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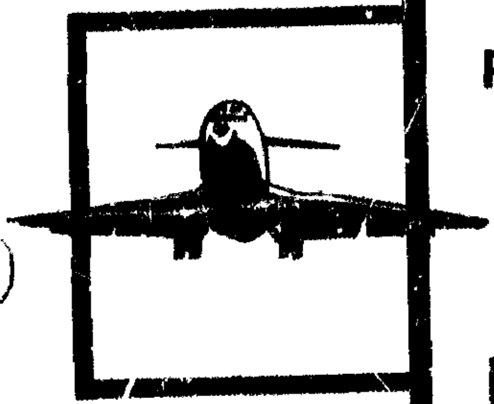

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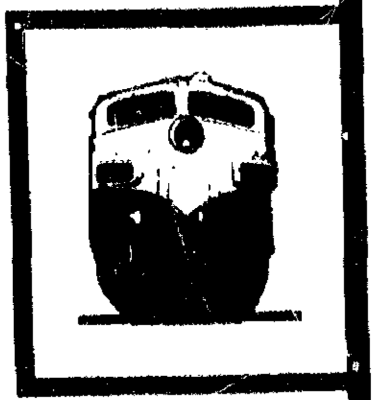

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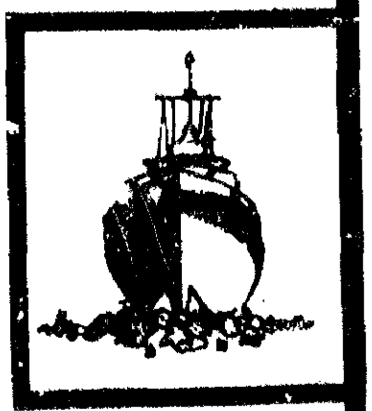
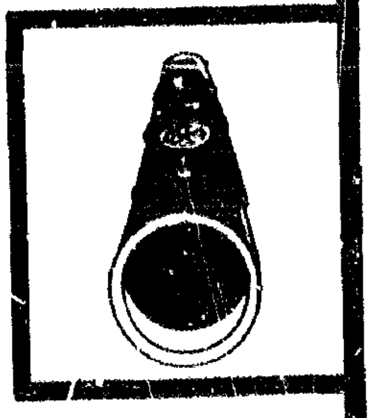


RAILROAD ACCIDENT REPORT

SEABOARD SYSTEM RAILROAD
FREIGHT TRAIN FERHL
DERAILMENT AND FIRE
MARSHVILLE, NORTH CAROLINA
APRIL 10, 1984



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16. Abstract At 9:30 a.m. on April 10, 1984, 18 cars of eastbound Seaboard System Railroad freight train FERHL derailed at Marshville, North Carolina, following the failure of a freight car axle journal as a result of the journal overheating. Two of the four derailed tank cars loaded with methanol, a flammable liquid, were breached during the derailment, and the released methanol was ignited. Three buildings and four automobiles were destroyed by the fire. An estimated 2,100 persons within a 1-mile radius of the accident site were evacuated, U.S. Highway 74 was closed, and the fire was allowed to burn until it subsided at 10 p.m. on the day of the accident. One person received a minor injury during the evacuation. Damage was estimated to be $1,383,000.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the traincrew to apply correctly information about an overheated journal provided by a freight car inspector and a wayside hotbox detector. Contributing to the accident was the failure of Seaboard System Railroad officials to enforce the company's traincrew monitoring program to ensure that Seaboard crews understood and complied with its operating rules. Contributing to the extent of damage resulting from this accident was the lack of bottom outlet protection on the tank cars containing methanol.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: April 30, 1985

SEABOARD SYSTEM RAILROAD FREIGHT TRAIN FERHL DERAILMENT AND FIRE MARSHVILLE, NORTH CAROLINA APRIL 10, 1984

SYNOPSIS

At 9:30 a.m. on April 10, 1984, 18 cars of eastbound Seaboard System Railroad freight train FERHL derailed at Marshville, North Carolina, following the failure of a freight car axle journal as a result of the journal overheating. Two of the four derailed tank cars loaded with methanol, a flammable liquid, were breached during the derailment, and the released methanol was ignited. Three buildings and four automobiles were destroyed by the fire. An estimated 2,100 persons within a 1-mile radius of the accident site were evacuated, U.S. Highway 74 was closed, and the fire was allowed to burn until it subsided at 10 p.m. on the day of the accident. One person received a minor injury during the evacuation. Damage was estimated to be $1,383,000.

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INVESTIGATION

The Accident

At 2 a.m., e.s.t., on April 10, 1984, a Seaboard System Railroad (Seaboard) freight traincrew went on duty at Bostic Yard in Bostic, North Carolina. They took charge of an inbound freight train from which they removed 20 loaded coal cars. They coupled 18 freight cars in the yard and connected the car air hoses. After receiving an airbrake test, the 18 cars were added to the train, and a test was performed to confirm that the brakes set and released on the rear car in the train. The crew received the waybills and a list of car numbers in lieu of a consist, because the computer at the terminal was not operating. The train, designated FERHL and consisting of 3 diesel-electric locomotive units, 87 cars, and 1 caboose, departed eastbound with the engineer and front brakeman in the control compartment of the lead locomotive unit and the conductor and rear brakeman in the caboose.

After traveling 34.7 miles, the train arrived at Cherryville, North Carolina, and remained standing on the main track for 1 hour 25 minutes awaiting the arrival of an opposing train. (See figure 1.) While the train was standing at Cherryville, the rear and head brakemen made a walking visual inspection of the train's running gear; the conductor remained at the caboose. The rear brakeman walked toward the front of the train, and the front brakeman walked toward the rear of the train. When the two met, they retraced their paths to their previous positions on the train. They noted no deficiencies in the condition of the train.

After resuming operation, the train passed a wayside hotbox detector 17.7 miles east of Cherryville, which detected no overheated journals. 1/ At Pinoca Yard, 14.2 miles east of Stanley, North Carolina, the train was stopped to remove two cars from the train. The engineer stated that he had been braking the train very heavily before its arrival at Pinoca Yard. A freight car inspector, employed by Seaboard and on his way to work, stated that as the train approached Pinoca Yard, he observed the train from his automobile and noticed smoke coming from a journal on a freight car in the passing train. He noted that the number of the car was SAL 45678 (the 47th car from the locomotive), and telephoned the yardmaster at Charlotte, North Carolina, to give him the car number and to ask him to notify the traincrew of the observation. Also, he told the yardmaster that the car was loaded with pulpwood. The yardmaster relayed all of this information by radio to the engineer of the train, and the engineer acknowledged that he heard the message "loud and clear." The conductor said he heard over the radio in the caboose parts of the information relayed by the yardmaster and was aware only that smoke had been reported coming from one of the pulpwood cars.

When the train reached an area where it would not interfere with highway crossings, it was stopped and crewmembers conversed by radio about the yardmaster's report. During these communications, neither the engineer nor the conductor questioned the other to determine that both had received fully the yardmaster's report; however, the engineer related his suspicion that a brake on one of the pulpwood cars was sticking. The front brakeman and engineer remained on the locomotive and the conductor remained at the caboose, while the rear brakeman walked forward to check for the problem. The rear brakeman, who had overheard the communications between the engineer and the conductor but had not heard the car number nor any of the specific information in the yardmaster's report, said he found a sticking brake on one of the cars loaded with pulpwood and released it. The train then was allowed to proceed.

The train continued through the Charlotte Yard and Matthews, North Carolina, and passed a hotbox detector 2.1 miles east of Matthews. An alarm from the hotbox detector was received by the traincrew over the radio. The message advised that there were 362 axles in the train and that the journal on the left side of the 157th axle from the rear of the train was overheated. To determine which car to inspect, the front brakeman said he subtracted 4 axles for each of the three 6-axle locomotive units from 362 (the total number of axles in the train as stated by the alarm) and then subtracted 157 from the result. He divided the remainder by four, the number of axles on each freight car, and determined that the position of the car with the hot journal was the 47th car from the front of the train. (See figure 2.)

1/ A journal is that portion of an axle in actual contact with a journal bearing.

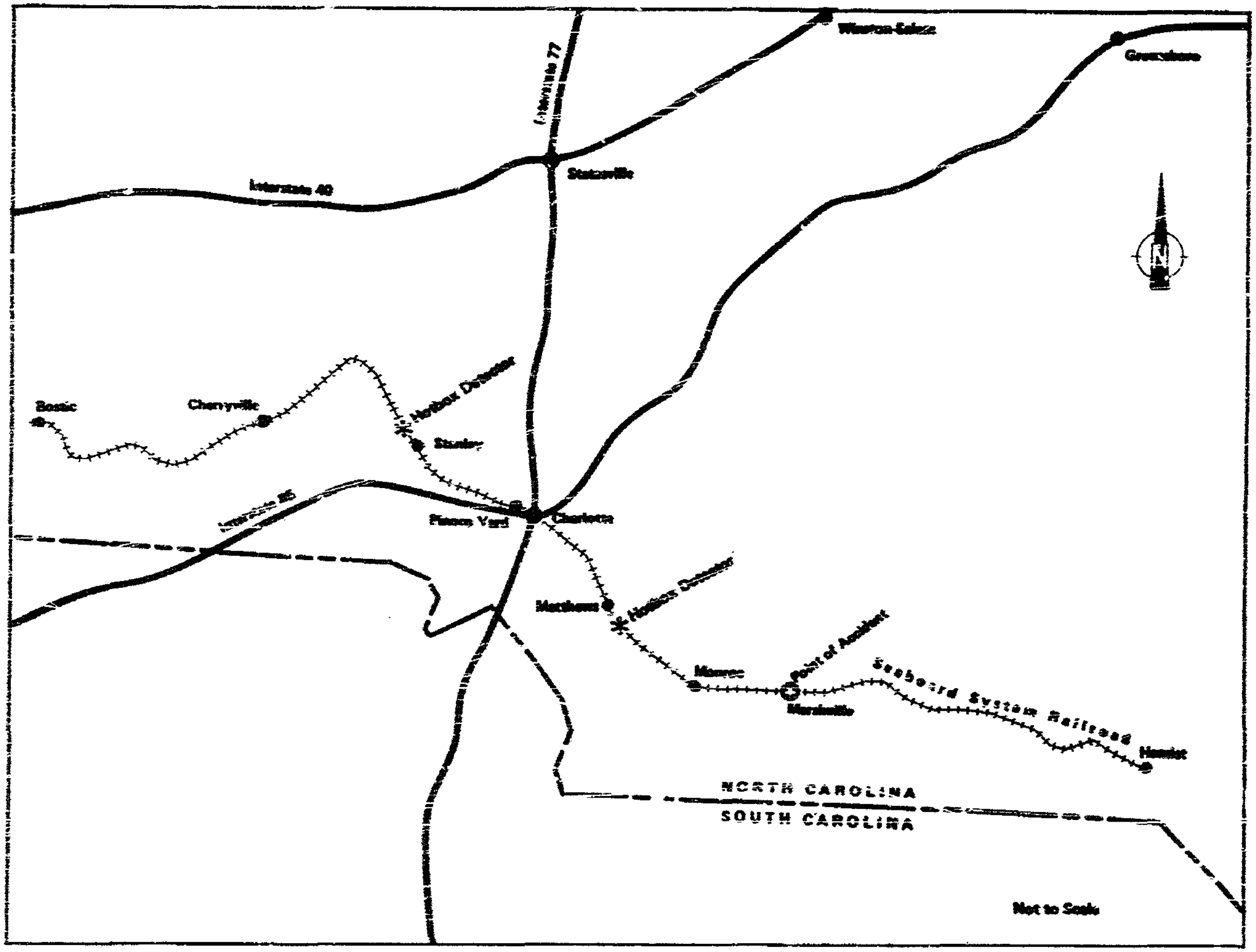

Figure 1.—Plan view of route of Seaboard train FERHL.

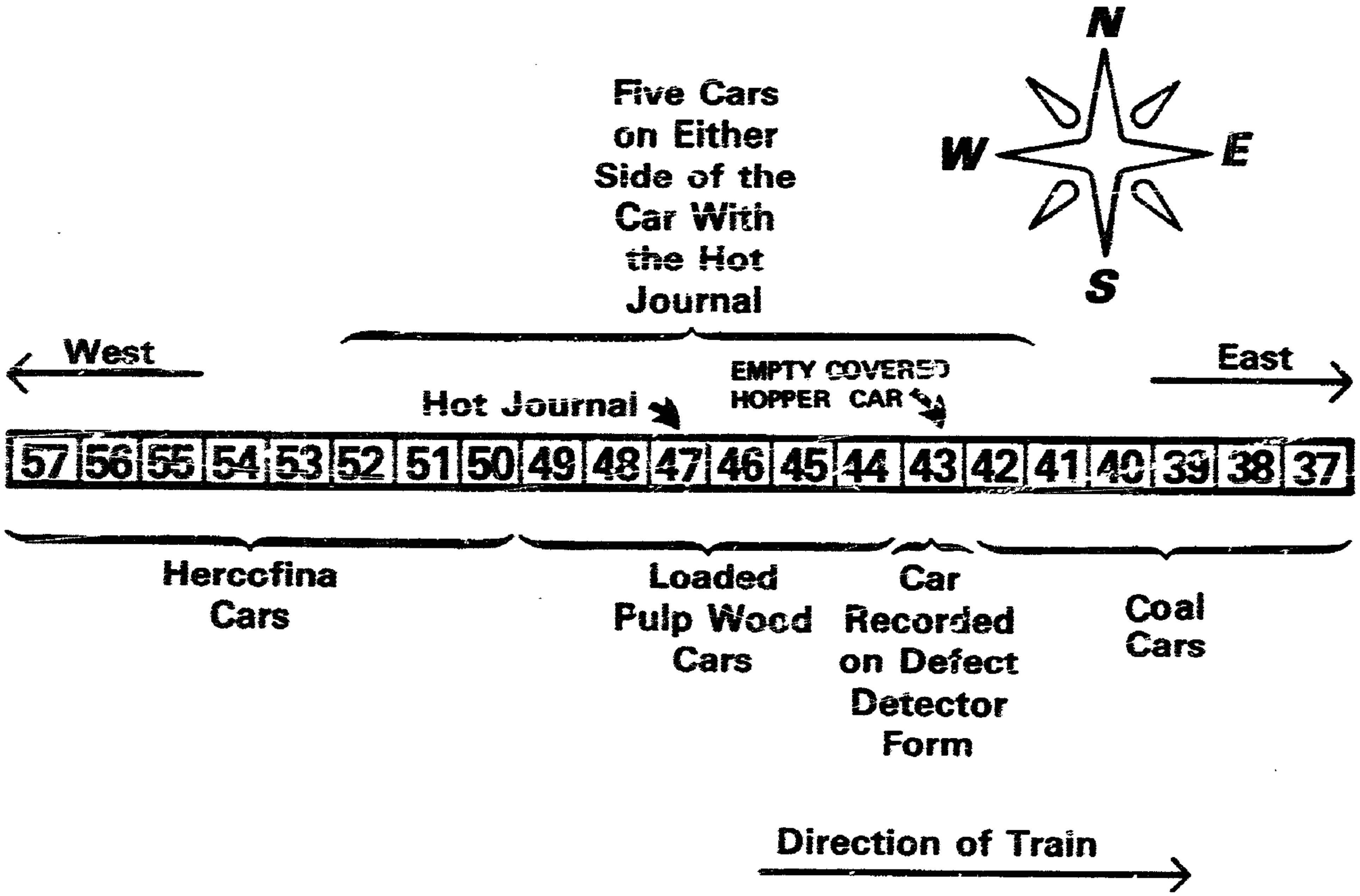

Figure 2.—Position of the cars near overheated journal in freight train FERHL at Charlotte and Matthews.

As the train was slowing to stop, the front brakeman stepped to the ground and the train moved several cars beyond him before it stopped. Then he started walking back to inspect the journal. The rear brakeman said that he walked forward about 15 or 20 cars but made no effort to help the front brakeman locate the hot journal because he knew that the front brakeman was capable of handling the problem. The conductor remained at the caboose. Even though the ambient temperature was 39° F and there was constant, moderate rain, the head brakeman was not wearing rain gear.

The front brakeman stated that he felt all of the journals on the left side of the train with his bare hand starting with the first car behind the coal cars (43rd car) to the beginning of the Hercofina cars (50th car). Further, he stated that he crossed to the right side of the train and while walking toward the front of the train, checked all of the journals until again arriving at the coal cars. He stated that he checked five cars in front of, and more than five cars behind, the suspect car. A temperature test stick 2/ was not used to indicate whether the journals were overheated. To obtain the information required by the railroad about the suspect journal, the conductor requested the front brakeman to record the size and manufacturer of the journal bearing on the covered hopper car, SAL 32254 (43rd car from the locomotive). Unable to find anything wrong with the train, the front brakeman stated that he assumed the hotbox detector had given the crew a false alarm.

The train departed Matthews and continued to Monroe, North Carolina, where the engineer and front brakeman set out 12 cars (1st through 12th cars) and added a diesel-electric locomotive unit to the train. The rear brakeman stated that while the cars were being set out, he carried the waybills from the caboose to the office and reboarded the caboose as the train was pulled by. The conductor had remained at the caboose. The train departed with 4 diesel-electric locomotive units (one of which was not operational), 73 cars, and the caboose.

At 9:30 a.m., as the train entered Marshville, North Carolina, at 35 mph, and while the train was moving over a turnout, an undesired emergency application of the train brakes occurred. The train separated, and the crew on the head end looked back and saw derailed cars on the ground. Crewmembers stated that this was the first indication they had of the derailment. Eighteen cars (the 35th through 52nd cars, which previous to the car changes at Monroe were the 47th through 64th cars) were derailed; one car struck and penetrated a warehouse.

During the derailment, the bottom outlet nozzles on two tank cars loaded with methanol were struck, and the bottoms of the car shells were torn open. The released methanol was ignited, and the fire spread to three nearby buildings and four parked automobiles. One hopper car load of granular plastics was consumed in the fire. Two other tank cars of methanol were not breached during the derailment. One of these two tank cars was exposed to the fire after the derailment and had an increase in internal pressure as evidenced by the distortion of its shell. Fearing an explosion, emergency response personnel began to evacuate the area rather than fight the fire. After the fire subsided at 10 p.m., firefighters were able to extinguish the remaining small fires quickly.

2/ A crayon that melts when touched to anything with a temperature in excess of 219° F.

Injuries to Persons

One person received minor injuries during the evacuation. She was examined at a local hospital and released.

Damage

Of the 18 cars derailed, 12 were destroyed and 6 sustained damage ranging from slight to severe. Three buildings and four automobiles were destroyed by the fire. About 850 feet of main track, 400 feet of auxiliary track, one number 10 turnout, and the automated grade crossing protection system were destroyed.

The estimated cost of damage is as follows:

Equipment	$ 815,000
Track	61,000
Signals	55,000
Nonrailroad structures	277,000
Lading	132,000
Lading transfer	13,000
Emergency response	30,000
Total	$1,383,000

Personnel Information

All of the crewmembers had passed Seaboard's annual examination on operating rules and were qualified by Seaboard for their respective positions. All of the crewmembers had been off-duty for the required time before reporting for duty. Before going on duty for this trip, the crewmembers had been off duty for a period of 19 hours 30 minutes. The conductor was employed by Seaboard on September 28, 1963, and promoted to conductor on December 30, 1966. The rear brakeman was employed on June 1, 1966, the front brakeman was employed on August 5, 1967, and the engineer was employed on July 28, 1969. The front and rear brakemen were qualified conductors.

The records of operational testing of this crew furnished to the Safety Board by Seaboard indicate that the crew's performance at hotbox detectors was not monitored during the period covered by the records from January 8, 1980, through January 4, 1984. Each crewmember stated that the only training he received in locating overheated journals was on-the-job training. Also, the conductor stated that he had not received training about actions required of him during emergencies involving hazardous materials.

Contrary to the testimony of the train crewmembers concerning the training they had received, Seaboard asserted that each of these crewmembers attended a rules class in 1982 which, through use of a slide presentation and oral instructions, provided training on the use of information received from hotbox detectors. Moreover, Seaboard stated that in 1983 the conductor attended a rules class that included training on the proper actions to take when a train transporting hazardous materials is involved in an accident and that the test taken and passed by the conductor after the rules class included 10 questions concerning hazardous materials. These questions concerned actions to be taken after an accident.

Train Information

Of the 73 freight cars in the train consist, 7 contained hazardous materials. The trailing tonnage was 7,501.

The four methanol tank cars were loaded and shipped by Hoechst Fibers, Incorporated, Forster, South Carolina, and were consigned to Hercofina, Incorporated, Hanover, North Carolina. All four were nonpressure, stub-sill, DOT 111A100W1-specification, uninsulated tank cars. The bottom outlet nozzles on two of the tank cars had "V" grooves where the nozzle could break off below the valve in an accident without any loss of commodity. The two tank cars that were breached did not have this protection. Three tank cars each contained an estimated 190,000 pounds of methanol, and the fourth contained an estimated 196,000 pounds of methanol. GATX 17600 was built in 1973, GATX 55112 and GATX 55119 were built in 1970, and NTAX 29001 was built in 1968.

Hazardous Materials

Methanol (methyl alcohol) (wood alcohol) is described, in part, in the Ninth Edition of the Condensed Chemical Dictionary by the following properties and hazards:

> Properties: Clear, colorless, highly polar liquid. Miscible with water, alcohol, and ether. Flash point 54 degrees F.
>
> Hazards: Flammable, dangerous fire risk. Toxic by ingestion (causes blindness). Tolerance, 200 ppm in air. Explosive limits in air 6-36.5% by volume.

Track Information

The hotbox detector located at Matthews was manufactured by the Servo Corporation of America and had an automatic voice crew notification alarm. This detector takes the average temperature of the two coolest journals of each car and multiplies the average by a factor of 2.8. If the temperature of any journal on the car exceeds the calculated reading, the hotbox detector sounds an alarm that is transmitted over the radio to the crew. The detector records the temperature of each journal by marking a chart which is lined in increments of millimeters, and if any journal causes the stylus to move 15 millimeters or more, the alarm will sound to prevent a car on which all journals are hot from going undetected. The average temperature of the journals on train FERHL caused the chart to be marked 3 to 4 millimeters. The journal that failed caused the detector to record a reading of 22 millimeters. A 6-millimeter marking would result from a journal operating at 219° F, and a 22-millimeter marking would indicate a journal temperature of 290° F to 300° F. The detector was tested after the accident and was found to be in proper working order.

During a postaccident examination of the track leading to the derailed cars, a journal and end cap were found on the north side of the railroad right-of-way, 1.6 miles west of Marshville. There were parallel wheel flange marks on the crossties extending from the area where the journal was found to the derailed cars. The distance between these parallel marks was the same as the distance between two wheels on the same axle of a freight car. The tops of the spikes and tie plates on the north side of the north rail were abraded along that part of the track extending from the area where the journal was found to the derailed cars at Marshville.

A postaccident examination of the freight cars revealed areas where some of the metal had been abraded from the underside of the left trailing truck sideframe of car SAL 45678. There were marks on the underside of the trailing (B end) body bolster that corresponded with the location and shape of the wheel flanges. The left-side roller bearing and journal on the trailing axle (L-1) were missing from car SAL 45678.

Method of Operation

The crew involved in the derailment of train FERHL boarded the train at Bostic and were en route to Hamlet Yard in Hamlet, North Carolina. The railroad between Bostic and Hamlet is part of Seaboard's Raleigh Division, which is comprised of two subdivisions. The Charlotte Subdivision is a single main track between Bostic Yard and Monroe, a distance of 99 miles. The track has an Absolute Block System, with no automatic block signals, consisting of 15 separate blocks which are controlled by the operator at Charlotte under the direction of the train dispatcher, who is located in Erwin, Tennessee. Movements are governed by Seaboard's operating rules for absolute blocks.

The Monroe Subdivision is a single main track between Monroe and Hamlet Yard, a distance of 56 miles, which has a Traffic Control System with movements governed by traffic control rules. The traffic control console is located in Raleigh and is under the direction of a train dispatcher; the maximum authorized speed for train FERHL in the area of the derailment was 35 mph.

Seaboard's rules guide its employees in performing their duties. These rules are superseded by special instructions in the timetable and further superseded by instructions in any special bulletins. Employees are required by rule to know and obey the carrier's rules and instructions. Seaboard requires its crews to render every assistance in their power to carry out the rules and instructions, which state that the conductor is in charge of the train but the entire crew is responsible for the safety of the train. Rules require crews to be observant of the condition of their train, to make running inspections of the train, to make walking inspections of the train anytime it is stopped long enough to do so, and not to proceed until it is safe to do so. The conductor is responsible for the action or lack of action of the crew, and he must see that his crew is familiar with their duties and the rules. In the event of an accident involving hazardous materials, among other requirements, he must seek out the emergency response personnel and furnish them with information as to the commodities involved.

To locate an overheated journal when the hotbox detector gives total axle count, the employee must begin counting axles from the front or rear of the train. In 1978, instructions to traincrews about the use of hotbox detector information were removed from Seaboard's timetables and added to the rulebook. Once an alarm from a hotbox detector is received by a crew, they are required to check the appropriate axle to determine if the journal is in fact overheated. If they do not find an overheated journal, the rule requires that they then check all other journals on the car and the journals on the three cars to the front and to the rear of the car they initially checked. Under this rule, a total of seven cars were to be checked. If, after all seven cars had been inspected, an overheated journal was not located, the train could proceed. However, in September 1983, the rule was amended to require checking the journals on five cars to the front and five cars to the rear of any car identified by a hotbox detector as potentially having an overheated journal. If an overheated journal was located, the car had to be set out of the train before the train could proceed.

Federal regulations, Title 49 CFR Part 217, require a carrier to make its crewmembers knowledgeable in the carrier's rules and to conduct tests to determine if the crews are complying with them. Seaboard's program for training and monitoring train crewmembers relative to their responsibilities consists of written rules, annual training, annual testing, and supervisory proficiency tests and observations.

Seaboard's supervisor responsible for training traincrews said that crewmembers participate in a 4-hour training session conducted annually by a division officer. Visual and oral presentations are made to instruct crews on the operating rules; rules on specific problem areas often are highlighted. He said that crewmembers then are given a 50-question, open-book test on the subjects covered by that day's training. Crewmembers who incorrectly answer a question are counseled concerning the proper answer and, before leaving the session, are required to sign a document stating that the rule related to the question has been explained to them and that they now understand the rule. Crewmembers who are unable to answer correctly at least 80 percent of the questions are removed from service until they are reexamined and answer correctly at least 80 percent of the questions. The reexamination may be taken the same day by taking the same test after receiving additional instruction from a railroad official. The annual testing of crews is not viewed by Seaboard's Superintendent for Safety and Rules Compliance merely as an examination; rather, he considers it a method for teaching traincrews the operating rules. This superintendent acknowledged that this method of training and testing of crewmembers generally was standard throughout the railroad industry. He also stated that he was not aware of any studies or other statistical analyses performed of this instruction and testing method to determine if it is an effective means of training crewmembers on activities required of them by the operating rules.

Seaboard has an efficiency test program which involves the periodic monitoring of crewmember activities by railroad officials. This program, according to the Superintendent for Safety and Rules Compliance, is Seaboard's basic means for testing crewmembers about their understanding of the operating rules and is capable of testing "a crew on any rule or special instruction." There are 62 predesigned tests with instructions detailing the actions to be taken by the official conducting the efficiency test. Additionally, there is a "type 10" test which is designed individually for any rule not covered by the 62 standard rules. Any test or observation may be accomplished unannounced by one or more officials both at the place the crew reports for duty or en route between stations. A train may be stopped by the official and questions asked of the crew, or a situation may be set up where the crew has to make a decision. On the other hand, an observation of the crew in the performance of their duties may involve no more than an official watching a train pass over a grade crossing. The Seaboard furnished information concerning the monitoring of this traincrew for compliance with operational tests and observations for a period of approximately 4 years, covering January 1980 through April 1, 1984. During this period, Seaboard was in the process of replacing its existing efficiency test program with the current test program.

Meteorological Information

The surface weather map for 0700 on April 10, prepared by the National Weather Service, showed a low-pressure area off the South Carolina-Georgia coast bringing northeasterly winds to the Carolinas. Conditions throughout North Carolina were characterized by overcast skies with moderate to steady rain and temperatures of about 38° F.

Fire and Emergency Response

The front of the train came to a stop adjacent to the Marshville Fire Department; the derailed cars were only two blocks from the fire station. The conductor radioed the Seaboard office at Monroe and reported the derailment and fire. He also asked the Monroe office to notify the proper county and local officials.

The county fire marshal was in the Marshville area when the accident occurred. As soon as the derailed train came to a stop, the conductor walked up a road parallel to the railroad in search of emergency response personnel and encountered the county fire marshal. The conductor gave the waybill information to the county fire marshal who immediately determined which materials were involved in the fire. The conductor said that he had not been trained in the proper action to take when involved in an accident with hazardous materials and that he acted on his own initiative in seeking out emergency response personnel to provide them information about the hazardous materials contained within the train.

Using information provided by the conductor, the fire marshal next conferred with the traincrew and other local community officials on the scene and initiated an evacuation at 9:50 a.m. of all persons from houses, businesses, and schools within one-half mile of the accident site. With the help of the State police, sheriff's personnel, a large number of firefighters from mutual-aid units, and civil servants from nearby communities, a well-organized effort to control and evacuate the area was carried out in a short time. This evacuation area was later enlarged to 1 mile. The fire marshal decided not to fight the fire immediately because of the possibility of a tank car rupturing violently.

A command post was established at a nearby school. A radio room operated by the State police supplemented the many mobile radios used by the various units that responded to the accident. A member from each agency was consulted before each decision was made. Shelters were set up for the evacuees at three schools and staffed by public health and Red Cross personnel. A portion of U.S. Highway 74 was closed during the emergency. The county fire marshal requested and received a temporary flight restriction over the area from the Federal Aviation Administration (FAA). The firefighters extinguished the subsiding flames at 10 p.m. on the day of the accident. The evacuation order was lifted at 1:16 a.m. the morning after the accident, and U.S. Highway 74 was opened to traffic.

Other Information

Tank Cars.--In the early 1960's, tank car manufacturers began building tank cars without continuous, full-length center sills. These so-called "stub sill" tank cars use the tank shell to support the loads imposed by the weight of the materials in the tank as well as to absorb the train draft and buffing forces. The bottom outlet and other bottom discontinuities that formerly were protected during derailments by the center sill now were exposed. (See figure 3.) The Federal Railroad Administration (FRA) requirements for protecting bottom outlets of cars with center sills continue to require that breakage grooves in outlets be above the bottom flange of the center sill; however, stub-sill tanks are allowed to have the required breakage grooves up to 15 inches below the bottom of the tank shell (49 CFR 179.200-17).

In 1974, the Tank Car Committee of the Association of American Railroads (AAR) approved protection specifications for bottom outlets, washouts, and sumps (discontinuities) for new stub-sill pressure cars (classes 112A and 114A and the proposed

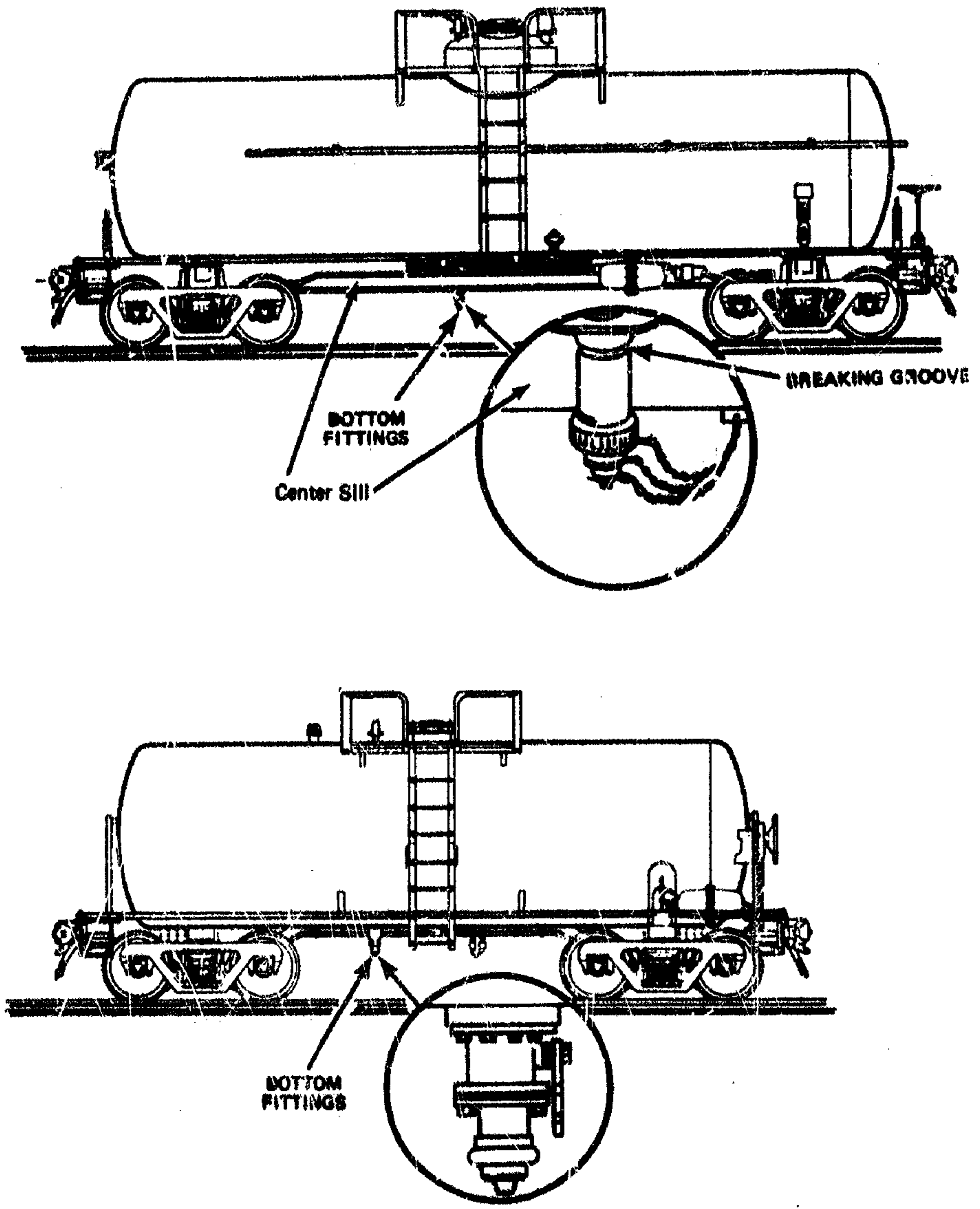

Figure 3.--Car with continuous full-length center sill (top) and car without continuous full-length center sill (bottom).

class 120A). Concurrently, the subject of bottom outlets on existing stub-sill tank cars came under study. In 1977, the committee developed protection specifications for bottom fittings on new nonpressure stub-sill tank cars. As of January 1, 1978, all newly built, low-pressure (less than 100-pound working pressure), stub-sill tank cars have been required to have bottom discontinuity protection if the bottom discontinuities extended more than 1 inch. In 1980, the AAR committee required protection of bottom discontinuities on existing class 112 and 114 stub-sill tank cars used to transport liquefied flammable gas or anhydrous ammonia. To develop a schedule of priorities for retrofitting other existing tank cars with bottom discontinuity protection, the committee appointed a task force of representatives from the railroads, the Compressed Gas Association, the Chemical Manufacturers Association, the Railway Progress Institute, and the AAR's Bureau of Explosives. The task force developed specifications to require protection of bottom discontinuities on existing nonpressure, stub-sill tank cars used to transport certain hazardous materials, listed in the eight AAR commodity groups. The dates by which this protection must be provided were established for each AAR commodity group. (See table 1.)

At the beginning of the AAR tank car bottom discontinuity retrofit program, there were 30,300 tank cars to be modified, and by industry projections it was determined the retrofits reasonably could be accomplished in 14 years. To date, after the lapse of 57 percent of the projected timeframe, the AAR estimates that 6,800 tank cars, just over 22 percent of the total, have been retrofitted. Even though only 22 percent of the tankcars have been retrofitted, the program is on schedule.

Hot Box Detector Research.--The development of a device for the detection of imminent railroad journal failure--by sensing the occurrence of abnormally high temperatures associated with incipient catastrophic failure--has been the subject of extensive research and development effort. The FRA has sponsored four or more programs that targeted the problems of detecting overheated journals.

The most successful device to date has been the hotbox detection system which consists of a "wayside" infrared heat detector and data transmission system. These detectors and their associated transmission apparatus are placed at track intervals of approximately 30 miles depending on traffic. They measure temperatures by remotely sensing the infrared energy emanating from each journal of a passing train, and in the event of an abnormally high temperature, signal the traincrew via wayside instrumentation to stop the train. Although these systems have been quite successful, there are a number of disadvantages:

(1) Initial capital outlays are on the order of $30,000 to $50,000, and each involves a substantial annual maintenance cost;

(2) Monitoring of journals is a sampling process and, thus, the possibility of missing failures exists;

(3) Local weather conditions, such as blowing snow or sand, often render the hotbox detectors ineffective; and

(4) Hotbox data are not used effectively by traincrews.

Table 1.—Bottom fittings protection requirements for AAR commodity groups 1 through 8.

AAR commodity group	Effective dates for protection
Group 1 - EPA categories X, A, B	January 1, 1980, for all bottom discontinuities
Group 2 - Flammable and thermally unstable* Flammable and polymerizable** Flammable and poison Flammable and corrosive	May 1, 1982, for bottom outlets; May 1, 1983, for all other bottom discontinuities
Group 3 - EPA categories*** C, D	July 1, 1983, for bottom outlets; July 1, 1984, for all other bottom discontinuities
Group 4 - Vacant	Materials initially assigned to this group are included in Group 6.
Group 5 - Poison	January 1, 1988, for bottom outlets; January 1, 1989, for all other bottom discontinuities
Group 6 - Flammable	July 1, 1988, for bottom outlets; July 1, 1989, for all other bottom discontinuities
Group 7 - Corrosive	January 1, 1989, for bottom outlets; January 1, 1990, for all other bottom discontinuities
Group 8 - Combustible	July 1, 1989, for bottom outlets; July 1, 1990, for all other bottom discontinuities

* Thermally unstable—A material which when exposed to elevated temperatures will spontaneously decompose with evolution of heat and pressure.

** Polymerizable—A material which will react with itself to form a larger molecule usually with evolution of heat.

*** For caustic soda, the bottom outlet date has been extended to July 1, 1987, subject to progress reports to be submitted to the Tank Car Committee.

The development of a continuous monitoring device is the only way of overcoming the statistical and meteorological uncertainties associated with hotbox detection systems. The feasibility of implanting a radio transmitter that is activated by the overheating of the journal in an end cap screw has been established. 3/ There are three known drawbacks to this miniature radio system: the short range of the radio transmission (one-half mile), vulnerability to vandalism, and cost.

Amtrak uses an onboard failure-protection system to alert the traincrew when journals overheat. This system is composed of a thermal sensing unit at the journal that is wired to an alarm in the control compartment of the locomotive. This type unit is necessary because the journals on most passenger equipment are located inside the wheels and wayside detectors are installed to scan journals located outside the wheels.

BiModal Roadrailers, a method of moving highway trailers by rail without flatcars, uses a system that connects the train air brake line to a fuse plug located at each journal. When a journal overheats, the fuse plug is melted and the train air brake line pressure is vented to the atmosphere, thereby causing an emergency application of the train brakes. This stops the train until the crew isolates the defective car.

The Timken Company, producers of railroad freight car roller bearings, manufactures a roller bearing end cap screw replacement that gives off an odor and leaves a stain on the end cap when a journal overheats. Crewmembers on the caboose should be able to detect the odor when a journal overheats and initiate a search for a stained cap screw. Some railroads have questioned the value of the odorant as a means of detecting overheated journals because of the trend to operating trains without cabooses.

ANALYSIS

The Accident

The evidence indicates that the derailment of train FERHL was precipitated by a journal failure, of undetermined cause, on the trailing axle of car SAL 45678, which had been the 47th car in the train before the car changes at Monroe. The cause of the journal failure could not be determined because none of the journal bearing was recovered. Continued rotation of a defective or improperly lubricated bearing around a journal will destroy the bearing, causing excessive heat to be generated in the journal and resulting in the failure of the journal. Because the journal is the load-carrying portion of the axle, the load of a failed journal will be transferred to the other end of the axle. With the weight from the car being applied only to one end of the axle, the wheel on the other end of the axle will rise until its flange loses contact with the rail. This allows the wheels to drop from the rails onto the ties and ballast. The Safety Board concludes that this sequence of events occurred in this accident, and that when the derailed wheel of car SAL 45678 struck the track turnout at Marshville, the other wheels on the car were derailed, initiating the derailment of the 17 following cars.

The traincrew had three opportunities to detect the journal problem and to prevent the derailment, and on each occasion they failed to take proper action. On arrival at Pinoca Yard, after traveling more than 71 miles from Bostic and passing a hotbox

3/ SKF Industries, Inc., DOT Contract DOT-TSC-035.

detector en route without receiving any indication of overheated journals, the engineer received a radio message stating that smoke had been observed coming from a journal on car SAL 45678 (the 47th car), which was transporting pulpwood. The engineer, apparently recalling the heavy braking he had performed on his approach to Pinoca Yard, did not repeat the message he had received to the crewmembers at the rear of the train; rather he advised them that a car loaded with pulpwood had a sticking brake. Had the engineer repeated exactly the message he received and had one of the crew performed a proper inspection of car SAL 45678, the overheated journal could have been identified, and the car would have been removed from the train. Instead, the rear brakeman, using the information provided by the engineer, located and released a sticking brake on one of the pulpwood cars (the 44th through 49th cars), and the train proceeded.

The second opportunity the traincrew had to identify the overheated journal was 2 miles beyond Matthews where the hotbox detector provided an alarm by radio and a message that the left journal on the 157th axle from the rear of the 362-axle train was overheated. The front brakeman, using procedures differing from those established by Seaboard for identifying a suspect car after receipt of an alarm from a hotbox detector, looked for an overheated journal on the car identified by his calculations and count of the cars as they were pulled by his location beside the track. The front brakeman's statement that he used his bare hands to feel the journals of five cars on each side of the car initially inspected, with the rearmost car being the 50th car from the locomotive, cannot be correct. Such an inspection would have included the overheated journal on the 47th car, which would have burned his bare hand if placed against the journal even momentarily. Since many of the cars he allegedly inspected were transporting pulpwood, it might be expected that the front brakeman would have related this information to the radio transmission that prompted the inspection at Pinoca Yard. Had he related the two events, he might have had more confidence in the validity of the hotbox detector alarm and rechecked his computations for using the information provided by the hotbox detector. Moreover, the instruction from the conductor to obtain information from the journal on the 43rd car in the train rather than the one he initially inspected also should have alerted the front brakeman that he might have made a mistake in his computations using the hotbox detector information. Had the front brakeman begun his inspection at the 43rd car and properly inspected five cars in each direction, this inspection should have detected the overheated journal.

The third opportunity the traincrew had to identify the overheated journal was at Monroe, about 10 miles before Marshville, where the train was stopped to set out cars and to add a locomotive. At this location and in violation of Seaboard Operating Rule No. 111, the conductor took no action to cause the train to be inspected despite the earlier report of smoke and the hotbox detector alarm. Even absent the previous difficulties, the conductor was responsible for requiring an inspection of the train to comply with Seaboard's operating rules.

<u>Crewmember Training and Monitoring</u>

The actions of each of the train crewmembers demonstrated a less-than-adequate understanding of Seaboard's operating rules even though each crewmember had many years of experience and each previously had passed required tests. The annual testing performed by Seaboard of its crewmembers, which according to Seaboard is representative of the industry practice, does not test fully a crewmember's knowledge of the operating rules because the tests are not comprehensive and because Seaboard has a policy of coaching employees on questions missed and then allowing them to immediately take the same test to meet the examination requirements. Such testing procedures only determine a crewmember's short-term memory of the rules included in the examination.

Seaboard contends that its annual rules examination actually constitutes training rather than testing. Further, it contends that it determines its employees' knowledge of the operating rules through its program of monitoring traincrew performance. The Safety Board agrees that the annual rules examination could better be characterized as training rather than testing of employees, but does not agree that Seaboard's present monitoring of train operations is adequate for determining a crew's knowledge or application of the operating rules. At the same time, the Safety Board believes that what Seaboard calls its training program does not even constitute a training program in comparison to training programs used on some more progressive railroads and throughout other sectors of the transportation community. While the operations of each crew are to be monitored, the crewmembers involved in this accident, according to Seaboard's records, had never been monitored to determine if each knew how to use information provided by hotbox detectors for locating overheated journals. Also, Seaboard has no specific proficiency test to determine if crewmembers understand what each is to do in the event of an emergency, such as a derailment, that involves the release or potential release of hazardous materials.

The training of crewmembers in the handling of information obtained from hotbox detectors and in their performance during emergencies that involve the release of hazardous materials both have been the subject of previous recommendations to Seaboard. During the 5-year period, 1976 to 1981, the Safety Board investigated nine accidents in which overheated journals previously had been identified by trackside hotbox detectors and which nevertheless led to derailments. As the Board stated in a special investigation report in 1981: 4/

> While the value of the hot box detector has been established as a tool to locate overheated journal bearings, the Safety Board is becoming increasingly concerned with the handling of hot box detector data after an overheated journal bearing has been identified. During the past 5 years, the Safety Board has investigated nine accidents in which overheated journal bearings that had been previously identified by trackside hot box detectors resulted in derailments.

As a result of the report, Safety Recommendations R-81-84 and -85 were made to six railroads, including the Louisville and Nashville Railroad (L&N) which later became a part of the Family Lines Rail System, which later became the Seaboard System Railroad:

<u>R-81-84</u>

Review and evaluate training and procedures for handling hot box detector data to ensure that correct action is taken to accurately determine the location of the bearing in the train and that the train is properly inspected when an overheated journal bearing is identified.

4/ Special Investigation Report--"Recent Accident History of Hot Box Detector Data Management" (NTSB-SIR-81-1).

R-81-85

> Establish a method for determining and verifying that actions taken to prevent journal failure when an overheated bearing is indicated by a hot box detector are of a sufficient and acceptable quality.

Family Lines responded on September 16, 1981, and stated that it too was concerned about a traincrew incorrectly computing the actual location of an overheated journal. Family Lines advised the Safety Board that appropriate action had been taken to ensure that procedures were established to accurately determine the location of the journal in the train and that L&N trains are inspected properly when a defect is signalled by the hotbox detector. Family Lines also advised that it had reviewed and evaluated its training procedures and was continuing to monitor them so that an accident would be prevented when an overheated journal is indicated by the detector.

In evaluating the Family Lines response on March 23, 1982, the Safety Board accepted the L&N action to establish procedures and to review and evaluate its training for locating and dealing with overheated journals as meeting the intent of the recommendations. The Board also stated that it would appreciate receiving a copy of the instruction or procedures that had been established to accurately determine the location of overheated journals and receiving more detailed information about the nature, length, and means by which training in locating and inspecting such journals is carried out. Pending the receipt of the requested information, the recommendations were classified "Open--Acceptable Action."

The Safety Board received the requested information in April 1982. The information included a revision of instructions in the Family Lines timetable that pertained to the actions to be taken at a hotbox detector when an alarm is received by the traincrew alerting them of an overheated journal. These changes increased the number of cars to be inspected from three on either side of the suspect car to five when an overheated journal as indicated by the hotbox detector could not be located. Also included in the information were bulletin orders that were to be incorporated into timetables and a copy of a narrative for an audio-visual slide program that was being used in instructing traincrews on the use of hotbox detector information. In conjunction with these efforts, the Safety Board was advised that continual supervisory checks were being made on crewmembers' knowledge and use of these instructions. After reviewing the information, the Safety Board classified Safety Recommendations R-81-84 and -85 as "Closed--Acceptable Action" on October 2[illegible] 1982. Further, Seaboard, Family Lines' successor, stated in a recent report to the FRA that in 1981 it had conducted 5,363 tests of employees, that 88 failures were recorded, and that corrective action had been taken.

In its report of a Seaboard train derailment in Colonial Heights, Virginia, in 1982, 5/ the Safety Board pointed out the need for improved crewmember postaccident emergency response activities, and on May 24, 1983, issued Safety Recommendation R-83-48:

> Periodically instruct and test traincrews and supervisory personnel on the procedures for using train documents to identify all cars transporting hazardous materials and the information to be provided to assist emergency response personnel.

5/ Railroad Accident Report--"Derailment of Seaboard Coast Line Railroad Train No. 120, Colonial Heights, Virginia, May 31, 1982" (NTSB/RAR-83/04).

This recommendation was the result of a traincrew member's failure to follow procedures for using train documents as outlined in a train bulletin. This bulletin required the conductor to search the train waybills for cars containing hazardous materials by using the Standard Transportation Commodity Code number and the United Nations identification numbers. Instead, the waybills were searched only for cars with a "Dangerous" endorsement, and as a result, one tank car loaded with hazardous materials was not identified to the city's emergency response personnel. Further, rather than providing the city's emergency response personnel with hazardous materials information from the waybills and consist, the conductor gave the documents to the fire department believing that the firefighters would know how to identify the hazardous materials involved.

Seaboard responded on July 24, 1984, stating that it had an ongoing program of training and testing its conductors on the use of pertinent waybill and consist information. Seaboard stated that it had incorporated into each Division Timetable, which every traincrew is required to have while on duty, special instructions concerning the handling of waybill and other hazardous materials information pertinent to the train consist. Although Safety Recommendation R-83-48 was placed in a "Closed--Acceptable Action" status, the Safety Board noted in its reply of January 11, 1985, that the problem of responsive traincrew actions during an emergency had arisen in the Marshville accident and in an accident in Clay, Kentucky, on February 5, 1984.

Seaboard has the responsibility to determine not only that its crewmembers are knowledgeable of its operating rules, but that crewmembers know how to apply the rules and that the rules are consistently followed. Programs appear to be in place for achieving these objectives, but this accident and others investigated by the Safety Board demonstrate that the programs and their administration by Seaboard officials are not accomplishing the desired results. While the annual training and rules testing may enhance a crewmember's current knowledge on selected rules, it does not ensure that a crewmember knows all operating rules. Moreover, the on-the-job monitoring of crewmember activities is ineffective because all crews are not monitored periodically on all rules, and crews are not monitored at sufficiently frequent intervals to ensure consistent compliance. Seaboard furnished information concerning the efficiency testing (operational testing and inspection) of the members of this traincrew for a period of approximately 4 years prior to this accident. During this time, Seaboard was in the process of phasing in a new test program. This information disclosed that the engineer had not been monitored on approximately 39 percent of the applicable tests, the conductor on approximately 38 percent, the front brakeman on approximately 41 percent, and the rear brakeman on approximately 37 percent. The information furnished by Seaboard revealed that none of the crewmembers of this train had been tested for proper performance at a hotbox detector during the period of time the information covered. The failure of Seaboard to enforce its efficiency test program not only reduces the level of safety for the crews, but endangers the public as well. Seaboard should enforce its policy requiring officials to monitor periodically each operating employee to ensure that each employee understands and complies with every company rule, timetable instruction, and bulletin applicable to the proper and safe performance of assigned duties and to correct deficiencies detected.

<u>Detection of Overheated Journals</u>

Hot box detectors located at intervals along the rail track structure have been effective in identifying the existence of overheated journals in trains and in reducing the occurrence of derailments resulting from journal failures. However, these devices are not required to be installed, the FRA has no standards controlling the interval between detectors, and crews have failed to locate overheated journals even after they were alerted by a detector. Both industry and the FRA have conducted research to identify better methods for identifying en route the existence of an overheated journal and for confirming the location of the overheated journal, including the development of new technologies and the improvement of existing technologies. The research has not yet identified economically feasible new means to accomplish these objectives.

Performance of Bottom Outlets

In this accident the tank cars transporting methanol were of the "stub sill" design, and their bottom outlets were struck during the derailment. The two tank cars that were not breached had internal valves, and their bottom outlet nozzles had breaking grooves that had been cut into the nozzles near the bottom of the tank. When these nozzles were broken from the tank, the valve seat was not destroyed, nor was a shearing force applied to the tank shell where the valve was attached; consequently, the methanol was contained safely by the tank. The two other tank cars containing methanol had bottom outlet nozzles less than 6 inches in length for which breaking grooves or other protection were not required. When these nozzles were struck during the derailment, the stress was transferred to the tank shells which were torn open, releasing their contents.

The release of methanol increased greatly the severity of this accident. Had all bottom outlets been protected on the tank cars containing methanol, it is likely that there would have been no release of hazardous materials, there would have been no fires, and there would have been no need to have evacuated the town. The tank car industry and the railroads have been improving the protection of bottom outlets for several years. Protection now is required by AAR Interchange Rules so that new tank cars are being fitted with protection, and retrofit of existing cars is in progress according to a time schedule based on the hazard posed by the material transported. Installation of protection on all tank cars is scheduled for completion by 1990.

The Safety Board has followed closely the progress made in providing this protection. As a result of a review of the FRA's hazardous materials program, 6/ the Safety Board issued Safety Recommendation R-79-24 on March 3, 1979, to the FRA:

> In coorperation with the [AAR's] Inter-Industry Task Force, determine what additional cost-effective steps, based on risk-ranking results, can be taken to make tank cars more resistant to hazardous materials releases in derailments.

On March 12, 1980, as a result of a special investigation of tank car safeguards, 7/ the Safety Board issued Safety Recommendation R-80-13 to the U.S. Department of Transportation:

6/ Safety Effectiveness Evaluation--"Review of the Federal Railroad Administration's Hazardous Materials Program and the Applicable Track Safety Standards" (NTSB-SEE-79-2).
7/ Special Investigation Report--"The Accident Performance of Tank Car Safeguards" (NTSB-HZM-80-1).

Take immediate steps to cause the modification of both new and existing tank cars so that damage to the top fittings and bottom outlet valves is minimized in train accidents.

The FRA replied on July 14, 1982, that because of the extensive voluntary efforts being made by the industry to protect bottom outlet valves, regulations for such protection were not warranted. Based on these comments, Safety Recommendations R-79-24 and R-80-13 were placed in a "Closed--Acceptable Action" status.

It is necessary to locate the bottom outlet of a tank car in the lowest point of the tank in order to drain the hazardous materials from the tank by gravity. This location places the bottom outlet closer to the ground than any other part of the tank, making it more vulnerable to impact with the ground if the tank car is involved in a derailment. The bottom outlets on stub-sill tank cars are even more vulnerable because of the absence of protection provided by a continuous full-length center sill. When a stub-sill tank car leaves its trucks, the lowest part of the tank, the bottom outlet, comes in contact with the track structure. When the bottom outlet is strong enough to withstand the impact, the bottom outlet becomes a lever and tears the bottom of the tank shell. In some cases, the bottom outlet may fracture inboard of the valve seat.

The Safety Board is concerned about the release of hazardous materials from tank cars involved in derailments because the released materials escalate the severity of the accident. The released hazardous materials often fuel fires that are capable of producing the heat necessary to cause a violent rupture of other tank cars carrying hazardous materials that were not breached by the derailment. The hazardous materials released when a bottom outlet fails threaten the safety of the crewmembers, the public, emergency response personnel, and spectators. The release of these materials results in the evacuation of the area and the disruption of activities at nearby facilities. In addition to the hazards posed to the public safety and health, the released materials damage the environment resulting in enormous cleanup expenditures. The cleanup of the materials released as a result of the Livingston, Louisiana, derailment cost in excess of $10 million. 8/

In the earlier years of the AAR tank car bottom discontinuity retrofit program, it was necessary for the industry to experiment with methods of protection and methods of applying that protection. Some types of protection and some methods of application had to be abandoned or modified. Another problem was the many different configurations of bottom discontinuities which required many different designs for the proper protection. Some tank cars had insulation jackets that presented additional problems. Tank cars with exterior heater systems have an irregular or corrugated bottom surface to which the bottom protection must be applied. Now the type of protection and method of application is perfected, and the time necessary to retrofit a car should have been reduced considerably. Nevertheless, fewer than 22 percent of the cars requiring protection have been modified, although 57 percent of the projected timeframe has passed.

There are many tank cars yet to be retrofitted with bottom outlet protection which transport poisonous liquids, flammable liquids, corrosive liquids, combustible liquids, and other materials that pose a threat to the public and the environment. The tank cars that

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8/ Railroad Accident Report--"Derailment of Illinois Central Gulf Railroad Freight Train Extra 9629 East (GS-2-28) and Release of Hazardous Materials, Livingston, Louisiana, September 28, 1982" (NTSB/RAR-83/05).

are used to transport many of these hazardous materials will not be required to be retrofitted with bottom outlet protection until July 1, 1990. While actions taken by the AAR are commendable, the Safety Board believes that the schedule for completion of the tank car retrofit should be expedited and encourages the AAR to ask owners of tank cars to accelerate their application of bottom outlet protective devices.

Emergency Response

Actions taken by the community and by the conductor after the derailment were effective. Waybill information provided by the conductor allowed prompt identification of all hazardous materials involved in the derailment and made possible the identification of the specific material in each rail car. Using this information, the fire marshal took complete charge of all emergency activities, assessed the hazards posed to the public by the derailment, and employed assertive management techniques for using available technical resources to evacuate the town and to bring the emergency under control.

CONCLUSIONS

Findings

1. The traincrew was qualified for their respective positions in accordance with Seaboard standards.

2. Smoke was observed coming from a journal on car SAL 45678 in train FERHL as it approached Charlotte, and this information was provided to the engineer.

3. Incomplete communication between crewmembers about the observation on car SAL 45678 resulted in incomplete inspection of the train at Charlotte.

4. The hotbox detector at Matthews identified an overheated journal on car SAL 45678.

5. The information provided by the hotbox detector at Matthews on the overheated journal was incorrectly used by the traincrew, resulting in their initial failure to locate the overheated journal.

6. Failure of crewmembers to follow Seaboard's procedures for locating overheated journals following receipt of a hotbox detector alarm resulted in the overheated journal not being located by the crew.

7. The failure of the overheated journal 1.6 miles west of Marshville allowed the wheels on the trailing axle of car SAL 45678 to derail.

8. Eighteen cars of train FERHL derailed in Marshville when the derailed wheels on car SAL 45678 encountered a turnout.

9. The unprotected bottom outlet nozzles on two tank cars containing methanol were broken off during the derailment breaching the tank shells and resulting in the release of the contents of the tank cars.

10. The released methanol increased greatly the hazards to public safety posed by the derailment.

11. Response to the emergency by the community was effective in minimizing the hazards to public safety because of effective preplanning and management of available resources.

12. Actions taken on the initiative of the train conductor supported effectively the actions of emergency response agencies.

13. Seaboard's programs for training and monitoring of operating crews does not provide reasonable assurance that crewmembers understand and comply with its operating rules.

14. Federal requirements for protecting external bottom outlets on stub-sill tank cars are not adequate.

15. The Association of American Railroads has developed standards for increased protection of bottom outlets, but its schedule for implementing this increased protection should be accelerated.

16. Improved means are necessary for identifying en route the existence of overheated journals and for assisting crews in the positive location of defective journals.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the traincrew to apply correctly information about an overheated journal provided by a freight car inspector and a wayside hotbox detector. Contributing to the accident was the failure of Seaboard System Railroad officials to enforce the company's traincrew monitoring program to ensure that Seaboard crews understood and complied with its operating rules. Contributing to the extent of damage resulting from this accident was the lack of bottom outlet protection on the tank cars containing methanol.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:

--to the Seaboard System Railroad:

> Immediately institute a program that requires that each traincrew member is monitored periodically on every applicable operational test. (Class II, Priority Action) (R-85-22)

--to the Association of American Railroads:

> Accelerate the schedule of the ongoing industry program for protecting bottom discontinuities on existing stub-sill tank cars so as to complete retrofitting by July 31, 1988. (Class II, Priority Action) (R-85-23)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ G. H. PATRICK BURSLEY
Member

April 30, 1985

APPENDIX

INVESTIGATION

The National Transportation Safety Board was notified of this accident at 10:45 a.m. on April 10, 1984, by the National Response Center. The Safety Board dispatched a team of investigators from Washington, D.C., and Atlanta, Georgia, to the accident site at 11:10 a.m. on April 10, 1984.

A public hearing was not held. Depositions were taken from Seaboard System Railroad employees.

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