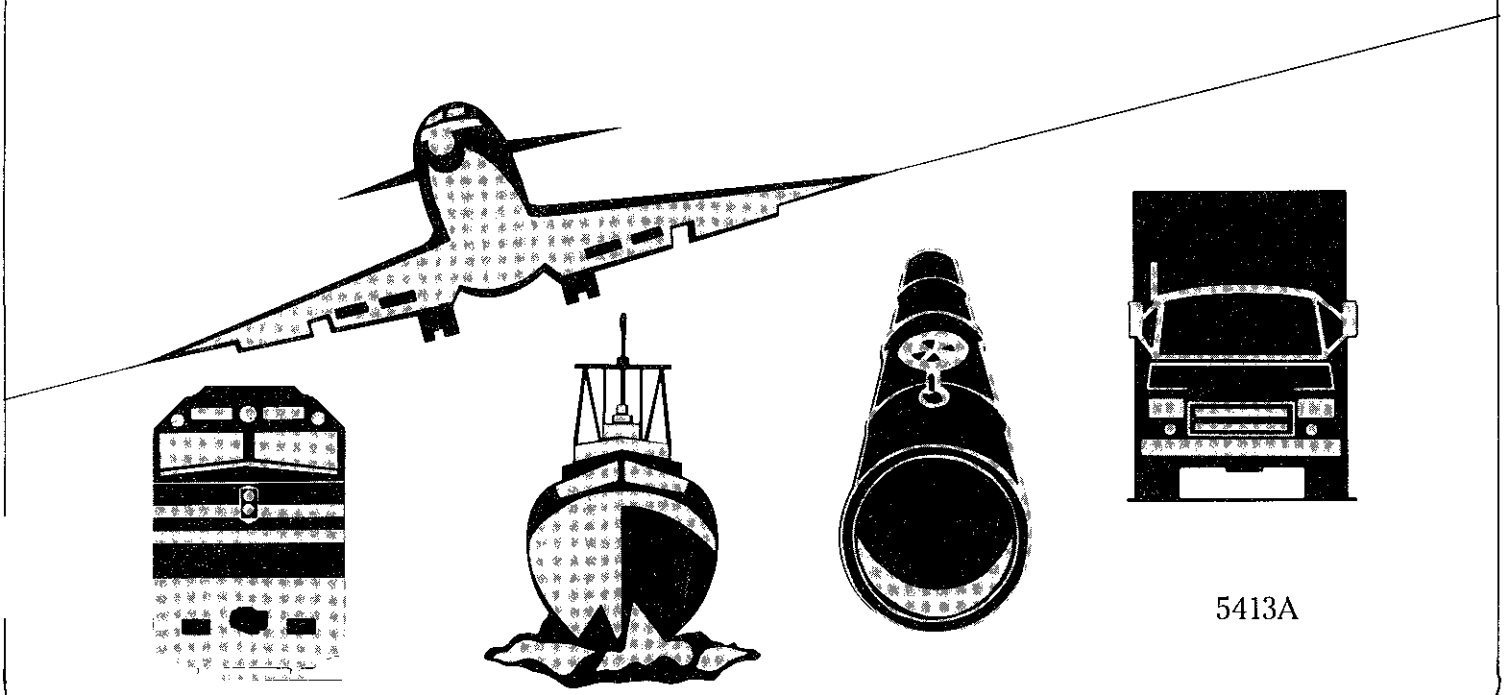
PB91-916303
NTSB/RAR-91/03

IONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY (ATSF) FREIGHT TRAINS ATSF 818 AND ATSF 891 ON THE ATSF RAILWAY CORONA, CALIFORNIA NOVEMBER 7, 1990



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ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY (ATSF) FREIGHT TRAINS ATSF 818 AND ATSF 891 ON THE ATSF RAILWAY CORONA, CALIFORNIA NOVEMBER 7, 1990

ADOPTED: July 23, 1991
NOTATION: 5413A

Abstract: This report explains the collision between two Atchison, Topeka and Santa Fe Railway freight trains in Corona, California, on November 7, 1990 Among the safety issues discussed are the following. effect of work/rest cycles on performance, crashworthiness of event recorders and locomotives, fuel tanks, positive train separation, company's method of detecting drug use by its employees, company's method of notifying pipeline operators of accidents, need to develop simplified format for work-record data collected by rail carriers, and need to develop policy blocking employees from working if they lack sleep

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

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EXECUTIVE SUMMARY

On Wednesday, November 7, 1990, about 4 11 a m Pacific standard time, two Atchison, Topeka and Santa Fe Railway Company (ATSF) freight trains collided head on at milepost (MP) 25.6 in Corona, California. The westbound ATSF freight train 818, which was traveling from Barstow, California, to Hobart yard, City of Commerce, California, was on the Corona siding It passed the stop signal, and the lead locomotive reentered the main track area, blocking all movement on the main track The eastbound ATSF freight train 891, which was traveling from Hobart yard to Chicago, Illinois, was on the main track and collided with train 818. Each train had three-person crews

As a result of the collision, the entire crew of ATSF 818 was killed and four locomotives and three rail cars were derailed The engineer and conductor of train 891 sustained serious injuries and the brakeman was killed, all three locomotives and five rail cars were derailed The total damage was estimated to be $4,400,000.

The major safety issues addressed in the report are

- Effects of the Crew's Work/Rest Cycle on Performance
- A Drug Policy Follow-Up Issue
- Crashworthiness of Event Recorders in an Accident

The National Transportation Safety Board determines that the probable cause of the collision was the failure of the engineer of train 818 to stop his train at the stop signal because he was asleep Contributing to the accident was the failure of the conductor and the brakeman to take action, probably because they too were asleep, to stop the train Also contributing to the accident were the irregular unpredictable work schedule of the engineer on train 818, the Atchison, Topeka and Santa Fe Railway Company's lack of a policy or procedure for removing crewmembers from service when they are not fit for duty because of a lack of sleep, and the inadequacy of the Federal rules and regulations that govern hours-of-service

As a result of its investigation, the Safety Board issued recommendations to the Atchison, Topeka and Santa Fe Railway Company, the Federal Railroad Administration, the California Public Utilities Commission, the California State Fire Marshal, the Brotherhood of Locomotive Engineers, the United Transportation Union, and the Association of American Railroads.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

COLLISION OF ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY (ATSF) FREIGHT TRAINS ATSF 818 AND ATSF 891 ON THE ATSF RAILWAY CORONA, CALIFORNIA NOVEMBER 7, 1990

INVESTIGATION

Accident

On November 6, 1990, at 10.15 p m. Pacific standard time, the crewmembers on the Atchison, Topeka and Santa Fe Railway Company (ATSF) freight train 818 went on duty at their away-from-home terminal in Barstow, California. Train 818 was a westbound cabooseless freight train originating in Barstow and destined for Hobart yard in the City of Commerce, California. The train consisted of 5 locomotives and 91 rail cars (74 were loaded and 17 were empty) It had 8,616 trailing tons and was 5,996 feet long

Barstow was part of the Cajon subdivision; Hobart yard was part of the San Bernardino subdivision. Both subdivisions were part of the ATSF California division, and, as figure 1 illustrates, the Cajon subdivision extended from Barstow to the city of San Bernardino, and the San Bernardino subdivision extended from the city of the same name to Los Angeles. Both subdivisions were governed by centralized traffic control (CTC),[1] timetables, track warrants, and train orders.

The crew of train 818 consisted of an engineer, a conductor, and a brakeman, all of whom, according to ATSF records, were qualified to operate in this territory The brakeman was on the return portion of her first road trip. All of the crewmembers had been off duty for 9 hours 35 minutes since their previous tour of duty.

According to the event recorder printout, the train left Barstow yard about midnight. It stopped from 12 47 a.m. to 12·57 a.m so that a helper engine could be coupled to its rear end. The helper engine was to stay with train 818 until it arrived at San Bernardino yard.

The train spent 4 minutes in San Bernardino so that the helper engine could be uncoupled. During the stop, the assistant train master noted that the engineer appeared to be tired while he was in the yard office Other ATSF personnel saw the brakeman dismount the engine during this time and stand alongside it After the stop, the train continued west, via the San Bernardino subdivision, toward Hobart yard According to the ATSF manager of operation's testimony, the San Bernardino dispatcher notified the train about 3.52 a m. that it would be going into the siding at Corona to meet an eastbound train.

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[1]CTC is a term applied to a system of railroad operations by means of which the movement of trains over routes and through blocks on a designated section of track or tracks is directed by signals controlled from a designated central point

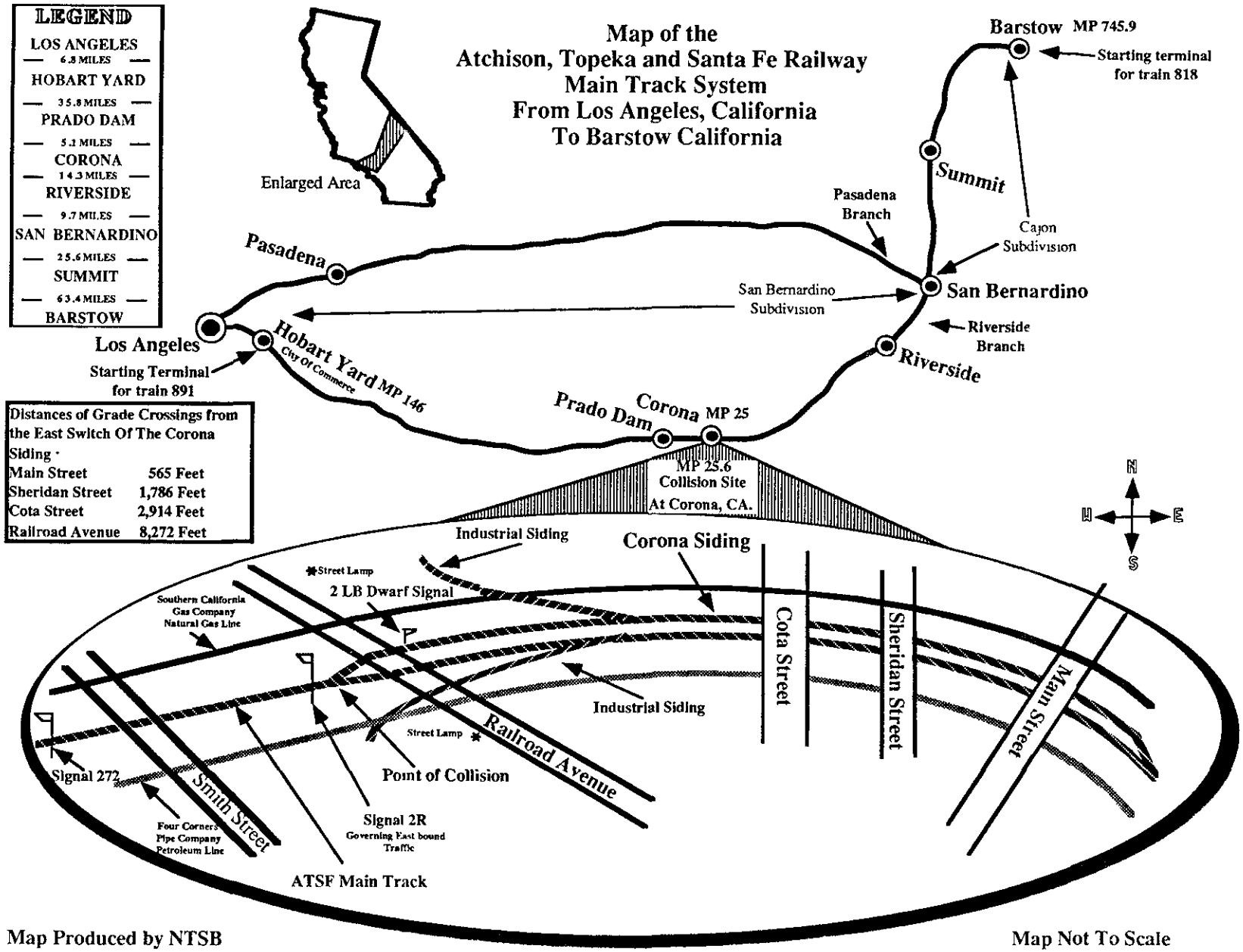

Figure 1 -- Map of the Atchison, Topeka and Santa Fe Railway main track system from Los Angeles to Barstow

According to the event recorder printout, when the train approached the east end of the Corona siding, its speed was gradually reduced by the dynamic braking[2] system. When the train entered the siding, there was a reduction of air pressure in the automatic air brake[3] system of 6 pounds, which retarded the train's speed to 15 mph, a speed that was in compliance with the maximum speed for this turnout. When the train was through the switch, the automatic air brake was released, and the dynamic braking maintained the train's average speed of 14 mph until it reached the vicinity of the Cota Street grade crossing. The wayside signal log showed that the train was clear of the main track at 4:08 a m

A security guard on the north side of the Corona siding in an industrial area saw and heard the train as it sounded its horn and crossed the Sheridan Street grade crossing When the lead locomotive passed him, he saw a male figure sitting with his back to the engineer's window; the window was open, and the interior dome light on the engineer's side was on.

The guard was a railroad enthusiast and wanted to take a photograph of two trains meeting in the night. He thought that since this train was in the siding, a meeting would occur at Railroad Avenue Once the train cleared the grade crossing, he drove toward Railroad Avenue, where he intended to take his pictures. He testified that en route to Railroad Avenue his automobile windows were open and he heard the train's horn sound for the Cota Street grade crossing.

The dwarf signal on the west end of the siding displayed a red "stop" aspect when train 818 entered the siding The signal log shows that about 4.10 a m the section of track past the stop signal was occupied. About 4·11 a.m. an emergency brake application[4] was made, according to the event recorder [5] No other trains were in the siding at the time. Train 818 came out of the siding; the lead locomotive blocked the main track, and obstructed eastbound traffic. The head end of the lead unit was positioned over the frog at impact The train remained in this position throughout the collision. All three crewmembers dismounted the train and attempted to flee the area During their attempt all of them were consumed by a fireball, which ignited after the collision.

On November 7, at 2 a.m., the crewmembers of train 891 went on duty at Hobart yard, their home terminal The train was an eastbound cabooseless trailer-on-flatcar train, which originated at Hobart yard and was en route to Chicago, Illinois. The crew was scheduled to operate the train only between Hobart

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[2]Dynamic braking is a method of train braking whereby the kinetic energy of a moving train is used to generate electric current at the locomotive traction motors, which is then dissipated through banks of resistors in the locomotive car body

[3]An automatic air brake is a braking system that draws air from the atmosphere and stores it under pressure A reduction in brake pipe pressure, regardless of how it is initiated (bleeding of air by use of a valve or by a break in the train line), automatically applies the brakes An increase in brake pipe pressure causes brakes to release

[4]An emergency brake application is a substantial reduction of brake pipe pressure made when a train must be stopped in the minimum distance possible An emergency application may also occur when a brake pipe is broken or when air hoses between cars are disconnected with angle cocks open An emergency application can be initiated by any crewmember

[5]The event recorder clock and the signal log clock were not synchronized.

yard and Barstow. The train had 3 locomotives and 47 rail cars (all loaded). It weighed 3,150 trailing tons and was 4,229 feet long.

The crew of train 891 consisted of an engineer, a conductor, and a brakeman, according to ATSF records, all were qualified to operate in this territory.

The engineer of train 891 talked with Safety Board investigators after the accident but refused to speak to the Safety Board during deposition proceedings In his testimony the conductor took no exception to the engineer's handling of the train during their tour of duty.

The conductor stated that he and the engineer were in the lead (eastmost) controlling locomotive and that the brakeman was in the second locomotive. The brakeman, according to the conductor's testimony, chose of his own volition to ride in the second unit.

The conductor further stated that as the train approached Corona, the CTC signals were displaying aspects[6] permitting it to proceed eastward When the train reached signal 2R (located at the west end of the Corona siding and governing eastbound traffic on the main track), the aspect changed from a yellow "approach" indication to a green "clear" indication. The yellow indication allowed train 891 to proceed but required that it be prepared to stop at the next signal and restricted the train speed to 40 mph. The clear indication allowed the train to proceed at the maximum authorized speed.

The conductor stated that when he saw the "clear" signal, the overhead speedometer on the left side of the cab, where he was seated, indicated that the train was traveling about 29 mph

He testified that when the train was about four or five car lengths from the signal, he got up from his seat to get something from his bag. A moment later he heard the engineer shout that the signal had changed The conductor said that the "clear" aspect had changed to a red "stop" aspect and he saw the headlight of an oncoming locomotive. He dropped to the floor and braced for the ensuing collision The impact threw the crewmembers about within the confines of their respective engine compartments. The engineer and the conductor sustained serious injuries, and the brakeman was killed.

The left front corner end sill area of the lead locomotive unit of train 818 collided with the left front corner end sill area of the lead locomotive unit of train 891; train 891's lead unit swerved to the south of the main track and landed on its right side. The second locomotive unit landed on its left side along the north side of the track The third locomotive unit proceeded eastward, ramping over parts from the other two locomotives, and landed on top of the control cab of the lead locomotive of train 818. An intense fire ensued.

About 4:24 a.m the ATSF dispatcher was notified by the Corona police department that there was a railroad accident in the vicinity of Railroad Avenue and Smith Street. The dispatcher's office then notified those individuals listed on the ATSF emergency response form.

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[6]An aspect is the appearance of a fixed signal conveying an indication

Injuries[7]

	Crew of ATSF 818	Crew of ATSF 891	Total
Fatal	3	1	4
Serious	0	2	2
Minor	0	0	0
Total	3	3	6

Damages

The ATSF estimated damages

Equipment	$3,868,780
Track	50,000
Signal	35,000
Labor	10,052
Lading Damage	450,000
Other (Railroad Property Costs)	19,170
Total	$4,433,002

Crew Information

ATSF 818

Engineer.--On Sunday, November 4, he worked a train from Barstow to Hobart yard, starting at 6:45 p m. and ending on November 5 at 7:30 a.m. He then drove home, arriving just before 9 a.m. He went on a school field trip with his children, returned home in the early afternoon, and took a short nap. After his nap, he telephoned the ATSF Voice Information Processing System (VIPS) [8] Following the call, he told his wife he expected to be called to work about 5 p.m. on the following day, November 6. He ate dinner with his family and went back to bed about 8 p.m.

About 1 30 a m on November 6, 1990, the wife of the engineer of train 818 received a call from the ATSF crew caller,[9] who said her husband was to report for work at 4·30 a m at Hobart yard. She woke her husband, and he left for Hobart yard, which was more than 60 miles away Before leaving, he told his wife that if he arrived at Barstow before noon he would return home (San Bernardino) to take care of one of their children while she attended her college classes. (He coowned an automobile that was garaged in Barstow and would have used the car to travel back to his house.) He reported at Hobart yard at 4:30 a.m and arrived in Barstow at

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

[8]VIPS is a telephone/computer interface system that allows ATSF employees to obtain the current train line-up and their own work status relative to other employees in the same pool

[9]The crew caller gave crewmembers whose home terminal was Hobart yard as much as 3 hours notice before they were to report for duty

12:40 p m., too late to accommodate his wife He called from Barstow and told her that since he anticipated a long layover, he did not expect to be called until the following morning and was not going to bed until later that day

Accompanied by the conductor and the brakeman, he checked into the ATSF-contracted motel at 1:30 p m. and went with them to eat. According to other ATSF personnel, he and the brakeman were in the recreation room of the motel between 3:30 p.m and 6 p.m. About 6 p.m. they joined another engineer for dinner, and they returned to the motel about 8 p m.

While he was in Barstow, he talked to several other ATSF crewmembers who were waiting to be assigned to outbound trains Through them he became aware of the status of the train line-up.

He called the ATSF crew caller about 8:40 p.m. and learned that he was being assigned to a crew with a starting time of 10:15 p.m At that time he discovered that three crews that were ahead of him in the line-up had been deadheaded.[10] During his conversation with the crew caller, he discussed the deadheading of the other crews and threatened to lay off[11] sick, implying that he had not slept Finally, he said that he wanted to speak to the supervisor of train operations (STO). The crew caller asked him if he was going to accept the assignment; he replied, "Well, I got, I mean what else am I going to do . . .?"

During a 12-minute recorded telephone conversation with the STO, the engineer complained about the method of determining how trains were assigned and, particularly, about the deadheading of crews He told the STO, " . . I mean how do you plan your life, you just live by surprises?" The STO testified that he concluded from the conversation that the engineer had not been to bed while he was in Barstow He further testified that he was sympathetic to the engineer's situation At the end of the conversation, the engineer did not lay off, he chose to accept the assignment.

The ATSF regional manager testified that had the engineer asked to lay off, the request would have been granted Although it was unusual for an employee to lay off at an away-from-home terminal, the ATSF was aware that at times things happened, such as illness or family emergencies, that forced an employee to lay off at an away-from-home terminal The regional manager further testified that crews ". normally would leave as a unit after they arrived as a unit "

The regional manager said, " . had he [the engineer] laid off, and he didn't have a history of it, and even though if it wasn't perceived as a good reason, I'm confident there wouldn't have been any punitive measures taken, other than to say, hey, you need to get your act cleaned up . ."

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[10]Deadheading is off-duty travel when train crewmembers are moved without service but with pay from one terminal to another at the railroad's convenience

[11]Laying off is a method by which an employee can report himself not available for duty

After he arrived at the Barstow terminal building, the engineer called his wife at 10·15 p.m. to tell her that he was returning. She later told investigators that during the telephone conversation he admitted that he was exhausted, that he had taken only a small nap, and that he wanted to lay off. When she asked him why he did not lay off, he replied, "I can't," and gave no further explanation

Investigators could not account for his actions between 8·55 p.m and 10 p.m. When the accident occurred, he had been awake for 26 hours 41 minutes, excluding the brief period of rest in Barstow

Conductor --On November 4, the conductor was called at 9 a m. to work on a train that was to leave Hobart at 12:01 p.m. and arrive at Barstow at 6.45 p.m. On the following morning, November 5, he was called at 1:30 a.m. to take a return train to Hobart that left at 2.45 a.m. and arrived at 10:15 a.m. He went home, and at approximately 1:30 a.m. on November 6, he received his next call, which was again to work a train from Hobart yard to Barstow.

As had the engineer, the conductor reported at Hobart yard for a trip that started at 4:30 a.m. on Tuesday, November 6 At 12:40 p m., he arrived at Barstow yard. He called his wife and told her that he would probably not get a return train until about 5 a.m. the following day and that he was going to bed.

After eating with his crew, he returned to the motel and went to his room. Investigators could not account for his actions between 2·30 p m. and 8 45 p.m , when the crew caller told him that he was assigned to train 818 The conversation between him and the crew caller was recorded; the conductor sounded as if he had just been awakened. When the accident occurred, he had been awake for approximately 6 hours.

Brakeman --At 1:30 a.m. on November 6, the crew caller told the brakeman that she was to go on duty at 4 30 a m. at Hobart yard. The trip was her first interterminal tour as a brakeman. She left her house at 2.30 a.m and arrived at Hobart yard about 3 a m

At Barstow, she joined the crew for a meal. When the crew returned to the motel, she remained in the engineer's company until shortly after 8 p.m , when she went to her room. The ATSF crew caller reached her at 8.43 p.m. and assigned her to train 818. Her conversation with the crew caller was taped, and she sounded as if she had just been awakened. She was next seen at San Bernardino yard, where the train stopped for a 4-minute layover and she dismounted the engine. When the accident occurred, she had been awake for 26 hours 41 minutes, excluding the brief period of rest in Barstow. Her activities on November 6 between 8 p.m and 10 p m. were unknown

ATSF 891

Engineer.--On Tuesday, November 6, at 11.15 p.m , the ATSF crew caller reached the engineer and assigned him to train 891, which was to originate in Hobart yard at 2 a.m. on Wednesday, November 7, and go to Barstow. He arrived at Hobart yard about 1:30 a.m. and left about 3.10 a m. He had been off duty 25 hours 45 minutes before reporting to Hobart yard. He had been awake for 4 hours 56 minutes at the time of the collision and stated (during a postaccident interview with investigators) that he had slept for most of the day and evening on Tuesday until he was awakened by the crew caller.

Conductor --On November 6, the conductor received a call from the ATSF crew caller at 11·15 p m , assigning him to train 891 En route to Hobart yard, he picked up his brakeman for train 891; the two reported to Hobart yard about 2 a.m and left about 3:10 a.m. The conductor testified that he was in the controlling compartment of the lead locomotive He had been off duty for 28 hours 20 minutes before reporting to work. At the time of the accident, he had been awake for 6 hours 11 minutes

Brakeman --He received his call assigning him to train 891 about 11:15 p.m. on November 6. According to the conductor, the brakeman boarded the second locomotive of his own volition. Before boarding the train, he had been off duty for 28 hours 20 minutes He had been awake 5 hours 11 minutes at the time of the accident

Train Information

General --The ATSF assistant chief mechanical officer testified that ATSF locomotives had been equipped with alerters[12] until about 10 years earlier. Due to mechanical difficulties and lost production time, the ATSF had removed them. The ATSF did not use cab signals[13] in locomotives.

The assistant chief mechanical officer stated that the ATSF had a policy of installing event recorders on even-numbered locomotives Investigators found that in the fleet of about 1,800 locomotives, 65 odd-numbered units also were equipped with event recorders. The officer said that the ATSF attempted to have an event recorder on "97 percent" of its engine consists that were in road service.

ATSF 818.--Train 818 consisted of 5 locomotives and 91 rail cars The locomotive consist included ATSF 5363 (Electro Motor Division EMD-SD 45), ATSF 5267 (EMD-SD 40-2), ATSF 5395 (EMD-SD 45), ATSF 8063 (General Electric-C 30-7), and ATSF 5328 (EMD-SD 45). Of the five locomotives units, only the fifth had an event recorder.

The SD 45 locomotive had 11-gauge (or 0 125) mild steel in its nose section The collision posts on the SD-45 were 59 inches high on the left and 54 inches high on the right. Both posts were made of mild steel with a specified minimum yield strength of 27,000 pounds per square inch (psi) See figure 2 for a photograph of an SD-45 locomotive.

The control compartment of the SD-45 was a standard design that had been used in the railroad industry since the early 1960s The control compartment was configured with the engineer's position on the right side and with the control stand on the engineer's left. Two fully adjustable seats were on the left side wall, one forward and one aft, for the conductor and brakeman

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[12]An alerter is a device that monitors the engineer for activity and provides a visible and audible warning for a predetermined length of time after which a penalty air brake application is made if the system is not reset

[13]A cab signal is a device in the control cab of the locomotive that indicates the condition of the track ahead (clear or occupied) by displaying lighted signals

Figure 2.--SD-45 locomotive.
Top: General Motors Electro-Motive Division.
Bottom: Engineer's control stand.

The SD-45 was equipped with a two-piece center horizontal windshield and a right front vertical windshield Each side of the control compartment had two operable slide-type side windows. One rear fixed vertical observation window was at the left rear of the control compartment.

The maximum capacity of the fuel tanks on the SD-45 locomotive was 4,000 gallons of diesel fuel. The end sill was 66 inches from the top of the rail to the top of the sill

Six rail cars in the train's consist contained hazardous materials. None of these cars was involved in the collision.

ATSF 891--Train 891's locomotive consist had ATSF 137 (EMD-GP 60M), ATSF 147 (EMD-GP 60M), and ATSF 152 (EMD-GP 60M). The control compartments of the first and second locomotives faced east, while the control compartment of the third locomotive faced west. Figure 3 is a photograph of a GP-60M locomotive. The train had 47 rail cars, all of which were flat cars carrying either highway trailers or containers.

The second and third locomotives each had an experimental event recorder that was being tested by the ATSF The recorders were in the vestibule area of the control compartments and employed solid state recording media to record the events instead of a removable magnetic tape cartridge.

The GP-60M featured 0 375-inch high-strength steel in its nose section and a 58.87-inch high collision post on each side of the hood. Both collision posts were made of high-strength steel that had a maximum yield strength of 50,000 psi.

All the locomotives were equipped with a North American-style control compartment designed in part by the ATSF. The new control compartment was equipped with a desk top control console on the right, or engineer's, side. On the left side were two fully adjustable seats, one behind the other, for the conductor and the brakeman. The design was based upon a design introduced in Canada in the early 1970s. The North American control compartments were first introduced on the ATSF in May 1990. This was the first accident investigated by the Safety Board involving this type of control compartment. At the time of the report, the Federal Railroad Administration (FRA) had no data about the crashworthiness of North American control compartments on locomotives that have been in collisions.

The forward entrance of the GP-60M was a heavy metal windowless door on the right side of the front wall. The exterior door led to a small vestibule in which an interior door led up two steps to the control compartment. The rear-entrance door, which had a fixed upper vertical window, was at the right rear of the control compartment, or behind the engineer's seat. The door led out to the right-side walkway, which ran alongside the engine compartment Figure 3 also illustrates the interior of the GP-60M control compartment.

The control compartment had a two-piece windshield, two operable sliding side windows (one on each side), and a fixed left-rear window. The rear wall had an electrical cabinet..

Each unit had a fuel tank that could hold 3,200 gallons of diesel fuel but according to ATSF policy, was limited to 2,900 gallons in order to reduce the wear and tear inflicted on the track and the locomotive's wheels. The locomotives on

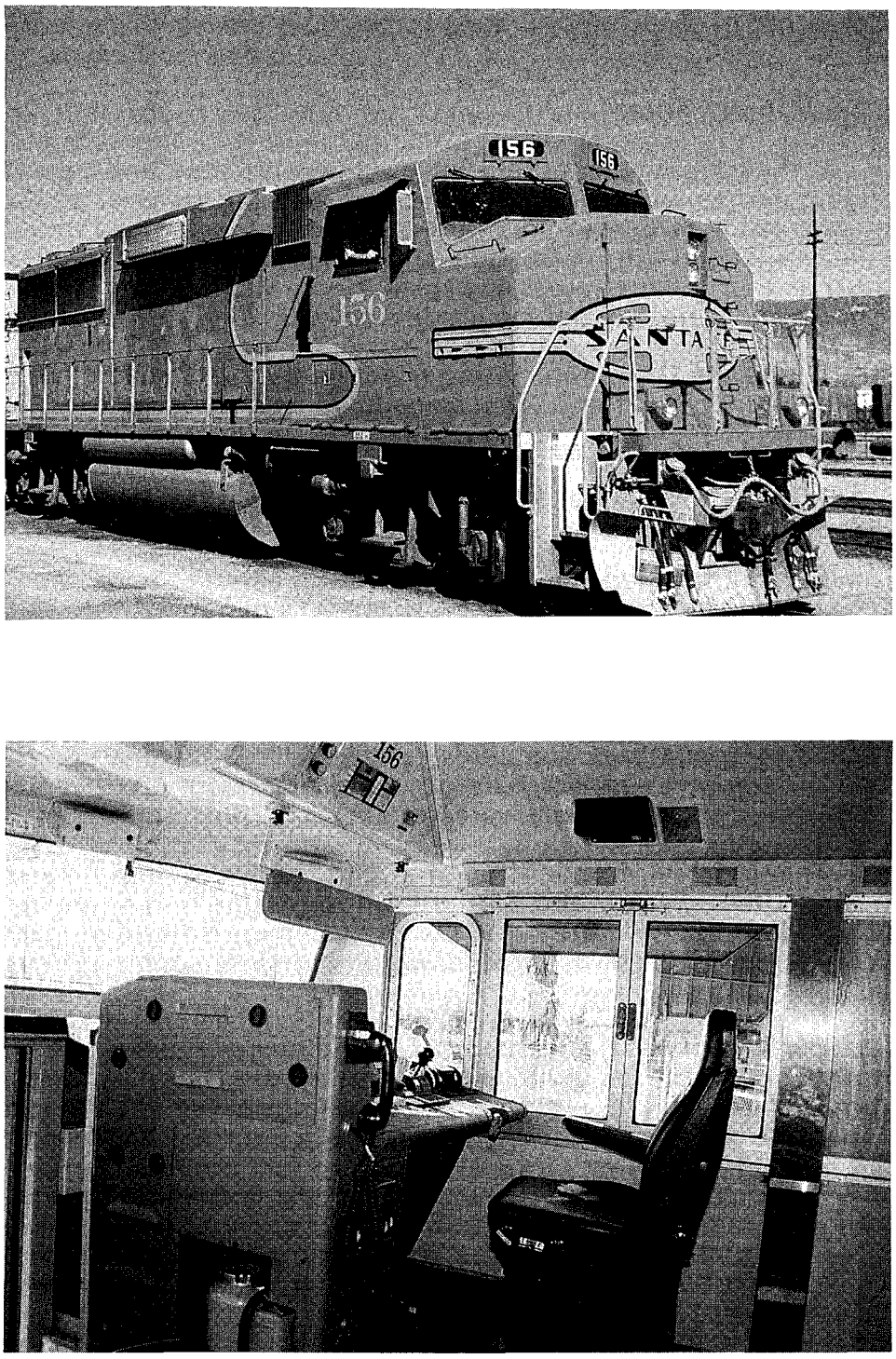

Figure 3.--GP-60M.
Top: General Motors Electro-Motive Division.
Bottom: Engineer's console.

train 891 had last been fueled in Belen, New Mexico, on November 5; they left Hobart yard with approximately 1,000 gallons each.

The sill height of the GP-60M was 63 inches from the top of the rail to the top of the sill.

Track and Signal Information

Track --At the collision point there was a single main track and a parallel siding, both extending east to west The collision point was directly west of the Railroad Avenue grade crossing in the vicinity of the turnout that connected the single main track and the west end of the Corona siding (See figure 1.) The accident occurred in a light industrial area of warehouses and small shops Working street lamps flanked and lit the north and south sides of the grade crossing

The track entering the Corona siding from the east had a descending gradient of 0.47 percent for 1,306 feet. The track gradient continued to descend at 0.82 percent for 1,400 feet, at which point it became level. It was level for 2,685 feet and then ascended at a gradient of 0 44 percent for 2,250 feet At that point, the track gradient ascended 0.08 percent for 866 feet until it reached the west siding turnout near Railroad Avenue

The main track extended east to west. The alignment at the collision point was tangent. The main track was tangent for 8,184 feet from signal 272 to signal 2R and continued to be tangent for another 40 feet past signal 2R to the collision point. The gradient at the collision point was descending at 0 08 percent

According to the ATSF assistant superintendent of maintenance, the main track was maintained to class 4 track standards[14] at the Railroad Avenue grade crossing The last time the track was inspected before the accident was on November 5 by an ATSF track inspector, and no defects were noted or reported

Signal.--The signal system consisted of a traffic control system for a single-track railroad having Union Switch and Signal Company (US&S) H-5 searchlight-type signals and a US&S M22A dual-control switch machine. Noncoded track and line circuits were controlled from a US&S computer-aided dispatching center in San Bernardino

The 2LB dwarf signal at the west end of the siding governed westbound traffic; it was located near Railroad Avenue and displayed a "stop" indication when train 818 entered the siding. According to the signal log, at 11 seconds past 4 10 a.m , the track circuit on the siding west of the 2LB signal was occupied

Signal 2R, which was west of the west end of the Corona siding and along the south side of the main track, was a home signal governing eastbound traffic. According to the signal log, at 8 seconds past 4.09 a m , it displayed a "clear" aspect; and at 11 seconds past 4·10 a m , it showed a red "stop" aspect, signifying that the track circuit east of the signal was occupied

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[14]According to 49 CFR 213.9, class 4 track is a segment of track maintained to accommodate the maximum allowable speed of 80 mph for passenger trains and the maximum allowable speed of 60 mph for freight trains

The Railroad Avenue grade crossing was protected by wig-wag warning signals on a mast alongside the roadway A round disc with a red lens lamp in its center hung from the mast. When the crossing warning signal was activated, a bell rang and the disc swung from side to side.

Radio --The existence of recorded conversations between the dispatcher and both crews shows that each train had an operational radio on board its respective control locomotive. The ATSF's single radio frequency was used for "point to train" communication, or communication by locomotive radio between the traincrew and the dispatcher. The frequency was also used for "end to end" communication, or communication by hand-held portable radio between the conductor and the rest of the traincrew The dispatchers were in San Bernardino.

Operational Information

Work/Rest Cycles.--ATSF operating employees used their seniority to place themselves in available work positions. The positions were in freight pool service, in yard service, on routinely operated local trains, or on an extra board.[15] Employees assigned to yard and local train service had schedules that were generally based on preestablished starting times.

The Safety Board obtained a list of the duty times for the engineer of train 818 during the 90-day period (August 8 to November 6) before the accident. On August 8, 9, and 10, he worked in pool service. On August 11, he laid off on personal leave before beginning a vacation that lasted 22 days, from August 12 until September 2.

He notified the carrier that he was available for service at 12·01 a m on September 3 He got his first train on September 5 and remained in pool service through September 16. On September 17, he transferred to the extra board and remained on it through October 7, when he transferred back to pool service. From October 7 until November 6, he worked nearly every time the pool rotation made work available.

In the 64 days from September 5 through November 7, he worked 47 calendar days His tours included 3 in yard service and 53 in road service;[16] of the 56 tours, 7 were deadheaded. On seven occasions, he had two tours of duty that started on the same calendar day. (See figure 4)

He laid off 1 day on personal leave, 2 days sick, and 2 days while on call[17] at his home terminal. The carrier did not discipline him either time for marking off while on call. Investigators noted that his average time on duty when he operated a train was 7 hours 18 minutes. His average deadhead time was 2 hours 41 minutes. His off-duty time between trips at his home terminal ranged from 11 hours 45 minutes to 96 hours, the average time was 33 hours 12 minutes. His off-duty time at his away-from-home terminal ranged from 2 to 27 hours; the average was 11 hours

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[15]Extra board engineers fill in temporary vacancies created when other employees lay off for any reason These vacancies occur in freight pools, yard service, and local trains

[16]Road service is the movement of freight over the railroad from one terminal to another.

[17]An employee is considered to be on call 24 hours a day If he lays off--says he cannot work--without giving the carrier 8 hours notice, he is said to be "laying off on call "

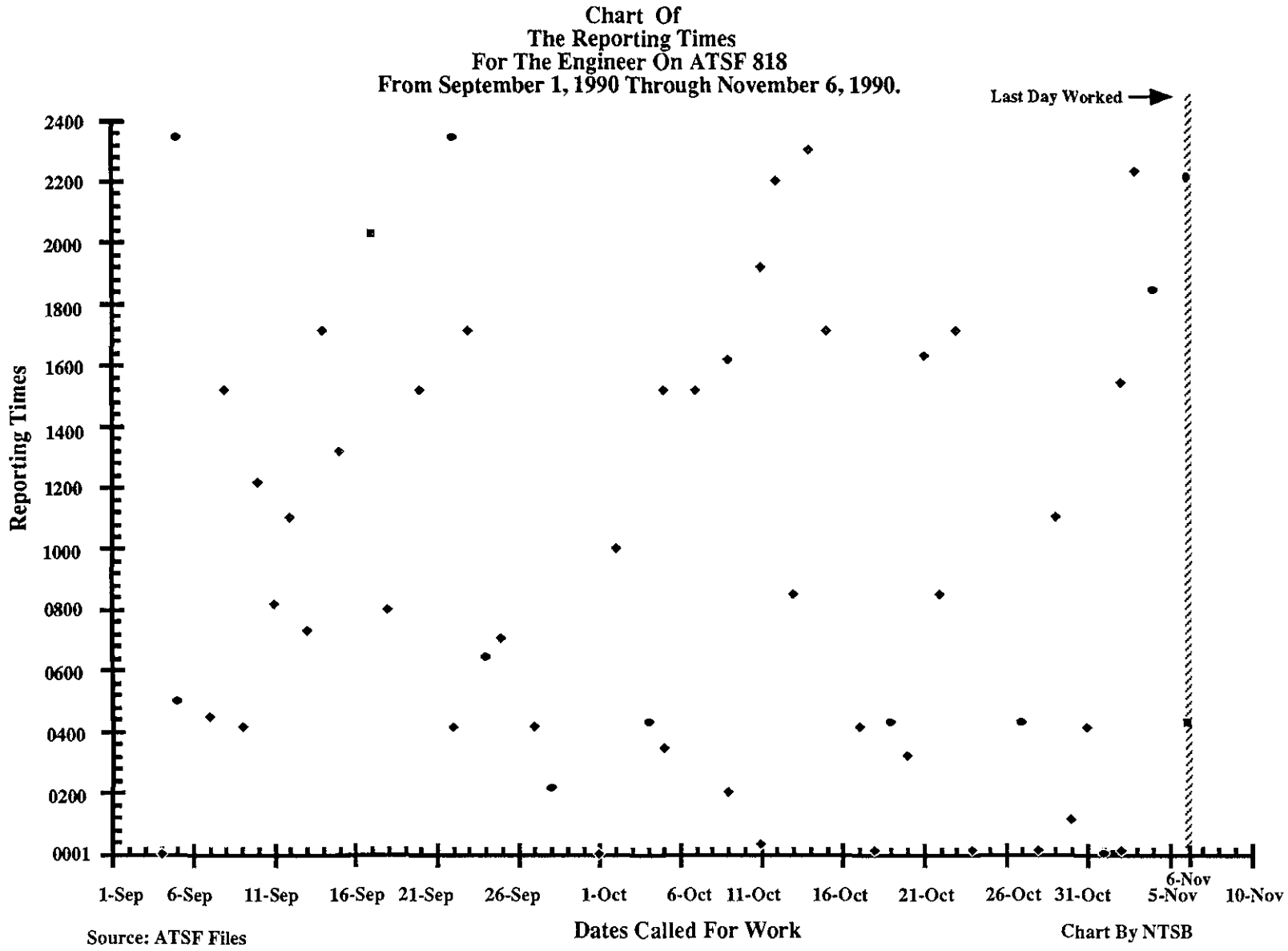

Figure 4.-- Reporting times for the engineer of train 818 from September through November 1990.

33 minutes Figure 5 shows the engineer's reporting times at both Hobart and Barstow yards.

Figure 4 illustrates the variation in his reporting time during the 64 days before the accident On April 1, 1989, Hobart yard became the home terminal for operating personnel, including the engineer of train 818, whose home terminal had been San Bernardino He continued to live in the San Bernardino area; his commuting time increased from 10 or 15 minutes to, depending on the traffic, 1 1/2 to 2 1/2 hours.[18]

When he was in Barstow, he stayed at an ATSF-contracted motel about 5 minutes away from the terminal. He received his calls, on the average, 1 hour 5 minutes before his reporting time.

Operations.--The ATSF is among the 41 railroads that are signatories of the General Code of Operating Rules. (See appendix C for a listing of the rules referred to in this report that are in the General Code)

At San Bernardino, the main track split into the San Bernardino and Pasadena subdivisions, which were reunited at Los Angeles. The ATSF manager of operations (MOP) testified that an average of 18 to 20 freight trains and 2 Amtrak passenger trains traveled through the Corona station area in a 24-hour period. Through trackage rights agreements, both Amtrak and Union Pacific Railroad trains traversed the San Bernardino subdivision east of Riverside

According to the ATSF timetable, the maximum authorized speed for freight trains on both the Cajon and the San Bernardino subdivisions was 55 mph On both subdivisions a train was restricted to 45 mph if it either weighed more than 7,000 trailing tons or had more than an average of 90 tons per operative brake. Train 818 had a total of 8,616 trailing tons.

The Corona siding paralleled the main line for the siding's entire length, 8,507 feet. The ATSF timetable showed the Corona siding with 8,370 feet of clearance[19] available for safe train operations.

The Corona siding was intersected by four grade crossings. (See figure 1) The first was Main Street, which was 565 feet from the east switch. The second was Sheridan Street, which was 1,786 feet from the east switch The third and fourth were Cota Street and Railroad Avenue, which were, respectively, 2,914 feet and 8,272 feet from the east switch

According to the ATSF timetable, the authorized speed through the Corona siding was 15 mph.

The General Code of Operating Rules specifies the actions that are to be taken when one train is met or passed by another. Rule 89 states that "when a train is met

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[18]Because employees living in San Bernardino had so far to travel and because traffic congestion in the Los Angeles area was often so bad, the carrier tried to give employees called for duty at Hobart yard 2 1/2 to 3 hours notice of their reporting times The engineer of train 818 received his calls when he was home 2 hours 32 minutes, on the average, before his reporting time

[19]The clearance is the area in which rolling stock and locomotives can safely clear structures and equipment on adjacent tracks

	From Hobart Yard							From Barstow			
Day	Date	Reporting Time	Time on Duty Hour	Min		Day	Date	Reporting Time	Time on Duty Hour	Min	
Wed	5-Sep	5:00 AM	5	35		Wed	5-Sep	11:45 PM	8	40	
Fri	7-Sep	4:45 AM	7	30		Sat	8-Sep	3:15 PM	2	30	
						Sun	9-Sep	4:15 AM	6	30	
Mon	10-Sep	12:15 PM	5	30		Tue	11-Sep	8:15 AM	6	30	
Wed	12-Sep	11:00 AM	8	5		Thu	13-Sep	7:30 AM	6	30	
Fri	14-Sep	5:15 PM	5	15		Sat	15-Sep	1.15 PM	6	30	
Sun	16-Sep	Called 1449	Laid Off On Call								
Mon	17-Sep	8:30 PM	2	10	Dead Head	Tue	18-Sep	8:00 AM	6	40	
Thu	20-Sep	3:15 PM	8	50	Yard Job						
Sat	22-Sep	4:15 AM	7	25		Sat	22-Sep	11:45 PM	5	45	
Sun	23-Sep	5:15 PM	5	30		Mon	24-Sep	6:45 AM	7	0	
Tue	25-Sep	7:05 AM	12	0							
Thu	27-Sep	4:15 AM	6	0		Fri	28-Sep	2:15 AM	7	45	
Sat	29-Sep	Called 1139	Laid Off Sick								
Tue	2-Oct	10:00 AM	12	0							
Thu	4-Oct	4:30 AM	9	30		Fri	5-Oct	3:45 AM	3	15	Dead Head
Fri	5-Oct	3:15 PM	8	0	Yard Job						
Sat	6-Oct	Called 0415	Laid Off On Call								
Sun	7-Oct	3:15 PM	8	0	Yard Job						
Tue	9-Oct	2:00 AM	4	50		Tue	9-Oct	4:15 PM	2	20	Dead Head
Thu	11-Oct	12:30 AM	4	0	Dead Head	Thu	11-Oct	7:15 PM	2	30	Dead Head
Fri	12-Oct	10:00 PM	2	20	Dead Head	Sat	13-Oct	8:45 AM	6	45	
Sun	14-Oct	11:00 PM	2	30	Dead Head	Mon	15-Oct	5:15 PM	6	30	
Wed	17-Oct	4:15 AM	10	0		Thu	18-Oct	12:15 AM	5	45	
Fri	19-Oct	4:30 AM	10	0		Sat	20-Oct	3:20 AM	5	25	
Sun	21-Oct	4:30 PM	5	45		Mon	22-Oct	8:45 AM	7	15	
Tue	23-Oct	5:15 PM	5	0		Wed	24-Oct	12:15 AM	5	0	
Thu	25-Oct	Called 3:00 AM	Laid Off Personal								
Sat	27-Oct	4:30 AM	7	0		Sun	28-Oct	12:15 AM	8	5	
Mon	29-Oct	11:00 AM	6	15		Tue	30-Oct	1.15 AM	6	55	
Wed	31-Oct	4:15 AM	8	30		Thu	1-Nov	12:01 AM	7	0	
Fri	2-Nov	12:15 AM	7	25		Fri	2-Nov	3:45 PM	6	30	
Sat	3-Nov	10:30 PM	6	50		Sun	4-Nov	6:45 PM	12	0	
Tue	6-Nov	4:30 AM	8	10		Tue	6-Nov	10:15 PM	Collision At Corona at 4:10 AM		
Source : ATSF										Chart By NTSB	

Figure 5 -- Reporting times for the engineer of train 818 at Hobart Yard and Barstow

or passed it must stop and remain not less than 400 feet from the signal or clearance point of a facing point switch over which a train may pass, if length permits."

In accordance with part 217.9 of Title 49 of the Code of Federal Regulations (CFR), the ATSF had an efficiency testing policy for testing operations employees on their knowledge of and compliance with its operating rules, timetable information, and special instructions. The policy included guidelines for 35 different tests, 5 of which were about restrictive blocks and interlocking signals One of the tests included operating rule 34, "Observe and Call Signals," which required crewmembers to call signals to each other when they rode in the controlling locomotive

According to the ATSF regional manager, "most supervisors were required to make efficiency tests each month." In 1990, supervisors in the subdivision performed 9,000 efficiency tests. About 10,000 trains traversed the subdivision during that period of time. The regional manager said that 25 percent of the tests were performed at night

All crewmembers involved in the accident, with the exception of the brakeman on train 818, had been tested during the year before the collision. The engineer had taken 76 tests He passed all of them, including two that were restrictive block signal tests. The conductor of train 818 had taken 24 tests with no failures. The engineer of train 891 had taken 36 tests, with 3 failures; the conductor had taken 70 tests, with 1 failure; and the brakeman had taken 54 tests, with 3 failures. Cumulatively, the five employees had taken 260 tests

ATSF maintained hours-of-service records for all crewmembers involved in the accident. These records were in compliance with 49 CFR Part 228.11.

The ATSF MOP testified that the carrier attempted to post a list of trains going on duty on a 4-hour rotation via the ATSF system called VIPS The ATSF tried to have the train line-up rotation information available at 1, 5, and 9 a m and 1, 5, and 9 p m.

The ATSF regional manager testified that on November 6, the STO decided on the train line-up from Barstow to Hobart at 4:17 p.m and decided which crews were to be deadheaded at 5·15 p m. The STO testified that on Tuesdays, and sometimes on Wednesdays, crews were "invariably deadheaded due to traffic cycles."

The crew calling office listed on VIPS those crews being deadheaded at 5.28 p m The engineer for ATSF 818 had last checked the crew board when he went off duty at 12 40 p.m

By contractual agreement, the ATSF was required to issue "penalty pay" to employees that were held at their away-from-home terminal 16 hours beyond the time they went off duty. The carrier tried to avoid this occurrence whenever possible.

Rule G of the General Code stipulated the carriers' prohibition of alcohol and narcotics on their property. See appendix C for a complete definition of the rule.

Meteorological Information

According to the National Weather Service, the ambient air temperatures ranged from 56° F to 61° F at the time of the collision Winds ranged from 12 to 19 mph; gusts ranged from to 21 to 25 mph. Temperature readings and wind observations were taken at the three airports nearest the accident site

A security guard who had been near the scene of the accident reported on local wind conditions He described winds from the northeast at 0 to 30 mph, "gusting on and off and blowing a lot of dust."

The conductor of train 891 indicated it was clear and breezy in the vicinity of the accident When specifically queried about the presence of blowing dust, he said, "I don't believe so There might have been some, but not enough to obstruct the visibility." He reported that blowing dust was not an obstacle to his seeing the signal.

Also interviewed were responding police officers, who reported a clear night with a breeze Neither officer noted that his vision of the collision scene was impaired by dust

Medical and Pathological Information

ATSF 818

Engineer.--According to the ATSF medical files, the engineer received his last physical examination on March 23, 1990 He was physically fit for duty and was issued a class I (unrestricted) medical certificate As part of his last two physical examinations, his urine was screened for drugs, none were found His uncorrected vision was 20/15 (distant) and 20/10 (near), he had normal color vision in both eyes His hearing was normal.

Conductor.--The conductor suffered from gastritis, which he had been treating with a prescribed drug called Zantac He took the drug only as needed, which, during the past 4 years, was infrequently. He had also suffered from headaches during the past year, which his personal physician attributed to stress His wife said that he had not been ill before his November 6 tour to Barstow, nor had he mentioned his health in the conversation he had with her while he was there

According to the ATSF medical files, the conductor received his last physical examination on April 19, 1990 He was physically fit for duty and was issued a class I (unrestricted) medical certificate During his last two physical examinations, his urine was screened for drugs, none were found. His vision, corrected through the use of glasses, was 20/20, he had normal color vision in both eyes His hearing was last tested on October 5, 1989, he had difficulty hearing high frequency sounds. According to the ATSF medical director, the conductor's hearing was not outside the standards set by the American Academy of Audiolaryngology and did not preclude him from performing his duties.

Brakeman.--The ATSF medical files indicate that she received her last physical examination on October 17, 1990 She was physically fit for duty and was issued a class I (unrestricted) medical certificate During her last physical examination, her urine was screened for drugs, none were found Her uncorrected vision was 20/20

(near) and 20/22 (distant) Her color vision in both eyes was normal. She had a hearing test on October 25, 1990, and was found to have normal hearing

ATSF 891

Engineer.--The ATSF medical files indicate that the engineer received his last physical on March 23, 1990. He was found physically fit for duty and was issued a class I (unrestricted) medical certificate As part of his last physical examination he underwent urine drug screening; the results were negative His uncorrected vision was 20/50; corrected by glasses, it was 20/20 in his right eye and 20/25 in his left eye. He had normal color vision in both eyes During his last hearing test, a slight difficulty in hearing high frequency sounds was detected in his right ear.

Conductor --The conductor had reported that he was not sick on the day of the accident. He was taking two types of medicine The first was Allopurinol, which was prescribed for gout The carrier knew that he was using the drug The second was Motrin, an over-the-counter drug, which he took for his arthritis. He had taken his normal dose of Allopurinol on the day of the accident and had taken a half dose (400 mg) of Motrin about 4 hours before the accident

According to the ATSF medical records, his last medical examination was on January 2, 1990. He was in good health and was issued a class I (unrestricted) medical certificate His distance vision was 20/20 uncorrected in his left eye and 20/25 uncorrected in his right eye, his color vision was normal in both eyes. He had difficulty hearing high frequency sounds with his left ear The examination included a drug screening, and the results were negative.

Brakeman --According to the ATSF medical file, he had his last physical on November 7, 1989. He was physically fit for duty and was issued a class I (unrestricted) medical certificate. His drug screen was negative. His uncorrected vision was 20/20, and he had normal color vision in both eyes. His last hearing test indicated that he had some difficulty hearing high frequency sounds with his left ear

Injuries

Fatal --According to the Riverside County coroner's office, the three crewmembers on train 818 died from smoke inhalation and thermal burns. The evidence of smoke inhalation was "soot in the airways " The autopsy surgeon further reported that the brakeman's blood was "cherry red," indicating "carbon monoxide intoxication." The autopsy report on the fourth fatality, the brakeman on train 891, stated that he died of a severe head trauma

The engineer of train 818 suffered extensive thermal burns, diffuse charring of his body, and asphyxiation by smoke inhalation. His body was found approximately 20 feet northeast of the right rear corner of train 818's first locomotive.

The conductor of train 818 suffered extensive thermal burns, charring of his entire body, and asphyxiation by smoke inhalation He had multiple injuries, including lacerations of the liver, fractures of the right third through tenth ribs, contusion of the right lung, and subdural and subarachnoid hemorrhages His body was found about 15 feet west of train 818's lead locomotive on the south side of the main track.

The brakeman of train 818 suffered extensive thermal burns, charring of her body, and asphyxiation by smoke inhalation. Her body was found about 20 feet west of train 818's lead locomotive on the south side of the main track.

The brakeman on train 891 suffered a fracture to the base of the skull, brain stem contusion, subdural and subarachnoid hemorrhages, extensive thermal burns, and charring of the body His body was found in the control compartment of the train's third locomotive unit

Survivors.--The engineer of train 891 sustained a concussion, an open fracture of the right kneecap, and lacerations of the head and face The conductor of train 891 sustained bilateral comminuted fractures of the distal tibia and the fibula, resulting in both ankles being broken Both surviving crewmembers were hospitalized.

Toxicology for Drug Testing

In compliance with 49 CFR Part 219, subpart C, blood and urine samples were collected from the survivors of train 891 and from the ATSF dispatcher In addition, tests were conducted on those who died.

The toxicology on the fatally injured crewmembers was reported by BioTox Laboratory. The carboxyhemoglobin (COHb) levels in three of the crewmembers of train 818 were less than 5 percent saturation; in the crewmember of 891, it was 6 percent BioTox Laboratories sent the blood specimens to Poison Laboratory, Inc , a clinical laboratory, for COHb analysis. According to telephone conversations with the chief toxicologist at Poison Laboratory, he was unaware that the specimens were from fatally injured persons or that they were victims of a fire.

Blood and urine from all crewmembers and tissue specimens from the fatally injured were sent to CompuChem Laboratories to be tested for drugs. In addition, the Safety Board sent blood and urine from all crewmembers to the Center for Human Toxicology (CHT) Neither laboratory found any evidence that any of the fatally injured crewmembers had taken illegal drugs.

CompuChem reported that the urine taken from the conductor of train 891 contained 2,430 ng/ml of morphine No morphine was found in his blood. The conductor had received morphine for pain between 8 a m. and 9.35 a m. on November 7. His blood and urine samples were collected at about 1 p m., almost 9 hours after the accident The CHT detected a morphine concentration in his urine of 12,000 ng/ml Using a cut-off level of 40 ng/ml, it did not detect morphine in his blood.

Blood and urine were collected from the engineer of train 891 at about 3:30 p.m., 11 hours after the accident CompuChem reported that his urine was positive for methamphetamine and amphetamine at concentrations of 457 ng/ml and 88 ng/ml, respectively At the methamphetamine cut-off level of 50 ng/ml, his blood was negative. The CHT reported that his urine contained 587 ng/ml of methamphetamine, 117 ng/ml of amphetamine, and 8 ng/ml of the acid metabolite of marijuana. Although CompuChem analyzed his blood, CHT did not have enough of his blood to analyze.

The medical file on the engineer of train 891 revealed that his urine had tested positive for marijuana and methamphetamine on three occasions before the accident. The following chronology on drug testing results was constructed from his medical file.

	Date	Results of Urine Tests	Comments
1	April 7, 1988	(+) for THC, Amphetamine, and Methamphetamine	Required to submit drug-free urine within 90 days
	April 22, 1988	(-) for drugs	Returned to duty on condition that he submit to being randomly tested for drugs, timing would be announced to him by certified mail
	April 28, 1988		Placed back in service
2	Dec 14, 1988		Requested by certified letter to have urine tested
	Feb 22, 1989		Accepted hand-delivered certified letter
	Feb 24, 1989	(-) for drugs	
3	June 15, 1989		Requested by certified letter to have urine tested
	July 27, 1989		Accepted hand-delivered certified letter
	July 31, 1989	(+) for THC	
	August 7, 1989		Put on medical leave and required to produce drug-free urine in 90 days
	August 15, 1989	(-) for drugs	
	August 18, 1989		Evaluated by EAP counselor as not chemically dependent
	August 28, 1989		Placed back in service
4	Dec 5, 1989		Requested by certified letter to have urine tested
	Dec 19, 1989		Hand delivery of certified letter
	Dec 22, 1989	(+) for THC	Required to provide drug-free urine within 90 days
	Jan 2, 1990		Put on medical leave
	Feb. 13, 1990		Provided urine but specimen container broke during shipment

Date	Results of Urine Tests	Comments
March 1, 1990		Evaluated by drug counselor as not chemically dependent
March 23, 1990	(-) for drugs	
April 25, 1990		Placed back in service

5. No further drug testing until accident

The "unannounced" notification to submit to urine drug testing was done by certified letter from the Chicago office of ASTF's medical director. Upon receipt of such a letter, the engineer was required to report to a specified laboratory within 5 calender days to provide a urine specimen. In the above chronology, the minimum number of days between the date on which the letter was certified and the date on which the engineer provided a urine specimen was 17

Drug Policy

In compliance with 49 CFR Part 219, the ATSF had a drug policy that was on file with the FRA. At the time of the collision, if a carrier's physician giving a routine physical discovered that the employee was taking drugs, he did not have to report the finding to Federal officials Nevertheless, the ATSF did take steps if a routine physical showed that an employee was taking drugs. The ATSF drug policy forced the employee to take a medical leave of absence, as the engineer of train 891 had done, until he produced a drug-free urine sample He could be required to submit to an evaluation by a counselor belonging to the ATSF Employee Assistance Program (EAP)

The ATSF drug policy addressed the medical examination situation as follows.

> 6.0 Medical Examinations
>
> All return-to-service, periodic and other employee medical examinations provided for by the Medical Director-System include a urine drug screen analysis.
>
> 6.1 Urine Tests
>
> Individuals examined under provision of Section 6 0 whose urine tests positive for substance, the use of which is prohibited by Federal Railroad Administration regulations, will be placed on medical leave of absence Subsequently, these employees will be instructed in writing to rid their system of drugs and within 60 days must.
>
> 1) undergo evaluation by the EAP counselor,
> 2) abide by the counselor's recommendations,
> 3) provide a negative urine specimen.

> An employee in a treatment program extending beyond the 60 day period must provide a negative urine specimen within five (5) days of discharge from the program Failure to abide by these conditions will subject the employee to dismissal for disobeying instructions.
>
> A decision by the Medical Director-System to withhold an employee from service under Section 6 of this policy is not and shall not be considered discipline
>
> 6.2 Follow-Up-Testing
>
> An employee who provides a negative urine specimen and has been permitted to return to service is subject, for a period of two (2) years, to urine testing as determined by the Medical Director-System If such further testing is positive, the employee will be placed on medical leave of absence. Such an employee will be subject to the same conditions set forth in Section 6.1.

On March 1, 1991, the ATSF issued a new drug policy, any employee could be fired the second time that tests, including those given during a routine physical, showed that he had been taking drugs

Fire

A postcollision fire enveloped both equipment and personnel. The fire was fed by diesel fuel that spilled from two ruptured locomotive fuel tanks Some of the fuel had been sprayed into the air, making it highly combustible.

Postaccident Damage Examination

The on-site investigation did not reveal any anomalies in the braking system of either train

The left front end sill area of the lead locomotive on train 818 collided with the left front end sill area of the lead locomotive on train 891 The lead locomotive of train 818 incurred damage due to the collision and subsequent fire The superstructure of its control compartment had sustained thermal damage and showed crush damage from the front end sill rearward for approximately 15 feet The locomotive remained on its trucks in the turnout on the west end of the siding, and its fuel tank was intact. (See figure 6) The first, third, fourth, and fifth locomotives of train 818 had derailed

The electrical switches in the control cab were burned, but investigators were able to document the following. rear headlight switch off, gauge lights on, front headlight on in dim position, generator field switch not discernible, engine run switch not discernible, side wall heater switch on high, and throttle next to the "idle stop" position The brake systems of all units were also inspected and found to be functioning as designed.

In an attempt to determine the approximate point of the emergency air brake application, investigators measured from the initial discharge of air brake sand to the collision point The sand trail began approximately 60 feet before the collision point The sanding system sequence is designed to automatically begin to

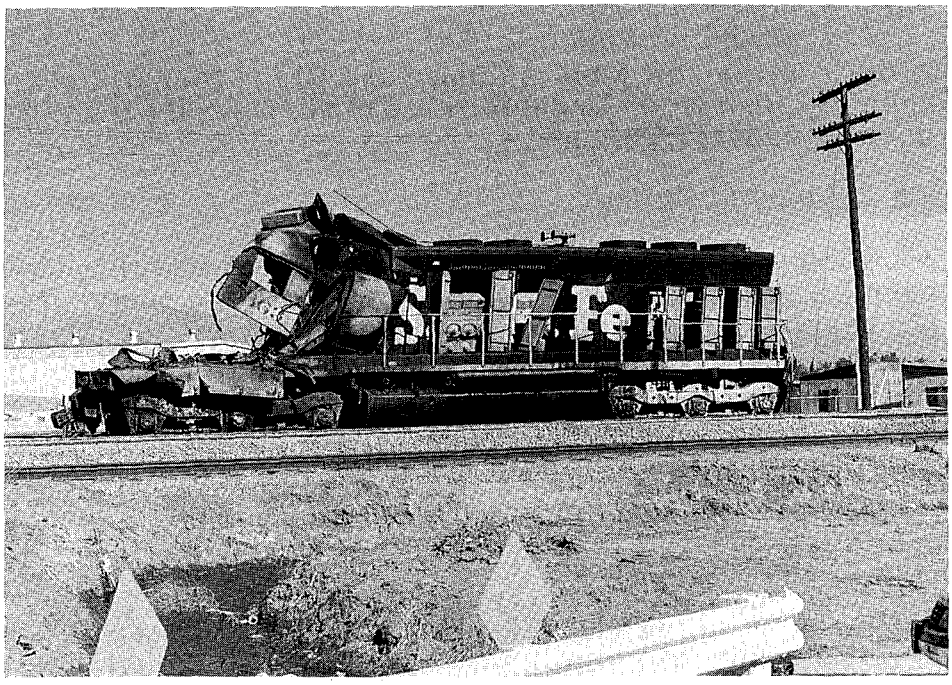

Figure 6.--Postaccident photographs of train 818's lead locomotive.

discharge its contents when an emergency brake application is initiated. There is an inherent time lapse within the system.

The 12th, 13th, and 14th rail cars were involved in a derailment that was subsequent to the collision.

All three locomotives on train 891 derailed, as did the first, second, third, and fourth rail cars The 31st rail car subsequently derailed due to the collision

The lead locomotive of train 891 showed minor damage on its left front; its pilot, fuel tank, and both trucks separated from its underside It also had collision marks 57 1/2 inches inboard on the left side of the 119-inch wide locomotive pilot/snowplow. Paint marks on the left side of its nose were the same color as the paint on the lead locomotive of train 818. Investigators noted that the unit had been hit on the front-end sill area and that the first impact was on the underframe of the anticlimber system.

The second locomotive of train 891 showed major thermal damage. Its "B" end (rear end) was bent downward and pushed forward. The left side showed moderate crush damage, and the left side of the control compartment's roof had collapsed downward approximately 10 inches. The interior of the control compartment was completely destroyed by fire. Both trucks had separated from the underside, the fuel tank, although ruptured, remained attached to the underframe.

The third locomotive of train 891 also showed major thermal damage. The left side of the control compartment showed moderate crush damage The interior of the control compartment was completely destroyed by fire and the fuel tank remained attached to the underframe and was ruptured. Both trucks had separated from the locomotive.

The collision damaged the main track and the Corona siding. Approximately 135 feet of the main track were damaged, as were 291 feet of the track and a number 10 turnout in the siding. The switch points and connecting rods of the west end siding turnout were also damaged.

The positions of all relays of the signal system were documented. When the positions were checked against the signal circuit plans, it was noted that signal 2R, the signal governing train 891's progress, was displaying a green aspect and that signal 2LB, the signal governing train 818's movement, was displaying a red aspect.

Signal 2LB had been struck before the accident, causing its mast to lean toward the track at about 5 degrees from vertical. No equipment or debris resulting from the collision was found in the vicinity of the signal

The power-operated switch machine was undamaged and mechanically locked in the normal position, lined for main track traffic; the normal indication contacts were closed

The wig-wag grade crossing signal was about 80 feet east of the collision point and was still activated when investigators arrived on the scene 12 hours after the collision.

Survival Aspects

Emergency Response --About 4·15 a.m the Corona police and fire dispatcher received a telephone call from a private citizen about a rail car fire in the area of Railroad Avenue and Smith Street. The accident was simultaneously reported to the California Highway Patrol by the Corona police Between 4:15 a.m and 4.24 a.m., one battalion chief, four fire engines, one rescue unit, and one ambulance were dispatched to the scene The fire, except for the burning cargo, was under control within an hour.

The Corona police department also responded. According to the police report, 17 units with 18 supervisors and officers were initially dispatched to the accident site. Their duties included documenting the scene, interviewing witnesses and train crewmembers, and controlling the traffic and the accident site perimeter

By 4:29 a.m., the police and fire departments had established a joint command post at the 1300 block of Railroad Avenue. The post was staffed until the afternoon of November 9 The fire chief was the incident commander

Crashworthiness --None of the locomotives involved in the accident sustained a direct frontal impact. No survivable space was left in the control compartment of the lead locomotive unit on train 818 as a result of the accident The bulk of the damage to the conventional cab of this unit was caused when train 891's third locomotive came to rest on top of the control cab of the lead unit on train 818

The North American cab locomotive on train 891 maintained its structural integrity throughout the collision No intrusions were noted to the cab areas of the GP-60M locomotives other than a minor dent in the roof area on the engineer's side of the lead unit, which was the result of the locomotive's falling on its side. There was survivable space for all occupants in the control compartments of the GP-60M locomotives

Pipeline Information

Natural Gas Pipeline --The ATSF main track at Corona was flanked on its north side by a 30-inch diameter natural gas pipeline that belonged to the Southern California Gas Company. At the time of the accident the line pressure was 554 pounds per square inch in gauge (psig)[20] The line was still under pressure when the investigating team arrived on the scene and was shut in[21] at 1 10 a.m. on November 8.

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[20]Gauge pressure is the difference between the total absolute pressure and the atmospheric pressure (14 7 pounds per square inch absolute)

[21]A segment of pipeline is considered to be shut in when pressurized liquid or gas is contained within the segment by closed valves

Petroleum Pipeline.--A 16-inch diameter crude oil transmission pipeline operated by the Four Corners Pipe Line Company flanked the south side of the main track. It was shut down[22] at 7 a.m on the day of the accident

Tests and Research

On November 21, two members of the mechanical group and designated personnel from the FRA and the ATSF met at the ATSF Topeka, Kansas, air brake shop to examine and test the air brake equipment from the lead locomotive of train 818 The automatic brake valve was removed and examined. Investigators found that the automatic brake handle shaft inside the engineer's stand was in the emergency position. ATSF records indicated that predeparture air brake tests and safety appliance inspections had been conducted at Barstow and Hobart yards and that both trains were in compliance with applicable railroad and FRA requirements

The horns from the lead locomotives of both trains were also tested by investigators and were found to be operational.

The Safety Board and the ATSF, using the Association of American Railroads Technical Center (AARTC) in Chicago, ran computer simulation tests to determine how the time required for each train to come to a complete stop varied according to its speed. Ten tests were made on a simulated train 818; during the tests, the speed of the train ranged from 4 to 8 mph Twelve tests were made on a simulated train 891 with speeds ranging from 25 to 35 mph. All 22 simulations took into consideration the tonnage and length of the trains, as well as the degree of grade of the respective tracks

The tests showed that when the speed of train 818 was between 4 and 6 mph, it required a minimum of 32 feet and a maximum of 116 feet to come to a complete stop after the emergency brake application.

According to the testimony of the conductor of 891, the train was about 5 car lengths (a car length is about 75 feet), or about 375 feet, west of the 2R signal when the engineer noted that the signal had changed to a red aspect. The train traveled 44 feet before the engineer was able to do anything, assuming that it took him 1 second to react and initiate emergency braking and that the train's speed was about 30 mph

The reaction of the air in an emergency braking application within the train's braking system was at a rate of 930 feet per second. Since train 891 was 4,229 feet long, it would have taken about 4 1/2 seconds for the air to travel from the lead locomotive to the last rail car Tests showed that at 30 mph, train 891 would have required between approximately 870 and 990 feet to come to a complete stop after the emergency brake application.

Sight Distance --On November 9 at 5.10 a m , the Safety Board conducted sight/distance tests at the accident location It was dark, clear, and calm; and the temperature was about 50° F. The same kind of locomotives were used as those

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[22]A segment of pipeline is considered to be shut down when pumps or compressors have been stopped and pressure in the pipe remains constant

that the train had on the night of the accident. The tests showed that when train 818 was in the siding, the stop signal could be seen at a distance of 1,391 feet.

The maximum distance from which crewmembers of train 891 could have first seen the headlight of train 818 was over 1,300 feet west of the collision point

Signal System --Although signal 2LB was leaning south, its focal point was clearly visible even in darkness at a distance of over 1,300 feet An electrical breakdown test of all control circuitry at west Corona was conducted on November 7, and no defects were found.

The control circuitry for operating the two wig-wag crossing warning signals at Railroad Avenue was also tested and found to be functional

On November 9, a breakdown test of the signal system was conducted that included clearing signals, simulating the reversing of the switch, and simulating train moves. The signal system functioned as designed and within the guidelines of the FRA rules and regulations governing railroad signal and train control systems No defects were found

Event Recorders.--On the day of the accident, ATSF personnel removed the event recorder data pack from train 818 and sent it to their Barstow engine facility. The next day, at the request of the Safety Board, the carrier gave the data pack to the investigator-in-charge, who in turn sent it to the Safety Board's laboratory in Washington, D.C.

The event recorder was on the fifth locomotive, it used a magnetic tape and recorded eight events. The events recorded were time, speed, locomotive amperage, direction of travel, automatic brake pressure, locomotive brake application, throttle, and dynamic brake application.

The Safety Board's laboratory noted that the dynamic braking was off, the throttle had dropped to zero, and an emergency application was made to the train's braking system just before the collision. The laboratory also noted that the train's speed was about 14 to 15 mph from the time train 818 entered the siding until about 2 1/2 minutes before the collision, approximately 10 to 15 seconds before the collision, its speed decreased to about 5 to 6 mph .

The event recorder data did not indicate whether the emergency application was initiated by the automatic brake valve or by the emergency brake valve. After the emergency application was made, the train moved about 80 feet west and either had stopped or was about to stop at the time of collision. According to the laboratory, there was a variable time lapse of 5 3/4 to 11 1/2 seconds between the time that certain events took place and the time they were recorded The time lapse was in accordance with the manufacturer's specifications The events affected by the time delay were throttle movement, automatic brakes, locomotive brakes, and direction of travel.

Between the San Bernardino yard and the east switch of the Corona siding (approximately 22 miles), the speed of the train exceeded 45 mph (maximum authorized train speed) 13 times.

The event recorders on train 891 were destroyed in the fire They were housed in a metal container designed by the manufacturer and located in the vestibule of the control compartment.

Information about how the train had been handled was derived from the conductor's testimony Consequently, vital information about such topics as braking, throttle manipulation, and the chronological relationship of events before the accident was not available.

Natural Gas Pipeline --On November 7, the Southern California Gas Company (SCGC)transmission department surveyed for extensive leakage and did a pothole inspection in the vicinity of the collision

On November 9, while the line was out of service, (SCGC) made a hydrostatic test on that portion of the line in the derailment area

Petroleum Pipeline --The Four Corners Pipe Line Company (FCPLC) shut down its line and replaced 115 feet of the line that was in the vicinity of where the lead locomotive of train 891 landed Both pipelines were undamaged by the collision

Other Information

Pipeline Notification --The ATSF did not directly notify either pipeline operator of the accident. The natural gas line operator was notified by the Corona police department, and the petroleum operator was notified by the California State Fire Marshal's office. According to the ATSF, it did not notify the operators because it knew they had been notified by the fire and police departments.

An emergency accident response form was used by the MOP or the STO on duty when an incident occurred as a checklist and an informational tool (See appendix F)

On the form, the western region was organized according to mile post reference points When an accident occurred, the MOP or STO referred to the form for the names of the emergency and carrier personnel who were responsible for the area affected by the incident The form did not include the telephone numbers of either the SCGC or the FCPLC

Locomotive Fuel Tank.--The integrity of locomotive fuel tanks has been compromised in several recent accidents [23]

During the postaccident investigation of this collision, the Safety Board noted that the fuel tanks on both the first and third locomotives of train 891 were ruptured and that their contents had been released. During the collision, one tank had been punctured by a set of wheel trucks, and the other had been ruptured either by debris or by the impact of landing on top of the lead locomotive of train 818.

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[23]The accidents investigated by the Safety Board in which locomotive fuel tanks were compromised were Sugar Valley, Georgia (DCA90MR008), Baker, Oregon (LAX90FR015), Roebuck, South Carolina (NYC91FR004), Lompoc, California (LAX91FR009), and Baltimore, Maryland (NYC91FR019)

The exterior shells of the fuel tanks were made of 3/16-inch mild steel with 1/2-inch end plates The tanks were installed between the wheel trucks underneath the locomotives' underframes.

The Safety Board questioned the EMD representative about past studies pertaining to the crashworthiness of fuel tanks. The EMD's senior project engineer testified that his company ". . . had been doing some investigation on the possibilities in trying to develop a tank that would limit the amount of spillage. But, it's an extremely difficult and complicated arrangement, and that's about as far as we've gone at this point "

The Safety Board asked both the FRA and the Association of American Railroads (AAR) about fuel tank crashworthiness and was unable to find any data pertaining to this subject

Positive Train Separation System.--Railroad collision avoidance has been one of the most frequently discussed issues at the Safety Board. Since the 1970s, the railroad industry has been studying how the new technology in computers and communications could be used in train control systems to prevent one train from colliding with another. Canadian and U.S. railroads have jointly examined this idea; and the AAR currently manages the project. The project is called the advanced train control system (ATCS)

Several U.S. railroads have actively pursued the matter and have experimented with systems on their respective properties These systems use on-board computers to monitor the actions of a train and automatically stop a train if the engineer fails to comply with a signal. Neither train 818 nor train 891 had a computerized collision avoidance system.

ANALYSIS

General

Neither the track nor the wayside signal system was a causal factor in the accident. Neither the locomotives nor the rolling stock of the trains had mechanical defects that would have contributed to the accident.

The train crewmembers were qualified for their positions The physical and medical conditions of the conductor and the brakeman of train 891 were not factors in the accident

Accident

Train 891 was traveling east on the main track approaching Corona and operating in accordance with the carrier's timetable.

At the same time, train 818 was traveling west. It entered the Corona siding, which was adjacent to the main track, at a speed of 15 mph According to the event recorder printout, from about 7 1/2 minutes before the collision until about 2 1/2 minutes before the collision, the train averaged about 14 to 15 mph; and then its speed gradually decreased to about 6 mph about 10 to 15 seconds prior to the collision. An emergency brake application was made after train 818 passed the 2LB dwarf signal about 10 seconds before the collision. Train 818 entered the main

track and blocked the progress of train 891; at 4:11 a.m., the lead locomotives of both trains collided head on

Based on the information from tests done at the AARTC, train 818 could have traveled a maximum of about 116 feet between the time the brake was applied and the time of the collision The Safety Board concludes that if the application occurred when the train was abreast the stop signal, about 120 feet from the main track, the train probably would not have obstructed the clearance of the eastbound train on the main track.

Train 891 was about 375 feet from signal 2R when it suddenly turned red. Tests showed that it would have taken about 830 to 990 feet to come to a complete stop. Therefore, the Safety Board concludes that when the lead locomotive unit of train 818 entered the clearance area of the main track, there was not enough distance between it and train 891 to allow train 891 to come to a complete stop.

Based on event recorder data, the position of the automatic brake valves, and the approximately 60 feet of air brake sand found alongside the lead locomotive, the Safety Board concludes that train 818 had either stopped or nearly stopped at the time of the collision.

Because the engineer, the conductor, and the brakeman of train 818 did not take timely action to stop the train for the stop signal, the Safety Board examined several factors that may have affected their performance. These factors included the work/rest cycles of the engineer and the conductor, the decisions of the engineer and the brakeman about when to sleep, and the decision of the engineer about whether to accept the work assignment.

Work/Rest Cycles

Engineer of train 818 --An extensive examination of the engineer's work/ rest cycle during the 90 days preceding the accident revealed a wide variation in his reporting times. The purpose of the examination was to determine to what extent the fluctuations in his schedule may have affected the events leading to the accident.

Near the beginning of the 90-day period, the engineer took a 3-week vacation, thereby changing his employment-induced work/rest cycle. Consequently, the Safety Board focused on the 64 days from his first day back at work, September 5, through the day of the accident, November 7

The engineer returned from vacation to his previous freight pool assignment, which required him to operate trains between Hobart yard and Barstow. He remained in the freight pool service for 12 days and then transferred to the extra board. He remained on the extra board for 3 weeks, after which he transferred back to freight pool service

During the 64-day period, he worked 47 days, averaging 7 hours 26 minutes on duty in a calendar day However, during the 47 days that he worked, he was called to duty 56 times, meaning that on 7 occasions he worked 2 tours of duty on the same calendar day

His work schedule was irregular, his duty hours ranged from as few as 2 hours 10 minutes (when he was deadheaded) to as many as 12 hours (when he was

operating a train) The amount of rest he had between tours of duty was correspondingly irregular, it ranged from as few as 2 hours to as many as 96 hours.

His work/rest periods were unpredictable In 54 tours of duty, he had 35 different reporting times. During 14 tours, he worked between 8 a m. and 4 p m.; during 15 tours, he worked between 4 p.m. and 12 a.m., and during 25 tours, he worked between 12 a m and 8 a.m.

On 25 occasions he reported to work 8 hours or more later than he had on the previous day, meaning that he changed shifts 46 percent of the time. Figure 4 summarizes this information.

Sleep research suggests that the human body maintains an approximate day-night cycle known as circadian rhythm [24] Researchers have noted the effect of violating the circadian rhythm.

> . the quality and quantity of sleep is degraded and performance is impaired as a result of working at night. These changes are primarily caused by the disharmony between the night worker's schedule and the underlying circadian rhythms of the body The two are completely out of phase The body is programmed to be awake and active by day and asleep and inactive by night, and it is extremely difficult to adjust this program in order to accommodate artificial phase shifts in the sleep-wake cycle.[25]

Thus, the biological clock regulating bodily functions and actual time are out of synchronization for workers with schedules like the engineer's Also, their biological clocks do not adjust quickly or easily to changes in the timing of their sleep that are imposed on them by irregular shift work The engineer hinted at this problem in his 12-minute conversation with the STO when the STO asked him if he had his rest He replied, "Well yeah, we've had what they called rest off, but can you force yourself to lay down and go to sleep when you are not tired?"

Indeed, research[26] has shown that shift workers never fully adapt to irregular night shift routines Workers have difficulty working at night, which the body normally reserves for sleep, and sleeping during the day, when the body is normally awake. When duty times are unpredictable as well as irregular, the conflict can be intensified.

As a result of this these conflicts, shift workers begin to suffer physiological changes and to experience job performance decrements Significant decrements have been observed in visual acuity, cognitive functions, memory, reaction time, and, particularly, vigilance levels across extended time periods As alertness

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[24]Circadian rhythm is a term used to define cyclical biological processes which occur at approximately 24-hour intervals in approximate synchrony with the earth's day/night cycle Sleep/wake patterns, body temperature, hormone levels, and metabolism are some of the processes that have recurring and predictable variations throughout a 24-hour period

[25]Tilley, A J , et al "The sleep and performance of shift workers " Human Factors, 1982, 24 629-641

[26]Mitler, M M , et al Catastrophes, Sleep and Public Policy Consensus Report Sleep, 1988, II No. 1 100-109

decreases, reaction time increases, and the quality of judgment and decisions decreases

Dr Donald Tepas[27] noted that studies of industrial workers have shown that people who work irregular shifts sleep less and also report more frequent sleep problems than do people who work regular daylight shifts.

Conversations with shift workers and other anecdotal evidence have shown that it can be difficult for a person to go to sleep when his schedule calls for it but his body does not. If he does manage to fall asleep, he may not be able to stay asleep as long as he should. Consequently, shift workers fail to obtain a sufficient amount of quality sleep and develop a sleep deficit that cannot be made up This accumulation of sleep deprivation causes chronic[28] fatigue, which they are unlikely to recognize unless they have had specialized training

Chronic sleep deprivation manifests itself in microsleep and napping. A microsleep is defined as a brief involuntary period of sleep that lasts from a few seconds to minutes and ends spontaneously. A microsleep can be disrupted by external stimuli, but only if they are massively sensory in nature, very unusual, or particularly meaningful. Microsleeps increase in frequency and duration as the loss of sleep increases The worker may have no warning of either the beginning or end of a microsleep; when he has finished his microsleep, he may not even know that it has occurred.

The onset of sleepiness that arises from chronic sleep deprivation is to some degree predictable. Research[29] indicates the existence of a circadian nadir, which occurs between approximately 1 a m and 7 a m., and a secondary trough, which occurs between 1 p.m. and 5 p m These are periods of diminished capacity for all workers, even those who are well rested. However, a worker's ability to resist their effects is greatly reduced when he has not slept, and it is during these periods that he is likely to microsleep.

If the work environment lacks stimulation, the worker is more likely to fall asleep For example, according to a Dinges study:

> Driving, no matter what the vehicle, seems especially prone to drowsiness, errors, missed signals, and accidents at the predicted times A study[30] of 2,238 failures to respond to warning switches (which then induced automatic braking) by 15,000 German train drivers revealed a temporal function with two peaks, 3 a m and 2 p m

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[27]Dr Tepas testified before the Safety Board during the public hearing regarding the collision of two Consolidated Railroad Corporation freight trains Please refer to "Head-End Collision of Consolidated Rail Corporation Freight Trains UBT-506 and TV-61 near Thompsontown, Pennsylvania, January 14, 1988 " NTSB/RAR-89/02,PB89-916302

[28]Chronic fatigue is attributed to accumulated sleep deprivation due to circadian disharmony (violation of sleep/wake cycle) or circadian desynchronosis (rapid crossing of time zones)

[29]Dinges, D F , "The Nature of Sleepiness Causes, contexts, and Consequences " Chapter 9 in Stunkard, A J , Baum, A eds Perspectives in Behavioral Medicine. 1988, 162

[30]Hildebrandt, G , et al "Twelve and 24-hour rhythms in error frequency of locomotive drivers and the influence of tiredness " International Journal of Chronobiology, 1974, 2, 175-180

15,000 German train drivers revealed a temporal function with two peaks, 3 a.m. and 2 p.m

The engineer of train 818 experienced chronic (long-term) sleep deprivation because of the irregularity and unpredictability of his work/rest cycle. In addition, the chance that he would fall asleep was greatly increased by the fact that he had so little sleep before he started the trip

After awakening on November 5, he stayed up about 4 hours and had dinner with his family before going to bed for the night. He slept for 5 1/2 hours before receiving a call to work again at 1·30 a m on November 6 He did not go back to sleep, but dressed and drove to work Thus, he began the tour of duty with insufficient sleep and at a time of day when, according to his circadian rhythm, he should have been asleep. The trip to Barstow was, however, successfully completed.

In the 26 hours 41 minutes between the time he was called to work, 1.30 a m., November 6, and the time of the accident on November 7, he had had very little sleep The maximum amount of sleep he could have had from the time he finished speaking to the STO until the time he left the Barstow motel to go to work was 1 hour 6 minutes (8.54 p.m to 10 p m.).

After being awake for more than 26 hours, the debilitating effects of sleep loss were high and they were greatly enhanced by his working during the low point of his circadian rhythm. These effects may have caused the fluctuation in the speed of the train between San Bernardino and the siding at Corona During this period of time, train 818 exceeded the maximum speed 13 times

He had his last radio communication with the San Bernardino dispatcher about 3:52 a m , when he acknowledged instructions to take the siding at Corona and allow the eastbound train to pass. According to the event recorder printout, a reduction was made to the train's braking system about 4·03 a.m. in order to slow the train to 15 mph The last action performed on the engineer's stand was about 4·11 a.m , when the throttle position changed from dynamic braking to zero throttle

Other than having to sound his horn at each grade crossing, there were no other performance demands on him until the train reached the signal at the west end of the siding. The engineer sounded the horn at Cota Street, which was 5,358 feet from Railroad Avenue, where an emergency brake application was made. Since he sounded the horn, he must have been awake at Cota Street However, the emergency brake application occurred when the train was beyond the stop signal and in the vicinity of the wig-wag grade crossing protection device, as indicated by the trail of air brake sand found on the track structure west of the stop signal. The Safety Board concludes that train 818 traveled over 25 feet from the point when the emergency brake application was initiated to when the sand began to spread onto the rail, based on the speed of the train coupled with the sanding system sequence.

It is likely that the rhythmic sound and motion of the locomotive's engines, the lack of physical activity, and a cab heater turned on full further produced an environment conducive to sleep The fact that the engineer had opened the cab window and turned on the interior dome light on the engineer's side suggests that he tried to keep himself awake.

Nevertheless, the Safety Board believes that his efforts to stay awake were unsuccessful. As stated in one study:[31]

> when sleep is lost or disrupted, by whatever means, the inevitable consequence is sleepiness during the wake period. If sleepiness becomes excessive, the person ceases to function effectively because ultimately the brain imposes sleep, typically in the form of overwhelming drowsiness or microsleeps, despite the individual's best efforts to stay awake

The engineer was operating in an unstimulating environment and attempting to function at the lowest point of his circadian rhythm He may have awakened from a microsleep spontaneously or as a result of stimuli Possible stimuli included the sight and/or sound of the wig-wag signal, the sight and/or sound of train 891, the jolt from the change in the roadbed as the train crossed the road crossing, or the actions of other crewmembers

The Safety Board believes that the engineer failed to stop the train at the stop signal because his chronic and acute fatigue[32] caused him to fall asleep for a critical period of time.

Conductor of train 818 --The conductor quite likely suffered sleep deprivation similar to that of the engineer. The conductor worked in freight pool service and was subject to the same irregularity and unpredictability of scheduling as was the engineer. His last four tours of duty are illustrative.

Beginning on November 4, he had successive starting times of 9 a m , 2:45 a.m., 4:30 a.m., and 10 15 p.m. Thus, he worked a day shift, two night shifts, and an evening shift, or changed shift twice in 4 days His schedule encouraged chronic sleep deprivation

He did not suffer the short-term acute fatigue that the engineer did before the accident trip, although the Safety Board does not know what he did in Barstow after he returned from eating with his crew. He may have slept, though he could not have slept for more than 6 hours

However, even if he slept for those 6 hours, he would not have eliminated the sleep deficit caused by his schedule. When the accident happened, he was working during the low point of his circadian rhythm. He had no duties to perform, other than that of being alert, once the train had entered the siding Since it is most unlikely that the conductor would allow the train to pass the stop signal without warning the engineer, the Safety Board believes that he too was asleep as the train approached the stop signal.

Brakeman of train 818 --She had been working a fairly regular and predictable schedule as a clerk before she became a brakeman, although her schedule changed while she was in brakeman service. She did not experience the

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[31]Dinges, p 147

[32]Acute fatigue is attributed to deficient quality and quantity of sleep within one normal circadian cycle

wide fluctuations in scheduling that the other two crewmembers did, thus, she probably was not suffering from chronic sleep deprivation

The crew caller notified her at 8.43 p m., allowing her a maximum of 43 minutes of sleep before her fateful trip. Other than those possible 43 minutes, her last bed rest was 26 hours 41 minutes before the accident. She had been in the engineer's company all day until about 8 p.m., when she went to her motel room On the trip from Barstow she was probably tired enough to succumb to the neurological pressures to sleep. As were the others, she was working during her circadian nadir. Her body was demanding sleep while she nevertheless had to be awake. Coupled with the neurological pressures were the facts that she was on the return portion of her first road trip and she was unfamiliar with night operations, with the Corona siding, and possibly with what to do in an emergency situation Although she had been trained to be aware of stop signals, it is possible that since this was her first trip at night, she overlooked the stop signal. Or, she may have been reluctant to act on what she observed

The Safety Board concludes that either she was asleep due to acute fatigue, did not know what to look for in unfamiliar territory at night, or was reluctant to take action when train 818 passed the stop signal

Behavioral Actions of the Crew of Train 818 --When a crewmember completes a tour of duty, he usually goes to bed shortly after coming off duty because he knows that in 8 hours he will be subject to being called for another tour He is particularly likely to go to bed at an away-from-home terminal, where a layover is usually short However, sometimes a layover at an away-from-home terminal exceeds 8 hours.

When the crewmembers arrived in Barstow at 12·40 p m , both the engineer and the conductor called their wives Each estimated that he would not go back on duty until about 5 a m the following day The estimates were based on the line-up of trains and on the number of crews in Barstow at the time and on the fact that a traincrew was normally called at 5 a m. The Barstow terminal had computer monitors that crewmembers used to find out the train line-up and crew information entered into VIPS According to the crew's estimates, they had enough time to have a meal before they went to bed. After eating, the conductor followed standard practice and went to his room

The engineer took a different approach to getting his rest. He stayed up, intending (as he told his wife) to go to bed later in the day and sleep until he was called for work Had he been able to follow his plan, the time between the end of his sleep and the beginning of his tour of duty would have been minimal and he would have been as well rested as possible In theory, his approach was sound. But because the unexpected occurred, in practice, it was not.

When the crew arrived in Barstow and checked the line-up, it did not show any pending deadhead moves. Based on that information, the engineer's and conductor's estimates of their next duty times were reasonably accurate During the day the engineer had conversations with members of other crews that were in Barstow, and they were not aware of any pending deadheads If the deadhead information had been available earlier in the day, it might have been entered in VIPS, and the engineer might have made a different decision about when to go to sleep. Since the information about the deadheading of crews was not available to the engineer, he probably wanted to take his sleep at the time he had been

accustomed to during the previous 2 days, which was at night In following this course of action, he would have been better rested at 5 a.m , when he expected to go on duty. He would have gone to bed about 8 hours before 5 a m.

However, he should not have relied completely on the information from VIPS or from members of other crews. The carrier's employees knew that the scheduling of trains and crews was subject to change Nevertheless, the Safety Board believes that the carrier should more closely adhere to the schedule for posting updated train and crew information every 4 hours.

Experience should have tempered the engineer's reliance on VIPS Because of the weekly traffic cycle of trains, crews were invariably deadheaded from Barstow to Los Angeles on Tuesdays and sometimes on Wednesdays The engineer should have been aware of the need to check VIPS after 5 p.m. and should not have relied on information obtained earlier that day However, VIPS was not updated every 4 hours, in this case, he would not have received the correct crew line-up until after 5·28 p m.

The Safety Board believes that had the ATSF made the users of VIPS aware of when the information had last been updated and when they could expect the next update, it might have made a difference. Had the above information about the deadheading of crews out of Barstow been available at 1 p.m. or 5 p m., when it was supposed to be, the crewmembers of train 818 might have made a different decision about how to spend their off-duty time

The Safety Board also concludes that the engineer was imprudent in not trying to sleep during the off-duty time that the carrier provided in compliance with Federal regulations The carrier should be allowed, without running the risk of contractual violation, to remove an employee from duty if he has admitted to not having enough sleep When an employee reports that he is, or is reported by another employee to be, suffering from a lack of sleep, a procedure is needed in the crew calling system that allows him to be taken out of board rotation without either the carrier or the employee incurring a penalty The procedure could work in a manner similar to the current by-pass agreement employed under rule G agreements [33]

Acceptance of Work Assignment --Once the engineer learned that he was being called to work at 10:15 p.m , he complained to the crew caller about the fact that the three crews in front of him were being deadheaded He complained about not getting his rest, and he implied that he might lay off sick, but he did not, and he accepted the call He continued his complaint in a conversation with the STO and implied that he had not slept during the day and was just getting ready to go to bed when he was called He told the STO, ". . . I mean how [do] you plan your life, just live by surprises?"

Had he chosen not to accept the assignment, he would have faced at least one and perhaps as many as four consequences. The first would have been the loss of a

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[33]Several carriers have agreements with their respective labor organizations about the handling of an employee who has had an alcoholic beverage while on call If the employee admits to having had the beverage, he is by-passed from duty and dropped to the bottom of the call board No penalty is incurred by either the employee or the carrier

tour of duty and no compensation The second was that he would have had to provide his own transportation home; the carrier would not furnish such transportation. The latter have would been of little consequence since he coowned an automobile that was garaged in Barstow.

A third consequence might have been peer pressure from the other crewmembers. The remainder of the crew could have been deadheaded home, or it could have had another engineer assigned and taken the trip. If the crewmembers were deadheaded, their pay would have been less than if they worked a train to Hobart yard.

A fourth consequence that might have affected the engineer's decision was the prospect of disciplinary action. The regional manager said ". . [if the engineer] didn't have a history of it [laying off], and even though if it wasn't perceived as a good reason, I'm confident there wouldn't have been any punitive measures taken . ." However, disciplinary action was a possibility because the engineer had laid off twice on call and the ATSF had not taken any action either time. He might have believed that another lay-off on call would have prompted action by the carrier

During his testimony to the Safety Board, the STO expressed "sympathy" for the engineer's predicament but said that when he had too many crews for the trains available, as he did in this case, he had to deadhead. He said the engineer's situation had never come up before, nor was he aware of anyone ever having laid off at an away-from-home terminal because he was tired The carrier had not provided policy guidance on what to do when a crewmember notified the STO of not having slept prior to coming on duty. Thus, no precedent seems to have been established on the ATSF for treating sleepiness in the same manner as other sources of impairment.

The Safety Board believes that outside pressure (personal commitment, peers, and professionalism) and circumstances (being at an away from home terminal) weighed heavily in the engineer's decision to accept the assignment. Despite his fatigue and lack of sleep, he believed that his best recourse was to take the assignment

As a result of the Safety Board's investigation of the collision between two Consolidated Railroad Corporation freight trains at Thompsonstown, Pennsylvania, the following recommendations were addressed to the AAR pertaining to work/rest cycles and performance of personnel on March 30, 1989:

R-89-21

Encourage its member railroads to improve their current methods of using train crews to reduce the irregularity and unpredictability of their work/rest cycles.

R-89-22

Encourage member railroads to provide education and counseling to employees on proper health regimens and avoidance of sleep deprivation.

R-89-23

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

The AAR responded on October 12, 1989, citing numerous ongoing activities by various railroads to correct problems associated with improper work/rest cycles. The Safety Board replied by asking the AAR to take an active role in encouraging member railroads to adopt policies and programs related to proper work/rest cycles and health regimens. The AAR, at a meeting with Safety Board staff in May 1991, stated that another effort would be made by the association to make the industry more aware of this issue Meanwhile, these safety recommendations are being held in an "Open--Acceptable Response" status pending the completion of the described efforts.

The Safety Board has made several intermodal recommendations concerning the study of work/rest cycles and performance of personnel. On May 12, 1989, the Safety Board issued three safety recommendations to the Secretary of the Department of Transportation (DOT) related to human fatigue in transportation. These safety recommendations are

I-89-1

Expedite a coordinated research program on the effects of fatigue sleepiness, sleep disorders, and circadian factors on transportation system safety

I-89-2

Develop and disseminate educational material for transportation industry personnel and management regarding shift work, work and rest schedules; and proper regimens of health, diet, and rest

I-89-3

Review and upgrade regulations governing hours of service for all transportation modes to assure that they are consistent and that they incorporate the results of the latest research on fatigue and sleep issues.

These Safety Recommendations are a part of the Safety Board's "Most Wanted Safety Recommendations Program "

The DOT responded on August 11, 1989, citing ongoing human factors research in the various modal administrations of DOT, the DOT Research and Development Coordinating Council, the then-proposed DOT National Transportation Policy statement, and ongoing reviews of policy regarding dissemination of educational materials and hours-of-service regulations in the various modal administrations The Secretary advised that he would keep the Safety Board apprised of progress.

On September 12, 1990, officials from the DOT pointed out at a meeting with Safety Board staff that the DOT was supervising a comprehensive program of research on human factors in transportation, including the causes of transportation accidents, the effects of operator impairment, perceptual errors, and fatigue, as well as design and operating changes that can eliminate or reduce those effects Each of the modal administrations discussed ongoing efforts related to this issue and how the individual efforts fit into the overall DOT policy

The FRA reported on the work being carried out in the railroad industry to document the performance of railroad engineers. The FRA is also conducting interviews with workers in the industry in an attempt to determine the actual extent of any operator overwork issue From these interviews, the FRA will attempt to sort out issues such as:

- reasonable commuting distances for operating personnel,
- potential needed revisions to the Hours of Service Act, and
- other efforts that may be needed to bring about a more normal work environment for rail crews

The Safety Board realizes that this kind of effort will require time to complete.

On June 21, 1991, the Chairman of the National Transportation Safety Board addressed Congress and noted the following pertaining to work/rest cycles.

> We are aware that the Federal Railroad Administration (FRA) is conducting industry interviews in an attempt to determine the true extent of the work/rest problem. They will attempt to determine what a reasonable commuting distance is for locomotive crews and what other changes might be needed to bring about a more normal work environment for rail crews
>
> However, it must be recognized that the ability of the FRA to do anything about these issues has been impeded, since the work hours of railroad employees--unlike those in any other mode of transportation--are governed by the Hours of Service Act (Act). While Congress had made some minor modifications to this law, it has remained essentially unchanged since it was signed into law by President Theodore Roosevelt in 1907 Ultimately, action by Congress will be needed to address key issues relating to the Act Most importantly, we believe the FRA should have the ability to work within the Act, so that regulations stemming from the Act can change as the times change. In that way, the FRA could mandate breaks and off-duty periods for train dispatchers and operators, and new workload limits for train dispatchers could be determined, without an act of Congress

Positive Train Separation

Notwithstanding the failure of the crewmembers of train 818 to comply with the stop signal on the west end of the Corona siding, the accident probably would have been prevented had the carrier been using a positive train separation system.

A properly designed and functioning system would have stopped the train before it passed the stop signal. The Safety Board realizes that much work remains to be done before a complete positive train separation system can be implemented. Nonetheless, this is another collision that could have been averted had a positive train separation system been available The Safety Board recently investigated a collision on the Norfolk Southern Railway at Sugar Valley, Georgia, and on the Southern Pacific Railroad near Tucson, Arizona, in which the circumstances were similar to those in this accident

If an ATCS had been monitoring the location, speed, and handling of train 818, the dispatch computer would have recognized the fluctuation in speed from San Bernardino to Corona and the engineer's failure to take action to brake as the train moved closer to the stop signal. Through a data radio link, the dispatch computer would have stopped train 818, thereby avoiding the collision. The railroad industry and the FRA must expedite the development of positive train separation systems

As a result of the Sugar Valley accident, the Safety Board on July 9, 1991, recommended to the FRA·

> In conjunction with the Association of American Railroads and the Railway Progress Institute, expand the effort now being made to develop and install advanced train systems for the purpose of positive train separation

Pathological

The autopsy surgeon reported the cause of death of all three crewmembers of train 818 to be smoke inhalation and thermal burns The report noted "soot in the airways"; however, the autopsy reports were limited in descriptive information For example, the depth of smoke inhalation in the respiratory tract was not provided In addition to the soot inhalation observations, one autopsy report referred to the "cherry red blood, carbon monoxide intoxication" in one of the smoke inhalation victims The toxicology reports did not reflect elevated COHb, as would be expected from death due to smoke inhalation

There are two possible explanations for the absence of elevated COHb in the smoke inhalation victims The most likely reason for the negative COHb finding is the inappropriate analysis for carbon monoxide Because the information concerning the nature of the specimens was unknown to the toxicologist, the laboratory used a spectrometric analytical procedure. However, because the victims were severely burned, it is highly probable that methemoglobin was also elevated, which can result in interference with carboxyhemoglobin analysis.

The second possible reason for the absence of elevated COHb is the reported postaccident flash fire that occurred. This flash fire could have led to rapid death, which could have prevented the development of elevated carboxyhemoglobin However, this latter rationale is unlikely since the autopsy report indicated cherry red blood in one victim, which is an unusually reliable symptom of elevated carboxyhemoglobin saturation Therefore, the Safety Board concludes that the crewmembers on ATSF 818 died due to smoke inhalation and thermal burns

Drug Issue

Conductor of train 891.--That his urine showed traces of morphine and his blood did not is consistent with his having received morphine about 4 1/2 hours before the specimens were collected. He was given morphine to help him cope with the pain caused by the injuries he received in the accident

Engineer of train 891.--His urine, which was positive for amphetamines (stimulants), also indicated a low concentration of the carboxylic acid metabolite of marijuana These findings are consistent with the engineer's previous drug testing history. Although the drug counselors determined that the engineer of train 891 did not have a chemical dependency problem, the engineer failed three drug tests during a period of about 20 months There is no evidence that the engineer knew that he was being drug tested when he took the physical that indicated he was positive for THC and methamphetamine. However, the drug tests that the engineer subsequently failed were, for all practical purposes, announced because he was notified by certified letters from Chicago and did not pick up these letters for an extended period of time. According to medical department rules, with which he complied, he was required to provide a urine specimen within 5 days of receipt of notification.

This record supports the conclusion that the engineer refrained from using drugs long enough to pass repeat tests The presence of the inhaler containing methamphetamine in his bag suggests that he was using the drug on the job The inhaler was not the type used for an over-the-counter inhaler containing the decongestant isomer of methamphetamine; it was most probably obtained for illicit drug use. Because the drug was not detected in his blood, he probably had not used it on the day of the accident (although detection in the blood depends greatly on the amount used because the half life is 12 to 34 hours, depending on urine pH). He provided a drug testing specimen about 11 hours after the accident.

The presence of the stimulants methamphetamine and amphetamine and the presence of the acid metabolite of the hallucinogen marijuana in the engineer's urine are consistent with his continued use of these drugs. The engineer supplied a final urine specimen for drug testing on March 23, 1990, and this specimen was negative for the five drugs required in the DOT drug testing program. However, this specimen had been required after he had submitted a positive specimen on December 22, 1988, and he delayed providing a specimen at that time for more than 30 days.

This accident occurred about 7 months after the last "unannounced" drug testing of the engineer The presence of 8 ng/ml of marijuana metabolite in his urine suggests that he continued his use of marijuana between the last testing and the accident He continued to use the stimulant methamphetamine and, in fact, carried methamphetamine, an addictive drug, with him on the train

Methamphetamine is a central nervous system stimulant, producing effects similar to that of cocaine, except the effects of methamphetamine last longer. The engineer was probably taking the drug to enhance his alertness, or to try to compensate for lack of proper rest However, there is no concrete evidence that performance is enhanced. Studies have shown that the drug has disruptive effects on behavior and leads to more aggressive behavior. Continued use leads to psychosis that includes symptoms of persecution, hyperactivity, visual and auditory

hallucinations, and change in body image Increased aggressive behavior is likely to lead to increased risk taking and aggressive train operations

The FRA's regulation (49 CFR Part 219) did not explicitly provide guidance on the finding of illegal substances during an employee's annual physical However, the ATSF issued its own policy, under which the medical department did not divulge the results of a drug test to other departments if the test was taken as part of a routine physical Consequently, although the medical department knew about the engineer's positive test results, the operations department did not.

The results of the ATSF follow-up and the Federally required postaccident testing indicate that the engineer was a chronic user of the stimulant methamphetamine and of tetrahydrocannabinol (marijuana). This drug use pattern suggests that he had a continuing drug problem that was not recognized as such by the EAP counselor. The engineer simply stopped using drugs each time he failed a drug test and then refrained from taking any until he was able to pass a retest

The Safety Board is concerned about the use and abuse of drugs by any railroad employee However, the Safety Board is especially concerned that this individual was not removed from his safety-sensitive position when he had been identified in repeated tests as a drug user 2 years earlier.

Examination of the engineer's record shows that ATSF's former drug policy was seriously flawed, it allowed the engineer to continue to operate despite his repeated use of drugs The new ATSF drug policy has addressed this issue by directing that each employee be allowed only one positive test result for drug use. If a second incident should occur, the employee will be terminated from employment by the carrier. The Safety Board recognizes the ATSF's efforts and initiative in addressing the issue of drug use by its employees

Work Records

Although the ATSF was in complete compliance with the maintenance of hours-of-service records as specified by 49 CFR subpart 228 11, investigators had trouble deciphering the information in these records pertaining to the work/rest cycles of the engineer on train 818 The ATSF developed its own record keeping system because there were no Federal guidelines to assist carriers in providing and maintaining the information As the importance of tracking work/rest cycles grows within the rail industry, so will the importance of the format used in recording the necessary information. The Safety Board believes that a simple format should be designed by the FRA so that it is easier to follow hours-of-service information

Locomotive Crashworthiness

The Safety Board believes that the majority of the damage sustained by the lead locomotive of train 818 was the result of the accident dynamics that occurred subsequent to the initial impact. No survivable space was left in the control compartment as a result of the initial impact However, the bulk of the damage to the conventional cab of this unit was caused when train 891's third locomotive came to rest on top of its control compartment.

Because the trains initially collided somewhat off center (left front to left front), the collision was not directly "head on," and the crash-resistant systems on train 818's lead locomotive unit were not fully utilized Thus, this accident did not provide a full assessment of how the North American cab would react in a direct head-on collision Due to the closeness in sill heights of the two lead locomotive units, there was no override in this accident.

The North American cab did perform its intended function, offering survivable space in a collision despite the death incurred by a crewmember riding in one of these compartments. However, the Safety Board was unable to compare the crashworthiness of the North American cab in this accident to its crashworthiness in other collisions due to the lack of data collected by the FRA The database of the FRA data collection system does not specifically address the locomotive unit type involved in an accident.

Train 891's lead locomotive had not sustained any fire damage, however, its second and third locomotives were extensively burned The structural integrity of the control compartments of all three locomotives remained intact, maintaining survivable space for all occupants. Although the locomotives separated and derailed in the accident, the most serious damage they sustained was caused by the fire. The Safety Board believes that this collision did not yield adequate information to evaluate the crashworthiness of the EMD-GP 60M

Fuel Tank Crashworthiness

Due to the lack of data, the Safety Board could not analyze the prevalence of fuel-tank-induced fires in rail collisions The FRA data collection system does not specifically address the matter of fuel tank involvement in accidents

The Safety Board is concerned that diesel fuel-generated fires can trap and burn crewmembers and cargo, contribute to starting hazardous-materials fires in the train, and place nonrailroad property in harm's way. Of the 643 rail accidents that have been investigated by the Safety Board, 23 had damaged locomotive fuel tanks that resulted in fire The Safety Board believes that there is a need to analyze the location and protection of the locomotive fuel tanks Thus, more information is needed concerning accidents that involve damaged fuel tanks.

Consequently, the Safety Board believes that the FRA needs to revise its data collection procedures so that it can identify the kinds of units that are involved in accidents, the accidents that involve fires, and the accidents in which the fuel tanks are ruptured.

Event Recorders

The fire destroyed the event recorders on the second and third units on train 891 An inspection of the fire-damaged units showed that the location of the recording equipment provided satisfactory protection from crash forces. However, the type of encasement employed by the manufacturer did not provide adequate thermal protection Had there been an event recorder on the lead unit, information would have survived the collision because the control department of the unit did not sustain any fire damage.

The most feasible approach to the preservation of event recorders is to set standards for resistance to crash forces and fire for these devices. The Safety Board believes that the FRA needs to develop requirements for crash- and fire-resistant event recorders similar to those used in aircraft Further, the Board believes the FRA should require event recorders on all locomotives.

Although the FRA recognized the need for more durable encased event recorders in its notice of proposed rulemaking (NPRM) dated June 19, 1991, the rulemaking does not require event recorders on all locomotives. The Safety Board will address both issues in its comments on the rulemaking

Notification of Pipeline Operators

The Safety Board recognizes the effort that the ATSF made to maintain a list of telephone numbers of those who should be notified when an accident occurs However, the list used in this accident did not include the names or phone numbers of the operators of the two pipelines that were in the vicinity of the accident site.

In California, the natural gas pipeline operators were under the jurisdiction of the California Public Utilities Commission (CALPUC), and the petroleum pipeline operators were under the jurisdiction of the California State Fire Marshal's Office. Both agencies had listings of their operators, but had not provided this information to the ATSF When the accident happened, CALPUC was in the process of compiling a list of operators whose pipelines ran parallel to or crossed railroad rights of way

Previous pipeline accidents have demonstrated how catastrophic such accidents can be Considering the potential for an accident in Corona, the Safety Board believes that when a rail accident occurs, there is an urgent need to notify pipeline operators of pipelines that may be affected. The pipeline operators, governing agencies, and the rail carriers should work together to devise an efficient notification process.

CONCLUSIONS

Findings

1 No anomalies or deficiencies were evident in the train brakes of either freight train or in the track or signal systems that contributed to the accident.

2 The engineer of train 818 failed to stop his train on the Corona siding at the stop signal because he was asleep or in a microsleep brought about by chronic and acute fatigue.

3. The chronic and acute fatigue of the engineer of train 818 was a result of the irregularity and unpredictability of his work schedule.

4. Because of fatigue, the conductor of train 818 either was asleep or experienced a microsleep as his train approached the stop signal on the west end of the Corona siding.

5 The brakeman of train 818 failed to take action to stop the train probably because she fell asleep as a result of acute fatigue.

6. The Atchison, Topeka and Santa Fe Railway Company did not have a policy or procedure in place to address the issue of an employee notifying the carrier of his or her lack of sufficient sleep

7. When the engineer of train 891 saw the 2R signal at Corona suddenly turn red, it was too late to take action to avert the accident.

8. Although the urine sample of train 891's engineer had traces of drugs, it could not be determined whether the drugs impaired his performance at the time of the accident. His actions did not contribute to the accident.

9 The Atchison Topeka and Santa Fe Railway Company policy of using certified letters to announce random drug screens was ineffective because it allowed the recipient of the letter to delay accepting the letter, thereby avoiding timely testing.

10. The encasements used to hold the event recorders that were on train 891 did not protect the recorders from fire damage Thus information about the handling of train 891 was incomplete

11 Neither research nor accident data exist about the effect of ruptured or leaking locomotive fuel tanks in railroad accidents in which postcrash fires occurred

12 The Atchison Topeka and Santa Fe Railway Company accident notification process did not include the emergency 24-hour telephone numbers of operators of pipelines that might have been affected by an accident

13 The accident probably would have been prevented had the trains been separated by a fully implemented advanced train control system.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the collision was the failure of the engineer of train 818 to stop his train at the stop signal because he was asleep. Contributing to the accident was the failure of the conductor and the brakeman to take action, probably because they too were asleep, to stop the train. Also contributing to the accident were the irregular unpredictable work schedule of the engineer on train 818, the Atchison, Topeka and Santa Fe Railway Company's lack of a policy or procedure for removing crewmembers from service when they are not fit for duty because of a lack of sleep, and the inadequacy of the Federal rules and regulations that govern hours-of-service

RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board recommends

--to the Federal Railroad Administration.

Develop a uniform simplified format for work-record data collected by the rail carriers. (Class II, Priority Action) (R-91-39)

To enhance current accident data collection and analysis, require the recording of data pertaining to postcrash fires involving locomotive fuel tank rupture and spillage, as well as types of locomotive units involved. (Class II, Priority Action) (R-91-40)

--to the Atchison Topeka and Santa Fe Railway Company:

In cooperation with the operating unions, develop an educational and counseling program designed to improve crewmembers' knowledge of health and diet regimens and methods of avoiding sleep deficits and sleep deprivation (Class II, Priority Action) (R-91-41)

In cooperation with the Association of American Railroads and the operating unions, develop a policy that would allow the carrier to stop an employee from accepting assignments and that would allow an employee to report off duty when the employee is impaired by lack of sleep. (Class II, Priority Action) (R-91-42)

Post on the Voice Information Processing System and on all crew call monitors the time of the last update and of the next projected update. (Class II, Priority Action) (R-91-43)

In cooperation with the California Public Utilities Commission and the California State Fire Marshal's Office, develop a complete list of 24-hour emergency telephone numbers for those pipeline operators whose transmission lines are near the Atchison, Topeka and Santa Fe Railway property. (Class II, Priority Action) (R-91-44)

--to the Association of American Railroads:

In cooperation with member carriers and the operating unions, develop a policy that would allow the carrier to prevent an employee from accepting assignments and would allow an employee to report off duty when he or she is impaired by lack of sleep. (Class II, Priority Action) (R-91-45)

In cooperation with member carriers and the Federal Railroad Administration, develop a uniform simplified format for work-record data collected by the rail carriers. (Class II, Priority Action) (R-91-46)

--to the Brotherhood of Locomotive Engineers

In cooperation with all rail carriers, develop a policy that would allow the carrier to prevent an employee from accepting assignments and would allow an employee to report off duty when he or she is impaired by lack of sleep (Class II, Priority Action) (R-91-47)

to the United Transportation Union:

> In cooperation with all rail carriers, develop a policy that would allow the carrier to prevent an employee from accepting assignments and would allow an employee to report off duty when he or she is impaired by lack of sleep (Class II, Priority Action) (R-91-48)

--to the California Public Utilities Commission

> In cooperation with the Atchison, Topeka and Santa Fe Railway Corporation (ATSF) and the California State Fire Marshal's Office, develop a complete list of 24-hour emergency phone numbers for those pipeline operators whose transmission lines are near ATSF property. (Class II, Priority Action) (R-91-49)

--to the California State Fire Marshal's Office·

> In cooperation with the Atchison, Topeka and Santa Fe Railway Corporation and the California Public Utilities Commission, develop a complete list of 24-hour emergency telephone numbers of those pipeline operators whose transmission lines are near ATSF property (Class II, Priority Action) (R-91-50)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ James L. Kolstad
Chairman

/s/ Susan M. Coughlin
Vice Chairman

/s/ John K. Lauber
Member

/s/ Christopher A. Hart
Member

/s/ John A. Hammerschmidt
Member

July 23, 1991

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The Safety Board was notified of the accident at 9 a.m. on November 7, 1990, and immediately dispatched an investigator from the Denver field office to the scene The Safety Board Chairman, a Member, the Managing Director, the Director of the Office of Surface Transportation Safety, the investigator-in-charge, and other members of the investigative team were also dispatched from Washington, D C. Investigative groups were established for operational, track, signal, human performance, and survival factors

Hearing

The Safety Board convened a 2-day deposition hearing as part of its investigation on January 21, 1991, at Riverside, California Parties to the hearing included the Atchison, Topeka and Santa Fe Railway Company, the Federal Railroad Administration, the General Motors Electro-Motive Division, the Brotherhood of Locomotive Engineers, the State of California Public Utilities Commission, and the United Transportation Union

APPENDIX B

PERSONNEL DATA

ATSF 818

Engineer

Mr. Gary R Ledoux, 35, had been hired by the ATSF as a clerk on August 27, 1973. In 1978 he accepted a position as a fireman and was promoted to engineer on February 26, 1980 The engineer's most recent training was in 1989, when he attended a locomotive operations seminar He successfully completed his last rules class on February 27, 1990 According to carrier records for the period from January 1989 through October 1990, he was given 76 efficiency tests with no failures.

Conductor

Mr James S. Wakefield, 55, had been hired by the ATSF on May 10, 1956, as a brakeman On May 1, 1961, he was promoted to conductor in the San Bernardino subdivision and worked his entire career in this area His most recent training occurred on April 11, 1989, when he attended a periodic ATSF-sponsored conductor's training class. His last rules class was on June 28, 1990 According to carrier records for the period from January 1989 through October 1990, the conductor was given 24 efficiency tests with one failure, which occurred on August 1, 1990

Brakeman

Ms Virginia C Hartzell, 29, had been hired by the ATSF police department on June 1, 1981, as a clerk On November 16, 1989, she changed positions and became a dispatcher trainee in San Bernardino She was promoted to dispatcher on May 1 1990, and left the dispatcher's office on August 30, 1990, to be a clerk in Hobart yard until transferring to the operating department as a brakeman on October 22, 1990 On November 2, 1990, she was placed on the brakeman's extra board. Her most recent training was a brakeman-in-training course from October 22 through November 1, 1990 No records indicate that she had taken any rules examinations or efficiency tests since she became a brakeman. Records indicate that she did pass, with a high score, the stringent dispatcher's examination and also passed the switchman's examination. According to company records, no disciplinary action was taken against her during her tenure with the carrier

ATSF 891

Engineer

Mr James A. Dawson, 50, had been hired by the ATSF on July 9, 1971, as a chair car attendant in Los Angeles. He held this position until September 9, 1971, when he transferred to the operating department as a switchman On November 11, 1971, he left the operating department and became a clerk in the Los Angeles division He held this position until transferring to fireman's status on July 25, 1974, and was promoted to engineer on February 13, 1976, in the Los Angeles division. He successfully completed his last rules class on June 11, 1990. According to carrier records for the period from January 1989 through October 1990, he was given 36 efficiency tests with 3 failures.

APPENDIX C

RULES APPLICABLE TO THIS REPORT

This report refers to several rules listed in the General Code of Operating Rules, which are quoted here in full:

Rule G

The use of alcoholic beverages, intoxicants, drugs, narcotics, marijuana or controlled substances by employees subject to duty, when on duty or on Company property is prohibited

Employees must not report for duty or be on Company property under the influence of or use while on duty or have in their possession while on Company property, any drug, alcoholic beverage, intoxicant, narcotic, marijuana, medication, or other substance, including those prescribed by a doctor, that will in any way adversely affect their alertness, coordination, reaction, response or safety

Rule 34

Observe and Call Signals: Crewmembers in control compartment of engine must be alert for and communicate to each other in a clear and audible manner, the name or aspect of each signal affecting the movement of their train as soon as it becomes visible or audible They must continue to observe signals and call any change of aspect until passed

If prompt action is not taken to respect signal, other crewmembers must remind engineer and/or conductor of rule requirement, and if no response, or engineer is incapacitated, other crewmembers must take immediate action to ensure safety, using emergency brake valve to stop the train if necessary.

Rule 89

Stopping Clear: A train stopping where it may be met or passed must stop and remain not less than 400 feet from the signal or clearance point of facing point switch over which a train may pass, if length permits

Rule 620

Riding Engine: When practicable, crewmembers on head-end of freight trains must ride in control compartment of the engine When the conductor is riding the head-end, he will ride in the control compartment.

His personnel record also indicated his removal from service in March 1985 for allegedly falsifying a time slip. In February 1986, he was suspended for 45 days for failing to take appropriate action after a hot box detector gave an alarm concerning a defective car. In June 1986, he was suspended for 100 days for refusing to accept a crew call He incurred a suspension of 45 days in 1987 for failure to give facts of a traction motor failure that resulted in field fires along the right-of-way

Conductor

Mr. Warren E Sanders, 52, had been hired by the ATSF on April 5, 1960, as a switchman in the Los Angeles terminal division He was promoted to engine foreman on March 7, 1962. He remained in this position until he was drafted for military service later that year. On June 10, 1964, he returned to the ATSF as a brakeman and was promoted to conductor on July 25, 1972 He successfully completed his last rules class on September 30, 1988 According to carrier records for the period from January 1989 through October 1990, he was given 70 efficiency tests with 1 failure

Brakeman

Mr. Ronald E. Westerfelt, 52, had been hired by the ATSF on July 10, 1957, as a brakeman and was promoted to conductor on April 28, 1964, in the Los Angeles division His most recent training was an ATSF-sponsored train operations seminar on March 10, 1990.

He successfully completed his last rules class on September 29, 1988. According to carrier records for the period of January 1989 through October 1990, he was given 54 efficiency tests with 3 failures.

APPENDIX D

NOTIFICATION FORM USED BY ATSF FOR PIPELINE OPERATORS

P I P E L I N E S A N D P O W E R A N D W A T E R

SANTA FE PACIFIC PIPELINES

1. EMERGENCY 213-624-9461
   213-624-9462
   OR
2. SCHEDULING CO 895-7840 OR 213-486-7840
   CO 895-7845 OR 213-486-7845
   CO 895-7850 OR 213-486-7850

DEPARTMENT OF WATER AND POWER FOR LOS ANGELES
ROERT GARCIA - CUSTOMER REPRESENTATIVE 213-481-5825 BETWEEN 8 AM & 5 PM

AREA	TELEPHONE NUMBER
LOS ANGELES METRO	1-800-624-3029
HARBOR	
WEST LOS ANGELES	

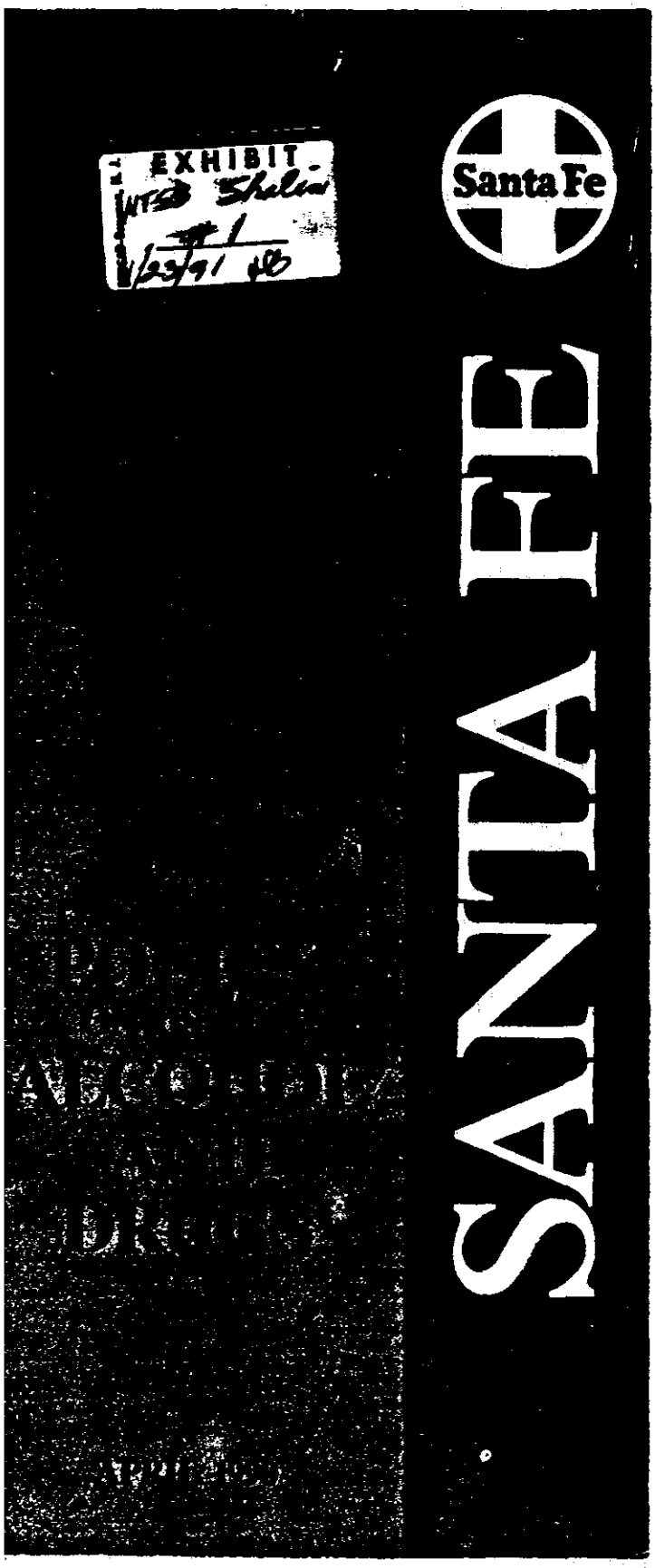
U.S. AIR FORCE EDWARDS AFB 805-277-1110

M O T E L S

LOCATION	MOTEL	PHONE NO.
DLES	ALLSTAR	619-326-5131
RKER	KASBAH	602-669-2133
BARSTOW	COOLWATER	619-256-8443
OCEANSIDE	ROYAL SCOTT	619-722-1821
BAKERSFIELD	RAMADA INN	805-327-0681
STOCKTON	VAGABOND	800-522-1555
STOCKTON	LA QUINTA	800-531-5900
PITTSBURG	HAMPTON	800-426-7866
SAN BERNARDINO	MURUKO HOTEL	714-381-6181
SAN BERNARDINO	LA QUINTA	714-888-7571/800-531-5900
SAN BERNARDINO	SUPER 8 MOTEL HOSPITALITY LANE	714-381-1681/800-843-1991
SAN BERNARDINO	VILLA VIEJO	714-889-3561
ALBUQUERQUE, NM	AMFAC	505-843-7000/800-277-1117
FLAGSTAFF, AZ	FLAGSTAFF INN	602-774-1821
GALLUP, NM	RODEWAY INN	505-863-9385
GLENDALE, AZ	RODEWAY GRAND AVE.	602-264-9164
PHOENIX, GLENDALE	RAMADA INN	800-228-2828
WICKENBURG, AZ	BEST WESTERN	800-528-1234
GRANTS, NM	HOLIDAY INN	800-465-4329

APPENDIX E

ATSF DRUG POLICY



TO ALL EMPLOYEES:

The object of this policy statement is to (1) provide a safe and efficient work environment for employees, and (2) encourage troubled employees to take advantage of the programs outlined herein Santa Fe employees must be free from the effects of alcohol or drug use on the job We must all recognize that a serious problem exists and identify employees who can be helped through counseling and rehabilitation. Treatable problems should not be allowed to become progressively worse and lead to resolution by disciplinary action.

You are encouraged to review this policy statement and keep its provisions in mind. While recourse to disciplinary measures cannot be completely eliminated, voluntary referral and co-worker reports offer employees better alternatives. The interests of employees and their families, the public and the company are best served by controlling personal problems arising from the use of alcohol and drugs that interfere with health, work, and safety.

I sincerely solicit your enthusiastic cooperation and interest in complying with this policy.

M. R. Haverty
President
The Atchison, Topeka and
Santa Fe Railway Company
Chicago, Illinois

Policy on Use of Alcohol and Drugs by Employees of THE ATCHISON, TOPEKA AND SANTA FE RAILWAY COMPANY

1 0 OBJECTIVE

The Atchison, Topeka and Santa Fe Railway Company (Santa Fe) strives to contribute to the health and well-being of employees by providing a safe and efficient work environment A workplace which is free from the effects of alcohol and drugs is necessary to accomplish this goal This policy is designed to protect our employees and the public from the undesirable consequences of allowing the employment of any individual whose actions may be influenced or impaired by the use of alcohol or drugs

Santa Fe endorses and complies with regulations covering this subject issued by the Federal Railroad Administration (49 CFR Part 219 "Control of Alcohol and Drug Use in Railroad Operation") and other pertinent legal authorities, copies of which are available for review upon request

Concurrently, Santa Fe provides positive conditions encouraging employees to seek relief from a need to use or abuse these substances by utilizing the Employee Assistance Program (EAP).

2 0 GENERAL POLICY

This policy supplements, but does not replace, disciplinary rules and procedures currently in force relating to violations involving use of alcohol and drugs

2 1 Toxicological Testing

Toxicology tests for the presence of drugs are conducted when conditions exist as outlined by statutes or regulations and applicable Santa Fe policy An employee whose sample tests positive is conclusively presumed to be incapable of safely or properly performing the duties of the position for which employed and is subject to the conditions outlined in this policy

2 2 Drugs

The word "drugs" refers to controlled substances which can influence or impair one's judgment, reaction and behavior Controlled substances include illicit drugs and certain drugs which may only be distributed by a medical practitioner's prescription or authorization, such as marijuana, narcotics, stimulants, depressants and hallucinogens

3 0 VOLUNTARY REFERRAL POLICY

This provision applies to employees who voluntarily seek the aid of the EAP

3 1 Eligibility

An employee is eligible for the provisions of Voluntary Referral whether self-referred (seeking assistance on one's own) or referred by another employee or by the employee's collective bargaining representative

An employee is not eligible for the provisions of Voluntary Referral if, prior to seeking assistance, the employee has been charged with conduct which is in violation of Santa Fe rules regarding the use of alcohol and drugs, or if the employee is in violation of such Santa Fe rules at the time of referral

3.2 Leave of Absence

Leave of absence for medical reasons without pay will be granted under provisions of Voluntary Referral when recommended by the Medical Director - System or the employee's physician, to allow treatment in a rehabilitation program outlined by an EAP counselor The duration of said leave of absence will be at least 45 days, if necessary, to complete treatment

Such leave of absence may be continued until determined by the Medical Director - System that it is appropriate to return the employee to work.

3 3 Confidentiality

An eligible employee who seeks assistance

under this Voluntary Referral provision will be treated on a strictly confidential basis.

4 0 CO-WORKER REPORT POLICY

These provisions control when employees are reported by their co-workers to be in violation of rules prohibiting the use of alcohol and drugs

4 1 Eligibility

Exclusively for purposes of this Co-Worker Report Policy, the terms "employee" and "Co-Worker" exclude (a) exempt personnel who do not perform service in a craft or class of employees of this Carrier and whose responsibilities are primarily and essentially supervisory, managerial or professional in nature and (b) Santa Fe special agents

For any given employee, the provisions of this Co-Worker Report Policy may be invoked only once. Also, these provisions are only applicable when that employee's violation of Santa Fe rules on alcohol and drug use is brought to the attention of a Santa Fe official exclusively through the report of a co-worker

Eligibility for the benefit of the Co-Worker Report Policy will continue only so long as the employee conforms to all requirements outlined in the procedures below.

4 2 Co-Worker Report Policy Procedure

In order to report a fellow employee for violation of Santa Fe rules on alcohol and drug use, a co-worker reports the suspected violator to a Santa Fe official.

When such a report is received, a company official will observe the alleged violator to determine whether a violation has occurred If, in the official's judgment, an employee is in violation, the employee will be suspended from service immediately pending formal investigation.

4 3 Excuse of Discipline

An employee eligible for treatment under the provisions of this Co-Worker Report Policy may avoid discipline based on the co-worker report and maintain an employment relationship with Santa Fe provided the employee fulfills all conditions outlined below:

4 3 1 A waiver will be included with the notice served for formal investigation according to current practices and agreements A reported employee who signs this waiver will· 1) waive the investigation, 2) agree to undergo an evaluation by the EAP counselor, and 3) if found to be dependent on a prohibited substance, agree to satisfactorily complete a program of treatment outlined by the counselor

4 3 2 If the employee elects to waive the investigation and be evaluated for alcohol or drug abuse, the waiver form (example on page 10) must be completed and signed 1) by the employee, 2) where applicable, witnessed by an appropriate union representative, and 3) delivered to the company official who issued the notice of investigation within five (5) calandar days from the date the notice of investigation was received by the employee.

4 3 3 The employee must contact an EAP counselor to arrange for the evaluation within three (3) calendar days from the date the signed waiver is delivered to the appropriate company official as specified in Section 4 3.2.

4.3.4 The EAP counselor will schedule the necessary interviews and complete the evaluation not later than ten (10) calendar days from the date of contact by the employee

4 3.5 An employee whose evaluation indicates no dependency on the use of alcohol or drugs will be returned to service within 5 days of completion of the evaluation, consistent with the recommendation of the Medical Director - System and stan-

dard Santa Fe practices, and may be subject to conditions outlined in Sections 6.0 and 6.2.

4 3 6 During the out-of-service period or following return to service outlined in Section 4 3 5, the employee may be required to participate in a program of education and training concerning the effects of alcohol and drugs on occupational/transportation safety, as the EAP counselor deems necessary.

4 3 7 An employee who fails to continue treatment may be withheld from service and placed on a medical leave of absence by the Medical Director - System. The employee's failure may also be reported by the counselor to Santa Fe officials.

4 3 8 An employee whose evaluation indicates dependence on the use of alcohol or drugs must satisfactorily complete a program of primary and follow-up treatment as outlined by the EAP counselor. An employee will be given an unpaid leave of absence of up to 45 days, if necessary, for purposes of meeting treatment needs. Upon completion of the primary treatment, the employee will be returned to service promptly, consistent with the recommendation of the Medical Director - System and standard Santa Fe practices. Follow-up treatment deemed necessary by the EAP counselor extends for a period of two (2) years from the date of the report.

4.4 Leave of Absence

A leave of absence without pay for medical reasons will be granted an employee eligible under Co-Worker Report Policy provisions when such leave is recommended by the Medical Director - System for treatment. Such leave of absence may be continued until determined by the Medical Director - System that it is appropriate to return the employee to work. The duration of said leave of absence will be at least 45 days, if necessary, to complete treatment.

4.5 Co-Worker as Witness

In no case will a co-worker who reports an employee's violation of Santa Fe rules concerning alcohol and drug use be required to appear or otherwise participate in a formal investigation conducted in connection with that reported employee's alleged alcohol and drug rule violation.

4.6 Intent

Nothing in this Co-Worker Report Policy is intended or shall be construed to create or form the basis of a contract or covenant of employment between Santa Fe and any employee or group of employees.

5 0 REINSTATEMENT

An employee who is dismissed for violating existing Company rules covering alcohol and drug use will not be considered for reinstatement to service until after an evaluation has determined medical fitness of the individual, and a favorable recommendation is received from the EAP counselor through the Medical Director - System.

6 0 MEDICAL EXAMINATIONS

All return-to-service, periodic and other employee medical examinations provided for by the Medical Director-System include a urine drug screen analysis.

6.1 Urine Tests Positive For Drugs

Individuals examined under provisions of Section 6.0 whose urine tests positive for a substance, the use of which is prohibited by Federal Railroad Administration regulations, will be placed on medical leave of absence. Subsequently, these employees will be instructed in writing to rid their system of drugs and within 60 days must:

1) undergo evaluation by the EAP counselor,
2) abide by the counselor's recommendations,
3) provide a negative urine specimen.

An employee in a treatment program ex-

tending beyond the 60 day period must provide a negative urine specimen within five (5) days of discharge from the program Failure to abide by these conditions will subject the employee to dismissal for disobeying instructions.

A decision by the Medical Director - System to withhold an employee from service under Section 6 of this policy is not and shall not be considered discipline.

6 2 **Follow-Up Testing**

An employee who provides a negative urine specimen and has been permitted to return to service is subject, for a period of two (2) years, to urine testing as determined by the Medical Director - System If such further testing is positive, the employee will be placed on medical leave of absence Such an employee will be subject to the same conditions set forth in Section 6 1

7.0 RANDOM DRUG TESTING PROGRAM

In order to comply with regulations issued by the Federal Railroad Administration, employees who perform service covered by the provisions of the Hours of Service Act are required to undergo random urine testing for use of certain prohibited or controlled drugs Selection of individuals who must provide urine samples is entirely random and computer generated

Employees selected for such testing will be asked either immediately after reporting for duty or before going off-duty to accompany a supervisor to a facility where urine samples will be collected by approved personnel. Employees who, upon being notified of their selection for testing, refuse to participate will be disqualified from covered service for a minimum period of nine (9) months Upon the expiration of this disqualifying period, said employees must provide negative urine specimens before being permitted to return to covered service

7.1 **Handling of Test Results**

Employees who have provided urine

samples under requirements of this Random Drug Testing Program are advised in writing of the results of their respective tests Individuals whose specimens test positive will be provided with a copy of the relevant laboratory reports. These employees will be instructed to contact the Medical Director - System within five (5) working days of receipt of the written notifications to discuss, confidentially, the results of their tests

Failure to contact the Medical Director - System as outlined above and provide documentation to his satisfaction will result in medical disqualification of the employee

7.2 **Medical Disqualification**

Employees who are medically disqualified as a result of positive urine samples will remain in said status until they have fulfilled the conditions set forth in Section 6.1.

7 3 **Follow-Up Testing**

Employees who provide negative urine samples and are permitted to return to service will be subject to the same conditions outlined in Section 6.2

8 0 ADMINISTRATION

Any questions regarding this policy should be referred to the Vice-President Human Resources

EXAMPLE

(Official to Whom Sent)

_____

_____
(address)

WAIVER

I, _____
by affixing my signature below, waive my rights to formal investigation, scheduled on _____, to develop facts and place my responsibility, if any, in connection with my being relieved from duty in suspected violation of Rule G, General Code of Operating Rules while performing service as a _____ on _____

I understand that discipline, if any, to be imposed as a result of the incident to be investigated will be excused, **provided** I contact the EAP counselor within three (3) calendar days from the date this waiver is executed, and thereafter enter into the program of treatment prescribed

I further understand and agree that any failure on my part to complete the prescribed program of treatment will result in my being placed on medical leave of absence with release to return to service to come only from the Medical Director - System

_____
(Signature)

_____
(SSA number)

Witness.

_____
(Signature)

_____
(Union Title of Witness)

Receipt Acknowledged

_____
(Signature)

_____
(Title)

_____
(Date)

Employee Assistance Program Counselors

Eastern Region:

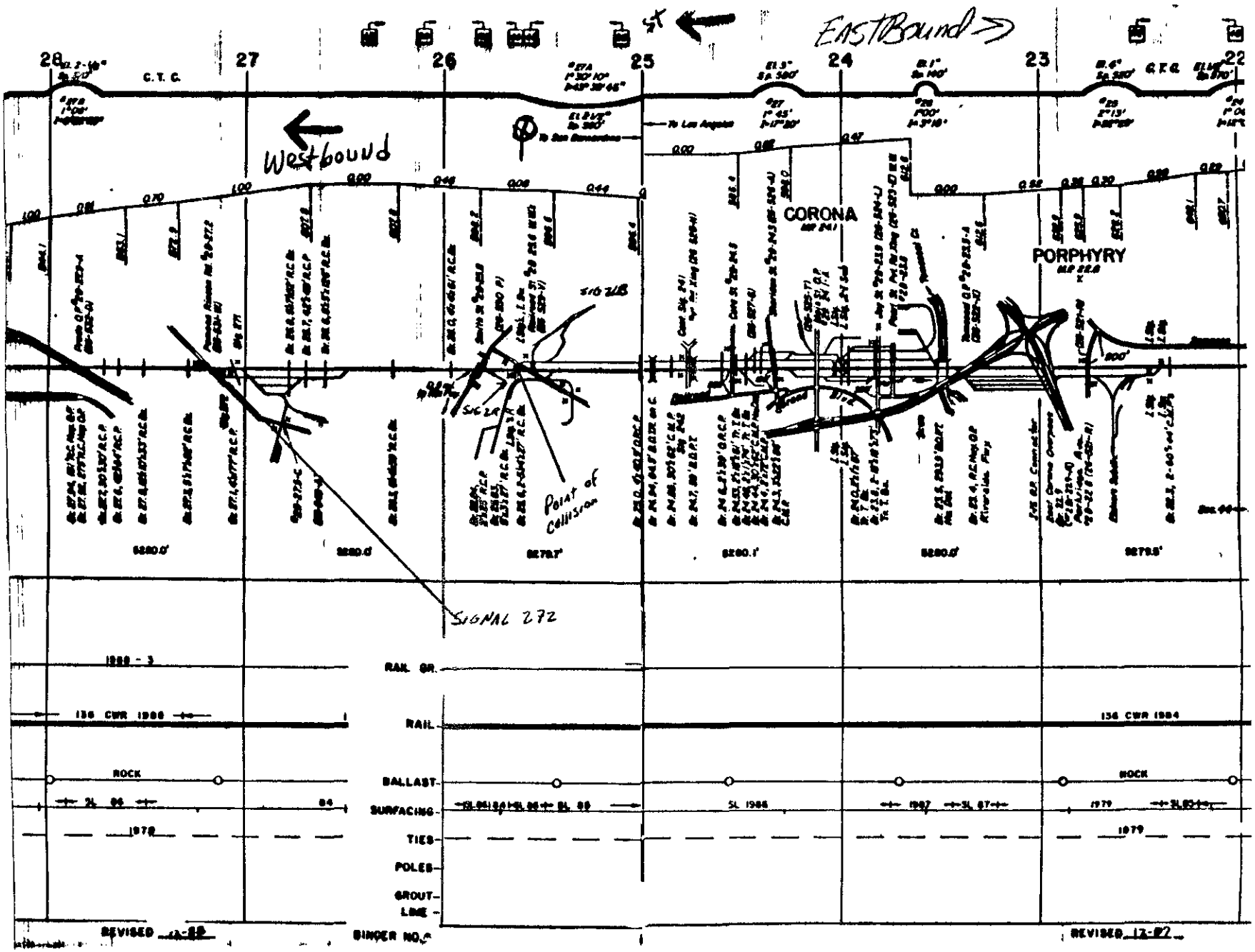
Terry L. Cordray
Program Manager
4515 Kansas Avenue
Kansas City, KS 66106
(913) 551-4465
Ext. 4465

Western Region:

Bruce J. Rehberg
1441 W Airport Freeway
Euless, TX 76040
(817) 868-3196
Ext 3196

James L Harrell
740 E. Carnegie Dr
San Bernardino, CA 92408-3571
(714) 386-4151
Ext. 4151

TRACK MAP OF COLLISION SITE



APPENDIX F