily over this section

According to the current timetable, the maximum allowable speed for mineral trains, such as UBT-506, was 40 mph; for trailvan (TV) trains, such as TV-61, it was 60 mph In certain curves and other locations noted in the timetable, both classes of trains were restricted to lower speeds. (See appendix D) On track 1 west of CP Port, TV trains were restricted to 50 mph for the first 2.4 miles Over the remaining 8 5 miles to CP Thompson, they were permitted the maximum 60 mph except through a mile-long series of curves beginning at MP 142 where a maximum of 55 mph was permitted This restriction ended at MP 143, about 0 4 mile west of signal 1421W. Conrail requires that the entire train has to pass through a section where speed is restricted before it can be accelerated to maximum authorized speed

Conrail rule 34 requires crewmembers in the operating compartment of a locomotive unit to observe and call out the aspects of all signals to other crewmembers Rule 551 requires the engineer to comply with the more restrictive aspect when wayside signal and cab signal aspects differ and to (Effie, white out this line)

take action at once to reduce to "restricted" speed when the cab signal changes to "restricting "[7] The rule further requires that the cab signal apparatus be considered to be in failure when any damage or fault occurs to any part of the cab signal apparatus, including a failure of the cab alerter device to sound when the cab signal changes to a more restrictive aspect Rule 554 stipulates that if a cab signal fails en route, the dispatcher must be notified promptly, the train may proceed according to signal indication, but it may not exceed 40 mph (See appendix C) Review of the radio recording tapes did not reveal a radio transmission from UBT-506 reporting that the train's cab signal system was in failure

Conrail rule 937 states that conductors are in charge of their trains and that they are responsible for (1) the care and safety of their trains, (2) the " vigilance, conduct, and proper performance of duty " of the other train crewmembers, and (3) " the observance and enforcement of all rules and instructions " (See appendix C)

Conrail had no rule stipulating that conductors ride the lead locomotive units with their engineers nor were timetable instructions or bulletin orders stipulating such a requirement issued on the Allegheny Division following the general abandonment of the use of cabooses on the end of freight trains The conductors of the trains involved in this accident stated that they rode the trailing locomotive units to be in a better position to observe their trains for defective conditions, although by doing so they were unable to monitor the engineer's response to the cab signals Both men also stated that it was within the scope of their authority to delegate the responsibility for observing the train to the brakemen

Computerized Dispatching System

Traffic Control System --The Allegheny Division employs a computer-based traffic control system located at Altoona The decentralized system with a Digital Equipment Corporation (DEC) model PDP-11/44 minicomputer is composed of three computers that are interconnected by a common electrical path called a unibus The primary "A" computer runs the CATD and is backed up by a "hot" standby computer ("B") that mirrors the "A" computer and will immediately take over the processing in the event the primary computer fails The Altoona minicomputer is linked by telecommunications lines to a master computer at Conrail's Philadelphia, Pennsylvania, headquarters where administrative and operational data is centralized into a train management system (TMS) The "C" computer at Altoona is used for remote communications with the Philadelphia computer via a modem [8] Because very fast response time is required, a disk-based, real-time operating system is used, this responds to time-critical events as they occur with delays as short as tenths of microseconds

The major components of the Altoona CATD system are the command processor, display processor, and indication processor The command processor accepts control requests from the dispatcher, displays what has been requested, awaits confirmation, and sends the request to the field site and the display processor The display processor presents the current systems status to the dispatcher The indication processor receives indication communication from field sites and passes the information to the system for display

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[7]Conrail defines restricted speed as, "Prepared to stop within one-half the range of vision, short of train, obstruction, or switch improperly lined, looking out for broken rail, but not exceeding 20 miles per hour outside interlocking limits, nor 15 miles per hour within interlocking limits Speed applies to entire movement " The definition was modified by timetable special instruction SP-1 which stipulated, "In the application of Restricted Speed, trains other than passenger trains must not exceed 15 miles per hour " (See appendix D)

[8]A modem (modulator/demodulator) is an electronic device that enables digital data to be sent over analog transmission facilities

In place of the modelboard of a conventional traffic control system, the CATD system employs color video display monitors, or CRTs The dispatcher in charge of the Altoona-CP Banks section ("A" desk) has seven such CRT monitors arranged on a wall in front of his desk Each CRT displays two or more adjacent interlockings and the tracks connecting them Tracks within interlocking limits and the tracks between interlockings are represented by separated rectangles on the screen Each rectangle represents a separate display circuit Identification symbols of trains operating over the individual sections are displayed on the appropriate CRT in yellow (See figure 5). The dispatcher also has a "local" CRT monitor at his desk, which he can use to call up any of the individual interlocking displays

At the time of the accident, the CP Port and CP Thompson interlockings were displayed on adjacent CRT screens with CP Thompson on the left The five signal blocks on each track between these interlockings are represented by three rectangles identified from west to east (left to right as displayed on the screens) as 1WAK, 1EBK, and 1EAK in the case of track 1 These display circuit indications represent track sections that are 23,794, 10,719, and 21,241 feet long, respectively Only circuit 1EBK represents a single block Circuit 1WAK represents the westbound approach block to CP Thompson and the adjacent block to the east Circuit 1EAK represents the eastbound approach block to CP Port and the block adjoining it on the west [9] The track 1 side of the interlocking at CP Thompson is represented by display circuit 2TK (See figure 6)

The condition of each track circuit is expressed in colors, to wit·

White	-	track is clear and unoccupied
Blue	-	switch reversed against normal movement through segment of interlocking
Violet or magenta	-	Blocking device applied to track and switches when out of service for maintenance
Green	-	indicates how the route is aligned, with the signal displayed
Red	-	track circuit occupied by train
Flashing Red	-	TOL-- track circuit shunted by cause other than a train; at interlockings, position of switches do not correspond.

When a route is set up for the movement of a train, the entire route is displayed in green on the CRT. As the train progresses, the track circuits change to red as soon as the train enters them A track circuit remains displayed in red and is not displayed in white as nonoccupied until the train clears both it and the following adjacent track circuit. Hence, three adjacent track circuits can be displayed in red simultaneously even though the middle track circuit invariably would be much longer than the train involved

Interlocking signals are also displayed on the CRT screen. A white signal indicates "stop " A green signal indicates "proceed " An uncolored signal indicates a signal is not displayed.

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[9]Since the corresponding track circuits between CP interlockings all have the same nomenclature, the track circuits on track 1 west of CP Thompson are also identified, from east to west, as 1EAK, 1EBK, and 1WAK

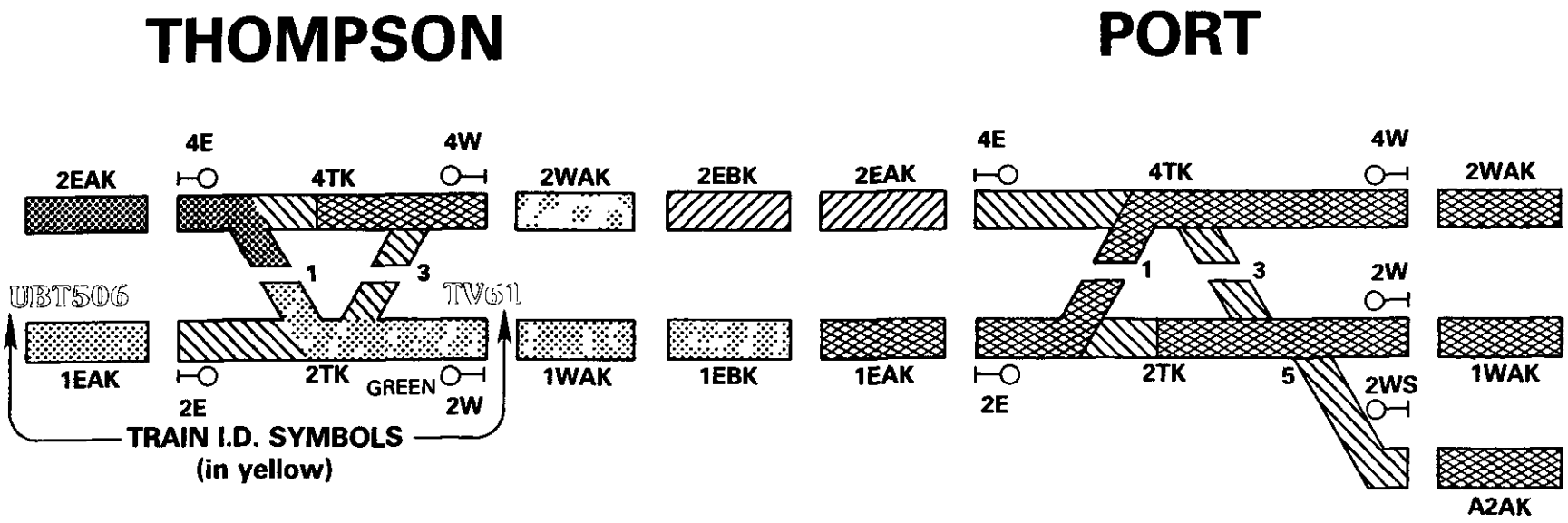
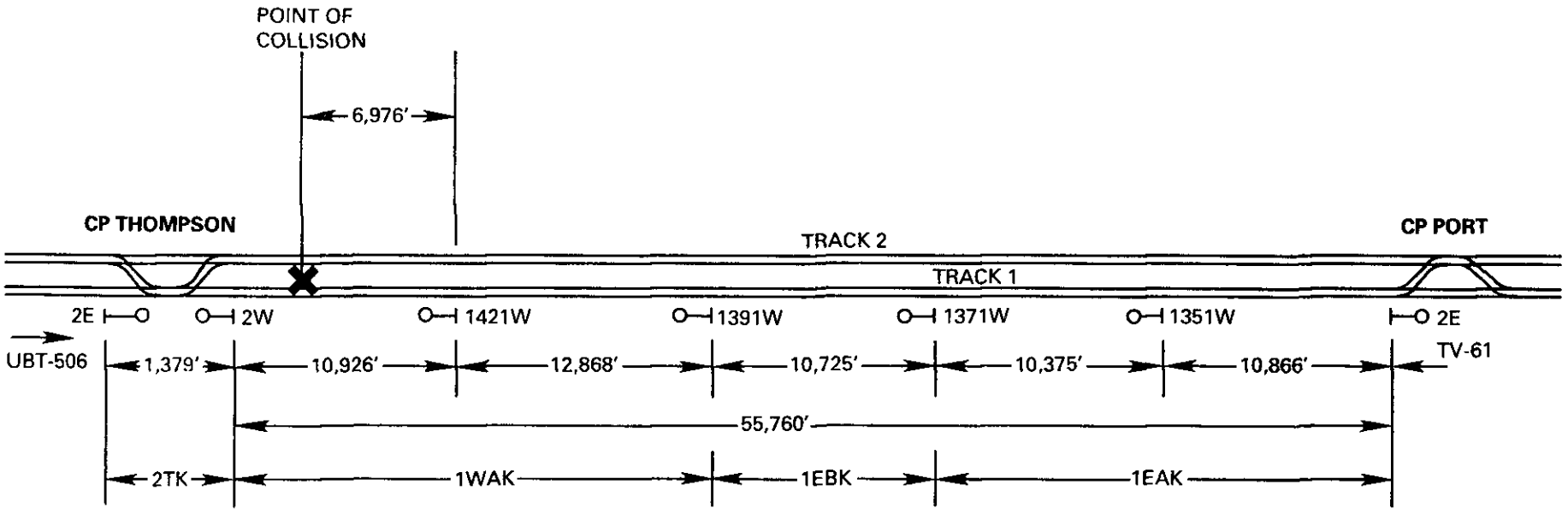


Figure 5.--The CRT display for CP Thompson and CP Port interlockings and the tracks connecting them at the Altoona dispatching center at 7:53:37 a.m., on , January 14, 1988. Track 1 is represented by the lower row of track circuits. Train UBT-506 had just passed home signal 2E and entered circuit 2TK causing the display for the crossover segment of the circuit to change from green to red, indicating that it was now occupied.



Not to Scale

Figure 6.--Diagram of tracks between CP Thompson and CP Port interlockings showing locations of wayside signals and the distances between them

Conrail does not have a simulator that can be used to instruct dispatchers in the use of the CATD system, and there is no method to train dispatchers to recognize and respond to unusual, unplanned, emergency, or stress situations Dispatchers are trained on the job, working with a qualified dispatcher Dispatchers are examined on the operating rules annually, but the examination does not include a proficiency evaluation of dispatchers assigned to the CATD system According to the 1987 Federal Railroad Administration (FRA) safety assessment[10], dispatchers are no longer required by Conrail to periodically familiarize themselves with the physical characteristics of the territory they deal with

The 1987 FRA safety assessment reported several software deficiencies in the CATD system, including an inability of dispatchers to clear signals at CP interlockings (at Olean, New York, and Renovo, Pennsylvania), an inability of dispatchers to apply track blocks at certain locations, and an undesired exchange of train identification symbols displayed on the CRT when the display contains three or more trains at the same time According to the FRA assessment, " dispatchers have not been provided with written notification of these software deficiencies or how to conduct operations where these deficiencies have occurred The carrier should make necessary improvements in the total system to eliminate any possible problems " According to the testimony of Conrail systems department staff at the Safety Board's public hearing on this accident, the software problems had not been corrected as of that time An electronics specialist on duty during each shift at the Altoona facility supports the dispatcher when problems or unusual situations occur with the CATD system When a problem appears to be the result of a software defect or anomaly, the specialist reports it to the systems programmers in Conrail's Philadelphia office who analyze the problem to determine whether it is unique to the field site or is commonly encountered within the CATD system The systems department uses a transaction simulator to test problem solutions and enhancements to software, especially to ensure that changes do not create new and unanticipated problems

Dispatcher's Recognition of Events --The "A" desk dispatcher responsible for the Altoona-CP Banks section came on duty at his regular 7 a m starting time on the morning of the accident. Regularly assigned to the "A" desk, he had worked in the Altoona dispatching office for 12 years and had about 11 years prior experience as a block operator During his regularly assigned hours, he was the only person in the office who was qualified on the "A" desk He had been trained on an earlier CATD system at Buffalo, New York, and had "hands-on" experience with the Altoona system since its installation in August 1984

The dispatcher testified that he worked a straight 8-hour shift and that during his tour of duty the workload was uniformly steady According to the dispatcher, if he was able to eat lunch, he did so at his desk. He stated, "I pack a lunch and maybe a couple of days a week I have time to go out and use the restroom and get my lunch and bring it in " The dispatcher also stated that since there was no one who could step in and take over for him, he could not eat or take restroom breaks when the workload was heavy.

According to the computer log, train TV-61 entered the middle display circuit (1EBK) at 7.48.09 a m. At that time, the rectangle on the CRT representing this circuit changed from green to red and the train's symbol appeared adjacent to the rectangle Circuit 1WAK and the crossover and east leg segments of circuit 2TK remained displayed in green as part of the intended and aligned route for train TV-61 The west leg segment of circuit 2TK (representing the track between home signal 2E and switch 1E) was displayed in blue Circuit 1EAK west of home signal 2E was displayed in red as being occupied by train UBT-506 and that train's symbol was displayed next to the rectangle representing circuit 1EAK Home signal 2E was displayed in white on the CRT for the UBT-506, and home signal 2W was displayed in green for TV-61

[10]FRA Office of Safety 1987 Safety Assessment, Consolidated Rail Corporation Central Region, January 1988

According to data retrieved from the computer log, the rectangle representing circuit 1WAK changed from green to red at 7·50 34 a m , indicating that TV-61 had entered that circuit All other displays remained unchanged At 7 51.52 a m , circuit 1EAK west of CP Port changed from red to white indicating that TV-61 had cleared the adjacent 1EBK circuit The display for 1EBK remained red throughout the subsequent sequence of events Again, on the basis of logged data, the east leg and crossover segments of circuit 2TK changed from red to green at 7 53 37 a m when train UBT-506 passed home signal 2E and entered the interlocking At this time, the white display for signal 2E disappeared, although the display for signal 2W remained green The west leg segment of 2TK remained blue, and the display for 1EAK west of the interlocking remained red, neither would change during the sequence of pre- and postaccident events

According to the dispatcher, about this time he noticed that the TV-61 symbol had moved to circuit 2TK on the screen There was no visual or audible alarm designed into the system to indicate when a train had entered a route set up for another train, and the dispatcher testified that he assumed that TV-61 had reached CP Thompson

About 4 seconds after UBT-506 ran through the crossover, it passed signal 2W and the display for the signal changed from green to white At 7.53:49 a m , the display for the 2TK crossover segment changed to flashing red and the white display for signal 2W disappeared The east leg of 2TK, 1WAK, and 1EBK all remained red Just after the last car of UBT-506 passed signal 2W, the east leg of 2TK changed to white and the crossover segment changed to flashing white

According to the dispatcher, he did not recognize any of the CRT display events as indicating that UBT-506 had passed through and beyond the interlocking When he saw the flashing displays for 2TK, he assumed that a TOL-type problem was causing an indication that a switch was out of correspondence and he called on the CATD technician for assistance The technician was of the same opinion as the dispatcher, so the dispatcher re-requested the crossover route at 7.57·24 a m The only resultant change in the CRT display was the 2TK crossover segment changing from flashing to continuous white

According to the taped record of radio transmissions, the conductor of TV-61 radioed the dispatcher at 7:58:18 a m calling, "Conrail emergency, emergency, emergency, track 1 " He did not identify himself, his train, or his location At 7:58.37 a m , the conductor of UBT-506, using the trailing unit's console radio, also reported the accident by calling, "UBT-406 (sic) here, we are wrecked also " At 8.01 04 a m , the TV-61 conductor radioed, "Conrail TV-61 to the Altoona east dispatcher," and again at 8.01.54 a m , "TV-61 to anybody who can hear me "

Still trying to restore his control over CP Thompson, the dispatcher told a track foreman who was calling him to, "Just stand by; I'm having problems down here " At 8·01·54 a m and again at 8·02 11 a m , he unsuccessfully tried to reach UBT-506 At 8 02 14 a m , the TV-61 conductor again called the dispatcher to report the emergency For the first time, at 8 02.28 a m , the conductor reported that his train was in a wreck near Thompsontown with what "looks like a coal train " At 8 02.35 a m , he reported, "Engines turned over and on fire," followed by, "Can you hear me, dispatcher," at 8:02:38 a m The dispatcher did not respond to the conductor until 8:03:02 a m , when he called, "Conrail Altoona dispatcher Nearhoof answering the 5017 [11] Over," and he did not acknowledge an understanding of the accident and its location until 8.03.21 a m

At the Safety Board's public hearing on the accident, Conrail's senior circuit engineer and assistant director of engineering development testified that the CATD system, as designed, did not

[11] Conrail locomotive unit 5017 was the lead unit of train TV-61

have the capability to provide display indications that a train had failed to stop short of an interlocking and had violated a route aligned for an opposing train Moreover, they stated that every interlocking would have to be redesigned and rebuilt to provide dispatchers with such information According to the senior circuit engineer, the CATD system performed its vital function by removing the track code and thereby providing the TV-61 engineer with an adequate cab signal warning

Track Information

Between Altoona and CP Banks, the Allegheny Division main line follows the courses of the Juniata and Susquehanna Rivers The gradient is generally descending from west to east over this distance There are only a few relatively short sections of eastbound ascending grade, none more severe than 0 2 percent (2 feet of rise in 1,000 feet) The longest sustained eastbound grade begins about 36 miles west of CP Thompson, it is 4 miles long and has a maximum gradient of 0 12 percent

The Juniata River follows a winding course through mountainous terrain, there are 130 curves in 119 miles and the longest continuous tangent is about 2 5 miles long Between Altoona and CP Banks, 10 public roads cross the railroad at grade, the most easterly of these is about 25 miles west of CP Thompson

The accident occurred on level tangent track The gradient is level for about 2 1 miles west of the accident location, for about a mile east of the accident location, the gradient is 0 34 percent ascending westbound Approaching the point of collision from the west, the tangent section is 7,060 feet long and is entered from a 1° 35′ left-hand curve that is 1,075 feet long Approaching from the east, the tangent section is 1,852 feet long and is entered from a 1° 4′ right-hand curve that is 934 feet long This curve is the westernmost of a series of six curves extending over a distance of about 1 6 miles between MP 141 7 and MP 143 3 The next curve east is a 2° 38′ right-hand curve, and the two curves are separated by a tangent about 1/3 mile long Forward sight distance through the curves and connecting tangent is 2,000 feet or less because of trees along the insides of the curves

Both main tracks consisted of 132-pound continuous-welded rail (CWR) laid in double-shouldered tieplates atop hardwood ties laid in crushed granite ballast The tracks were maintained to FRA Class 4 safety standards which permit a 60-mph maximum speed for freight trains

Crossover switch 1E at CP Thompson was a No 20 right-hand turnout with 39-foot switch point rails and undercut stock rails Following the accident, wheel marks were found on the field side of the left-hand switch point rail approximately 26 feet 7 inches from the switch point end. The switch connecting rods were bent and the switch machine was damaged by the switchpoint rails being forced over.

Signal Information

Wayside Signal System --The double-aspect, position-light type of wayside signals at and approaching CP Thompson are illuminated as they are approached Home signal 2E governing eastbound traffic on track 1 is mounted on a vertical mast located south of the track Eastbound distant signal 1461E for track 1 is mounted on an overhead signal bridge spanning the tracks at a point 11,612 feet west of signal 2E Eastbound intermediate signal 1481E is located 10,862 feet west of signal 1461E

Home signal 2W governs westbound traffic on track 1 at CP Thompson Both it and westbound distant signal 1421W are mounted on vertical masts located to the south, or field side, of track 1 Signal 1421W is 10,926 feet east of signal 2W

Except for the top aspect of home signals, the wayside signal aspects display combinations of three amber lights in either vertical, horizontal, or diagonal configuration depending on the location of the signal and the indication to be displayed The top aspects of home signals can display a pair of red lights horizontally or three amber lights vertically or diagonally (See Test and Research, page 34, for further discussion of the signal system)

The position-light signal combinations that would be displayed for an eastbound train approaching CP Thompson on track 1 with switch 1E aligned for westbound movement from track 1 to track 2 (see appendix C) are as follows:

Intermediate Signal 1481E (single aspect)

Rule	Aspect	Name	Indication
281	Vertical	Clear	Proceed

Distant Signal 1461E

Rule	Aspect	Name	Indication
285	Diagonal on top aspect	Approach	Proceed not exceeding Medium Speed prepared to stop at next signal. Reduction to Medium Speed must commence before engine passes Approach signal

Home Signal 2E

Rule	Aspect	Name	Indication
292	Horizontal on top aspect (red)	Stop Signal	Stop

With switch 1E aligned for westbound movement from track 1 to track 2 at CP Thompson, the signal combinations that would be displayed for a westbound train approaching CP Thompson on track 1 would be as follows·

Distant Signal 1421W

Rule	Aspect	Name	Indication
281(B)*	Diagonal on top, flashing vertical below	Approach Limited	Proceed approaching next signal at Limited Speed which must not be exceeded until receiving a more favorable indication

Home Signal 2W

Rule	Aspect	Name	Indication
281(C)*	Horizontal on top, flashing vertical below	Limited Clear	Proceed; Limited Speed within interlocking limits and through turnouts

*Rules 281(B) and 281(C) stipulate that the fixed (wayside) signal will govern in cab signal territory

Automatic Cab Signal System (ACS) --On Conrail's lines between Conway, Pennsylvania, and Perryville, Maryland, a continuous-induction ACS system repeats the wayside signal aspects on a four-aspect cab signal in the locomotive units' operating compartments As the train passes a wayside signal or a code change point, the corresponding aspect of the cab signal is illuminated ACS also informs the engineer when a condition occurs after he passes a wayside signal by changing to the appropriately more restrictive indication From top to bottom, the four ACS aspects are "clear," "approach medium," "approach," and "restricting " (See figure 7) Wayside signal aspects "approach limited" and "stop" are displayed on the cab signals as "approach medium" and "restricting," respectively The same code rates[12] in the rails that activate the wayside signals also activate the cab signals The code rates and resulting cab signal aspects are

Code Rates	Aspect
0	Restricting
75	Approach
120	Approach Medium
180	Clear

Approaching CP Thompson on track 1 from the west, there is a cab signal code change point, identified as CS-5532, located 5,052 feet west of home signal 2E With signal 2E displaying a "stop" aspect, the cab signals of an eastbound train would change from "approach" to "restricting" at this code change point

According to the testimony of Conrail's regional engineer of communications and signals, when train UBT-506 ran through switch 1E, the code rate would have been lost, that is to have gone to zero, on track 1 east of CP Thompson Loss of the code rate would cause all the westbound wayside signals displaying permissive signal aspects for track 1 between CP Thompson and CP Port to change to their most restrictive aspects and would cause the cab signals of train TV-61 to immediately change to "restricting "

Conrail rule 290 stipulates that a "restricting" aspect on a wayside and/or cab signal permits a train governed by it to "Proceed at Restricted Speed until the entire train has passed a signal displaying a more favorable aspect "

[12]The "code" is generated by a code transmitter that controls the current supplied to the track circuit in the rails so that the rails will be intermittently energized with "on" and "off" periods of approximately uniform length The rate at which these periods occur determines the "code "

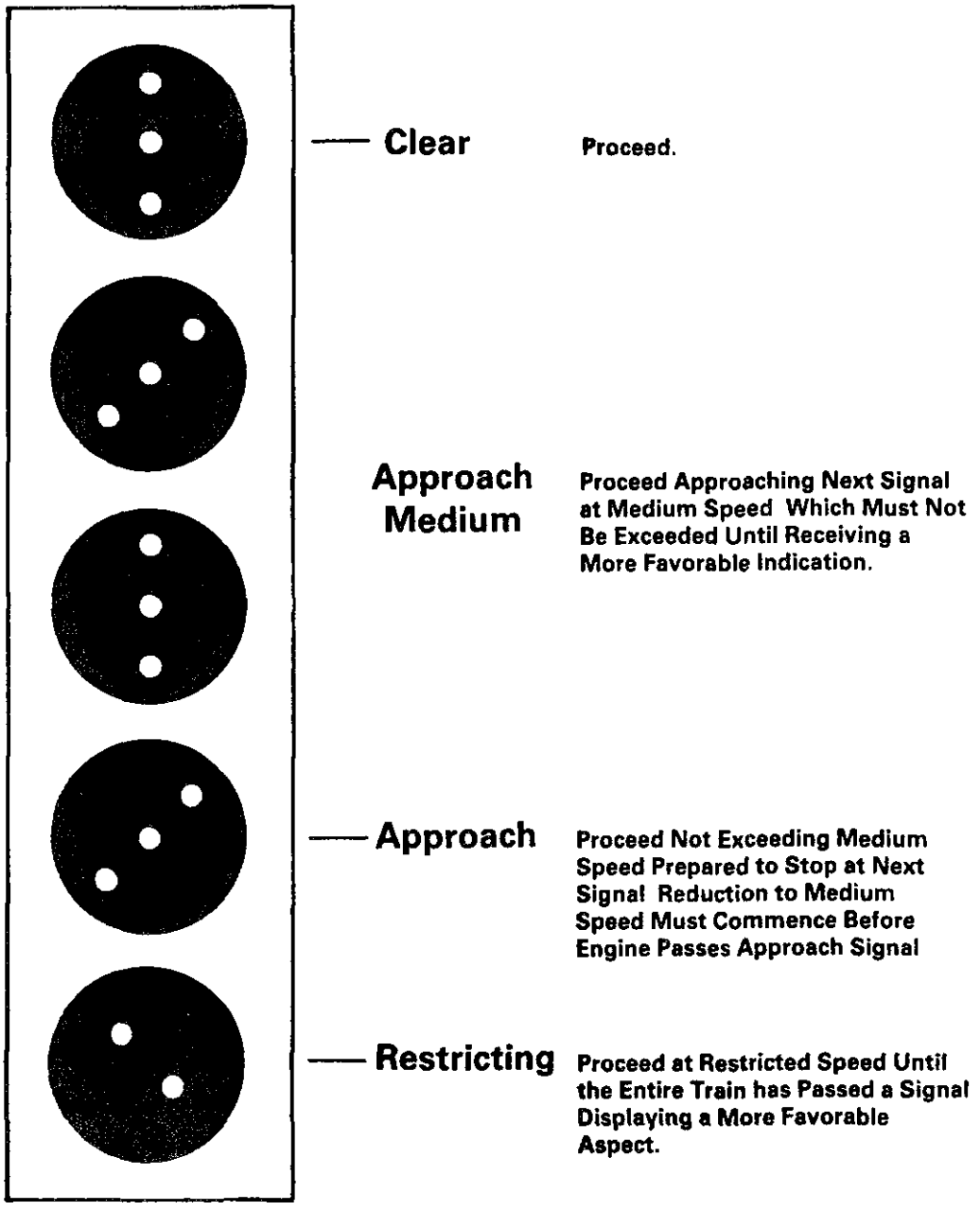


Figure 7 --Aspects displayed by the ACS system as they are arranged on the signal box inside the locomotive operating compartment

Train Information

UBT-506 --Train UBT-506 consisted of two General Motors model SD40 diesel-electric freight locomotive units and 105 open-top hopper cars loaded with coal The rear car was equipped with a battery-powered marker light in lieu of a caboose The train was about 4,500 feet long and reportedly had a trailing weight of about 10,800 tons

Each locomotive unit was rated at 3,000 horsepower, had 3-axle trucks, and had a sill height of 64 5 inches The locomotive units were being operated from lead unit CR 6265 which had the low-profile short hood and operating compartment forward, the trailing unit had the corresponding end headed rearward The operating console, brake stand, radio speaker, and engineer's seat were located on the right side of the operating compartments Two other seats were located on the left side and in the middle of the compartments

Each locomotive unit of UBT-506 was equipped with type 26-L automatic air brake equipment with a pressure-maintaining feature and standard dynamic braking Both units had event recorders that recorded speed, time, and distance, and both were equipped with functioning console radios Each unit also was equipped with a fuel-saver device that was activated by means of an on-off pushbutton on the control stand of the lead unit When in use, the fuel-saver device reduced the power output of the trailing unit while the lead unit remained in the selected-throttle position

Lead unit CR 6265 was equipped with a "deadman" safety control device that included an elongated foot pedal on the floor forward and to the left of the engineer's seat The foot pedal had to be continuously depressed to prevent a "penalty" full-service brake application The penalty application also could be avoided by cutting the deadman feature from the airbrake system A cut-out cock for this purpose was located under the cab floor; it could be accessed through a trapdoor in the floor without leaving the cab According to Conrail, deadman cut-out cocks are required to be kept sealed in the "in," or operative, position Due to collision damage, the deadman cut-out cock on unit CR 6265 could not be found, and it was not possible to determine whether it had been in the "in" position at the time of the accident

Unit CR 6265 was equipped with a four-aspect ACS cab signal display box mounted above the middle of the windshield As with all of Conrail's 1,416 road freight locomotive units, the ACS system of the lead unit had been modified during 1987 and early 1988 through the addition of an automatic train stop (ATS) feature and by the replacement of the air-operated ACS warning whistle with an electronic "warbler" alerter that could not be muted or rendered inoperative as long as the ACS system was functioning

Each of the lower three cab signal aspects is more restrictive than the one above it A change to a more restrictive ACS aspect causes the warbler alerter to sound The engineer must acknowledge the change by depressing and releasing the acknowledgment pedal located on the floor in front of the engineer's seat and to the right of the deadman pedal If the engineer fails to take this action, the ATS feature will cause a penalty brake application in less than 8 seconds after the alerter device begins sounding

Unlike the deadman pedal, the ACS/ATS acknowledging pedal cannot be kept continuously depressed because it is a two-stage device that must be depressed and then released to silence the alerter device and to prevent the penalty application Inasmuch as the ACS/ATS system does not function on the trailing units of a locomotive consist, the cab signal aspects are not displayed and the alerter device does not sound on these units

A cut-out cock to cut the ACS/ATS system out of the airbrake system was located in the front-end nose compartment of unit CR 6265 and was accessible from the cab The ACS/ATS cut-out cock also is required to be kept sealed in the "in" position Following the accident, the cutout cock was recovered and found in mid-position between "in" and "out " The wire seal was still attached to the handle, but the wire was stretched and broken According to Conrail's superintendent of motive power, it was possible that the seal wire had been severed and the cut-out cock handle moved as a result of the collision impact He testified that tests had shown that with the handle in mid-position, the ACS/ATS feature remained cut into the airbrake system and was fully operative It was the consensus of the vehicle factors investigative group that the ATS cut-out cock had been cut in and sealed before the accident

Conrail rule 132 stipulates that employees " are prohibited from altering, nullifying, or in any manner restricting or interfering with the normal intended function of any device or equipment on engine In case of failure, or where seals are found to be tampered with, broken or missing, report must be made immediately to the train dispatcher "

Train UBT-506 originated at Shire Oaks, Pennsylvania, on January 13, 1988, and had traveled about 258 miles when the accident occurred The train's cars and locomotive units had been inspected and had received the required initial terminal air brake test at Shire Oaks The originating engineer stated that, before the train entered ACS territory, he had performed the required tests of the ACS/ATS system and that it had functioned properly The makeup of UBT-506 was not changed en route except that two manned helper locomotive units were used on the rear of the train over the Allegheny Mountain grade between Conemaugh (Johnstown), Pennsylvania and Altoona, about 36 miles

Three engineers operated UBT-506 between Shire Oaks and Thompsontown According to the first engineer and the engineer who subsequently operated the train from Blairsville, Pennsylvania, to Conemaugh, the ACS/ATS system, audible ACS warning device, console radio, and automatic air brake system had functioned properly en route The second engineer also stated that he passed this information to the engineer who relieved him at Conemaugh and who was operating the train when the accident occurred

TV-61 --Train TV-61 consisted of three 4-axle diesel-electric freight locomotive units and 61 flat cars loaded with highway trailers and containers The train had no caboose, but the rear car had a battery-powered, rear-end telemetry device (EOT)[13] affixed to the rear coupler knuckle and air hose TV-61 was about 5,500 feet long and had a trailing weight of about 3,650 tons

TV-61's lead locomotive unit, CR 5017, was a General Electric (GE) Model B36-7 and had its short hood or cab end forward The middle unit was a GM Model GP40 and the rearmost unit was a GM Model GP40-2 The two trailing units had their cab ends headed rearward The total rated horsepower of the locomotive units was 9,600 The sill or platform height of the GE unit was about 70 inches, that of the two GM units was about 64 5 inches The cab configuration, door locations, and walkways of unit CR 5017 were similar to those described previously for unit CR 6265 The engineer's seat was on the right side, and two single seats were located on the left side of the cab.

Lead locomotive unit CR 5017 was equipped with the same automatic air brake and ACS systems as described for CR 6265 The locomotive unit also had been modified in 1987 with the addition of

[13]This device employs continuity and pressure transducers to produce telemetric signals that are radio-transmitted to a receiver on the locomotive control stand Brakepipe pressure at the rear of the train is thus digitally displayed for the engineer The device also has a flashing amber marker with photoelectric cell that functions at night or when light values otherwise fall to a given level When battery power is lost, the cab device displays a "no comm" (no communication) indication

ATS and the electronic ACS alerter device Changes to more restrictive cab signals had to be acknowledged in the same manner as previously described to prevent penalty airbrake application CR 5017 also had the deadman safety control device with floor pedal and cut-out cock However, the deadman cut-out cock was located in the nose compartment, and the cut-out cock for the ACS/ATS system was located outside the cab in a compartment just aft of the right front step well Both cut-out cocks on CR 5017 were found sealed in the "in" position after the accident

CR 5017 was equipped with an 8-track Pulse event recorder that continuously recorded data on tape The data included speed, distance, time, throttle position, traction motor current, operation of automatic and independent air brakes, dynamic braking, application of the power control switch (PCS), and operation of a Select-a-Power fuel saver device The tape from unit CR 5017 was recovered after the accident

TV-61 originated at Port Elizabeth, New Jersey, on January 13, 1988 Before departure, the train was inspected by shop personnel and received the required initial terminal air brake test According to the inspection report, the ACS/ATS cut-out cocks on all the units were cut in and sealed and the ACS/ATS systems on unit CR 5017 and the rear unit were tested as required The report also states that there were operable console radios on the lead and rear units and that the radios were tested and found to function properly at that time (See appendix E)

The original engineer of TV-61 said that he used the airbrakes and dynamic braking en route to Harrisburg and they had functioned properly He also stated that although he operated the train through non-ACS territory, he made a satisfactory running test of the cab signals en route

At Harrisburg, the makeup of train TV-61 was changed by setting off some cars and adding 28 cars to the head end These cars had been inspected and airbrake-tested previously by car inspectors According to the conductor assigned to the train when it left Harrisburg, the crew took the locomotive units from the servicing area and coupled the Harrisburg pickup to the remainder of the original train that had been brought in from Port Elizabeth He also stated that a car inspector performed an air brake test on the train before it left Harrisburg

Shortly after TV-61 left Harrisburg, the crew was advised by radio that the second car from the rear end had a sticking brake According to the conductor, the train was stopped and the problem was corrected by the engineer making an application and release of the train brakes The conductor stated that no further problem was experienced with the car, although he estimated his ability to inspect the train from the head end as being limited to the forward 20 cars when the train was moving at its maximum authorized speed

The conductors of UBT-506 and TV-61 stated that the rear locomotive units on which they rode had functioning console radios Each conductor also had a functioning portable radio on his person at the time of the accident

Meteorological Information

The surviving train crewmembers stated that at the time of the accident it was daylight, clear with good visibility, and very cold According to the Man-Computer Interactive Data Access System (MCIDAS), the following weather data were reported for January 14, 1988, at locations between Conemaugh and the accident site.

Time (e.s.t.)	Location	Ambient Temperature (degrees F)	Wind Chill Temperature	Wind Speed (knots)	Wind Direction
0300	Johnstown	3	-30	14	NW
0400	Gallitzen	8	-8	8	N
0500	Gallitzen	8	-8	8	N
0500	Altoona	8	-8	8	N
0600	Altoona	8	-8	8	N
0700	Lewistown	7	-15	10	N
0800	Lewistown	6	-11	8	N

Visibility given for each location and time was 7 miles or greater

Personnel Information

Each train crew consisted of a conductor, an engineer, and a brakeman who was a qualified conductor All crewmembers were qualified under Conrail rules The conductor of train TV-61 was required to wear "corrective lenses" at all times when on duty No other crewmember was restricted in any way.

Searches of the National Driver Register and the Pennsylvania Department of Transportation files failed to yield any record of suspension, denial, or revocation of the motor vehicle operator licenses of the train crewmembers involved in this accident

Crewmembers of UBT-506 --The crewmembers of train UBT-506 had gone on duty at Conemaugh at 2.30 a m , January 14 and had been on duty 5 hours 25 minutes at the time of the accident The engineer and brakeman were regularly assigned together in the Conemaugh-Harrisburg crew pool with Conemaugh as their home terminal At the time they reported for duty, they had been off duty for 40 hours 30 minutes The conductor had been off duty for 53 hours before reporting for duty He formerly had been assigned to the Altoona extra board and had successfully bid into the crew's vacant conductor position on January 13 He knew the brakeman, having worked with him previously, but he was not well acquainted with the engineer

The engineer and conductor lived at Altoona, about 45 miles from Conemaugh, the brakeman's home was in Gallitzen, Pennsylvania, between Altoona and Conemaugh As was their practice, the engineer drove to a Conrail facility near Gallitzen where he met the brakeman They then drove to Conemaugh together, leaving one of their automobiles at the facility Under this arrangement with good weather conditions, the engineer had to leave home at least an hour before his reporting time The brakeman had to allow about 40 minutes to get to work in good weather In inclement weather, both men would have to allow additional time particularly since the terrain they had to travel was mountainous Formerly, Altoona had been the home terminal for both men, but extension of the crew operating districts had eliminated Altoona and other locations on the Conrail system as crew change points.

The conductor drove his automobile to the Conemaugh facility, arriving there before the engineer and brakeman The conductor spent about an hour with the other crewmembers while they waited for their train to arrive at Conemaugh The conductor testified that the engineer and brakeman were in good spirits and that he observed nothing abnormal in their appearance or actions

The engineer was hired as a locomotive fireman by Conrail's predecessor, Penn Central, in 1969 and was promoted to engineer in 1974 on the basis of on-the-job-training as a fireman Also in 1974, the engineer was suspended for 5 days after admitting he had fallen asleep while his train was standing, thereby delaying it 22 minutes In 1976 and again in 1979, he was suspended for 30 days for minor accidents, and in 1980, he was again suspended for 30 days for operating a train at 7 mph in excess of allowable speed The engineer last passed an examination on Conrail's operating rules on May 19, 1987 Conrail's records indicated he had not missed a call to duty during 1987

The engineer was described by his supervisors and coworkers as congenial, responsible, and reasonably skilled The trainmaster at Conemaugh said the engineer was a good employee, "very cooperative," and not one to waste time or cause other problems

Conrail records indicated that the engineer had been the subject of 550 supervisory rules checks during the 16 months preceding the accident A total of 140 checks directly pertained to compliance with specific signal rules None of the signal checks was reported as a failure Of the remaining checks, the records indicated five failures for inadequate identification or response in use of the radio and one failure for not having acquainted himself with a specific bulletin order According to a trainmaster, in July 1987 he verbally reprimanded the engineer for having a flag stick and air hose near the deadman pedal of his locomotive unit, and he cautioned him against doing anything to defeat the purpose of a safety device The trainmaster told Safety Board investigators that brake shoes and other heavy objects were commonly used to hold down the deadman pedal At the time the engineer was reprimanded, having these objects in the operator compartment was not a violation of any rule or special instruction

Originally employed by the Pennsylvania Railroad in 1964 as a trackman, the brakeman transferred to train service as a brakeman in 1965 and was subsequently promoted to conductor Conrail's records indicated he had never been disciplined or injured on duty The records also indicated the brakeman had not missed a call to duty during 1987 He was last examined on the operating rules on March 30, 1987

The trainmaster at Conemaugh said he had known the brakeman for many years and that he had the highest personal regard for him He described the brakeman as completely dependable and conscientious Another trainmaster stated that the brakeman had a reputation as one who would "never, ever sleep on duty," and who would never permit tampering with safety devices The only recorded event in the brakeman's service record provided to the Safety Board was a 1982 commendation for going to the aid of a motorist whose car was on fire

The conductor was originally employed as a brakeman by Penn Central in 1974 His discipline record indicated he was suspended for 15 days for a 1981 rule violation The conductor was most recently examined on the operating rules on May 22, 1987

Crewmembers of TV-61 --The TV-61 traincrew had gone on duty at their home terminal of Harrisburg at 5 20 a m , January 14 and had been on duty 2 hours 35 minutes at the time of the accident Before going on duty, the engineer had been off duty for 53 hours 25 minutes, and the conductor and brakeman had been off duty 16 hours 50 minutes The engineer lived at Thompsontown, about 40 miles from Harrisburg, the conductor and brakeman lived near Harrisburg

The engineer had been employed by Conrail as a student fireman in 1976, qualified as a engine hostler later the same year, and promoted to engineer in 1978 His record was clear of disciplinary action. He last passed examination on Conrail operating rules on September 3, 1987

The conductor was originally employed as a yard brakeman by Conrail's predecessor, Erie Railroad, in 1953 and was promoted to conductor in 1955 In 1977, he was dismissed by Conrail for a rule violation but was reinstated 4 days later The conductor was last examined on Conrail rules on June 22, 1987

The brakeman was originally employed by the Erie Railroad as a yard brakeman in 1952 and was promoted to conductor in 1954 In January 1978, he was dismissed by Conrail for violating an operating rule, but he was reinstated 4 1/2 months later The brakeman last passed examination on the operating rules on September 18, 1987

Work Shifts and Rest --After transferring to the Conemaugh-Harrisburg crew pool in July 1987, the engineer of train UBT-506 had worked almost exclusively on eastbound coal trains and westbound empty hopper trains This traffic was geared to the operation of the coal mines that originated it. The Conrail pool crews handling this traffic were subjected to irregular and unpredictable work/rest cycles

During the 90-day period preceding the accident, the engineer had worked whenever his turn in the pool crew rotation had made work available to him. Except for taking a week of vacation during December 14-20, he had not marked off or missed a turn during this time. In all, he made 57 trips, including 5 trips when he was deadheaded by automobile The engineer's average time on duty when he actually operated a train was sightly more than 9 hours, his on-duty time when deadheaded averaged a little less than 4 hours His off-duty time between trips when at his home terminal varied from 12 1/2 to 114 hours with the average time between trips being 48 1/2 hours When laying over at Harrisburg, the engineer was off duty from 8 to 30 hours, the average being 15 1/2 hours The following table gives the engineer's work record, the times he reported for duty, and the time he was subsequently on the job The brakeman of UBT-506 had a similar work pattern during the period, except that he had not taken vacation

UBT-506 Engineer's 90-Day Record

From Conemaugh			From Harrisburg		
Day	Reporting Time	Time on Duty (Hrs.- Min.)	Day	Reporting Time	Time on Duty (Hrs.- Min.)
Thur , 10/15	0500	11-0	Fri , 10/16	1114	3-46*
Sat , 10/17	2200	7-30	Mon , 10/19	0545	4-45
Tues , 10/20	1500	8-40	Wed , 10/21	1114	3-46*
Fri , 10/23	1230	11-0	Sat , 10/24	1800	6-50
Mon , 10/26	1145	7-45	Tues , 10/27	1430	10-45
Wed., 10/28	2045	11-45	Fri , 10/30	0430	10-15
Sat , 10/31	1915	10-15	Mon , 11/2	0440	8-0
Wed., 11/4	0845	8-45	Thur , 11/5	0930	8-30
Fri , 11/6	2300	10-45	Sat , 11/7	1900	8-15
Mon , 11/9	1930	13-0 x	Wed , 11/11	0500	10-0
Fri , 11/13	1900	10-50	Sat , 11/14	1350	7-10
Tues , 11/17	1045	4-15*	Wed , 11/18	0700	8-0
Fri , 11/20	2015	7-15	Sat , 11/21	2000	11-30
Mon., 11/23	1645	12-15 x	Tues , 11/24	1500	13-0 x
Wed , 11/25	1630	7-15	Fri , 11/27	0100	7-0
Sun , 11/29	0001	7-59	Sun , 11/29	1600	8-30
Tues , 12/1	0101	2-59*	Tues , 12/1	1345	14-15 x
Wed , 12/2	1830	10-15	Thur., 12/3	1730	11-0

From Conemaugh			From Harrisburg		
Day	Reporting Time	Time on Duty (Hrs.- Min.)	Day	Reporting Time	Time on Duty (Hrs.- Min.)
Fri , 12/4	2300	9-30	Sun , 12/6	0145	6-45
Mon , 12/7	1530	8-0	Tues , 12/8	0730	6-20
Thur , 12/10	0930	10-0	Fri , 12/11	2315	7-0
Sun , 12/13	0730	9-30	Mon , 12/14	1315	10-15
Wed , 12/23	0045	7-45	Wed , 12/23	1630	8-15
Mon , 12/28	1900	6-45	Wed , 12/30	0130	7-0
Wed , 12/30	1830	10-30	Thur , 12/31	1300	7-30
Mon., 1/4	1800	7-45	Wed , 1/6	0745	10-15
Fri , 1/8	0130	10-15	Fri , 1/8 2315	10-15	
Mon , 1/11	1030	4-30*	Mon , 1/11	2300	11-0
Thur , 1/14	0230	5-25			

* Deadhead trip
x Relieved of responsibilities after 11 hours 59 minutes

The engineer and brakeman of UBT-506 had been off duty for 40 1/2 hours before reporting for duty on January 14 Details of the engineer's activity after he arrived at home between 11 a m and noon on January 12 were provided to Safety Board investigators by the engineer's wife and stepfather The engineer spent the afternoon visiting and shopping with his stepfather, ate supper at home with his family, and retired with his wife late in the evening He was still asleep when his wife left for work the following morning According to the engineer's wife, he was at home during the day inasmuch as he had arranged for a contractor to estimate the cost of putting in a new gas line to the house After the engineer's wife returned home about 5 30 p m , she and the engineer ate supper and drove to Altoona to pick up their daughter While in the city, the engineer stopped at the Conrail yard office to find out when he might be called to work He returned home about 8 30 p m , napped for about an hour on a couch, and went to bed about 10 p m According to the engineer's wife, she awoke about 1 a m and noticed the engineer was preparing to go to work Conrail's records indicate the engineer had been called about 11.30 p m and told to report at Conemaugh at 2.30 a m

Like the engineer, the brakeman of train UBT-506 had gone off duty at Conemaugh at 10 a m on January 12 after an 11-hour trip The brakeman's activities thereafter are unknown until shortly after 4 p m when his wife came home from work According to his wife, at that time, the brakeman was at home and was up After eating supper, he went to the nearby home of his terminally-ill mother who required the presence of a family member at all times The brakeman spent the night with his mother and returned home at 8 30 a m on January 13 The Safety Board could not determined how much sleep, if any, the brakeman got during the night According to the brakeman's wife she came home for lunch, which he prepared; she returned from work at 4 p m , and they had an early supper together The couple went to bed between 9 p m and 9.30 p m , and about 11.30 p m the brakeman was notified to report for duty at 2 30 a.m

When the conductor of train UBT-506 reported for duty on January 14, he had been on off-duty status for 53 hours During the preceding month, he had worked a variety of extra board relief assignments out of Altoona These assignments included five road trips and one yard assignment Three times he had relieved road crews that had exhausted their allowable hours on duty, and he had been deadheaded back to Altoona by automobile from outlying points five times during this period The conductor worked the following days during the last month preceding the accident

Day	Reporting Location	Reporting Time	Time on Duty (Hrs.- Min.)
Fri , 12/11	Harrisburg	0516	3-0 *
Sat , 12/12	Altoona	0015	11-25 x
Sun , 12/13	Altoona	0030	4-30
Mon , 12/14	Altoona yard	1500	8-0
Thur , 12/17	Altoona	1520	6-0
Thur , 12/17	Harrisburg	2121	2-25 *
Sun , 12/20	Altoona	2015	5-45
Mon , 12/21	Conway	0200	2-45 *
Wed , 12/30	Altoona	0630	8-15 x
Thur , 12/31	Altoona	2145	5-45
Fri , 1/1	Harrisburg	0331	3-0 *
Fri , 1/8	Altoona	0500	3-45 x
Mon , 1/11	Altoona	1000	8-0
Mon , 1/11	Conway	1801	3-29 *

* Deadheaded by auto; no duties performed
x Relieved a crew en route

The conductor stated that he worked in relief of a regular conductor on a train from Altoona to Conway, Pennsylvania, on January 11 and was deadheaded back to Altoona where he arrived at 9.30 p m after 11 hours 29 minutes on duty He slept that night and spent the next day at a car auction, returning home about midnight After arising on the morning of January 13, he went to the call office at Altoona and found that a temporary vacant assignment for a conductor existed in the Conemaugh-Harrisburg pool, which he bid on successfully According to the conductor, he went to bed about 9 p m and slept for an hour or two before being notified by telephone to report for work at 2 30 a m He testified that before he went to bed he was aware that his new crew assignment was the next or second to the next to be called to duty at Conemaugh

The conductor said that he did not go to bed earlier because he wanted to spend time with his family He testified at the Safety Board's public hearing on the accident that, "You can't forget your family just because you're working on the railroad " The conductor further testified that he normally retires between 11 p m and 11 30 p m and sleeps for 8 hours He also related that he needs 4 to 5 hours sleep to feel rested, but can "get by one night" without proper rest. The conductor further noted that he had been allowed to turn down previous assignments because he had not been rested and that this action had not resulted in his being disciplined by Conrail

The conductor recalled that before the accident trip he drank a cup of coffee, but he did not remember having eaten anything at the time He testified that he took no food or drink to consume while on the job The investigation also determined that it was not customary for the engineer and brakeman to carry lunches to work

Medical Information

Medical History of UBT-506 Crewmembers --The 40-year-old engineer had last received a Conrail physical examination on April 30, 1986, at the Altoona medical department The examination included an electrocardiogram (EKG) which was noted as normal and not significantly different than the EKG performed at the time of his 1983 Conrail examination The 1986 examination report stated that the engineer's uncorrected distance acuity in both eyes was 20/400 (he was not required to wear corrective lenses); his hearing acuity was given as adequate in both ears.

The 46-year-old brakeman last received the full periodic Conrail physical examination at the Altoona Medical Department on April 9, 1986 The report of this examination states that he was given an EKG, which was noted as normal, that his uncorrected distance vision acuity was 20/22 in both eyes, and that his auditory acuity was adequate The brakeman noted on the examination report that he was taking medication, and the doctor listed this as "Corgard - 40 mg daily "[14] There was no mention of any condition for which the medication was prescribed Under the report section headed, "Since your last examination in the Medical Department have you had: " the brakeman checked the "no" box next to the line reading "Weakness or Fatigue "

According to the brakeman's personal physician, he had prescribed Corgard for treatment of hypertension in February 1986, but on July 7, 1986, he changed the medication to Aldoril 15[15], taken twice daily. The doctor stated that he had changed the medication because the brakeman complained that he had been fatigued ever since he had started taking Corgard According to the doctor and the brakeman's wife, the brakeman was taking Aldoril at the time of the accident and had not complained of any side effects from the medication

The 33-year-old conductor was last examined by the Altoona medical department on August 7, 1985 The examination did not include a toxicological screen or an EKG At the time, the conductor's uncorrected distant visual acuity was 20/20 in the right eye, 20/18 in the left, and his hearing was apparently considered to be adequate

Medical History of TV-61 Crewmembers --The 30-year-old engineer was last examined for Conrail by a "fee-for-service" doctor on September 4, 1986 The report of the examination gives the engineer's uncorrected distant visual acuity as 20/20 and hearing as adequate An EKG was normal No urinalysis or toxicological screen was performed

The brakeman, 56, was last examined by a Conrail "fee-for-service" physician on April 4, 1986 (his first examination since January 1983) The examination did not include an EKG, pulmonary function test, or toxicological screen The examination report gave the brakeman's uncorrected distant visual acuity as 20/25 in both eyes and hearing as adequate

The 60-year-old conductor had been last examined by a Conrail "fee-for-service" physician on June 8, 1987 The examination report indicates the conductor had uncorrected distant visual acuity of 20/100 in the right eye and 20/70 in the left; corrected vision was shown as 20/20 in both eyes. The conductor was not given an EKG or pulmonary function test A toxicological screen for illicit drugs was negative An audiometer test indicated a hearing deficiency ranging from 15 db at 500 Hz to 80 db at 6000 Hz in the right ear, and 15 db at 500 Hz to 60 db at 6000 Hz in the left ear The examining doctor did not note in the report whether the conductor's hearing was "adequate" or "deficient " Under the heading, "Since your last examination . have you had:," the conductor checked the "yes" box adjacent to "Difficulty in Hearing." The conductor also testified at the Safety Board's public hearing that he was hard of hearing Since 1977, he had been required to wear corrective eyeglasses at all times when on duty

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[14]Corgard (Nadolol) is a Beta-blocker commonly prescribed in the treatment of hypertension Its potential side effects include slight drowsiness, trouble in sleeping, and unusual tiredness or weakness

[15]An antihypertensive preparation containing 250 mg methyldopa and 15 mg hydrochlorothiazide The Physician's Desk Reference, 1988 edition, gives adverse effects of methyldopa as sedation, "usually transient," and decreased mental acuity The comment is also given that, " significant adverse effects have been infrequent and this agent usually is well tolerated "

Conrail Medical Policy --Conrail requires pre-employment and periodic physical examinations for all train service employees· every 3 years for those 50 and younger and every 2 years for those over 50 [16] Employees who fail to comply with this policy are subject to being held out of service until they are examined Due dates for scheduled examination are the employees' birth months, and the medical department and appropriate line supervisors are notified in advance of the due dates by a computer log

The physical examinations are conducted at Altoona and three other Conrail regional medical departments and by about 100 private "fee-for-service" doctors at locations that are remote to the regional medical departments Private doctors submit reports of their examinations to the appropriate Conrail regional medical department where they are reviewed and filed According to Conrail's chief medical officer, the private doctors are furnished a Conrail manual of medical standards and efforts are made to familiarize them with Conrail's medical policies and procedures

Both pre-employment and periodic examinations include testing of eyesight and hearing, measurement of height, weight, and blood pressure, electrocardiogram, and statements by the individual including whether medication is being taken Since 1987, the examinations also have included screening of urine for illicit drugs Urine samples also are analyzed for sugar and albumin; normally blood glucose testing is no longer done, although this was part of the examinations done by Conrail's predecessor, Penn Central

According to Conrail's chief medical officer, individuals are approved for hiring as train service employees as long as they meet certain standards relating to the individual's ability to function safely within the physical requirements of the job. According to personnel in the Altoona medical department, examinations there have become less comprehensive in some respects as a result of reductions in staff

At the time of the accident, employees were asked during their physical examinations if they had begun taking medication since their last examination, however, they were not required to advise the medical department of any initiation or change of medication between periodic examinations.

Formerly, the second paragraph of Conrail's operating rule G read, "Employees under medication before or while on duty must be certain that such use will not affect the safe performance of their duties " In February 1987, rule G was changed to read, "Employees shall not report for duty or perform service under the influence of, or use while on duty, any drug, medication or other controlled substance, including prescription medication, that will in any way adversely affect their alertness, coordination, reaction, response or safety Questionable cases involving the adverse effects of prescribed medication shall be referred to a Company medical officer " According to Conrail's director of operating rules, it is entirely the responsibility of the employee to recognize that he is experiencing adverse symptoms as a result of his taking prescribed medication

As long as train service employees did not report adverse reaction or effect, the Altoona medical department did not oppose their taking normal dosages of anti-hypertensives, Beta-blockers, or other cardiovascular preparations The rationale given by the medical department was that usually there was a high degree of individual tolerance to such medication and the occurrence of significant nervous/psychiatric effects, such as sedation, fatigue, lethargy, drowsiness, and sleep disorders were considered relatively rare

[16]Conrail's principal predecessors required more frequent examinations Penn Central train and engine service employees over 45 were examined annually while younger employees were examined every 2 years All Erie-Lackawanna employees were examined annually

According to the physician's assistant, information relating to an employee's health history and treatment could be obtained from his personal physician as long as the employee gave the medical department a signed release However, he stated that such communication with personal physicians was rare except in cases where a very serious condition, such as heart attack, had occurred

Supervision and Training

At the time of the accident, train operations over Conrail's Allegheny Division between Conemaugh and CP Banks were supervised by a superintendent, one assistant superintendents, two trainmasters, a division road foreman, and four road foreman--all headquartered at Altoona In addition, a trainmaster was assigned to Conemaugh from 6 a m to 2 p m , Monday through Saturday The trainmaster testified that he generally worked as late as 4.30 p m to 5.30 p m. No other supervisor was assigned to Conemaugh

According to the division road foreman, he and the four road foremen collectively supervised 214 engineers, or an average of about 43 each. Each road foreman was required to ride a minimum of five trains weekly to evaluate the engineers' performance, but the road foremen were not required to ride the entire length of a train's run. The bulk of train-riding activity was over the 14-mile section between Gallitzen and Altoona, which included the heavy Allegheny Mountain grade. According to the division road foreman, the handling of heavy trains, particularly coal trains, down this grade was the most critical operational aspect of the division Therefore, he said, supervision was concentrated there

Trainmasters also were required to ride trains, but only once a month Collectively, the trainmasters and road foremen supervised 63 road passenger and freight crews, 20 one-man helper crews, and 6 yard crews

Under the "Conrail Operating Rules Promote Safety" (CORPS) operating rules testing program, trainmasters and road foremen were required to make compliance tests relating to 235 different operating rules On the Allegheny Division, no specific testing quotas were imposed. During its investigation of a railroad accident at Chase, Maryland on January 4, 1987,[17] the Safety Board learned that supervisors on Conrail's Harrisburg Division were required to make a minimum of 250 tests monthly and that 10 percent of these tests had to be related to cab signal rules. CORPS efficiency tests were not necessarily of the "surprise" variety as some could only be made by a supervisor riding on a train's controlling locomotive unit Moreover, the Safety Board's investigation of the Thompsontown accident, as well as the 1987 FRA safety assessment of Conrail[18] determined that many speed checks were made from event recorder printouts The only radar speed guns on the Allegheny Division were assigned to road foremen, and if a trainmaster wanted to make a wayside speed check, he had to borrow a radar gun from the division road foreman

According to the FRA, in one March 1987 instance, an Allegheny Division road foreman reported making 120 speed tests involving seven trains solely on the basis of event recorder analysis In another instance cited by the FRA, an Allegheny Division supervisor claimed to have made 239 CORPS tests in one day at one location The FRA also asserted that many Allegheny Division CORPS signal and speed tests were not meaningful because they were conducted by terminal supervisors who lacked radar guns and failed to have signals shunted before testing According to the FRA, there was

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[17]Railroad Accident Report--*Rear-End Collision of Amtrak Passenger Train 94, the Colonial, and Consolidated Rail Corporation Freight Train ENS-121, on the Northeast Corridor, Chase, Maryland, January 4, 1987* (NTSB/RAR-88/01)

[18]FRA Office of Safety 1987 Safety Assessment, Consolidated Rail Corporation Central Region, January 1988

no "effective management oversight of the program," and testing on many rules critical to safety were generally neglected [19]

Emphasis was placed on checking Allegheny Division traincrews' compliance with the "approach" signal aspect (rule 285), and a single observation of a train could be cited by a supervisor as constituting three different rule 285 tests of each crewmember During 1986, the division reported making 5,934 rule 285 signal tests (more than half of all signal tests made) with only one failure observed (a failure rate of less than 0.0002 percent) However, the FRA safety assessment asserted the Allegheny Division signal test failure rate was greatly understated According to the FRA, its observation of 340 Allegheny Division employees during the safety assessment detected 44 persons violating operating rules (a failure rate of 12 9 percent) When FRA inspectors observed Conrail supervisors making compliance tests, 5 of 33 employees failed to comply with rules (a 15 1 percent failure rate) [20]

Although the FRA assessment did not delineate the number of rule 292 "stop" signal tests made on the Allegheny Division, the Safety Board's investigation indicated that these were relatively few compared to the quantity of rule 285 tests The CORPS testing record of the UBT-506 engineer included 14 rule 292 tests and 69 rule 285 tests

Also, the FRA criticized the system-wide CORPS program on the grounds that it was not uniformly administered, a high degree of divisional autonomy was permitted, the operating divisions were judged on their productivity rather than safety performance, and the operational testing program had degenerated into a numbers exercise [21] The FRA's safety assessment asserted that Conrail rule 132 was not being universally enforced since supervisors on some unnamed divisions ignored the practice of keeping brake shoes, flag sticks, air hoses, and other heavy objects in the vicinity of the control stand In response to the FRA safety assessment, on February 2, 1988, Conrail's director-operating rules issued new special timetable instruction 132-1 for system-wide application This instruction reads "In application of Rule 132, flag sticks, air hoses, brake shoes or any other item which could be used to nullify or interfere with the intended function of deadman pedal or any other safety feature must not be located in the area of the engineer's control stand " CORPS test 1321 deals with rule 132 compliance, and, according to the director-operating rules, special attention has been given to this test since the issuance of special instruction 132-1 He reported that as of September 1988, more than 5,800 CORPS 1321 tests reportedly have been made resulting in 79 violations being discovered

The timetable for the Central Region, which includes the Allegheny Division, was not amended to include instruction 132-1 until December 20, 1988 However, the provisions of the instruction were issued in the form of Allegheny Division bulletin notice 3-33 on March 14, 1988 According to the Central Region manager of rules, the provisions of instruction 132-1 had not been issued in any other form on the Allegheny Division before that time

Allegheny Division road foremen also participated in the training and qualification of engineers on Conrail's train handling and air brake procedures According to the division road foreman, the scope of air brake training had been substantially reduced in recent years, the result of increased emphasis on training engineers to control the speed of their trains through throttle modulation and dynamic braking, supplemented when absolutely necessary by minimal service air braking The use of air braking in normal train handling was discouraged because it resulted in costly wheel overheating and wear, brake shoe wear, and delays to trains caused by sticking brakes

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[19]FRA 1987 Safety Assessment

[20]FRA 1987 Safety Assessment

[21]FRA 1987 Safety Assessment

Conrail records established that road foremen had ridden with the UBT-506 engineer on six occasions during June and July 1987, the period when he was qualified to handle coal trains down the mountain Four of these test rides lasted between 1 hour and 70 minutes and were conducted between Gallitzen and Altoona, 12 to 14 miles, and the others were for about 2 miles each at Altoona proper. The total distance involved was 58 miles and the road foremen were with the engineer for a total of 6 hours 20 minutes The only other recorded instance when a supervisor rode with the engineer during the 3 years preceding the accident was on April 8, 1985, when a road foreman accompanied the engineer from Altoona to CP Banks. The trip lasted 2 hours 32 minutes In this instance, the road foreman remarked on his report, "Called all signals " The 1987 trip reports gave remarks ranging from, "Good, needs practice but will be O K ," to "very professional" and "nice job "

Conrail train and engine service employees are required to take an annual class with written examination on the operating rules during the month of their birth At the time of the accident, the classes were 5 to 6 hours long and included instruction on the rules, hazardous materials, and safety subjects The employees also were required to attend an air brake rules class at least once every 2 years Since the accident, the rules and airbrake classes have been combined and the combined classes are about 8 hours long Minimum passing score on the written examination is 85 percent

Toxicological Testing

Following the accident, samples of blood and tissue were collected from the engineer of train UBT-506 and the brakeman of train TV-61, urine, tissue, and vitreous humor were obtained from the engineer of TV-61; and tissue samples were obtained from the brakeman of UBT-506 According to reports of testing done by the Center for Human Toxicology (CHT), these samples were negative for alcohol and illicit drugs except that in the case of the UBT-506 brakeman ethanol was detected in the liver at 0.02 gram per 100 milliliters, 0 07 gr/100 ml in the kidney, and 0 028 gr/100 ml in muscle tissue The samples tested had been exposed to postaccident fire and were contaminated by coal and diesel fuel The director of CHT concluded that " there is a reasonable probability that these low ethanol concentrations do not represent ethanol that was ingested before the accident occurred "

Urine and blood samples were obtained 3 to 5 1/2 hours after the accident from the surviving train crewmembers and the dispatcher These samples also were submitted to CHT for testing All were found negative for alcohol and illicit drugs except that the urine submitted by the UBT-506 conductor was found to contain 23 nanograms per milliliter of the carboxylic acid metabolite of delta-9-tetrahydrocannabinol, the pyschoactive ingredient of marijuana The conductor's blood sample was reported negative for the metabolite at an instrumental sensitivity of 2 ng/ml

The UBT-506 conductor told Safety Board investigators that he had not used illicit drugs nor had he been taking prescription medication before the accident He subsequently testified at the Safety Board's public hearing on the accident that he was not under the influence of any drug, medication, or alcohol on the morning of the accident and during the 2 days previous He refused to state whether he had been in the company of a marijuana user during that period

None of the samples sent to CHT were analyzed for the presence of methyldopa and other controlled prescription drugs

Survival Aspects

As a result of the collision, lead unit CR 5017 of train TV-61 overrode lead unit CR 6265 of train UBT-506, resulting in the operating compartment and other superstructure of the latter being

sheared off at the frame. The trailing unit of UBT-506, CR 6349, was overridden by the loaded hopper cars behind it. The hopper cars sheared off the superstructure and the upper part of the operating compartment, but left the short hood, control stand, and seats relatively undamaged. (See figure 8.) Unit CR 6349 came to rest on its left side.

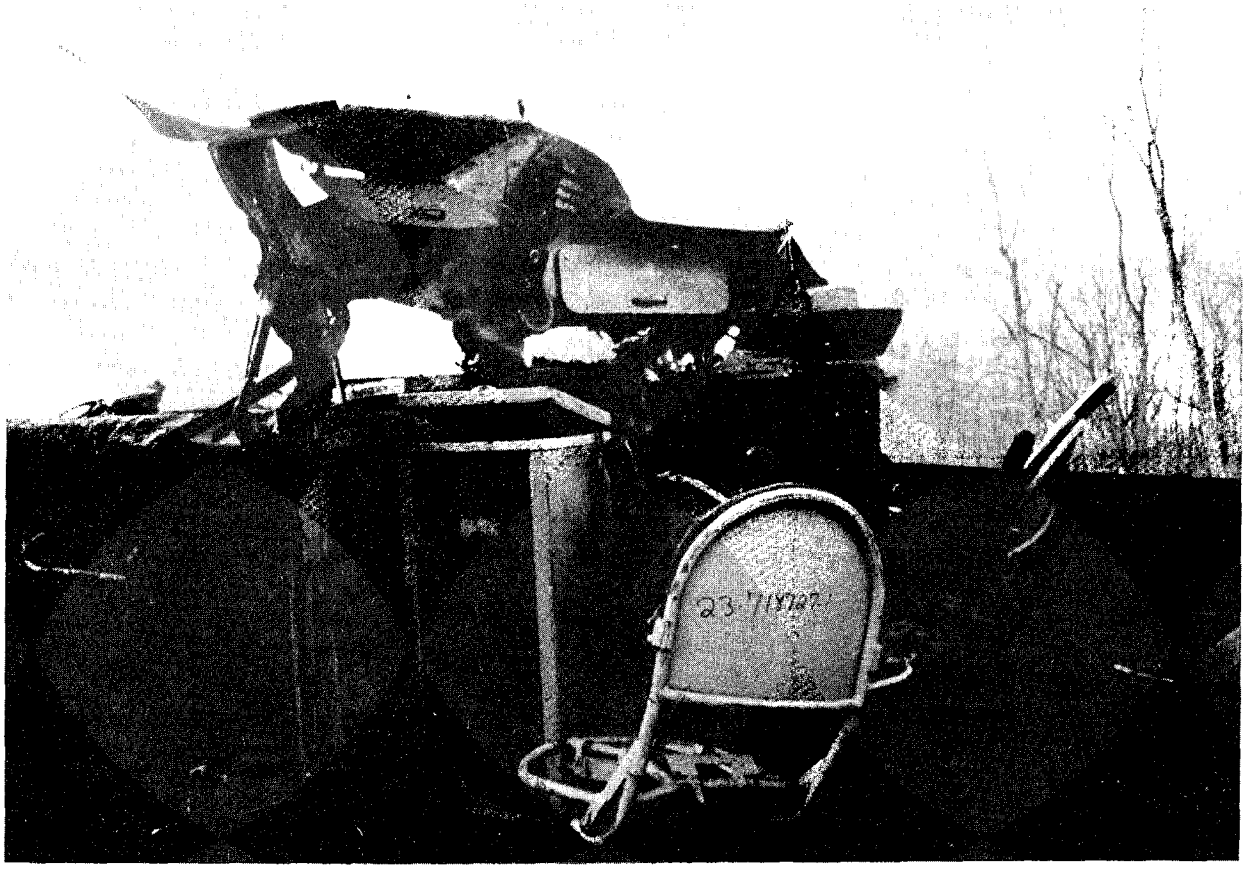

Figure 8.--Operating compartment of CR 6349, trailing locomotive unit of train UBT-506, after the collision near Thompsontown

Unit CR 5017 came to rest on its right side atop the wreckage of UBT-506 and perpendicular to the track. The operating compartment remained intact, although there was heavy damage to the remainder of the carbody. The superstructure of the middle TV-61 unit was destroyed when it was overriden by the rearmost unit. The rearmost unit, CR 3054, came to rest on its left side in line with the track. The operating compartment of the unit was to the rear and did not sustain any distortion or intrusion, although the remaining superstructure was heavily damaged and deformed. (See figure 9.)

According to the UBT-506 conductor, the engineer and brakeman of his train were on lead unit CR 6265 when the trains collided. Their bodies were found in the wreckage of their train. The UBT-506 conductor stated that, although he was unaware of the impending collision, he survived the accident by curling into a "ball" (fetal position) on the floor near the front of the operating compartment of the trailing unit.

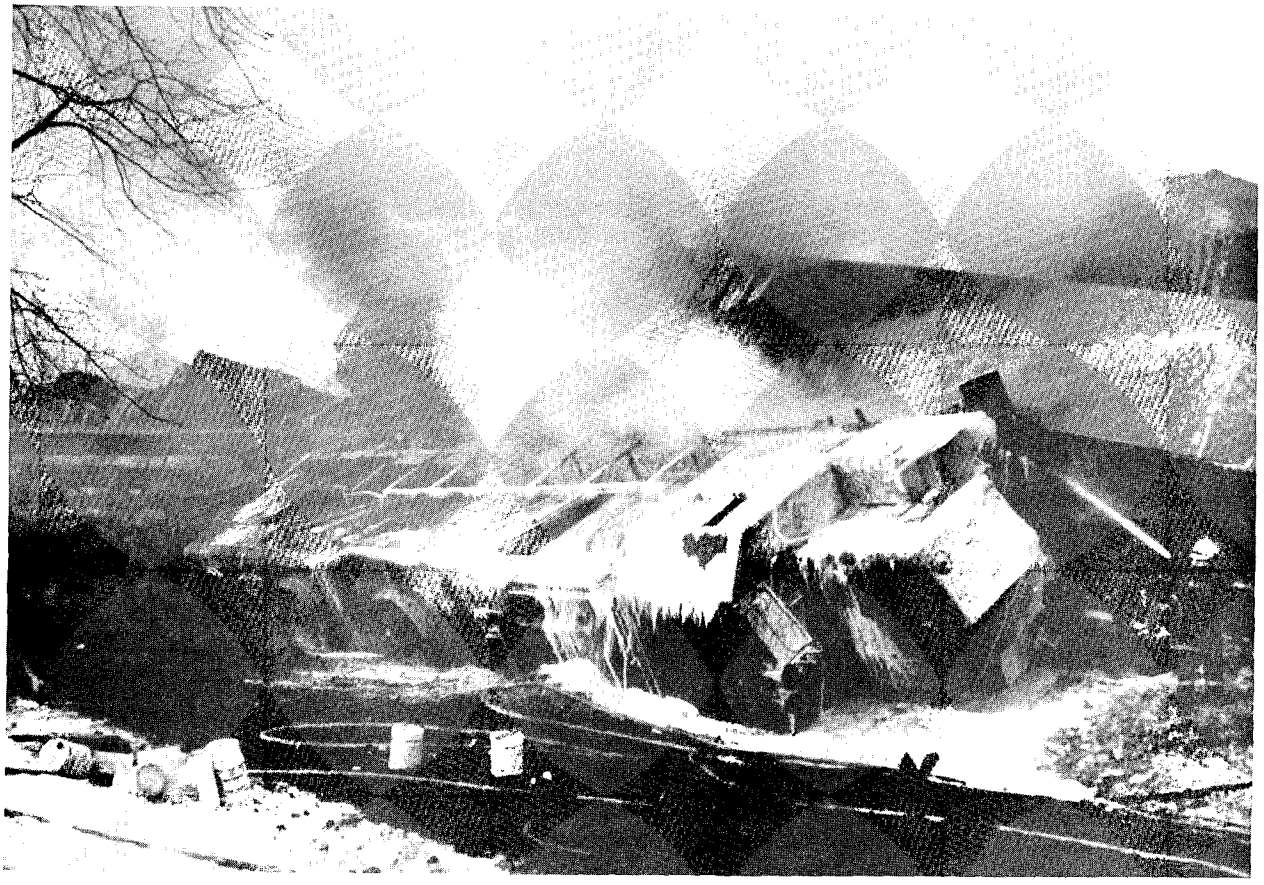

Figure 9.--CR 3054, the rearmost locomotive unit of train TV-61, after the collision near Thompsontown. The operator compartment of this unit escaped being heavily damaged and the conductor, who was inside, survived the accident.

The TV-61 conductor testified that he saw the brakeman of his train jump or fall from the north side of unit CR 5017 just before the collision. The brakeman was found under a pile of coal near his train's rearmost locomotive unit. It could not be determined whether the TV-61 engineer had jumped from or had been ejected from the lead unit. He was found under debris near the middle locomotive unit of his train. The TV-61 conductor remained inside the operating compartment of the rearmost unit. He survived the accident.

Response to the Emergency

At 8 a.m., about 5 minutes after the accident, an anonymous person at Thompsontown telephoned the Juniata County Sheriff's Department Communications Center and reported seeing a large quantity of black smoke rising from the neighborhood of the Conrail tracks. Six minutes later, a second anonymous caller notified the communications center that she had seen the train wreckage and gave its approximate location (about 2 1/2 miles west of the village of Thompsontown). On the basis of these reports, the Thompsontown Volunteer Fire Department was dispatched to the accident site at 8:08 a.m. The response was under the command of the assistant fire chief who was

notified by pager and telephone at his place of employment He drove to the accident by way of the fire station, a distance of about 7 miles

Ultimately, 3 units and 12 firefighters of the Thompsontown fire department responded to the accident They were supported by 13 units with 44 firefighters from other area fire departments under an informal mutual aid agreement

Upon arriving at the accident site, the Thompsontown assistant fire chief was informed by the surviving train crewmembers that four other crewmembers were missing and unaccounted for The assistant fire chief searched the wreckage without finding any of the missing men and then began directing efforts to extinguish the burning diesel fuel and coal that had spilled from derailed cars of train UBT-506 As there were no accessible hydrants, water was obtained from tank trucks and by siphoning a nearby stream About 130 gallons of aqueous film-forming foam (AFFF) from a Thompsontown firetruck and a Lewistown State Fire Academy firetruck was used to extinguish the burning diesel fuel The fire was brought under control about 2 1/2 hours after the accident

The Thompsontown ambulance with two crewmembers was dispatched to the site at 8 13 a m About 8·35 a m , it departed the accident site en route to the hospital at Lewistown with the two surviving train crewmembers The ambulance later transported the deceased crewmembers to the Lewistown hospital

When the Sheriff's Department Communications Center was initially notified of the smoke sighting, two units with four deputy sheriffs were dispatched to the scene At this time, the communications center notified the Pennsylvania State Police who responded with 5 units and 5 troopers These police units collectively controlled access to the accident area until State Highway Department crews erected barricades and Conrail police arrived to take over the control responsibility

At the time of the accident, no coordinated emergency response plan had been promulgated between Conrail and the fire departments at Thompsontown and elsewhere in Juniata County, Pennsylvania

Tests and Research

Postaccident testing established that eastbound home signal 2E governing track 1 at CP Thompson could be seen and the aspect distinguished beginning at a point approximately 2,950 feet west of the signal Distant signal 1461E could be distinguished from a distance of 2,270 feet

Following the accident, complete inspections and tests of the signals were performed by Conrail signal engineers and FRA signal inspectors in the presence of Safety Board investigators These tests revealed no defect in the system and the signal system was found to have functioned as designed

During February 1988, five malfunctions of the ACS/ATS systems were reported on locomotive units operating over Conrail cab signal territory between Conway, Pennsylvania, and Perryville, Maryland With one exception, the malfunctions occurred in subfreezing conditions In each case, it was reported that the ACS alerter would not sound and the ATS feature did not apply the brakes after there was a change to a more restrictive ACS aspect In two instances, 2 days apart, locomotive unit CR 6331 was involved, the unit was of the same model and vintage as CR 6265, the lead and controlling unit of train UBT-506

After the first reported malfunction, the ACS/ATS system of CR 6331 was inspected at Conway, the report of the inspection indicates under "remarks" that the air lines were "thawed out " Two days later, CR 6331 was the controlling unit of a train being operated from Harrisburg to Perryville,

and Harrington, Delaware, by way of the Amtrak Northeast Corridor line After leaving Harrisburg, the engineer reported that the unit's alerter did not sound and that the brakes did not apply when more restrictive cab signal aspects were displayed on six occasions According to the engineer, the outside temperature was about 25° F when the malfunctions occurred [22] When the train reached Perryville, the alerter functioned properly By this time, according to the engineer, the outside temperature had risen to about 35° F On returning to Harrisburg, CR 6331 was subjected to another ACS/ATS test, but nothing was found that might have caused the malfunctions

The modification adding the ATS backup feature to the ACS system of Conrail locomotive units involved the installation of a H-5 relay air valve and 3/8-inch outside diameter (o d) copper tube air lines connecting the H-5 valve to the existing NM-1 reducing valve of the ACS system, as well as to the existing No 10 air line (connecting the 110-cubic inch reservoir to the P-2-A brake application valve of the automatic air brake system) and the No 26 air line (connecting the automatic brake valve with the P-2-A valve) (See figure 10) The newly installed H-5 valve and the copper tubing connections were located in a noninsulated compartment under the floor of the operating compartment

Because of concerns that frozen condensation or other foreign matter might foul the relay air valve and prevent the operation of the alerter and penalty brake application feature, a third inspection of CR 6331 was performed at the request of the FRA When freon was applied liberally to the relay air valve, it would stick in either the open or closed position at subfreezing temperature, but the valve would function properly at above freezing temperature With the valve removed and torn down, 1/2 ounce of water was found in the valve port connected to the No 26 line Also, an indication of "rust or sludge" was found at that location A small crescent-shaped sliver of metal also was found in the valve port connected to the NM-1 valve According to the test report, the No 26 line connection was blown out, but " no appreciable amount of water (was) detected" in the line The report of the test does not indicate that the No 10 air line connection or the NM-1 valve connection was checked for foreign matter

According to experts at the Westinghouse Air Brake Company (WABCO), blockage of the No 10 line or NM-1 valve connections to the H-5 valve caused by frozen condensation or other foreign matter would prevent operation of the electronic alerter and penalty brake application feature of the ACS/ATS system A controlled test witnessed by Safety Board's investigators was conducted at the WABCO facility on April 20, 1988 About an ounce of water was placed in the valve port to which the No 10 air line connection was attached After the valve was placed in a cold box with constant temperature of 25° F for 24 hours, it functioned properly, that is the penalty brake application was not prevented by ice in the valve

Effect of Irregular Work Shifts and Sleep Deprivation

Dr Donald I Tepas, an expert on shiftwork stress and sleep research,[23] testified at the Safety Board's public hearing on the effects of sleep deprivation and unpredictable and irregular work/rest cycles According to Dr Tepas, research during the past decade has yielded dramatic findings relating to the interaction between work schedules and life Studies of industrial workers have shown that people who work irregular shifts sleep less and more frequently report sleep problems

[22]Actual recorded temperatures at the times and locations cited by the engineer ranged from 21° F to 25° F according to the Man-Computer Interactive Data Access System (MCIDAS)

[23]Dr Tepas is a Professor and Director of the Division of Industrial and Organizational Psychology at the University of Connecticut, U S representative on the Scientific Committee on Shift and Night Work of the International Commission on Occupational Health, and a consultant to the Technical Committee on Unusual Workshifts of the American Industrial Hygiene Association

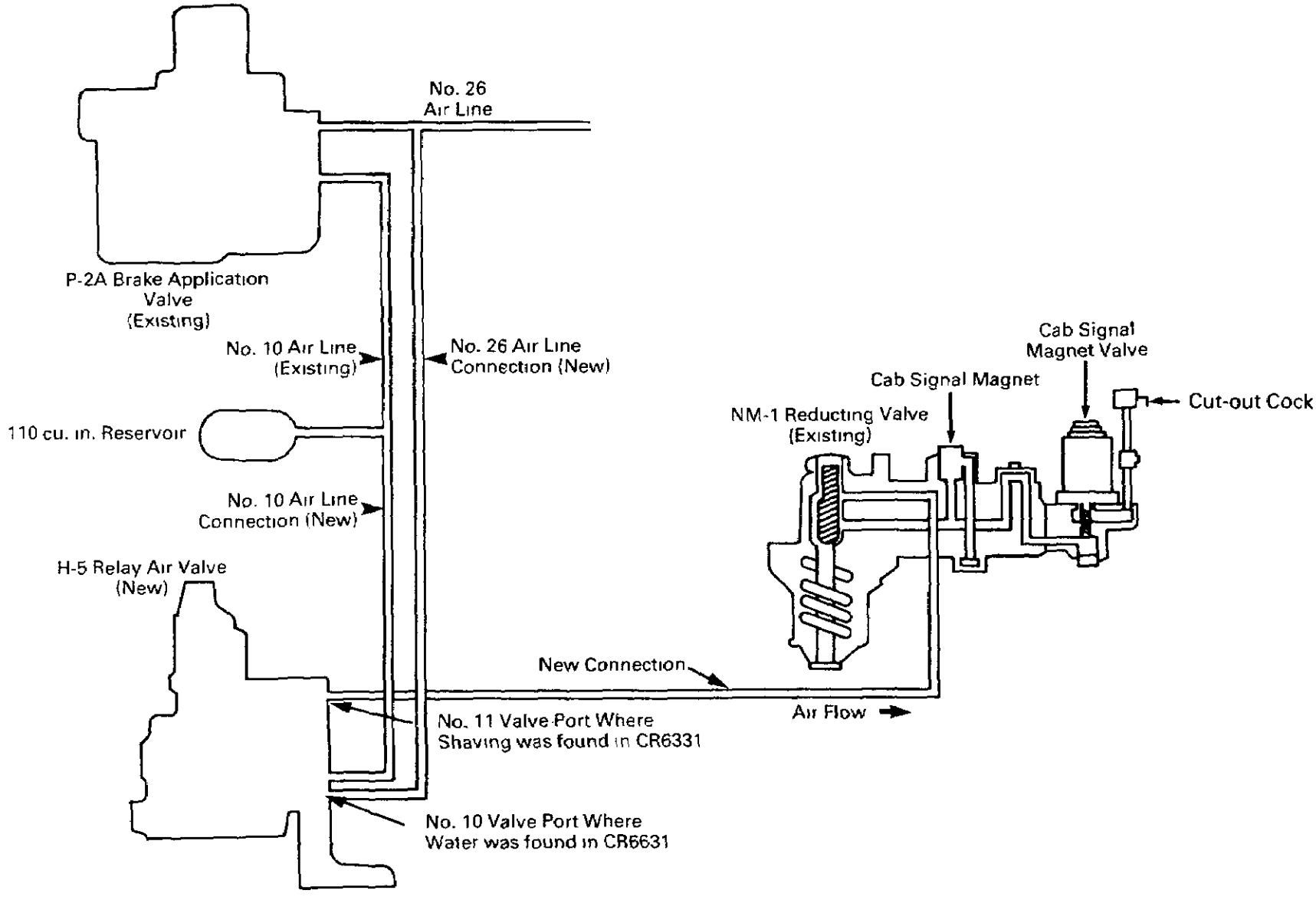

Figure 10.--Schematic diagram showing additions and modifications to the ACS system of Conrail locomotives in adding the ATS feature

than people who work regular daylight shifts According to Dr Tepas, people never adapt to irregular shifts, and, in the long run, people who work irregular shifts typically exhibit decrements in job performance, life characteristics, and physiology Moreover, these problems are exacerbated with persons who work unpredictable shifts Because people do not make up lost sleep, such workers have been shown to have increased susceptibility to chronic sleep deprivation which they usually do not recognize unless they have had specialized training Dr Tepas also testified that chronic sleep deprivation results in fatigue, frequent microsleeps [24] or lapses, and napping

He stated that the frequency and duration of such lapses increases as a person becomes more chronically sleep-deprived Moreover, he said that the individual is often unaware of the onset or the end of microsleeps and later may also be unaware that they had occurred Nevertheless, according to Dr Tepas, the person is asleep during the lapse Just before and just after the lapse, the person will perform quite well, during the lapse, he does not perform at all and will not respond to external stimuli unless they are massively sensory in nature, very unusual, or particularly meaningful

According to Dr Tepas, workers subject to nonsystematic and unpredictable changes in their work shift are highly susceptible to variations in alertness and consciousness that are associated with their circadian "body clock," which is typically at its lowest ebb roughly between 1 a m and 7 a m Moreover, they are highly susceptible to adverse environmental conditions that tend to promote sleep. Dr Tepas identified as such potentially adverse conditions the continuous rhythmical motion and sound associated with a laboring locomotive, extremes of temperature, and job duties that are highly repetitive, boring, and monotonous over a relatively long span of time

Dr Tepas cited studies made in Japan, France, Sweden, and Mainland China that have yielded objective quantitative data on traincrew job performance These studies revealed documented instances when entire traincrews have fallen asleep on the job, even when they were aware that their physiological and behavioral responses were being recorded and observed

A sleeping person can discriminate sounds, muscle tone is well-maintained during at least the first hour of sleep, and a person can perform reflex actions without thinking according to Dr Tepas He testified that, "In all stages of sleep, it is possible for people to make simple, discriminative responses to simple stimuli " As an example, he cited the common ability to turn off an alarm clock while asleep without remembering having done so He also cited the fairly complex behavior demonstrated by sleepwalkers After hearing the alerter warbler and operating the acknowledging pedal used on Conrail locomotives, Dr Tepas stated that an experienced engineer could operate the pedal in response to the alerter while asleep without being aware that he had done so He further stated that to arouse an engineer from a microsleep or nap, the locomotive alerter and acknowledging devices should include action that requires thought on the part of the engineer and that is more complex than a simple motor response

According to Dr Tepas, controlled research studies of U S industrial workers have clearly demonstrated that workers who do not have special training in self-monitoring are not reliable judges of the effects of fatigue (or environmental factors) on their workplace performance

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[24]Dr Tepas described a microsleep as a period of sleep lasting from a few seconds to minutes and from which the person awakens spontaneously

The Safety Board's investigations of two 1984 train collisions on the Burlington Northern Railroad (BN) in Colorado and Wyoming determined that irregular work/rest cycles and employees' voluntary sleep deprivation were causative factors in both accidents [25]

In 1987, the BN expanded the scope of its employee assistance program (EAP) to include a stress-management educational workshop This self-help program, which is being offered to employees and their families around the system, is designed to raise the level of awareness to various stress factors including sleep, diet, and exercise According the the EAP director, the stress-management workshop has been well-received by employees and their families, and evidence indicates that it has brought about significant cultural changes within the BN management organization

In September 1988, the BN's medical and safety departments with the assistance of a consultant, initiated a sleep deprivation seminar on an operating division in Nebraska Also oriented toward employees and their families, this trial study program is designed to help employees cope with irregular work schedules and to avoid sleep deprivation As far as the Safety Board has been able to determine, this is the first such program to be undertaken by a major American railroad system It has been endorsed by the Brotherhood of Locomotive Engineers According to BN's vice president of human resources, the irregular work/rest cycles with which most train service employees must contend is a very serious problem and one that the railroads must find ways to alleviate He stated that, in his view, BN may eventually have to abolish its extra boards and provide regular working assignments for all traincrews

During the Safety Board's public hearing, Conrail's senior vice president-operations was asked his opinion concerning the irregularity and unpredictability of train crew work shifts He pointed out that during the early 1950's he had worked for about 3 years as a brakeman and was always able to accommodate himself with the "odd hours " He added that, " if you like this work, you stay with it, and if you don't, you find some other source of employment "

Although Conrail has an EAP program that is under the aegis of its chief medical officer, this program does not provide education or counseling to assist employees in developing desirable sleep, dietary, and hygiene regimens When queried on the point, Conrail's chief medical officer stated that he thought that expanding the EAP program to provide such assistance might be highly desirable and beneficial

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[25]Railroad Accident Report--*Head-on Collision of Burlington Northern Railroad Freight Trains Extra 6714 West and Extra 7820 East, Wiggins, Colorado, April 13, 1984*, and *Rear-end Collision of Burlington Northern Railroad Freight Trains Extra 7843 East and Extra ATSF 8112 East Near Newcastle, Wyoming, April 22, 1984* (NTSB/RAR-85/04)

ANALYSIS

Events Preceding The Accident

Because of a track occupancy indication on track 2 between CP Port and CP Thompson, it was necessary for the "A" desk dispatcher to route all trains over track 1 between those interlockings until the cause could be determined and corrected Such occupancy anomalies were common, particularly in very cold weather, such as existed on the morning of the accident Moreover, the CATD system was designed to give the dispatcher optimum flexibility in moving trains over the busy main line between Altoona and CP Banks With closely spaced interlockings, each with remotely-controlled crossovers, dispatchers frequently routed expedited trains around slower-moving or disabled trains

The dispatcher experienced no difficulty in requesting and receiving the route for train LMPI-3, or in re-requesting the route for following westbound train TV-61 LMPI-3 encountered no problems in traversing the track 1 route between CP Port and CP Thompson The appropriate crossover switches, including switch 1E at CP Thompson, were reversed for crossover movement and the interlocking and cab signals were properly displayed After LMPI-3 cleared the crossover at CP Thompson, the crossover switches were left in reverse position; all of this information was confirmed by the CATD computer log

A review of data yielded by train TV-61's locomotive event recorders established that the train's engineer had been carefully complying with the requirements of the signals and timetable speed restrictions Approaching CP Port, the engineer reduced the speed from 58 to 40 mph through gradual throttle reduction to idle, without braking The train, which was slightly more than a mile long, passed completely through the crossover at CP Port at precisely the allowable 40 mph, and it did not accelerate until it was well clear of the interlocking Later, the engineer properly complied with the 50-mph restriction just west of CP Port and had his train safely under the 55-mph restriction through the curves between mileposts 142 and 143

Ahead at CP Thompson, the engineer again would have to slow TV-61 down to 40 mph, and the Safety Board believes that it is reasonable to assume that he again intended to rely on the technique of gradual throttle reduction, avoiding braking altogether, to do so He had done this successfully from 58 mph approaching CP Port; he was unlikely to have trouble doing it from 53 mph approaching CP Thompson The engineer began reducing throttle even before reaching distant signal 1421W, which should have been displaying "approach limited" until the locomotive passed it The "approach limited" aspect informed the engineer that switch 1E and its opposite number on track 2 were correspondingly reversed for his train to cross back to track 2

At 7:53:37 a m , shortly after the locomotive of TV-61 passed signal 1421W, the cab signal in the lead unit should have changed from "approach medium" to "restricting" as a result of train UBT-506 running through switch 1E and causing the track code to drop to zero At this time, the engineer of TV-61 should have immediately received the audible alarm from the ACS alerter which he had to acknowledge within 8 seconds, at most, to avoid a full-service penalty brake application from the ATS feature Considering the engineer's careful attention to speed restrictions previously, the Safety Board believes he must have acknowledged the alerter because the event recorder data shows no full-service brake application being made at any later time

The Safety Board also believes that since the engineer had just passed a more favorable wayside signal indicating the route ahead was set up for his train, he must have been aware that the cab signal had changed to "restricting" and that some totally unanticipated event had suddenly occurred Considering that the temperature was under 10° F at the time, it is entirely conceivable that a rail had broken or a rail weld had pulled apart in the block the train had just entered It is

unlikely that the engineer ever considered the possibility that another train had entered the other end of block Even so, the possibility of a break in the integrity of the track ahead posed a very real danger to his train

In any event, the engineer of TV-61 was obliged under the requirements of the restricting cab signal to immediately reduce to restricted speed When the cab signal changed to restricting, the head end of the train was probably in or exiting the 2° 38' right-hand curve just west of signal 1421W With only 1/3 mile of tangent between the right-hand curve and a left-hand curve ahead and foliage on the inside of both curves, the engineer had, at the most, 2,000 feet of forward sight distance, which would progressively reduce until the train exited the next curve leading into the relatively long tangent through CP Thompson. The restricted speed rule allowed him only a speed from which he could stop the train in half the forward sight distance, no more than 15 mph in any event The Safety Board believes, however, that it is doubtful the engineer could have stopped the train from 15 mph in 1,000 feet, and that an even lower speed was required in the situation Moreover, the Safety Board believes that it was imperative that the engineer immediately employ maximum service braking to reduce speed as much as possible in the shortest possible time

Nevertheless, at least 20 seconds, perhaps longer, passed after the cab signal should have gone to "restricting" and before the engineer of TV-61 initiated braking action Even then, he first initiated dynamic braking and then made a minimum application of the train brakes He later increased the air brake application somewhat, but he never made a full-service application before putting the brake into emergency about 30 seconds after his initial brake application During the 50 odd seconds after the cab signal changed to restricting, the train's speed was reduced only by 8 mph, to 45 mph, whereas during the 30 seconds the train was in emergency braking, speed dropped from 45 to 31 mph

The Safety Board believes it is probable that the engineer of TV-61 did not put his train in emergency braking until it was far enough through the left-hand curve for him to see train UBT-506 approaching By this time, probably no more than 1/2 mile separated the trains, whereas when TV-61's cab signal should have changed to restricting, the trains were more than 2 miles apart If the engineer had promptly initiated full service braking to reduce speed in accordance with the requirements of restricted speed, he would have reduced the closing rate of speed and given his train more time to slow down Indeed, the Safety Board believes that the speed of TV-61 would have been reduced sufficiently to enable the engineer and his brakeman to have evacuated the train safely

The engineer's apparent hesitancy to reduce to restricted speed was seemingly out of character with his earlier adherence to the letter of the rules and restrictions He may have been mindful of the sticking brake which earlier necessitated stopping and delaying the train Perhaps he thought the problem might recur if he made a full-service application of the train brakes and that there would be no way to know for certain since the car with the problem was so far to the rear of the train that it could not be seen from the locomotive units

Another possible cause for the engineer's delayed response may have been reluctance born of Conrail's heavy emphasis on use of dynamic braking in lieu of using the air brakes to the greatest degree possible Most of the engineer's training and experience was accrued during the period when Conrail was increasingly emphasizing the decreased use of air brakes There were compelling reasons from the operational and maintenance cost viewpoints for such a doctrine However, the selection of dynamic braking supplemented by minimal service braking was a poor choice in a potential emergency situation

After leaving Altoona, train UBT-506 operated over what was generally a downhill, water-level grade, there were few stretches of ascending grade, and these were relatively short so that most of

the time the engineer could and probably did employ the fuel-saver device which reduced the power output of the trailing unit Cutting the fuel-saver in or out required the engineer to push an on-off switch The last location where the engineer would have been likely to have taken such action ended about 31 miles west of CP Thompson

For more than 2 hours after leaving Altoona, the engineer and brakeman of UBT-506 were subjected to the steady drone of the diesel engine in full throttle, as well as the sound and motion of the locomotive rolling over the track with little variation in speed As far as the Safety Board's investigation was able to determine, UBT-506 was never stopped, switched from the one track to the other, or otherwise delayed after leaving Altoona En route to CP Thompson, it averaged its maximum authorized speed of 40 mph

There was little that the engineer had to do that would help him stay alert and awake He and the brakeman were required by Conrail rule 34 to observe and call out the signal aspects However, based on its investigation experience, the Safety Board has found that train crewmembers rarely call out "clear" aspects, which were probably all that UBT-506 encountered between Altoona and the distant signal for CP Thompson Moreover, after the train left Altoona, there were no hotbox or dragging equipment detector radio transmissions to trains on track 1 These transmissions identified the detector location and the track being used by the train involved Since the transmissions could be heard on the console radio of a locomotive 25 to 50 miles away, and the detectors were 10 to 14 miles apart, the crew of UBT-506 could have reasoned that there was no eastbound train directly preceding them on track 1 Although there was no assurance that opposing trains were not using track 1, the engineer, who was monitoring and responding to the detector transmissions, may have assumed the way ahead was clear About 27 miles west of CP Thompson, UBT-506 cleared the Anderson detector and received a "no dragging equipment" transmission that the engineer completely and correctly responded to in 4 seconds, a strong indication that he was fully awake at the time

Aside from responding to the detector transmissions, observing signals, and controlling the speed of his train, the engineer also was obliged to sound the whistle for public road crossings Two miles closer to CP Thompson, the train reached the last public road it would have to cross at grade before reaching its destination Two detectors and two 35-mph speed restrictions that required action by the engineer were located beyond the crossing There is no question that the engineer responded, albeit tardily, to the first speed restriction at CP Lewis, 3 8 miles east of the grade crossing because the train was decelerated from 40 to 30 mph while it was entirely on a 0 46 percent descending grade The deceleration could only have been accomplished by braking action initiated by the engineer

At 7:29 a m , about 8 minutes and 4 1/2 miles after UBT-506 had begun its rapid deceleration at CP Lewis, the Shawnee hotbox detector emitted a "no defects" transmission to which the engineer apparently failed to respond Almost immediately after the Shawnee transmission, at 7 29 15 a m , another hotbox detector located about 1 1/2 miles east of CP Thompson reported "no defects" to westbound train LMPI-3 on track 1 The transmission was promptly and properly responded to by the LMPI-3 crew, this transmission was the first radio transmission to and from another train on track 1, other than his own, that the UBT-506 engineer could have monitored If he had heard and understood these transmissions, he should have perceived that an opposing train was on his track only 17 or so miles ahead The UBT-506 engineer would have had no way of knowing whether he was to be crossed over or stopped for the train, but he should have been aware that one of these two events must occur If such an event did not occur at CP Thompson, then it would have to occur at the next westward interlocking, CP Mifflin, which was now only 6 or 7 miles ahead Nevertheless, UBT-506 continued its acceleration from 30 mph that had begun about 3 miles west of the Shawnee detector, reaching about 46 mph when the train was within 1/2 mile of CP Mifflin about 7:38 a m

The Safety Board believes that after the UBT-506 engineer belatedly slowed his train for the speed restriction at CP Lewis, he probably fell asleep for a period of 10 to 12 minutes during which he apparently failed to respond to the Shawnee detector, probably failed to hear and comprehend the detector transmissions involving train LMPI-3, and failed to control the speed of his train However, the engineer apparently awoke by the time his train entered the last of the 35-mph curve restrictions at CP Mifflin because the train speed was again sharply reduced on a descending grade It is unlikely that this would have occurred without the engineer resorting to braking

Ten minutes after slowing at CP Mifflin, UBT-506 passed the Mexico dragging equipment detector where the engineer was again apparently asleep for he failed to respond to the detector transmission Also, he later failed to slow his train in response to "approach" wayside and cab signal aspects at signal 1461E, a "restricting" cab signal aspect at code change location CS-5532, and the "stop" aspect of home signal 2E The warbler alerter should have sounded at signal 1461E and the code change location If the warbler alerter failed to arouse the engineer and brakeman, the ATS feature should have stopped the train unless the engineer had been depressing and releasing the acknowledging pedal in each instance

Failure of the ACS/ATS System to Prevent the Accident

From the outset, the most enigmatic aspects of the investigation were the failures of the UBT-506 crew and the ATS feature of their locomotive, which was intended as a fail-safe backup for the crew, to prevent exactly this type of accident The Safety Board examined three courses that could explain the failure of the ATS· (1) the crew cut out or otherwise disabled the ATS apparatus, (2) a mechanical malfunction prevented an ATS-initiated penalty application of the air brakes, or (3) the ATS feature was entirely functional, but the engineer had acknowledged changes to more restrictive cab signal aspects without taking the actions required to comply with those aspects

In a letter dated August 31, 1988, Conrail contended that, "the only logical explanation [for the accident] is that the ATS device was cut out ;" Conrail provided no evidence to support its contention However, Conrail's contention is in conflict with the testimony of Conrail's chief mechanical officer and the Safety Board's findings

Considering the incidents which reportedly occurred after this accident, particularly the repeated loss of the ACS alerter and ATS function on unit CR 6331, the possibility that the ATS may have malfunctioned on unit 6265 cannot be dismissed Condensation can form on any metal surface, and it is not uncommon for water to collect within an air brake system At Thompsontown on the morning of the accident, it was certainly cold enough for condensation to freeze The compartment on unit CR 6265 containing the valves and their tubing connections was not protected against the cold. Nevertheless, postaccident inspection of the NM-1 valve determined that it contained no water, sludge, or other foreign matter Testing demonstrated that even introducing water into the H-5 valve and freezing it would not prevent a penalty brake application

Frozen condensation or blockage by other foreign matter in the 3/8-inch copper tubes connecting the H-5 valve with the No 10 air line and the NM-1 valve could prevent the NM-1 magnet valve from functioning. This would, in turn, prevent the sounding of the ACS alerter and the ATS penalty brake application. This manner of blockage may have occurred with unit CR 6331 since a metal shaving was found in the H-5 valve port that was connected to the NM-1 valve Condensation could collect on such shavings, freeze, and prevent the proper operation of the magnet valve A similar phenomenon might have occurred with CR 6265, but considering that problems with the ACS/ATS system have been thoroughly documented with only one of the more than 1,400 Conrail locomotive units that received the ATS modification, the Safety Board believes that the likelihood that this happened is extremely remote

Adequacy of Safety Backup Devices

The lead unit of UBT-506 was equipped with a deadman pedal that the engineer was supposed to keep depressed with his foot If he failed to do this, a penalty brake application would be automatically initiated that would stop the train However, the deadman pedal is an inadequate substitute for a state-of-the-art alerter that requires a recurring and relatively cognitive response from the engineer and provides an audible warning if he fails to respond Moreover, the deadman device can easily be defeated by placing a heavy object on the pedal, a practice the FRA 1987 Conrail safety assessment reported as being widespread and not uniformly discouraged Indeed, the engineer of UBT-506 had been cautioned against defeating the deadman when his superior concluded that the engineer intended to do so

Conrail has recognized the shortcomings of the deadman pedal and has undertaken a program to replace it with sophisticated alertness devices on all locomotive units In addition, all new locomotive units being bought have such devices instead of deadman pedals Nevertheless, the majority of Conrail locomotive units still have the pedals The Safety Board urges Conrail to expedite the retrofit program for completion at the earliest possible date

According to Dr Tepas, even if the engineer kept the deadman pedal depressed with his foot, as required, he could easily continue to do so while being asleep The Safety Board finds it inexplicable that Conrail continues to rely on the outmoded deadman device that is so easily defeated and, if not defeated, compels the engineer to remain at his seat at all times, unable to move about the operator compartment, or otherwise relieve the monotony of his job Although Conrail reports it has undertaken a program to phase out the deadman devices in favor of state-of-the-art alerters that cannot be defeated, the Safety Board believes that this program should be expedited for the earliest possible completion

After viewing a demonstration of the alerter and the ACS/ATS acknowledging pedal, Dr Tepas concluded that it was possible for the engineer to respond to the audible alerter by depressing and releasing the pedal in his sleep Conrail, and the rail industry in general, need to modify the pedal or replace it with a sophisticated alertness device so that the action required by the engineer is more cognitive than a simple reflex motor response

Alertness of the UBT-506 Crewmembers

Even if the ACS alerter and ATS system malfunctioned, an alert crew should have observed and complied with the wayside signals which postaccident testing established to be functioning properly Moreover, a failure of the alerter and ATS function would not prevent the proper display of the cab signals As demonstrated by the engineer of CR 6331, who repeatedly observed and reported the fact that his cab signals changed to more restrictive aspects without the alerter sounding, an alert crew is not totally dependent on the alerter and the ATS functions The Safety Board believes that there is ample evidence to support the conclusion that the crewmembers of UBT-506 did indeed fall asleep some time before their approach to CP Thompson

The Safety Board believes that the engineer of UBT-506 responded to the ACS alerter when the cab signals changed to more restrictive aspects at distant signal 1461E and code change location CS-5532, even though he may have been asleep at the time According to Dr Tepas, individuals in all stages of sleep can make a well-developed, simple motor response to external stimuli. He also stated that the act of depressing and releasing the floor-mounted acknowledging pedal of a Conrail locomotive by an engineer who is conditioned to hearing and responding to the alerter would fit the parameters of that conclusion This, Dr Tepas said, would be particularly so if the engineer was in the habit of resting his foot against the pedal.

The brakeman of UBT-506 had a long record of violation-free service and a reputation for "never, ever sleeping on the job " He was highly regarded by his fellow workers and supervisors. The Safety Board's investigation left little doubt that the brakeman was a conscientious worker It is unlikely that he would have idly observed the engineer fail to respond to the detector transmissions and restrictive signal aspects without taking action if he were awake and alert Aside from observing and calling the signal aspects, the brakeman had no other duties to help him stay awake Under the circumstances, the Safety Board believes that the brakeman must have inadvertently dozed off even before UBT-506 reached the Shawnee detector Thereafter, he, too, may have had brief periods of wakefulness between naps, but not at the critical times when responses were required

By riding the trailing unit of UBT-506 and isolating himself unnecessarily from the other crewmembers, the conductor had removed himself completely from what little required activity there was on the lead unit He also ignored his responsibility to ensure that the other crewmembers complied with the requirements of the rules and timetable Although Conrail allows its conductors to ride on trailing units, at least on the Allegheny Division, it also places them in charge of their trains To discharge their responsibility under Conrail rules and to be fully cognizant of what is happening, conductors need to be on the lead unit where they can observe the cab signals and hear the ACS alerter The Safety Board does not understand this dichotomy in Conrail management policy

Of course, even when on the trailing unit, the conductor did not have to be totally unaware of what was and was not being done He should have continuously monitored the radio, had he done so, he would have realized that the engineer failed to respond to the last two detector transmissions He should have monitored the engineer's compliance with the wayside signals The wayside signals were generally about 2 miles apart, and to see them, the conductor had only to turn around every 3 minutes or so Nevertheless, the conductor stated that he did not observe the last five signals the train passed before it reached CP Thompson

After leaving Altoona, the conductor was not compelled to remain on the trailing unit at all times He could have gone forward to see if all was well on the lead unit Failing to do this, he could have communicated with the other crewmembers by radio To have done these things would have helped him and the others stay awake However, he never took either action The Safety Board is not convinced that the conductor was, as he testified, awake and alert at all times, particularly during the last 30 critical minutes preceding the accident

Although postaccident toxicological testing detected a residual trace of the marijuana metabolite in the UBT-506 conductor's urine, the metabolite was not detected in his blood It was not possible to determine whether the conductor had used marijuana or had been in the presence of a marijuana user in the recent past, but given the low value of metabolite in the conductor's urine, it is improbable that he may have been impaired by marijuana before the accident The other train crewmembers in the accident were judged to be free from impairment by alcohol or drugs before the accident

Work and Rest Patterns of UBT-506 Crewmembers

During the 90 days preceding the accident, the engineer took a week of vacation, was off on the usual holidays, and worked 57 tours of duty Other than the vacation, he worked every tour of duty that was available to him An individual working a straight 5-day, 40-hour week who took a week of vacation and was off on holidays, would also have worked 57 days during the same period Excluding several short "deadhead" tours when the engineer performed no duties and was simply transported from one place to another, his average tour of duty was slightly longer than 9 hours.

That, too, would be about average for the typical 40-hour, day worker Additionally, the engineer spent an hour or so each working trip commuting from or to his home, but that was scarcely out of the ordinary for people holding jobs anywhere The brakeman's work regimen was similar to that of the engineer, except that he spent a little less time commuting He, too, rarely lost an opportunity to work

Beyond the overall amount of time the engineer and brakeman had to devote to their jobs, there was no similarity between their work/rest cycles and those of a typical day worker Most striking was the utter lack of regularity and predictability in their work shifts and rest periods Whereas a day worker who regularly is on the job between 8 a m and 5 p m , Monday through Friday, and is off every weekday for 15 hours and every weekend for 63 hours, the engineer was off anywhere from 12 1/2 to 112 hours at a time and averaged more than 48 hours between work shifts when at home Away from home, the average rest period was much shorter, almost the same as that of the day worker However, the amount of time off was never uniform, the spread was from 8 to 30 hours

When at home, the engineer and brakeman never could be certain when they would have to return to work In 29 tours of duty beginning at Conemaugh, the engineer had 26 different reporting times--8 between 8 a m and 4 p m ; 14 between 4 p m and midnight, and 7 between midnight and 8 a m Away from home, the engineer's reporting times were just as unpredictable At Harrisburg, he was called at 26 different times of the day for 28 trips He worked every day of the week, most frequently on Mondays, Wednesdays, and Fridays, but he did work six Saturdays and four Sundays during the 90-day period

Based on the testimony of Dr Tepas, the engineer and brakeman could never adapt to this nonsystematic pattern of work times, and they were probably highly susceptible to variations in alertness and consciousness associated with their body clocks, adverse environmental conditions that tend to promote sleep, such as rhythmical motion and sound, and repetitive and monotonous job duties Also, they probably were susceptible to sleep disorders and chronic sleep deprivation resulting in fatigue, frequent microsleeps or lapses, and napping According to Dr Tepas, they were unlikely to have recognized the sleep disorder and never made up their lost sleep

The wives of the UBT-506 crewmembers all worked daytime jobs with regular hours, and it was around these jobs and the daily regimen of the children, in the case of the engineer, that the family routines revolved The investigation established that upon returning from work, the crewmembers would immediately fall into their family routines

The crewmembers ate at the usual times, slept at night, engaged in family activity in the evening, and otherwise lived "normally " If the crewmembers were not called to work for a protracted time, which was almost always the case, they would get one, two, or more nights of sleep. If their next call to duty came late in the day, they probably got little or no rest until after they arrived at Harrisburg In the engineer's case, he reported for duty between 4·30 p m and 7.30 a m on 21 of the 29 occasions he worked out of his home terminal during the 90 days preceding the accident Considering that he was called 3 hours before his reporting time, he probably went to work deprived of sleep to at least some degree in each of those 21 instances In some, he probably had no meaningful sleep for 24 hours or longer by the time he had completed his trip to Harrisburg

The testimony of the UBT-506 conductor was probably instructive as to how train crewmembers typically deal with the unpredictable nature of their work He said he normally went to bed between 11p m and 11·30 p m., and slept 8 hours He also said that he needed a minimum of 4 to 5 hours sleep to feel rested, but could get by one night without sleep Even though he knew well in advance that he would probably have to work some time during the night preceding the accident,

he made no effort to get adequate sleep by retiring early The Safety Board believes that, under the circumstances, it would not be surprising if, at 6 a m or so on the morning of the accident, the conductor was seriously fatigued, particularly since his body clock was still at low ebb Alone on the trailing unit without any compelling duties to keep him busy, it would be easy for him to submit to his fatigue by taking a nap

The engineer and brakeman also probably understood they might be called out on the night before the accident, yet neither departed from their custom of going to bed in the evening The brakeman was long conditioned to going to work at any time of the day or night, but from the standpoint of fatigue, he may have been worse off than the other crewmembers. During the 40 hours preceding the accident, he probably had little more than the 1 1/2 to 2 hours bed rest he got before being called to work The night before, he probably managed to get some sleep while sitting with his terminally-ill mother

The engineer had about 1 1/2 hours of bed rest and a 1-hour nap in the 24 hours or so before the accident, although it is questionable that he actually obtained 2 1/2 hours of meaningful sleep in the process The Safety Board believes that this sort of behavior may have been typical, not only of this crew, but of other crews on the Allegheny Division and elsewhere on Conrail and other railroads As Dr Tepas observed, it is probably not so surprising that the crew of UBT-506 fell asleep and allowed their train to overrun the interlocking at CP Thompson as it is that similarly caused accidents are not more commonplace

Management and Union Attitudes

As pointed out in the Safety Board's 1985 report of the Burlington Northern collisions in Colorado and Wyoming,[26] railroad train crews are confronted by the most uniquely unpredictable work/rest cycles in the transportation industry Moreover, there is probably little that is even remotely comparable in other industries To some degree, unpredictability in work schedules has been generally characteristic of the railroad industry since its inception However, in the past when there were many scheduled passenger and freight trains, as well as large numbers of yard and local freight runs, that had regularly assigned crews, most of the irregular and unpredictable work fell to local extra boards staffed by younger employees with low seniority The past 20 to 30 years have brought sweeping changes to the industry, not the least of which have been wholesale elimination of passenger trains, yard operations, scheduled freight trains, and a proliferation of crew pools and division-wide extra boards.

Additionally, larger American railroad systems, such as Conrail and BN, are the result of the mergers of many smaller systems within the past 30 years As a result of these mergers and competitive forces, many duplicate operations have been eliminated Because of management-labor agreements protecting employee seniority, this has resulted in widespread relocation of work assignments Also, railroads have eliminated many operating divisions resulting in changed reporting points and longer freight runs All of these changes have brought economic advantages to the railroads, and quite often, to the employees as well But, the Safety Board believes that neither railroad management nor the railroad unions have adequately considered the adverse impact that many of the changes have wrought on the working regimens of freight train crewmembers. Under present conditions, many train crewmembers may well work their entire careers without ever having a job with regularly assigned working hours and off-duty periods

The traditional "it goes with the territory" attitude of railroad management toward the unpredictable nature of train crew work was revealed succinctly by Conrail's senior vice president-

[26]Railroad Accident Report--NTSB/RAR-85/04

operations at the Safety Board's public hearing on this accident The Safety Board understands that freight train operations are subject to fluctuations in traffic, delays in transit, and work rules, and that attempting to return to a higher level of regularly assigned work shifts would be a major undertaking Nevertheless, as recognized by BN the situation demands far more than a simplistic "we lived with it, they can live with it or get out" analogy

In citing his own relatively brief experience as a young brakeman, the Conrail senior vice president failed to consider that many of his employees will have to cope with unpredictable work/rest cycles for their entire working lives, even into their 50's and 60's The Safety Board believes that Conrail and the rest of the railroad industry need to make an in-depth assessment of what can be done to restructure their cultural approach to train operations and work/rest cycles In the meantime, they can expand their training and counseling programs to provide sound advice to employees and their families on what constitutes good health and diet regimen, good behavior, and acceptable performance Such programs will need the endorsement and cooperation of the operating unions, particularly the Brotherhood of Locomotive Engineers and United Transportation Union In structuring the counseling programs, Conrail and the other railroads ought to take note of what is currently being done on the BN, the nation's largest railroad system

The Safety Board is particularly encouraged by the initiative BN has demonstrated in providing education and counseling to its employees and their families Particularly noteworthy, in the Safety Board's opinion, are BN's recognition of the scope of the problem, its efforts to change the traditional thinking of managers and to improve its operational format, and its willingness to undertake the pilot sleep-deprivation workshop The Safety Board is also encouraged by the Brotherhood of Locomotive Engineers' cosponsorship and cooperation in the BN programs. Hopefully, the United Transportation Union will also support these and/or similar efforts

Conrail's Medical Program

An area of concern to the Safety Board was the fact that a review of the most recent Conrail medical examinations of the six crewmembers involved in this accident, including three by fee-for-service physicians, revealed considerable disparity in the purview of the examinations Not all included EKG examination In the case of the TV-61 engineer, no urinalysis results were shown Although the TV-61 conductor declared he had difficulty hearing, and hearing deficiencies were evident from the audiometer test results, the medical examiner gave no opinion on the adequacy of the conductor's hearing The UBT-506 brakeman was allowed to go 15 months past his required physical examination date, during which time his hypertension was diagnosed and treatment was undertaken In this instance, also, the examiner gave his general impression of the brakeman as "abnormal" without giving a detailed basis for this finding

The Safety Board's investigation revealed that since its formation, Conrail has relaxed the medical programs and standards followed by its predecessor companies Mandatory company examinations are required less frequently, and even then, some employees manage to escape examination for protracted periods Conrail's full-time medical staff has been drastically reduced with greater reliance placed on fee-for-service private practitioners While Conrail reportedly makes efforts to familiarize them with its policies and procedures, the Safety Board believes it is unreasonable to expect doctors who occasionally examine and treat Conrail employees as a small part of their practice to understand the physiological implications inherent in railroad job duties and environments In any event, they can be expected to be less well-informed in this respect than doctors who exclusively deal with the railroad's employees

The motivation for requiring periodic company physical examinations has always been the fact that the safe operation of railroads demands a proper level of employee fitness Unless employees are seriously ill or injured, they cannot be expected to seek regular physical examination More

than ever, railroad employees should be subject to more stringent physical standards and regular, more comprehensive physical examinations by practitioners who understand what the employees do and under what circumstances they have to do it

Computerized Dispatching

Despite the fact that the "A" desk dispatcher was experienced, fully qualified, and had 3 1/2 years of "hands-on" experience with the computerized traffic control system, he failed to comprehend that UBT-506 had run through the crossover switch at CP Thompson, intruded into the route set up for an opposing train, and, consequently had collided with TV-61 Moreover, he retained a completely erroneous impression as to the relative locations of the two trains until repeated calls from the TV-61 conductor finally apprised him of the actual situation

The dispatcher's inability to recognize what had occurred was due to inadequacies in the design of the CATD system The Safety Board's investigation left little doubt that the system's primary function was to collect data, whereas its function of providing visual information to the dispatcher was secondary and marginally adequate at best

One serious weakness was the representing of the two signal blocks on each side of an interlocking by a single display circuit together with the displaying of a circuit as occupied until the train cleared the adjoining circuit Unless the dispatcher happened to be monitoring the CP Port-CP Thompson CRT screens when TV-61 entered the 1WAK circuit and saw the display for the circuit change from green to red, he had no way of knowing even the approximate location of the train At that time, all three circuits between the interlockings were displayed in red as being occupied by TV-61 The circuits embraced five blocks between signals with a total distance of 55,754 feet-- more than 10 times the length of TV-61 which could not have occupied parts of more than two signal blocks at any given time.

When UBT-506 intruded into the route set up for TV-61 at CP Thompson, the east leg and crossover segments of the 2TK circuit changed from green to red and the TV-61 symbol display moved to the 2TK circuit These were all events that would occur when TV-61 reached CP Thompson Both the 1WAK and 1EBK circuits remained displayed in red, as they could be expected to do. Had the system been designed so that the 1EBK circuit changed from red to white when it was no longer occupied, the dispatcher could have recognized that as long as it was still red, TV-61 could not be occupying the 2TK circuit Hence, the occupancy indication would have to be the result of some other phenomenon

Another system inadequacy which understandably misled and confused the dispatcher was the continuous red occupied display for the circuit west of CP Thompson, together with the unchanging blue display for the adjoining west leg segment of the 2TK interlocking circuit The latter represented track 1 between home signal 2E and crossover switch 1E Had this been represented by a discrete and separate track circuit that would have changed to red when UBT-506 entered it, the dispatcher would have recognized the incursion for what it was. Even so, the system needed some sort of audible and/or visual alarm to alert the dispatcher in the event he was preoccupied with one or more of the other screens he might have to monitor at the critical moment As it was, the display always indicated that UBT-506 was west, not east, of CP Thompson

The first visual sign of a problem was the change of the crossover and east leg segments of circuit 2TK from red to flashing red which occurred after UBT-506 cleared the interlocking just moments before the collision Because of frequent software problems, including false TOL occupancy indications and erroneous train symbol displays that created a lack of confidence in the system's reliability, the dispatcher and the technician were convinced that the flashing red signal indicated an "out-of-correspondence" switch display resulting from some malfunction within the system

The Safety Board believes that in its design of the Allegheny Division CATD system, Conrail failed to comprehend that a train crew might not comply with the signal system and intrude into an interlocking that had been aligned for the movement of an opposing train Moreover, Conrail failed to correct known problems with the software systems that provide information to the dispatcher, even after these were well understood and had been delineated in the FRA safety assessment Apparently, the Conrail systems department, both in its design of the CATD system and its response to demonstrated problems, was satisfied that the loss of the track code occasioned by undesired intrusion was sufficient to protect against a collision But neither the loss of the track code nor the addition of ATS to locomotives was sufficient to prevent the accident and the casualties that resulted from it Had the dispatcher immediately understood what had happened at CP Thompson, he may not have been able to arouse the crew of UBT-506, but he probably could have apprised the crew of TV-61 early enough for them to stop their train or at least to slow it enough for the engineer and brakeman to evacuate safely

Also potentially troublesome was the lack of redundancy in qualified personnel in the Altoona train dispatching office This was brought out by the "A" desk dispatcher's testimony that aside from a "couple of days a week," he could not eat his lunch or take a restroom break because he was too busy and no one in the office could step in and take over for him Even if he became ill on the job, the dispatcher would presumably have to continue to the end of his work shift The Safety Board believes that the continual stress of so demanding a situation could impact unfavorably on dispatchers' performance and the safety of train operations

Just as Conrail has failed to appreciate the impact of unpredictable work/rest cycles on traincrew performance, it apparently has allowed cost-factor considerations to impose an unreasonably harsh and stressful workload on its dispatchers The Safety Board believes such a situation is inconsistent with an enlightened human resource management philosophy The situation is probably not unique to Conrail, but may be relatively commonplace in the rail industry

In its investigation of a 1986 derailment of an Amtrak passenger train at Fall River, Wisconsin, the Safety Board cited a similar situation on the Soo Line Railroad [27] The dispatcher involved in the accident stated that his workload was so heavy that he frequently had to postpone restroom breaks for long periods According to Soo Line management, it was impractical and not a good business decision to provide relief for the dispatcher, although it was admitted that the dispatcher worked a safety-critical position As a result of its investigation, 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 of duty

In addition, the Safety Board recommended that the Federal Railroad Administration:

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[27]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)

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 daily 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

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 has not responded to Safety Recommendations R-87-65 and -66 Soo Line responded that it was studying ways to redistribute dispatcher workload but had not provided additional staffing requisite to affording dispatchers relief or break periods during their tours of duty On the basis of this response, the Safety Board has classified Safety Recommendation R-87-63 as "Open--Unacceptable Action "

Management and Supervision

The Safety Board notes that no supervisor was on duty at Conemaugh, an important main line reporting point, except on the first shift Although the Conemaugh supervisor testified that he often worked past his 2 p m quitting time, no one was on hand to monitor the condition of train crews reporting at night During the 90 days preceding the accident, the UBT-506 engineer reported at Conemaugh 21 times out of 26 between the hours of 4 p m and 8 a m Although these reporting times may not have been completely representative of all crews working into and out of Conemaugh, the Safety Board believes that it does suggest that a high percentage of crews at that point were not observed by a supervisor for fitness for duty

The Safety Board's investigation indicated that Conrail may have allowed aberrations as well in the strength of the Allegheny Division supervisory force and its relative effectiveness During the Chase, Maryland accident investigation,[28] the Safety Board learned that road foremen on the Harrisburg Division had an average of 20 engineers to supervise, on the neighboring Allegheny Division, the average per road foreman was 43 This disparity may account for the fact that Harrisburg Division road foremen were able to meet the requirement that they ride with engineers for their entire runs when evaluating their proficiency, whereas this was not being done on the Allegheny Division A road foreman or other supervisor rode with the UBT-506 engineer from Altoona to Harrisburg only once in the 3 years preceding the accident All other proficiency evaluation rides had been confined to the 14-mile section between Gallitzen and Altoona or for even shorter distances at Altoona proper

The Safety Board's investigation confirmed the FRA assessment's allegation that there was much duplication of testing with a high percentage of tests done on the basis of event recorder evaluations rather than "surprise" wayside observations on the Allegheny Division The Safety Board finds no fault with supervisors routinely evaluating event recorder printouts as long as this evaluation is only part of a comprehensive, safety-oriented approach to rules enforcement The

[28]Railroad Accident Report--NTSB/RAR-88/01

Safety Board is not convinced that 5,934 rule 285 signal tests could result in only a single failure being observed as long as the tests were conducted properly and the reported number of tests were actually made Certainly, the results of testing made in the presence of FRA inspectors bears out that contention

The Safety Board concurs in the FRA assessment that Conrail's systemwide CORPS program had permitted a high degree of autonomy to division-level supervision in the program's implementation without adequate management input and oversight If, as a result, and as the FRA assessment asserted, the Allegheny Division program had "degenerated into a numbers exercise," without regard to enhancing the safety of train operations, then the program had ceased to have real value The program's degeneration was especially probable since supervisors had no mandatory quota of tests that were highly critical to safety, such as were required on the Harrisburg Division, and the supervisors may have become primarily preoccupied with operational performance and economy

The sense that the Allegheny Division CORPS testing program and the general thrust of supervision had become misapplied is reinforced by the way signal tests were being performed The Safety Board found that most signal tests were focused on compliance with the rule 285 "approach" aspect without the logical following Rule 292 "stop" test The Safety Board believes that this misapplication is a strong indication that supervisors making the tests were loathe to stop the trains they were testing It may have been, in fact, the result of divisional or regional policy, and it is doubtful that this was not recognized and understood by the train crews

The Safety Board also believes that the delay in putting timetable instruction 132-1 into force on the Allegheny Division and elsewhere on the Central Region may be indicative of a local deficiency in the determination of priorities In light of the stated concerns of the FRA that the deadman device was widely being defeated by traincrews, and despite the fact that the device had failed to prevent the Thompsontown accident, nearly 1 1/2 months passed before the Allegheny Division responded to the rules department directive that the timetable instruction be issued system-wide

Another area of concern to the Safety Board was the abbreviation of air brake training and the great emphasis placed on the avoidance of using a train's air brakes on the Allegheny Division While this approach may deliver economies in equipment maintenance and avoidance of train delays, it should not be permitted to overshadow the need to maximize braking performance in a potential emergency The Safety Board believes that when the cab signals of train TV-61 changed to "restricting" shortly after the train passed a permissive signal indication, there should have been no question in the engineer's mind that a potential emergency existed and no hesitancy on his part to take the action necessary to reduce to a speed that would permit stopping the train in half his clear forward sight distance

Survivability and Crashworthiness

At a closing speed of approximately 71 mph, this accident was not survivable for the occupants remaining aboard the lead locomotive units of the trains Because the platform, or sill, height of lead unit CR 5017 of TV-61 was substantially higher than that of lead unit CR 6265 of UBT-506, CR 5017 was bound to have overriden CR 6265 upon impact. The impact force thus imposed on CR 6265 was far beyond the collision resistance of its superstructure Since the integrity of the operating compartment could not be maintained, it could provide no significant protection to its occupants

Although the engineer and brakeman aboard unit CR 5017 had no way of knowing what would occur at impact, the unit's operating compartment escaped serious damage and they probably could have survived the accident had they stayed in it They might have survived their attempt to

evacuate if the unit had been moving more slowly and they had more time to alight before the trains collided

Neither the dispatcher's delay in recognizing the nature and location of the emergency, nor the lack of coordinated local emergency planning impacted on the severity of the personnel casualties resulting from this collision

CONCLUSIONS

Findings

1 Because of a track problem, the "A" desk dispatcher had to route all trains over track 1 between CP Port and CP Thompson interlockings Since the dispatcher set up this route for TV-61 and other westbound trains, it was necessary to stop and hold UBT-506 west of CP Thompson interlocking

2 The crew of UBT-506 failed to comply with restrictive wayside and cab signals approaching CP Thompson and ran through the interlocking No effort was made to stop the train before it collided with TV-61

3 The wayside signal system and track circuitry for the cab signal system were free of defects and functioned properly at and approaching CP Thompson

4 The UBT-506 engineer failed to respond to the last two defective equipment detector transmissions west of CP Thompson because he had fallen asleep for intermittent and indeterminate periods Because he was asleep, he also failed to comply with restrictive signal aspects at and approaching CP Thompson

5 The TV-61 cab signal changed to restricting when UBT-506 entered the interlocking at CP Thompson Although the TV-61 engineer had meticulously complied with signal indications and speed restrictions previously, he failed to take immediate action to reduce to restricted speed As a result, he materially reduced his opportunity to mitigate the severity of the collision, as well as enhance his and his brakeman's ability to survive the accident

6 Because the automatic train stop feature did not require a cognitive acknowledging procedure, the UBT-506 engineer was able to prevent it from applying the brakes to stop the train by simply depressing and releasing the acknowledging pedal in his sleep

7 The lead unit of UBT-506 probably was in open-throttle operation at all times after the train left Altoona constantly producing a monotonous drone The train was never stopped and the engineer had few duties to help him stay alert and awake in such an adverse environment The brakeman was subjected to the same environment and had even less to do He did not take action when the engineer failed to respond to the detector transmissions and restrictive signals because he, too, had fallen asleep

8 The UBT-506 conductor did not observe the signals, monitor the radio, or otherwise ensure himself that the engineer and brakeman were awake and complying with the rules

9 Conrail's policy permitting the conductor to ride in other than the lead unit with all crewmembers of a freight train situated on the locomotive is inconsistent with the conductor's responsibility to oversee the engineer's compliance with the rules and instructions

10 The engineer and brakeman of UBT-506 were probably chronically sleep-deprived because their work shifts and off-duty periods at home were unpredictable and irregular As a result, the crewmembers customarily fell in with the normal work and living routines of their families, sleeping during the conventional night hours They did not try to get meaningful sleep beforehand whenever they could anticipate being called to work late in the day or at night but would try to get by without adequate sleep until they arrived at Harrisburg

11 None of the UBT-506 crewmembers had more than 2 hours of restful sleep during the 22 to 24 hours preceding the accident The brakeman may not have slept for more than 2 hours at any given time during the preceding 48 hours The crewmembers' sleep-deprived condition was compounded by the monotonous environment of the locomotive cab and possibly by their failure to eat a meal for at least 13 hours before the accident

12 The deadman pedal is an inadequate backup device because it can be defeated or kept depressed by a sleeping engineer. Had the lead UBT-506 unit been equipped with a state-of-the-art alertness device, the train would have been stopped and the collision would have been avoided

13 Frequent false track occupancy indications and software anomalies that caused improper video displays added to the dispatcher's workload, distracted him, and undermined his confidence in the computer-based traffic control system Although aware of the problems with the system, Conrail had not taken steps to alleviate them

14. The computer-assisted train dispatching system displays for CP Port and CP Thompson interlockings were inadequately designed because there was no discrete display circuit for the segment of CP Thompson interlocking between home signal 2E and crossover switch 1E, and there was no visual or audible alarm to inform the dispatcher when a train intruded into a route set up for an opposing train

15 Since the dispatcher continued to assume that UBT-506 was still west of CP Thompson on the basis of the video display and he thought that the flashing indication in the 2TK circuit was an anomaly within the circuit, he was unaware of the accident for more than 8 minutes after it occurred Even then, he learned of it only because the TV-61 conductor was able to use a radio to inform him directly

16 The lack of redundancy in qualified personnel in the Altoona dispatching office resulted in a continuously demanding and stressful workload on dispatchers that could impact unfavorably on their performance and the safety of train operations

17 The changing nature of railroad operations and competitive factors have materially increased the relative number of train crewmembers who must work irregular and unpredictable shifts on a long-term basis

18 Since train crewmembers lack the requisite training to recognize the condition, they may allow themselves to become chronically sleep-deprived and develop physiological problems that impact adversely on their performance Conrail and the other railroads need to recognize and deal with this probability by modifying their operations to reduce shift irregularity and by instituting educational and intensified medical examination programs

19 Conrail's medical department has relaxed its physical standards and examination requirements and has reduced its staff, increased reliance on fee-for-service physicians who may lack an understanding of train crew regimens and stresses will further degrade the qualitative value of the periodic employee physical examination

20 Conrail and the railroad operating unions have failed to adequately consider the effect of unpredictable work scheduling and the relaxation of medical standards and procedures Cooperative efforts are needed to reduce the element of unpredictability and to train and educate employees and their families about what constitutes proper fitness and performance

21. Although trains arrived at and departed from Conemaugh around the clock, the only supervisor there worked on the first, or daylight, shift As a result, a high percentage of the train crews were never observed or checked for their fitness for duty

22 Supervisors were not required to make a minimum number of compliance checks of many safety-critical rules, and much of the rules testing was through evaluation of event recorder printouts rather than wayside "surprise" checks This type of testing may not have been effective since failures were virtually nonreported, and the Conrail Operating Rules Promote Safety testing program on the Allegheny Division may have been little more than an exercise in numbers

23 If supervisory testing of proficiency, rules compliance, and fitness was inadequate and road foremen rarely rode with train crews, this may have resulted in a tendency on the part of crewmembers to go to work when they were sleep-deprived and fatigued since they were unlikely to encounter a supervisor on the job

24 Even had the collision occurred at a much lower speed, the lead unit of TV-61 would have overridden its counterpart on UBT-506 since it had a higher platform height As long as the UBT-506 unit was overridden, there was little chance for the survival of crewmembers in its operating compartment

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the sleep-deprived condition of the engineer and other crewmembers of train UBT-506, which resulted in their inability to stay awake and alert, and their consequent failure to comply with restrictive signal aspects Contributing to the failure of the crewmembers were their unpredictable work/rest cycles, their voluntary lack of proper rest before going on duty, and the inadequate alertness and acknowledging devices of the locomotive safety backup systems Contributing to the severity of the accident was the failure of the engineer of train TV-61 to adequately reduce the speed of his train in conformance with a restricting cab signal and the inability of the dispatcher to recognize the emergency because of the inadequacies in the computer-based traffic control system.

RECOMMENDATIONS

As a result of its investigation, the Safety Board made the following recommendations

--to the Consolidated Rail Corporation.

Expedite the current program for replacing the deadman safety control with state-of-the-art alertness devices (Class II, Priority Action) (R-89-8)

Redesign the cab signal acknowledging device to require action that is more cognitive than a simple reflex motor response and that cannot be performed by a sleeping engineer (Class II, Priority Action) (R-89-9)

Require road freight conductors to locate themselves on the controlling locomotive units of their trains, and enforce the provisions of operating rule 937 (Class II, Priority Action) (R-89-10)

Provide education and counseling to employees and their families on proper health and diet regimens, as well as the avoidance of sleep deprivation (Class II, Priority Action) (R-89-11)

Improve the current methods of utilizing train crews to reduce the irregularity and unpredictability of crewmembers' work/rest cycles (Class II, Priority Action) (R-89-12)

Provide train crewmembers with uniform periodic physical examinations that are based on reasonable standards and are consistent with current physiological findings and practices (Class II, Priority Action) (R-89-13)

Take action to ensure that fee-for-service physicians perform all test and evaluation requirements that are prescribed for periodic physical examinations for train service employees, and implement methods to review their examination reports (Class II, Priority Action) (R-89-14)

Correct the identified software anomalies in the Allegheny Division computer-assisted train dispatching system that result in improper train identification displays (Class II, Priority Action) (R-89-15)

Modify the computer-based traffic control system displays to provide discrete track circuits for the various segments of the interlockings and for the approach blocks, as well as audible and/or visual alarms when trains intrude into aligned opposing routes (Class II, Priority Action) (R-89-16)

Provide train dispatchers on all shifts with qualified backup relief, a mandatory lunch break, and at leat one additional break in each half of any 8-hour tour of duty (Class II, Priority Action) (R-89-17)

Amend the Conrail Operating Rules Promote Safety testing program priorities to ensure that the program is uniformly applied on all parts of the Conrail system (Class II, Priority Action) (R-89-18)

--to the Brotherhood of Locomotive Engineers and the United Transportation Union.

Cooperate with the Consolidated Rail Corporation and the other railroads in the implementation of voluntary education and counseling programs designed to improve train crewmembers' knowledge of proper health and diet regimens, as well as the necessity to avoid sleep deprivation (Class II, Priority Action) (R-89-19)

Cooperate with the Consolidated Rail Corporation and other railroads in the implementation of operational and crew utilization changes that are designed to alleviate and minimize the current irregularity and unpredictability of crewmembers' work/rest cycles (Class II, Priority Action) (R-89-20)

--to the Association of American Railroads:

Encourage its member railroads to improve their current methods of using train crews to reduce the irregularity and unpredictability of their work/rest cycles (Class II, Priority Action) (R-89-21)

Encourage member railroads to provide education and counseling to employees on proper health regimens and avoidance of sleep deprivation (Class II, Priority Action) (R-89-22)

Recommend to those member railroads with locomotive cab signal systems to evaluate their cab signal acknowledging devices and redesign those that could be operated through a simple motor response by a sleeping engineer (Class II, Priority Action) (R-89-23)

Also, the Safety Board reiterated the following safety recommendations to the Federal Railroad Administration:

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

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

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ James L. Kolstad
Acting Chairman

/s/ Jim Burnett
Member

/s/ John K. Lauber
Member

/s/ Joseph T. Nall
Member

/s/ Lemoine V. Dickinson, Jr.
Member

February 14, 1989

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The Safety Board was notified of the accident shortly after it occurred on January 14, 1988, and immediately dispatched an investigator from the New York field office The investigator-in-charge and other members of the Safety Board investigative team were also dispatched from Washington, D C Investigative groups were established for operational, track and signal, vehicle, human performance, survival and emergency response, and toxicological factors

Hearing

The Safety Board convened a 3-day public hearing as part of its investigation on May 11, 1988, at York, Pennsylvania Parties to the hearing included the Consolidated Rail Corporation (Conrail), the Brotherhood of Locomotive Engineers, the United Transportation Union, the American Train Dispatchers Association, and the Federal Railroad Administration Testimony was taken from 25 witnesses, and 63 exhibits were entered into the record

APPENDIX B

PERSONNEL INFORMATION

Train UBT-506

Engineer Melvin Russell Curry

Engineer Melvin Russell Curry, 40, was employed as a locomotive fireman by the Penn Central Transportation Company on May 12, 1969, and he was promoted to the position of engineer on November 1, 1972 All of his training was of the on-the-job variety

Mr Curry was last examined on Conrail operating rules on May 19, 1987, and he last passed a Conrail physical examination on April 30, 1986

Brakeman Francis Joseph Madonna

Brakeman Francis Joseph Madonna, 46, was employed as a trackman on a regional rail gang by the Pennsylvania Railroad on June 20, 1964 On March 8, 1965, he was transferred to the position of brakeman Mr Madonna was subsequently promoted to the position of conductor and was qualified as such at the time of the accident

Mr. Madonna was last examined on Conrail operating rules on March 30, 1987, and he last received the full Conrail medical examination on April 9, 1986

Conductor Jerry Lynn Haselbarth

Conductor Jerry Lynn Haselbarth, 33, was employed as a brakeman by the Penn Central Transportation Company on October 28, 1974, and he was subsequently promoted to conductor

Mr Haselbarth was last examined on Conrail operating rules on May 22, 1987, and he last received a Conrail physical examination on August 7, 1985

Train TV-61

Engineer Russell Paul Henderson

Engineer Russell Paul Henderson, 30, was employed by Conrail as a student fireman on June 30, 1976, was qualified as a locomotive hostler on September 1, 1976, and completed the engineer training program with promotion to engineer on March 15, 1978 Mr Henderson was last examined on Conrail operating rules on September 3, 1987

Brakeman Charles Stephen DeSantis

Brakeman Charles Stephen DeSantis, 56, was employed as a yard brakeman at Youngstown, Ohio, by the Erie Railroad on August 28, 1952 He was promoted to conductor on August 26, 1954, and became a Conrail employee on August 9, 1976, with seniority transferred to the Allegheny Division about 1983

On February 10, 1978, Conrail dismissed Mr DeSantis on a charge that he violated Conrail Rule G (prohibiting the use or possession of intoxicants, narcotics, amphetamines, and hallucinogens while on or subject to duty - see Appendix C) He was reinstated on June 1, 1978 Mr DeSantis was last examined on Conrail operating rules on September 18, 1987

Conductor Donald Leroy Hull

Conductor Donald Leroy Hull, 60, was employed by the Erie Railroad as a yard brakeman at Youngstown, Ohio, on February 16, 1953, and was promoted to conductor on February 13, 1955 He became a Conrail employee on August 9, 1976, and transferred his seniority rights to the Allegheny Division about 1986

According to Mr. Hull's service record, he was dismissed for violations of Conrail operating rules on October 31, 1977, and was reinstated without loss of seniority on November 4, 1977

Mr Hull was last examined on Conrail operating rules on June 22, 1987.

APPENDIX C

EXCERPTS FROM CONRAIL OPERATING RULES

Consolidated Rail Corporation

Rules of the Transportation Department

Revision No 3
Effective January 1, 1986

GENERAL RULES

G. The use of intoxicants, narcotics, amphetamines, or hallucinogens by employees subject to duty, or their possession or use while on duty, is prohibited

Employees under medication before or while on duty must be certain that such use will not affect the safe performance of their duties

Consolidated Rail Corporation

Rules of the Transportation Department

These rules govern the operation of the railroad owned and operated by Conrail These rules supersede all previous Operating Rules and instructions and must be observed by all employees whose duties are in any way affected by them They apply equally to Conrail employees and employees of other railroads while on Conrail property

Use of the male gender throughout this Book of Rules is for the sake of convenience and clarity only All rules apply equally to male and female personnel occupying affected job titles

Revision No. 4
Effective February 1, 1987

GENERAL RULES

A Employees whose duties are affected by these rules must maintain a copy and have it with them while on duty

Employees whose duties are affected by the Timetable must maintain a copy and have it with them while on duty

Employees must maintain a copy of the Safety Rules prescribed for their department

B Employees must be familiar with and obey all rules and special instructions If in doubt as to their meaning or application they must apply to the proper authority for an explanation

C. Employees whose duties require them to be qualified on the Rules of the Transportation Department and Timetable must pass required examinations These employees must be re-examined annually, or as required by proper authority

When reporting for examination they must present their copy of the Rules of the Transportation Department, Timetable and other instructions for inspection

When an employee passes a physical characteristics examination, the territory on which the employee is qualified must be shown on the qualified for service page of the employee's Timetable

E Gambling, fighting or participating in any illegal, immoral or unauthorized activity while on duty or on Company property is prohibited Card playing while performing service is prohibited

Reading other than Company instructions while performing service is prohibited

Sleeping or assuming the attitude of sleep when required to perform service is prohibited Use or possession of televisions, radios or similar devices other than those provided for railroad operations is prohibited when required to perform service

G. Employees reporting for duty or on duty are prohibited from having in their possession, using or being under the influence of alcoholic beverages or intoxicants

Employees shall not report for duty or perform service under the influence of, or use while on duty, any drug, medication or other controlled substance, including prescribed medication, that will in any way adversely affect their alertness, coordination, reaction, response or safety Questionable cases involving the adverse effects of prescribed medication shall be referred to a Company medical officer

The illegal use, possession or sale while on duty of a drug, narcotic or other controlled substance that affects alertness, coordination, reaction, response or safety is prohibited

An employee may be required to take a breath test and/or provide a urine sample if the Company reasonably suspects violation of this rule Refusal to comply with such requirement will be considered a violation of this rule and the employee will be promptly removed from service

DEFINITIONS

BLOCK A length of track with defined limits on which train movements are governed by block signals, block-limit signals, cab signals or verbal block indication

BLOCK SIGNAL A fixed signal, or hand signal in the absence of a fixed signal, at the entrance of a block to govern use of that block

BULLETIN ORDER Order issued by authority of and over the signature of the Superintendent which contains items affecting the movement of trains

CAB SIGNAL A signal located in the engine control compartment indicating a condition affecting the movement of a train, and used in conjunction with interlocking signals and with or in lieu of block signals

CONTROL STATION A place from which remote control signal appliances or switches are operated

CONTROLLED POINT (CP) A place where signals and other functions of a traffic control system are remotely controlled from the Control Station

DISTANT SIGNAL A fixed signal used to govern the approach to a home signal

DIVISION: That portion of the railroad assigned to the supervision of a Superintendent

FIXED SIGNAL A signal of a fixed location affecting the movement of a train

GENERAL ORDER Order issued by authority of and over the signature of the designated official, which contains changes in rules, Timetable or other instructions

HOME SIGNAL A fixed signal governing the entrance to an interlocking

INTERLOCKING: An arrangement of signals and signal appliances interconnected so that their movements must succeed each other in a prearranged sequence and for which interlocking rules are in effect

INTERLOCKING LIMITS: The tracks between the opposing home signals of an interlocking

INTERLOCKING SIGNALS The fixed signals of an interlocking

INTERLOCKING STATION: A place from which an interlocking is operated

MAIN TRACK A track designated by Timetable upon which train movements are authorized by a block signal system, or written authority

SIGNAL ASPECT The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train, the appearance of a cab signal conveying an indication as viewed by an observer in the engine control compartment

SIGNAL INDICATION The information conveyed by the aspect of a signal

SPEEDS

NORMAL SPEED	The maximum authorized speed
LIMITED SPEED	For passenger trains, not exceeding 45 MPH, *for freight trains, not exceeding 40 MPH*
MEDIUM SPEED	Not exceeding 30 MPH
SLOW SPEED	Not exceeding 15 MPH
RESTRICTED SPEED	Prepared to stop within one-half the range of vision, short of train, obstruction, or switch improperly lined, looking out for broken rail, but not exceeding 20 miles per hour outside interlocking limits, nor 15 miles per hour within interlocking limits Speed applies to entire movement

TRAFFIC CONTROL SYSTEM (TCS) A block signal system in which train movements are authorized by block signals, cab signals or both, for trains moving in either direction

Rule 281

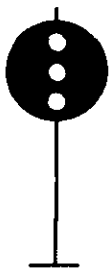


FIG A

FIG A 1

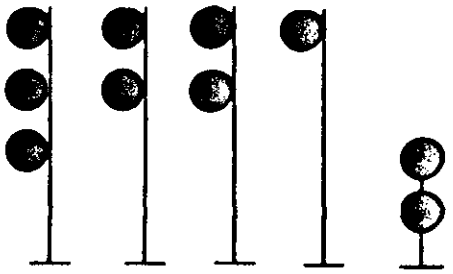


FIG B FIG B 1 FIG B-2 FIG B-3 FIG B-4

IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY

INDICATION: Proceed

NAME: *Clear*

4 Employees qualified on the operating rules and located on the leading engine or car must observe and then communicate to each other in an audible and clear manner the name of each signal affecting the movement of their train as soon as the signal becomes clearly visible After the name of a signal has been communicated, it must continue to be observed until passed and any change communicated in the required manner

When a train is two (2) miles from a temporary restriction, qualified employees located on the leading engine or car must immediately communicate with the engineer and confirm the requirements of the restriction

If train is not operated in accordance with the requirements of the signal indication or restriction, qualified employees located on the leading engine or car must communicate with the engineer at once, and, if necessary, stop the train

77 Employees must observe passing trains for defects Trains must be notified and stopped if observed with any of the following defects

(1) Hot Journal
(2) Sliding wheel
(3) Broken wheel
(4) Sticking brake
(5) Swinging door on freight car or trailer
(6) Open plug door
(7) Defective truck
(8) Dragging equipment
(9) Shifted lading over side or end of car

If attention is called to a dangerous condition, train must be promptly stopped, consistent with good train handling techniques, inspection made and train dispatcher notified If defects cannot be corrected, cars unsafe for movement must be set out and report made to train dispatcher, including location where waybill is to be left

132 Employees are prohibited from altering, nullifying, or in any manner restricting or interfering with the normal intended function of any device or equipment on engines, cars or other railroad property

Rules Governing Movement of Trains in Either Direction on the Same Track by Block Signals

261. On designated tracks specified in the Timetable, trains will operate in either direction governed by block signals

All **Rules of the Transportation Department,** except as modified by Rules 261 to 265 inclusive, remain in effect

Rule 281(B)

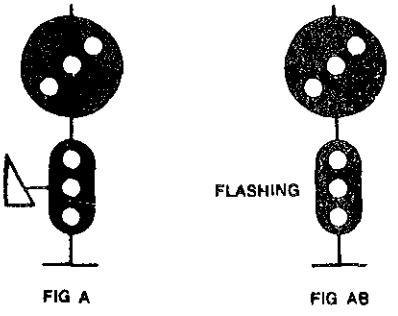


FIG A FIG AB

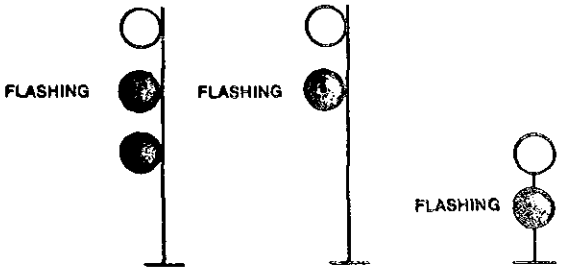
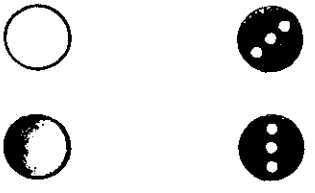


FIG B FIG B 1 FIG B 2

IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY



AND FIXED SIGNAL INDICATION WILL GOVERN

INDICATION: Proceed approaching next signal at Limited Speed which must not be exceeded until receiving a more favorable indication

NAME: Approach Limited

Rule 281(C)

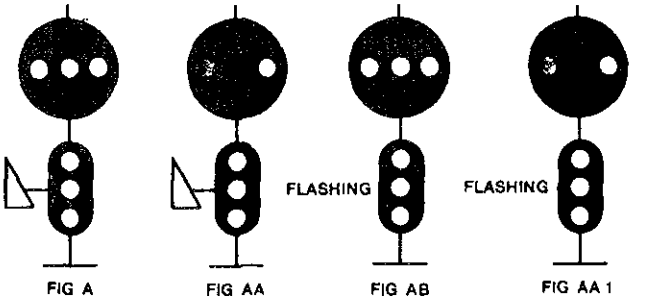


FIG A FIG AA FIG AB FIG AA 1

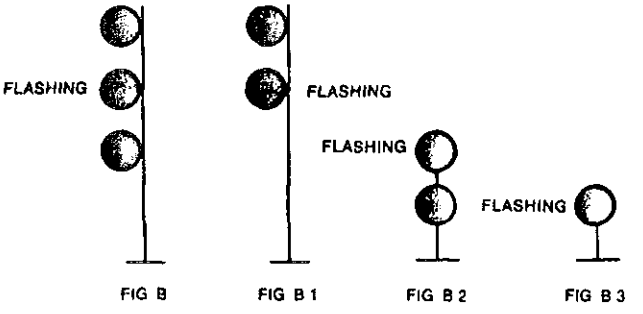
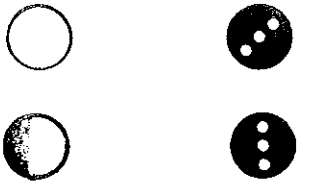


FIG B FIG B 1 FIG B 2 FIG B 3

IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY



AND FIXED SIGNAL INDICATION WILL GOVERN

INDICATION: Proceed; Limited Speed within interlocking limits and through turnouts

NAME: Limited Clear

NOTE: In cab signal territory, trains not equipped with operative cab signals must not exceed Limited Speed to next signal

Rule 285

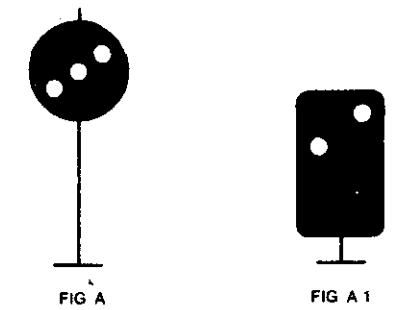


FIG A FIG A 1

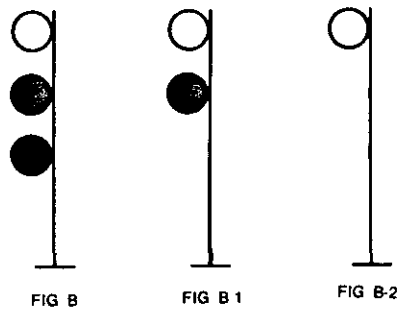


FIG B FIG B 1 FIG B-2

IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY

INDICATION: Proceed not exceeding Medium Speed prepared to stop at next signal. Reduction to Medium Speed must commence before engine passes Approach signal

NAME: Approach

Rule 290

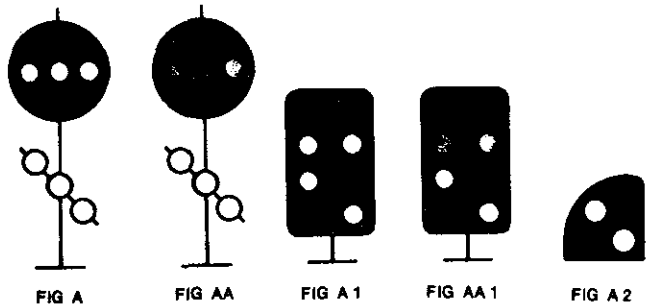


FIG A FIG AA FIG A 1 FIG AA 1 FIG A 2

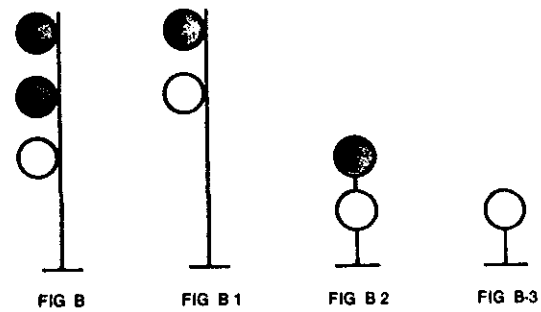


FIG B FIG B 1 FIG B 2 FIG B-3

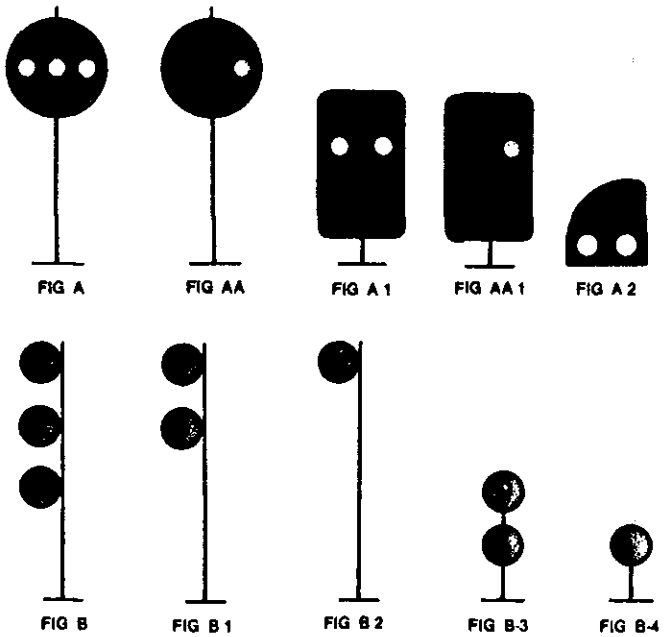
IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY

AND FIXED SIGNAL INDICATION WILL GOVERN

INDICATION: Proceed at Restricted Speed until the entire train has passed a signal displaying a more favorable aspect

NAME: Restricting

Rule 292



IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY

AND FIXED SIGNAL INDICATION WILL GOVERN

INDICATION: Stop

NAME: Stop Signal

CAB SIGNAL SYSTEM

NOTE: Rules 550 to 561 inclusive will be effective in territory designated by Timetable Special Instructions

550 The Cab Signal System apparatus on the engine must be tested at least once in each 24 hour period except when a single trip exceeds 24 hours, in which case the original test shall be valid for the entire trip The test must be made prior to departure of an engine from its initial terminal to determine if apparatus is in service and functioning properly When Cab Signal apparatus is cut-out or deenergized after departure test has been made, it must be tested again prior to entering equipped territory

When test of the Cab Signal System apparatus is made by an employee other than the engineer, the prescribed form stating that engine has been tested must be filled out in its entirety and accompany engine to its final terminal The engineer, when taking charge, must assure himself that Cab Signal System apparatus is energized and that the audible indicator will sound when acknowledging device is operated If the Cab Signal System has been deenergized or audible indicator fails to sound when the acknowledging device is operated, the engineer must inform the train dispatcher and must not enter equipped territory

551 The Cab Signal System is interconnected with the block signal system so that the Cab Signal must conform with the fixed signal indication within eight seconds after the engine passes fixed signal governing the entrance into the block in the direction for which the track and engine are equipped Engineer will be governed as follows

(a) When Cab Signal and fixed signal indications conform when entering the block and conditions affecting movement of train in the block change, the Cab Signal will govern

(b) When Cab Signal indication changes to Restricting, the engineer must take immediate action to operate train at Restricted Speed

(c) When Cab Signal indication changes from Restricting to a more favorable indication, speed must not be increased until train has moved a distance equal to its length

(d) If Cab Signal indication authorizes a speed different from that authorized by the fixed signal when the train entered the block, the lower speed will govern The engineer must notify the train dispatcher or operator by radio or by message as soon as possible without delaying the train, giving location and track on which nonconformity occurred

(f) The Cab Signal apparatus will be considered as having failed when

(1) The audible indicator fails to sound when the Cab Signals change to a more restrictive indication

(2) The audible indicator continues to sound although the Cab Signal change was acknowledged and speed of train has been reduced to speed required by the Cab Signal indication

(3) The Cab Signal fails to conform at two fixed signal locations in succession

(4) The Cab Signal displays "Restricting" while approaching a fixed signal displaying "Approach" or more favorable aspect, and the Cab Signal fails to conform after passing fixed signal

(5) Damage or fault occurs to any part of the Cab Signal apparatus

When Cab Signal apparatus has failed, or has authorized a speed greater than authorized by the fixed signal, the train will proceed governed by Rule 554 The engineer must notify the train dispatcher or operator by radio, when unable to report by radio, details must be rendered at first point of communication where stop can be made without excessive delay Upon arrival at the engine terminal, the engineer must advise the foreman or his representative and make written report on the prescribed form

554 The movement of a train equipped with Cab Signals not in operative condition for direction of movement is prohibited, except when Cab Signal failure occurs after leaving initial terminal The train may then operate at a speed not exceeding 40 miles per hour, governed by fixed signal indications The train dispatcher must be advised as soon as practicable

937 Conductors have charge of the trains to which they are assigned, and all persons employed aboard are subject to their instructions They are responsible for the prompt movement, safety and care of their trains, for the vigilance. conduct and proper performance of duty of train employees, and for the observance and enforcement of all rules and instructions

APPENDIX D

EXCERPTS FROM CONRAIL CENTRAL REGION TIMETABLE NO. 3

CONRAIL

TIMETABLE NO. 3

EFFECTIVE 12:01 A M , SUNDAY MAY 10 1987

CENTRAL REGION

R E GRATZ
General Manager
Pittsburgh, PA

W D MURPHY
R S PYSON
Regional Superintendents — Transportation
Pittsburgh, PA

Division	Division Superintendents	Located
Allegheny	G M SPIEGEL	Altoona, PA
Columbus	M A LOVE	Columbus OH
Pittsburgh	R N DAWSON	Pittsburgh, PA
Southwest	R L HOOVER	Indianapolis, IN
Youngstown	R N DAWSON	Pittsburgh PA

SPECIAL SPEEDS — TRAINS — ENGINES

		MPH	Note
	Maximum track speeds are shown on Station Pages and must not be exceeded.		
SP- 1	RESTRICTED SPEED — In the application of Restricted Speed, trains other than passenger trains must not exceed 15 miles per hour		
SP- 2	When a speed restriction is in effect at a CP or interlocking, the restriction applies between the extreme outer interlocking signals		
SP- 3	A Train Van (TV) is a train consisting entirely of equipment designed to carry trailers or containers and/or multilevel automobile carrying cars.		
SP- 4	Mail symboled trains will operate at speeds shown for TV Trains		
SP- 5	TV trains will operate at speeds shown for TV trains.		
SP- 6	TV trains consisting of 61 cars or more unless otherwise restricted	60	
SP- 7	TV trains having cars equipped with friction bearings (except cabooses).	60	
SP- 8	Unless otherwise restricted, Double Stack Equipment operated as a unit train		
	Up to 35 cars (175 platforms)	60	
	More than 35 cars	50	
SP- 9	Conrail inspection trains may operate at speeds shown for passenger or TV trains		
SP-10	(Allegheny, Pittsburgh, Youngstown Divisions) Symbolled freight trains except mineral, grain and trains with symbol beginning with the letter "W" may operate at speed shown for TV trains unless otherwise restricted		
SP-11	Grain Trains	40	
SP-12	Mineral Trains	40	
	Jenny type cars		
	In mineral trains, when loaded	40	
	In other than mineral trains when loaded	50	
	In any train when empty	50	
SP-13	Trains handling welded rail cars	40	
SP-14	Circus trains (speeds greater than 30 MPH may be authorized by the General Manager and as determined by the Clearance Bureau)	30	
SP-15	Revenue trains handling machinery of rotary or swinging type, such as cranes, derricks, steam shovels, etc , moving on own wheels		
	On straight track	30	
	On curves	20	
Note	Unless a greater speed is authorized by the Clearance Bureau		
SP-16	Passenger train assisted by an engine on rear and air brake controlled by leading engine	30	
SP-17	Pushing cars and air brake is controlled by pushing engine		
	Passenger cars	30	
	Freight cars	20	

(Continued)

9

PITTSBURGH LINE (W)

INT	INT STA	BLK & TO	BLS	STATION Distance from Philadelphia	MP	Sidings	Note
				(Eastern Reg.)(Harrisburg Div.)			
				HARRISBURG	104 6		
X	X	X★		HARRIS	104 8		
				★DED—2	106 4		
X				CP ROCKVILLE (Buffalo Line)	109 9		
				MARYSVILLE	112 0		
X				CP BANKS	113.2		2
				DIVISION POST (Allegheny Div.)	113 5		
				★DED—1 2 CS	116 0		
X				CP CANNON	118 9		
				★HBD—DED—1 2	122 6		
X				CP PORT	133 5		
				★HBD—DED—1 2	143 0		
X				CP THOMPSON	144 4		
				★DED—1 2	148 7		
X				CP MIFFLIN	153 7	31600 CS	
				★DENHOLM SCALES	155 8		
X				CP HAWSTONE	160 0		
				★HBD—DED—1 2	162 3		
X				CP LEWIS	165 7		
				LEWISTOWN	165 7		
X				CP LONG	168 8		
				★DED—1 2	172 3		
X				CP MCVEY	179 6		
				★HBD—DED—1-2	186 6		
X				CP JACKS	191 3		
				★DED—1 2	196 2		
				HUNTINGDON	202 3		
X				CP HUNT	202 4		
				★HBD—DED—1 2	206 7		
X				CP TUNNEL	212 9		
				★DED—1 2	216 3		
				TYRONE	222 1		
X				CP GRAY	223 3	47000 CS	
				★HBD—DED—1 2-CS	227 0		
X				CP ANTIS	232 4		
X				CP HOMER (Rose Connecting) — R Alto	234 0		
X				CP WORKS	235 7		
				ALTOONA	236 1	5000 CS	
X	X	X★		ALTO (Cove Secondary)	236 7		
X				SLOPE — R Alto	237 2		
				¶DED—2 3 W—E—LIGHT	240 7		
				¶DED—1 2-E—E—LIGHT	242 2		
X				MG	243 5		
				¶DED—1 2—E—E—LIGHT	246 2		
X				BENNY	246 3		
X				SF	247 2		
				GALLITZIN — R-AR	248 1		
X				UN	248 4		
X	X	X★		AR	248 4		
				★DED—0 1 2 3	250 4		
X	X	X★		MO (Cresson Irvona Secondary)	250 5		
				CRESSON	251 0		
				★DED—1-2 3	258 8		
				¶HBD—2 3—C	261 2		
X				W (South Fork Sec.) — R-SO	264 6		
X	X	X★		SO	266 1		
				★DED—1-2 3	269 5		
X				AO — R-C	271 2		
				CONEMAUGH	272 6		
X	X	X★		C	273 2		

(Continued)

13

SPEED — PASSENGER

Between:	Track No 1	No 2	No 3	No 4	Note
	MPH				
CP Trobe and CP Rade	70	70			
Except: 1st curve west of MP 322	60				
CP Rade and CP Traff	70	70			
Except: Curves at MP 328	50	50			
Curves MP 328.4 to MP 330.4	45	45			
CP Traff and CP Wing	70	70			
Except: All curves MP 337 to MP 339	45	55			
Curve west of Wilmerding	45	45			
CP Wing and MP 345	35	35			
MP 345 and CP Home	60	60			
Except: Wye tracks Home — 15 MPH					
CP Home and CP East Pitt	50	50			
Except: Curve at East Liberty	35	40			
MP 349 to MP 350	40	40			
Curve west of MP 350	35	35			
1st and 2nd curve east of MP 351	30	30			
Curve west of MP 351	35	35			
CP East Pitt and CP Pitt	30	30			
CP Pitt and CP West Pitt	15	15			
Controlled Siding — 15 MPH					
Against Current of traffic unless other specified				50	
Except: Alto and UN—AR				30	

SPEED — TV — FREIGHT — GRAIN — MINERAL

PITTSBURGH LINE	No 1 Track			No 2 Track			No 3 Track			Note
	TV	FRT	GM	TV	FRT	GM	TV	FRT	GM	
Between:	MPH									
Div Post Eastern Region and MP 119	50	50	40	50	50	40	CS Same As No 1 Track			
Except 1st and 2nd curves east of MP 119	35	35	35	35	35	35				
MP 119 and MP 121	50	50	40	50	50	40				
MP 121 and CP Port	60	50	40	60	50	40				
CP Port to MP 136	50	50	40	50	50	40				
MP 136 and MP 152	60	50	40	60	50	40				
Except: West portion of a curve between a point 2400 feet west of MP 138 and MP 139	50			50						
Curves at MP 142	55			55						
Curves MP 142 to MP 143	55			55						
Curve at MP 148	55			55						

(Continued)

14

SPEED — TV — FREIGHT — GRAIN — MINERAL

Between:	No 1 Track			No 2 Track			No 3 Track			Note
	TV	FRT	GM	TV	FRT	GM	TV	FRT	GM	
	MPH									
MP 152 and CP Mifflin	50	50	40	50	50	40				
Except: Curves MP 153 to CP Mifflin	40	40		40	40					
CP Mifflin and MP 159	50	50	40	50	50	40				
Except: 1st curve west of CP Mifflin	45	45		45	45					
MP 153 to MP 154 eastward only			35			35				
Controlled Siding 30 MPH except MP 155 to MP 156 over Weigh in Motion Scale — 10 MPH										
1st curve west of MP 157	45	45		45	45					
MP 159 and CP Lewis	60	50	40	60	50	40				
Except Curves at MP 163 to MP 164	55			55						
2nd and 3rd curves east of CP Lewis	50			50						
1st curve east of CP Lewis	35	35	35	35	35	35				
CP Lewis and MP 168	50	50	40	50	50	40				
Except: 1st curve west of CP Lewis	40	40		40	40					
MP 168 and MP 191 3	60	50	40	60	50	40				
Except Curves MP 170 9 to MP 172	50			50						
Curve at MP 173	55			55						
Curves MP 182 to MP 183 5	40	40		40	40					
MP 191.3 and MP 201	60	50	40	60	50	40				
MP 201 and MP 209 1	50	50	40	50	50	40				
Except 1st curve west of MP 206	45	45		45	45					
MP 209 1 and CP Tunnel	60	50	40	60	50	40				
Except MP 211 to CP Tunnel eastward 61 cars or more	55			55						
CP Tunnel and MP 214	40	40	40	50	50	40				
MP 214 and MP 222.3	35	35	35	35	35	35				
MP 222.3 and CP Gray	50	50	40	50	50	40				
CP Gray and MP 224	50	50	40	50	50	40				
MP 224 and MP 228	60	50	40	60	50	40	CS Same As No 1 Track			
Except: MP 224 to MP 225 eastward 61 cars or more	50			50						
MP 228 and CP Antis	50	50	40	50	50	40				
CP Antis and CP Works	50	50	40	50	50	40				
Except CP Antis to MP 234	40									
MP 233 to MP 234				45						
MP 234 to CP Works westward 61 cars or more				45						
CP Works and Alto	25	25	25	25	25	25				
Controlled Siding — 15 MPH										
Alto and Slope	25	25	25	25	25	25	25	25	25	
No. 101 track — 25 MPH										
Slope and MP 241 7	35	35	35	35	35	35	35	35	35	
Except MP 238 to MP 240 eastward only			30			30				
MP 241.7 and UN—AR	30	30	30	30	30	30	30	30	30	
							and No 4			
UN—AR and MO	45	45	40	45	45	40	35	35	35	
Except: 1st curve east of MO	40	40		40	40					
No 0 track — 30 MPH										

(Continued)

APPENDIX E

LOCOMOTIVE INSPECTION REPORTS

EL 106-A RB 2-86 Printed in USA MU

CONRAIL

PRA No 2A

Locomotive inspection report

Each locomotive unit shall be inspected in accordance with Rule 203 of the laws, rules, and instructions for inspection and testing of locomotives other than steam

Train symbol:	Units: Show initial CR	1 5017	2	3	4	5	6
		7	8	9	10	11	12

Consist position	Report code	Electrical problems
	11	Trips ground relay in ☐ motoring ☐ dyn braking
		How many times did ground relay trip? ___
___	16	Wheel slip in ☐ motoring, ☐ dyn braking at ___ mph
___	20	Dyn brake not working (no amperage)
___	20	Dyn brake too heavy or erratic [ ] Brake warning light comes on
___	13	Not loading (no amperage)
___	08	Not loading properly (not enough amps or drops amps frequently)
___	17	Will not make transition at ___ mph

Consist position	Report code	Engine problems
___		Engine dies:
	66	☐ Low oil tripped
	57	☐ Low water tripped
	37	☐ Crankcase pressure tripped
	44	☐ Overspeed tripped
	38	☐ No apparent reason
___	43	Engine makes black smoke or has fire out of stack
___	30	Engine has unusual noise or vibration
___	33	Engine hunts badly
___	15	Engine has hot engine alarm

Consist position	Report code	Miscellaneous defects
___	24	Radio
___	78	Speed indicator and/or recorder not working
___	83	Air brake equipment (explain in "Remarks")
___	89	Water cooler not working
___	87	Defective lighting
___	23	Cab signal (explain in "Remarks")

Cab signal test

A end X B end ___

Date 1-13-88 Time 1230pm

Location PN

Signature J. Frizzello

Title Elect.

Main reservoir pressure ___ lbs Brake pipe pressure ___ lbs

Condition of brakes and brake rigging ___

Outbound consist tested per MP 751 procedures

Signature ___ Time ___ Date ___

Signature ___ Time ___ Date ___

Place ___

Other defects and remarks:	Repaired by
1)	
2)	
3)	
4)	
5)	
6)	
7)	
8)	
9)	
10)	
11)	
12)	
13)	
14)	
15)	

Signature of employee making inspection	Occupation	Place	Date	Time

The above work has been performed except as noted and the report is approved	Signature	Occupation	Available for service Date Time M

EL 106-A, RB 2-86 Printed in USA MU

CONRAIL

FRA No 2A

Locomotive inspection report

Each locomotive unit shall be inspected in accordance with Rule 203 of the laws, rules, and instructions for inspection and testing of locomotives other than steam

Train symbol:	Units: Show initial	1	2	3	4	5	6
TV61	CR	3054	3394	5017			
		7 11-2	8 11-5	9 10-22	10	11	12

Consist position	Report code	Electrical problems
	11	Trips ground relay in ☐ motoring ☐ dyn braking
		How many times did ground relay trip? ______
	16	Wheel slip in ☐ motoring ☐ dyn braking at ______ mph
	20	Dyn brake not working (no amperage)
	20	Dyn. brake too heavy or erratic ☐ Brake warning light comes on
	13	Not loading (no amperage)
	08	Not loading properly (not enough amps, or drops amps, frequently)
	17	Will not make transition at ______ mph

Consist position	Report code	Engine problems
		Engine dies:
	66	☐ Low oil tripped
	57	☐ Low water tripped
	37	☐ Crankcase pressure tripped
	44	☐ Overspeed tripped
	38	☐ No apparent reason
	43	Engine makes black smoke or has fire out of stack
	30	Engine has unusual noise or vibration
	33	Engine hunts badly
	15	Engine has hot engine alarm

Consist position	Report code	Miscellaneous defects
	24	Radio
	78	Speed indicator and/or recorder not working
	83	Air brake equipment (explain in "Remarks")
	89	Water cooler not working
	87	Defective lighting
	23	Cab signal (explain in "Remarks")

Cab signal test

A end ______ B end ______

Date ______ Time ______

Location ______

Signature ______

Title ______

Main reservoir pressure 140 lbs Brake pipe pressure 90 lbs

Condition of brakes and brake rigging good

Outbound consist tested per MP 751 procedures

Signature G. Fiorillo Time 2:15 pm Date 1-13-88

Signature E. Rude Time ______ Date 1-10-88

Place P.N.

Other defects and remarks:	Repaired by
1)	
2) mach. insp.	E. Rude
3) 3054 - Bell don't work.	E. Rude
4)	
5)	
6) ELECT. INSP.	OK
7)	
8) 3054 (SAP 1257.1)	OK
9)	
10) 3394 (SAP 1521.5)	OK
11)	
12) 5017 (SAP 1188.7)	OK
13)	
14)	
15)	

Signature of employee making inspection	Occupation	Place	Date	Time
E. Rude	MM	PN	1-13-88	2:15 PM

The above work has been performed except as noted, and the report is approved.	Signature	Occupation	Available for service
	R. McKenny	Foreman	Date 1/13/88 Time ______ M

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Cab signal inspection report

CONRAIL

LOCO. NUMBER	TERMINAL	DATE	RELAY GROUP INDATE FOR 92 DAYS
6265	Enola	12-10-87	[X] YES [ ] NO IF NO, RECORD SERIAL NUMBER OF ALL REPLACED EQUIPMENT IN "REMARKS"

INDICATE TYPE OF INSPECTION: PERIODIC (circled) ROAD FAILURE

(For Diesel Locos. Use SMR No. 902)

	RIGHT FOUND	RIGHT LEFT	LEFT FOUND	LEFT LEFT
FRONT RECEIVER HEIGHT	7"	7"	8"	8"
REAR RECEIVER HEIGHT	7"	7"	7¼"	7¼"

INSULATION RESISTANCE READINGS – TERMINAL TO GROUND – OHMS (Circle Type)

US & S TYPE "AR"	US & S TYPE "E"	US & S TYPE EL (circled)	FOUND	LEFT
C	C	C	2 Meg	2 Meg
A	A	A		
R	R	R		
L	L	L		
S	B32	B32		
B32	SP	FT		
FT	PC	TC		
TC	TC			

SYSTEM VOLTAGE B 32 TO C FOUND 32 VOLTS LEFT 32 VOLTS

DECODING RELAY CURRENT WITH 2 AMPS. IN RAIL		FOUND	LEFT
	180 R OR "A" RELAY - 180 CODE	60 MA	60 MA
	120 R OR "R" RELAY - 120 CODE	62 MA	62 MA
	LLV OR "L" RELAY - 75 CODE	64 MA	64 MA
	180 R OR "A" RELAY ON 120 CODE	2 MA	2 MA
	180 R OR "A" RELAY ON 75 CODE	2 MA	2 MA
	120 R OR "R" RELAY ON 75 CODE	3 MA	3 MA

SIGNAL-PICK UP (AMPS IN RAIL CIRCUIT - 180 CODE)	NO. 1 END FOUND	NO. 1 END LEFT	NO. 2 END FOUND	NO. 2 END LEFT
	1.6	1.4	1.6	1.4

DELAY TIME: FROM CHG. OF CODE TO BLAST OF WHISTLE)		FOUND	LEFT
	180 CODE TO 120 CODE	2 SEC	2 SEC
	120 CODE TO 75 CODE	2 SEC	2 SEC
	75 CODE TO NO CODE	2 SEC	2 SEC

OPERATING TEST MADE (1.3 TO 1.6 RAIL AMPS.) YES (circled) NO

REMARKS: All Equipment In Date

A-066976	5-25-87	180-L596822	10-86
RP-LP-L841563	5-25-87	120-L491123	8-83
R-L543392	5-25-87	75-L659808	8-83
SP-L543300	5-25-87	Amp-L490835	3-14-84
L-L518947	5-25-87		
MR-L520872	10-25-86		

SIGNED T J Kegr (NAME) Elect (TITLE)

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