NATIONAL TRANSPORTATION SAFETY BOARD

RAILROAD ACCIDENT REPORT

DERAILMENT AND SUBSEQUENT BURNING OF DELAWARE AND HUDSON RAILWAY FREIGHT TRAIN AT ONEONTA, NEW YORK FEBRUARY 12, 1974

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C. 20591
REPORT NUMBER: NTSB-RAR-74-4

SS-R-28

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TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-RAR-74-4	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Railroad Accident Report - Derailment and subsequent burning of Delaware and Hudson Railway freight train at Oneonta, New York, February 12, 1974.		5. Report Date October 17, 1974 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C 20591		10. Work Unit No. 1379 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20591		13. Type of Report and Period Covered Railroad Accident Report February 12, 1974 14. Sponsoring Agency Code

15. Supplementary Notes

This report contains Railroad Safety Recommendations R-74-31 through R-74-34.

16. Abstract

This report describes and analyzes a derailment which occurred when a train separation resulted in unequal deceleration of the two parts of the train. Unusual lateral forces at the rear of the third locomotive unit canted the outside rail of a 3° 30' curve outward enough to allow the wheels to drop inside. A tank car of propane was punctured and the ensuing fire impinged other tank cars and caused the violent rupture of three of them. Fifty-four person were injured by the fire and rocketing parts of tank cars.

The National Transportation Safety Board determines that the probable cause of this accident was the inability of the track to resist the lateral forces which canted the outside rail outward and widened the gage of the track. These forces which were induced at the third locomotive unit resulted from the emergency application of the brakes when the train was separated between the third and fourth cars as it entered the 3° 30' curve. The train separated as a result of the broken center sill on the fourth car.

17. Key Words	18. Distribution Statement
Railroad accident, Derailment, Freight train, Broken Center Sill, Emergency Brake Application, Spread Track, Tank Car Repairs, Hazardous Material, Tank Car Ruptures, Liquefied Petroleum Gas, Rocketing of Tank Cars.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	25	

NTSB Form 1765.2 (Rev. 9/74)

FOREWORD

The accident described in this report has been designated as a major accident by the National Transportation Safety Board under the criteria established in the Safety Board's regulations.

This report is based on facts obtained from an investigation conducted by the Safety Board, in cooperation with the Federal Railroad Administration. The conclusions, the determination of probable cause, and the recommendations are those of the Safety Board.

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SYNOPSIS

About 4:20 p.m. on February 12, 1974, Delaware and Hudson Railway freight train NWB-4, derailed as it moved northward around a 3° 30' curve just north of Oneonta, New York. Of the derailed cars, seven were tank cars loaded with liquefied petroleum gas (LPG). The tank of one of the cars split open in the derailment, and the escaping LPG ignited. Four of the remaining tank cars ruptured about 30 minutes after the derailment. The ensuing explosions and fire injured 54 firemen and members of the press.

The National Transportation Safety Board determines that the probable cause of this accident was the inability of the track to resist the lateral forces which canted the outside rail outward and widened the gage of the track. These forces which were induced at the third locomotive unit resulted from the emergency application of the brakes when the train was separated between the third and fourth cars as it entered the 3° 30' curve. The train separated as a result of the broken center sill on the fourth car.

FACTS

The Accident

At 1:55 p.m. on February 12, 1974, Delaware and Hudson Railway Company's (D&H) freight train NWB-4 departed Binghamton, N.Y., bound for Mechanicville, N. Y. The train consisted of 3 locomotive units and 122 cars. Cars 20 through 27 were tank cars loaded with liquefied petroleum gas (LPG).

Inspections and brake tests were performed before the train departed Binghamton. The crewmembers made numerous inspections of the train en route. The train was slowed to 20 mph as it passed through Oneonta, N.Y., where a carman inspected it as it passed. None of the inspections disclosed any defects.

When NWB-4 was about 4 miles north of Oneonta, N.Y., it was operating on the No. 1 track, the westermost track of the double-track section; its speed was 32 mph. At 4:19 p.m. as NWB-4 rounded a 3° 30' curve, the crewmembers on the locomotive felt an unusual movement, looked toward the rear of the train, and saw some of the head cars rock violently and Car 4 turn over on its side along the west side of the track. The fireman and brakeman instructed the engineer to apply the emergency brakes. The engineer applied the brakes immediately, but did not know if the braking was the result of his application or the result of the train's action. The front of the train moved about 1,200 feet and stopped. When the brakes were applied, the flagman in the caboose was thrown against the handrail and injured.

Cars 5, 6, and 7 passed Car 4 and stopped in various positions just north of Car 4. (See Figure 1.) Cars 1, 2, and 3 remained coupled to the locomotive, but overturned when they stopped.

Car 21, a tank car, was crushed by the derailing cars and split open, and escaping LPG was ignited immediately. The derailed cars were, in turn, set on fire.

The engineer notified the railroad's Oneonta office by radio of the derailment and fire. The two front locomotive units were uncoupled from the train and moved northward about 1/2 mile. About 10 minutes after the derailment, firemen from the Oneonta Fire Department arrived and began to fight the fire. They were followed shortly by other companies.

The intensity of the fire increased for 30 minutes and the tanks' sheets adjacent to the vapor space were heated to a point that they became thin, and the tanks consequently ruptured. As a result one of the cars exploded violently and several persons including firemen were injured. Three additional explosions occurred in 10-minute intervals following the first. During the explosions, half sections of Cars 23 and 25 were propelled eastward about 1,200 feet. Cars 22 and 24 separated into two tub-shaped ends, and portions split longitudinally. A small split occurred in the tank of Car 26 near the manway during the derailment. The escaping LPG ignited, was allowed to burn, and was consumed in about 7 days.

The injured firemen were removed from the scene, and the others were instructed to pull back a safe distance. Car 27, which was not damaged, was rerailed and moved southward.

Some typical damage outside the immediate area 3/4 to 1 mile from the site was as follows: Windows were broken, siding was blown from the side of a house, and a sink was blown from the wall of a house.

Location of Accident and Method of Operation

South of the 3° 30' curve, the tracks are straight for a considerable distance and the grade is 0.87 percent, ascending northward. A railroad

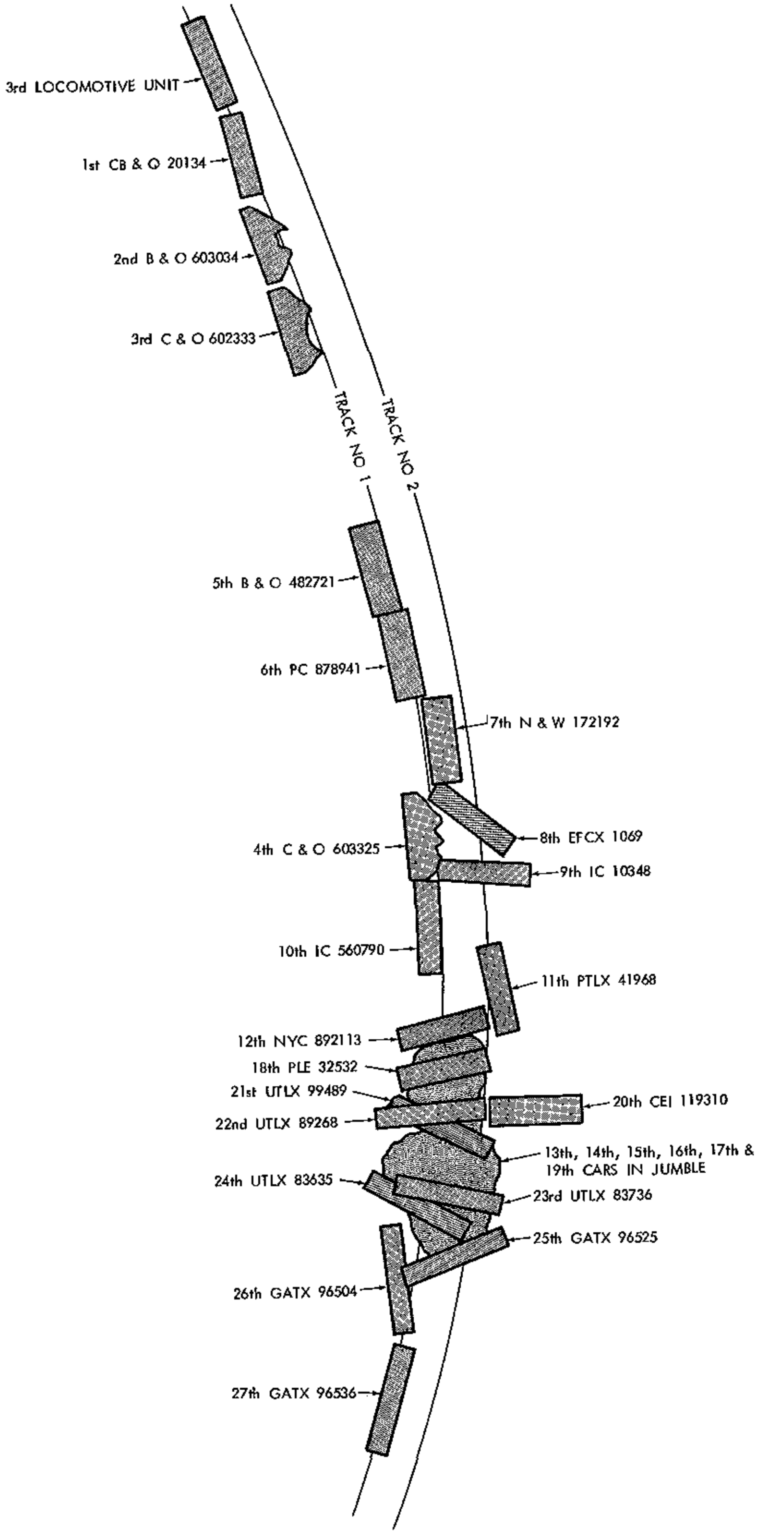

Figure 1. Relative positions of derailed cars before explosions.

service road parallels the tracks on the east. Access roads were provided on each side of the accident site. (See Figure 2.)

Trains are operated on both tracks in each direction by signals from a traffic control system which is controlled by a train dispatcher at Colonie, New York. The maximum authorized speed is 40 mph.

The weather for the Oneonta vicinity on February 12 was: Low temperature - 9°F., high temperature - 35°F., cloudy, and 0.1 inch of snow had fallen.

The Track

Structure. The No. 1 track consisted of 112-lb. RE rails manufactured by the Bethlehem Steel Company in 1942, and laid in track the same year. The 39-foot rails were connected by 6-hole, head-free joint bars and were laid on 24 hardwood crossties per rail, with single and double shoulder tie plates intermixed. Originally, the D&H used two spikes per tie plate on a curve of 3° 30', but it had currently been using three spikes per tie plate as ties were replaced. However, there were no records to indicate the number of ties through the curve that had been secured with three spikes per tie plate. The rails were anchored with 16 to 24 rail anchors per rail length. The track was laid on crushed stone ballast, with full ballast sections.

Inspection. The No. 1 track in the accident area was last inspected by a track foreman-inspector on February 11, 1974. His inspection was made on foot, and the only discrepancy noticed was that several joint bolts were loose.

The Federal Railroad Administration's Track Inspector had inspected the tracks in the derailment area in October 1973. There were no discrepancies reported for Tracks 1 and 2 around the curve.

Damage. About 960 feet of the No. 1 track was destroyed during the accident. The east, or high rail, was canted outward and intermittent wheel marks were found on the web of the rail from a point about 560 feet north of the south end of the curve to where the third locomotive unit stopped. The west rail was displaced westward by the wheels of the locomotive unit and cars which dropped inside of the rail when the east rail moved outward.

Since the crossties in the derailment area were badly damaged and burned, the number of spikes holding the rail and the condition of the crossties at the time of the accident could not be determined.

Derailing cars destroyed 400 feet of the No. 2 track.

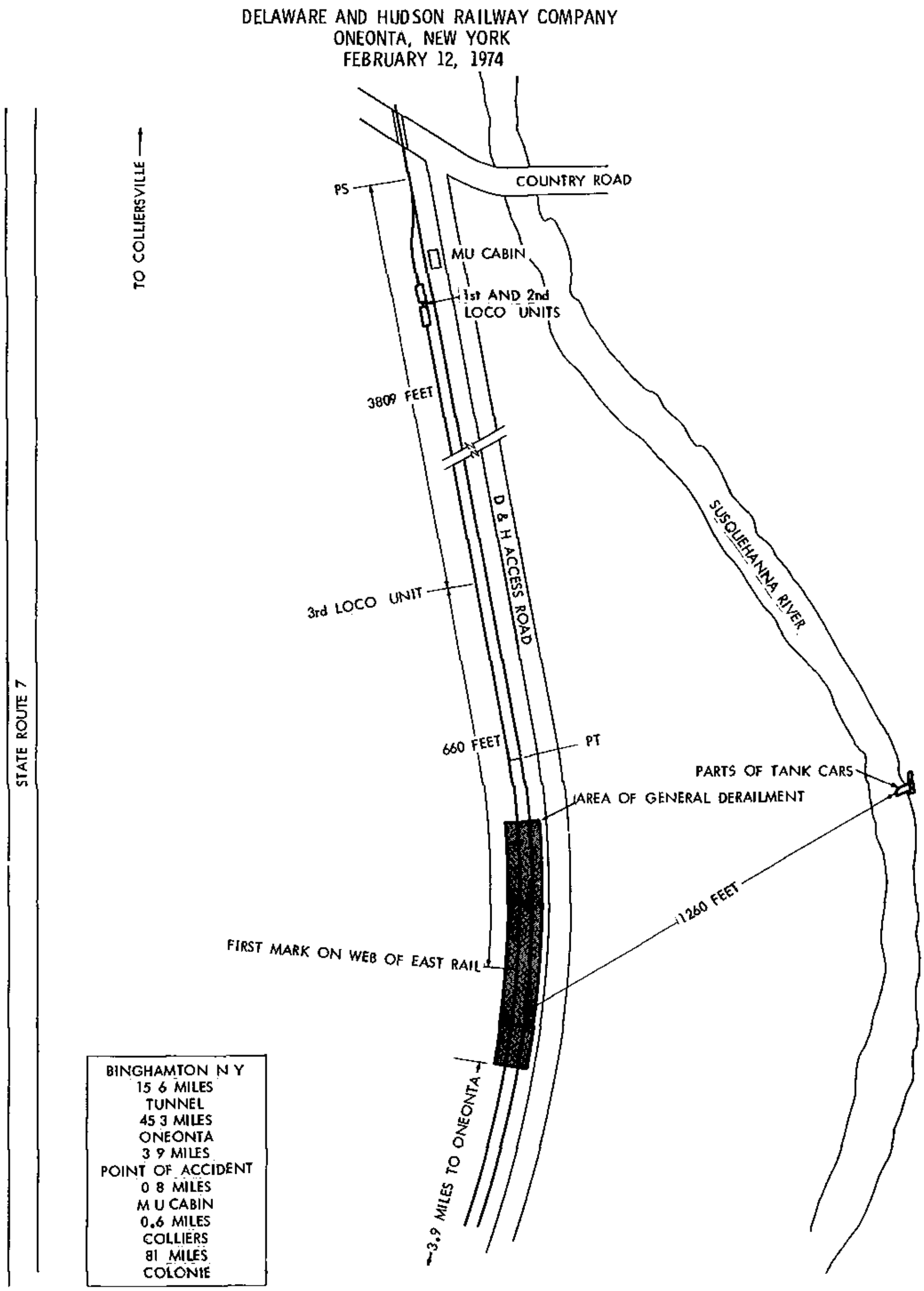

Figure 2. Area of the derailment.

The Train

Locomotives. The lead locomotive was a 3,300 hp, type U33c, and the other two locomotives were 3,000 hp, type U30c. The locomotives were manufactured by the General Electric Company and were equipped with six wheel trucks. Each unit weighed about 390,000 pounds.

Before the train was dispatched from Binghamton, the locomotives were inspected and tested. No discrepancies were noted. After the accident, the locomotives were again inspected, and no conditions were found that would have contributed to the cause of the accident.

The wheels of the third locomotive were examined. Scrape marks were discovered on the back and front faces of the rims, and gouge marks were found on the flanges and treads which indicated that all of the wheels had derailed. When the locomotive was examined at the scene, all of the wheels on the west side were derailed inside the west rail. The wheels on the left side, except for the outside pair of wheels on the north truck, were riding on the web of the canted east rail. The outside pair of wheels of the north truck was on the rail.

None of the wheels of the other units were derailed, and they did not bear any indications of having been derailed.

Speed Recording Tapes. Calibration of the speed recorders on the three locomotive units disclosed that they accurately recorded the train's speed. The tapes were examined, and they indicated that the train was moving at 32 mph when the emergency brakes were applied. Each of the tapes contained evidence that the train had been subjected to a severe run-in when the emergency brakes were applied, and that the brakes were applied when the locomotive entered the 3° 30' curve.

Car Equipment. Car 4, C&O 603325, was a covered hopper loaded with 190,000 lbs. of shelled corn. The car had a capacity of 100 tons, a light-weight of 61,900 lbs., and a load unit of 201,100 lbs. The car was constructed of welded steel and provided with 4 wheel-roller bearing trucks which had 36-inch wheels. The car was manufactured in December 1969 by the Pullman Standard Company. The car was provided with a continuous center sill, of AAR design, fabricated from two Z angles welded together with reinforcing angles.

An examination of Car 4 disclosed that the center sill on the north end (B end) of the car was distorted upward about 7 1/2 inches. Marks were found on the "B" end coupler and on the knuckle of the coupler of Car 3, which indicated that the couplers had moved vertically one above the other and had become disengaged. This caused the train to separate. The center sill was cracked through the vertical web on the west side of the sill, 11 feet 4 inches from the north end where the center sill passed between the hoppers of the car. The sill was cracked where the bottom flange of the center sill had been removed to permit application of the hopper. Rivets attached a reinforcing angle to the inside of the sill in this area. The progressive crack had started in the rivet hole and extended through the remaining portion of the bottom flange, through the vertical web, and partially across the top flange. The sill was slightly bent upward at this point. The portion of the center sill which contained the fracture was removed and examined further. (See Figure 3.)

Since the accident, the owner of the car, the Chessie System, selected randomly 15 percent of the covered hoppers, built to the same specifications, and found no indications of failure in the center sills. There are no reports of comparable failures in covered hoppers of similar design.

An examination of the following cars disclosed that they too contained evidence that a heavy lateral force had been exerted in the train.

Car 3	C&O 602333 -	Striking casting on north end, east side, was broken. Coupler cross key was bent.
Car 5	B&O 482721 -	Marks on sides of striking casting and couplers indicated heavy contact. Striking casting on south end was bent.
Car 6	PC 878941 -	Coupler carrier iron was broken on one end and marks on striking casting and coupler indicated heavy contact.
Car 7	N&W 172192 -	Side of center sill was bent and broken on south end.

<u>The Tank Cars</u>. Cars 20 through 27 were "jumbo-type" tank cars, and were loaded with an average of 30,200 gallons of LPG. These cars did not have continuous center sills, but had stub sills welded to the bottom of the tank at each end. The tanks were not insulated and were constructed to DOT Specification 112A-340W. An examination of the fractured surfaces of the tanks disclosed that some steel sheets had thinned to 3/8 inch. Their original thickness was 3/4 inch.

<u>Fire and Rescue</u>. The Oneonta Fire Department was first notified of the derailment by the yardmaster at the Oneonta railyard. Since the department was informed that the fire was caused by gas, firemen left the station with the impression that they would encounter a tank car gasoline fire.

The Oneonta Fire Department, the Schenevus Fire Department, and the Milford Fire Department, which are part of the 29 fire companies from

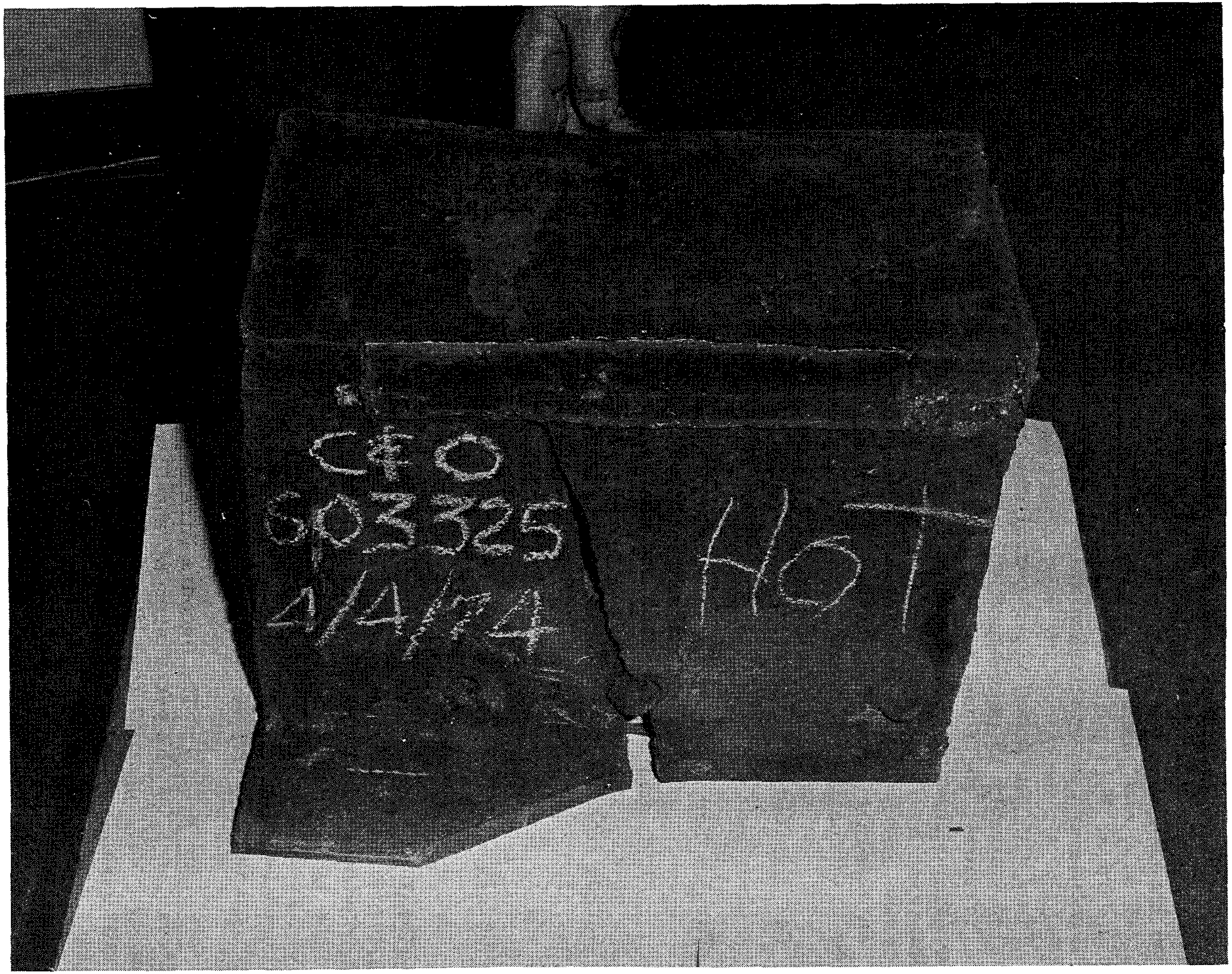

Figure 3. Portion of center sill removed from car -- showing fracture.

Otsego County's Fire Department Mutual Aid program, responded to the alarm. They approached the accident via the north access road to the railroad's service road, passed the locomotive, and went directly to the accident.

Water to fight the fire was supplied from tank trucks while hoses were being laid to the nearby Susquehanna River. Each fire company responded to the scene with two pumpers and a water tank truck.

When firemen first arrived at the scene, they believed that they could control the fire and that it would be necessary to play water on the tank cars to keep them cool. This was the reason for laying hoses to the river. As each fire company arrived after Oneonta, they were instructed to aid in this project.

Just before the first explosion, firemen heard several tank-car safety valves operate and were ordered by two company chiefs to withdraw from the immediate area. Because there was no central communications system available, the withdrawal instruction probably did not reach each firefighter. Consequently, the area had not been completely evacuated when the explosion occurred, and a number of persons were injured. Most of the injured were firemen and several members of the press; the total injured was 54. No further attempts were made to cool or to extinguish the fire; instead, the area was secured, and injuries were treated. The fire was allowed to burn itself out.

There was no pre-established system between the D&H railroad and the responding fire companies for the exchange of information either at the scene or by telephone contact. Few firemen knew that waybills describing the contents of each car were available on the train. Those who were aware of the waybills were not sure whether they were located on the engine or on the caboose. Usually, waybills are carried on the caboose, but on NWB-4, they were carried on the locomotive. Other than waybills, the D&H does not provide information on hazardous materials to the crewmembers on either the locomotive or the caboose, except for the required notice of explosives.

Paid firemen in the Oneonta Fire Department are required to take training courses, but the training of volunteer firemen is not mandatory. Most volunteer fire companies, however, require some training. Training courses and some training materials are provided by the New York State Fire Training Program, and a qualified State instructor teaches courses that are available to volunteer firemen. Training material is also received from the State of New York, the National Fire Protection Association (NFPA), and the Bureau of Explosives of the Association of American Railroads (AAR).

The firemen were not familiar with CHEMTREC (The Manufacturing Chemists Association), and only a few knew of the Bureau of Explosives.

The chiefs of the volunteer departments believed that any information and advice regarding fighting unusual hazardous materials fires could be obtained from the county fire coordinator. No one knew of a specific point of contact with the D&H where they could obtain information concerning the trains or the railroad.

Those firemen interviewed indicated they were not trained to deal with large volumes of LPG or to deal with a railroad accident. Their exposure to propane gas fires was limited to training information on 100-lb. home storage tanks. Most firemen had no concept of the force or potential of the quantity of the LPG carried by a single "jumbo" railroad tank car.

ANALYSIS

The Accident

The fractured center sill of Car 4 weakened the car's structure to the extent that the heavy lading caused the center sill to be deflected downward as the train proceeded toward the accident site. The center sill probably deflected after the train was dispatched from Binghamton. Such a deflection would not be detected during a running inspection, and crewmembers would not be able to detect the deflection during en route inspections.

The downward deflection of the sill caused the north end of the sill, at the coupler, to be canted upward. Therefore, the pulling faces of the couplers were at an angle to each other, instead of parallel. The coupler of Car 4 was pulled upward as force was applied and eventually passed over the coupler of Car 3, and the train separated.

The air hoses between Cars 3 and 4 were pulled apart when the train separated, which produced an automatic emergency application of the train brakes. Normally when an emergency application is made by a crewmember at the brake valve, it is readily discernible, and the engineer would have been aware if his action had initiated the emergency application.

When the emergency brakes were applied on the locomotive, the power control switch reduced the power to idle. The emergency brakes on the locomotive and on the head 3 cars became effective before the brakes on the rear 118 cars. This difference in deceleration caused the rear of the train to collide with the slower-moving front portion, which produced an excessive run-in. Indications of such a collision were found on the couplers, the striking castings, and the ends of the head cars.

The unusual movement felt by the crewmembers on the locomotive, which caused them to look rearward, was probably caused by the separation of the train. When the locomotive brakes were applied and the power was removed, the heavy axial force produced by the collision would have been applied between the train and the third locomotive unit. Part of the longitudinal force would have been converted to a lateral force at the third locomotive unit. At the time of impact, the locomotive had entered the 3° 30' curve, which caused the locomotive and Car 1 to be at an angle to each other. The positions of the locomotive and car produced an outward force against the east, or high, rail. The force was greatest at that location, because of the resistive force available when the brakes were applied on the locomotive.

The force caused the east rail to cant outward, which widened the gage of the track so that the west wheels of the third locomotive dropped inside the west rail. As the locomotive moved northward, the track was progressively destroyed by the wedging action of the wheels.

When Car 4 collided with the front portion of the train it was probably rocked violently, and the force of the collision turned it over along the west side of the No. 1 track. This was probably the reaction which the fireman and head breakman saw when they looked rearward. Cars 5, 6, and 7 passed Car 4, derailed, and stopped along the west side of No. 1 track. Cars 2 and 3 derailed and were dragged northward by the locomotive. Cars 8 through 27 derailed and stopped on the track structure.

Car 21, a tank car loaded with LPG, stopped crosswise on the track structure, and several cars overturned on its tank. The west portion of the tank was crushed and split open, which allowed a large volume of the LPG to escape. The escaping gas was ignited almost immediately by some source produced in the derailment. LPG probably flowed under the wreckage, vaporized, and ignited, setting fire to the wreckage. Four of the derailed tank cars stopped in positions which permitted their tanks to be impinged by the fire. The tanks were heated, the operation of several safety valves was heard, and more fuel for the fire was provided. The fire increased in intensity, and tank sheets adjacent to the vapor spaces of the four exposed tanks heated to the point where the internal pressure in the tank exceeded the strength of the steel sheets, and the tanks ruptured.

Need for Inspections

The undetected failure in the center sill of the covered hopper suggests that cars should be inspected more thoroughly while they are in the shop. The failure was inside the hopper, and in normal inspections the car inspector does not see that part of the sill. Since the crack was progressive, the failure could have been found before the accident if the center sill had been accessible to inspectors.

Since similar failures have not been reported and since the 15-percent sample of cars did not reveal such failures, the failure of the center sill on Car 4 was probably an isolated case. However, since the failure occurred in an area that is not inspected regularly, owners of similarly constructed cars should check them more closely for defects.

Track Structure

The events of the derailment indicate that the east rail of the track was subjected to lateral forces that exceeded the rail's resistance. Since the evidence was not available to determine how many of the crossties in the curve were spiked with additional rail-holding spikes, the magnitude of the lateral and vertical forces, or the ratio or lateral to vertical forces required to overturn the rail, the track structure required to resist overturning of the rail when the emergency brakes were applied could not be determined.

There is reason to believe, however, that in this case the spiking and crossties required by Federal track safety standards would not have prevented the overturn, because the railroad was using three spikes on 3° 30' curves when ties were replaced, and Federal Standards require only two. The railroad's experience had prompted them to use the additional spike. Therefore, although track in the derailment area met or exceeded Federal Track Safety Standards, it was not able to support the forces which resulted from an emergency brake application. Other Federal standards require emergency braking under certain operating circumstances. Thus, two Federal Railroad Administration standards, one requiring emergency braking and the other requiring only two spikes per crosstie, are incompatible.

These standards should be changed so that they will be compatible. The Board discussed a general approach to the problem in its Special Study of Proposed Track Safety Standards, which states in part:

"E. Future Development of Standards

"The Safety Board recognizes the very difficult and complex task that FRA was faced with in these initial proposals, which were based as they must be on existing empirical approaches to definition and standards, and the existing non-analytical track assembly methods. These constraints prevent the initial standards from resolving some of the problems which will develop in the future as a larger part of the field is covered. The Safety Board's experience in reviewing the development of standards in other fields suggests that certain positive steps could be taken to smooth the advance of such standards:

"1. Execution of the necessary testing and research to determine the actual degrees of various types of performance provided by track which meets the existing design-based standards. This would be a first step toward providing a full performance definition of the major functions of a railroad system.

"2. Create uniform graded definitions for test purposes of various forms of environment, vehicles, operators, and system controls. The grading of track by speed, as in these regulations, is an example. There are as yet no uniform grades or ratings of various types of rolling stock or equipment operators. It is to be noted, for example, that these initial proposals do not provide any consideration of the various characteristics of rolling stock. The fact that track effects on rolling stock are not classified as yet prevents the inclusion of probable useful alternatives in these standards. All must be treated the same.

"3. Determine, by study, all of the necessary functions of track in relation to other sub-systems of the railroad system and reclassify future standards according to functions. The present classes of roadbed, geometry, structure and appliances, if continued alone, will prevent the standards from being fully developed as performance standards. These classifications are useful for enforcement, but not defining performance.

"4. Be prepared to develop and employ both performance and design-based standards. It is quite practical to establish both forms of standards, the former to allow new technology and promote alternatives and the latter to provide simplicity in enforcement. When a given design has been qualified by test to prove that it fulfills the defined performance, its condition can be controlled by a design specification. In this way, a design specification and inspection format can be accepted for each different way of meeting the performance requirement. Both flexibility and enforcability can be obtained.

"5. Reduce the range of variability in materials and assembly methods so that the results are more predictable. This variability not only requires unnecessarily high and wasteful safety factors, but insures that unknown hazards will exist when new technology such as very high speeds, welded rail, high center of gravity cars, and rapid deceleration rates are introduced. (See Safety Board report of accident at Crete, Nebraska, p. 43.)"

This one accident occurring on a track which was believed to meet Federal track safety standards, strongly suggests that, with some combinations of locomotives and the location of loaded cars in the train, emergency braking which originates at the front of a train may consistently produce a derailment on such sharp curves by overturning the rail.

This particular problem inadequacy of track to sustain emergency braking, may not be the most frequantly encountered track problem, however, it does contain the elements of the general problem of avoiding derailment by physical failure of track under such braking conditions. The Board believes that an analytical approach to this problem will reveal the underlying problems of analysis and the need to consider long range staged development of track standards which will interrelate with equipment standards, as recommended earlier. A consideration of this problem will thus tend to show the need for a system-building concept including some of the considerations of Section E of the Safety Board's Special Study of Proposed Track Safety Standards.

Tank Cars

The tank cars involved in this accident were constructed similarly to those that have been involved in past catastrophic accidents. The safety problem was first addressed by the Safety Board in October 1969, in its report of an accident in Laurel, Mississippi. 1/ Following the Safety Board's recommendation, the Railway Progressive Institute (RPI) and the Association of American Railroads (AAR) established a research group titled the RPI-AAR Railroad Tank Car Safety Research and Test Project, to study the problem created when the tank cars are exposed to an accident or a fire. The study, with a few exceptions, has been completed, and several recommendations have been made to the industry and the FRA.

One phase of the study involved full-scale fire tests of tanks loaded with propane. The tests are being conducted jointly with the FRA to determine if an insulating material satisfactory to tank car users could be developed for use on the tank car's exterior to lengthen the time a tank can be exposed to a fire before it ruptures. Although the tests have been completed, the data have not been evaluated to make recommendations for its use.

In this accident, a proper insulation would have lengthened the exposure time, and, perhaps, would have prevented the explosions by allowing heat to dissipate laterally from the hot area to colder parts of the tank. Under the circumstances, it could not be determined what amount of water would have been needed to prevent rupture indefinitely.

Following the accidents at Laurel, Mississippi, and Crescent City, Illinois, 2/ the rail industry and FRA became genuinely alarmed at the possibility of further catastrophe involving populated areas. To a con-

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1/ NTSB Report of derailment of Southern Railway's freight train at Laurel, Mississippi, January 25, 1969.

2/ Railroad Accident Report NTSB-RAR-72-2, Toledo, Peoria, and Western Railroad Company's Train No. 20 at Crescent City, Illinois, June 21, 1970.

siderable degree, FRA has relied upon the voluntarily initiated research of Railway Progress Institute and Association of American Railroads to provide answers to the catastrophic fire threat when tank cars are involved in a rail crash. This field of effort was recommended to AAR by the Safety Board in October 1969, before FRA possessed comprehensive regulatory authority or a significant safety research budget of its own. The Safety Board reported to Congress on December 1, 1971, that another accident of this type (now represented by the Oneonta accident) could occur at any time, because the hazards had not been resolved. In October 1972, the Safety Board recommended that the tank car research be expedited. The Oneonta accident is the second major accident of this type since that advisory to Congress and the second which has produced more than 50 injuries to firemen. Nevertheless, it still appears that another accident of this nature could occur at any time and in a populated area.

The ultimate responsibility to guard the bystanding public against the consequences of such accidents is that of FRA. The perspective in this task includes the fact that the smaller tank cars which preceded the "jumbo car" of specification 112A and 114A had a much lesser potential for catastrophic community damage by explosive ruptures because of the smaller quantity of fuel which could be released and because the smaller tank cars were insulated. A major cost-saving change in the larger cars was the omission of this insulation. As the Board has noted elsewhere, the type 112A cars were proliferated under Federal regulation without full-scale testing beforehand. The testing in public usage since that time has resulted in heavy loss to the public and firefighters. In fact, in four accidents involving heating and explosion of cars investigated by the Safety Board, the human loss has been borne exclusively by persons along the right-of-way and by firemen. There have been 3 fatalities and more than 300 injuries, which include 1 fatality and more than 140 injuries to firemen.

Given this accident experience, the period of testing in public usage should now be considered complete and ready for judgment. A proper finding from this period of usage is that movements of multiple car blocks of type 112A and 114A cars loaded with certain products can produce community-size disasters. It is doubtful that these cars would have been permitted to come into use unaltered had their loss characteristics been known and had an opportunity to halt their proliferation been available. However, the cars are now in use and an economy employing LPG fuel has developed around the availability of large shipments of LPG to areas distant from pipelines. The acceptably low cost of using this fuel includes savings derived from omission of car insulation, use of much larger tanks, and shipment of numbers of loaded cars in a close-packed group to the same destination.

One of FRA's tasks is that of converting the accident experience and research of the last 4½ years into regulations that must reduce the community hazard at least to the level which preceded the acceptance of the "jumbo tank car". The users of LPG have received benefits in terms of lower cost of fuel. Therefore, the task of FRA is also one of deciding how much of this cost-saving to LPG users is to be employed for the purpose of protecting bystanders and firemen by requiring costly changes. The bystanders and firemen have been bearing the human cost of more efficient LPG carriage. The acceptable cost of the corrections to be required by regulation may be increased by another factor -- tank car manufacturers and users have already benefited economically by being permitted to use the lower cost, more efficient cars for long periods of time. About 15,000 cars have been permitted to be manufactured. The fact that the public has absorbed the human accident loss which made the cost savings possible should weigh strongly in the question of the cost of correcting new cars alone or, also, retrofitting the 15,000 existing cars. There is no way by which the existing tank cars can be made less sensitive to fire effects without retrofit, and they will constitute a large fraction of the cars in use for years ahead.

Emergency Response by Firemen

Evidence indicates that local firefighters may not be adequately trained or informed to fight fires involving 30,000-gallon tanks of LPG. The initial decision to cool the fire-impinged tanks was based on known procedures for management of propane fires; however, it appears that the fire authorities had insufficient information and expertise to support the on-scene decision regarding the larger tanks. Since the firefighters had been trained to fight fires involving only small amounts of propane, there was no way that the firefighters could determine the amount of water required to cool a 30,000-gallon tank. The lack of satisfactory training and materials for the local firemen was a definite factor in the injuries which resulted from the accident.

The criticism in this analysis is not of the individual fire companies or the dedicated firefighters who constitute them. The problem lies in the methods used by firefighters in the management of hazardous materials accidents, which continue to produce unnecessary casualties and losses.

A lack of communications between firefighters was evident at the scene. When the fire increased in intensity, orders were issued for the firemen to pull back to a safer point; but before the orders could be executed, the tanks exploded. (See Figure 4.)

Communications between the Fire Departments and the Railroads

A railroad derailment or accident which involves tank cars loaded with hazardous materials can develop situations that are unusual for the average fire department. For this reason, railroads should provide the

Figure 4. Location of some firemen at the time of violent reaction of fire.

fire departments, in whose territory the railroad passes, with as much information as possible so that the firemen can properly assess the situation and reduce the risks. The Safety Board's 1969 recommendations to the AAR along these lines has been acted upon by only one or two individual railroads, but not by the AAR.

Fire departments should be instructed about waybills -- what information is provided by the waybill, where they are carried on the train, which crewmember is in charge of the waybills, and how he can be identified.

Information should be made available on both the locomotive and caboose concerning hazardous materials being carried by the train so that it will be readily available if an accident occurs. Firemen should have appropriate emergency telephone numbers beforehand so that further specific information can be easily obtained at any time.

In addition to being familiar with the information that can be provided by the various transportation industries, firemen should also be trained regarding the techniques to be used in combating fires of the magnitude encountered in this accident. Such training could be accomplished by the States, or by the proposed National Fire Academy at such time as it is established. Also, valuable information regarding the risks encountered in accidents involving the transportation of hazardous material by rail, which would be useful for training purposes, can be obtained from the Safety Board, the AAR and the FRA.

After the derailment of the Missouri Pacific's train 94 and catastrophic explosion of vinyl chloride at Houston, Texas, on October 19, 1971, the Safety Board issued a safety letter 3/ to all State fire marshalls advising that,

> "In the absence of the information necessary for an evaluation of the risks of explosion or rocketing in a fire involving several tank cars, a prudent course of action may be the complete evacuation of the area within a radius of 2,000 feet. Exposure of emergency personnel to abrupt flareups or explosions can be kept to the absolute minimum by this method when no other persons or minimal property are at risk. Under no circumstances should spectators be allowed in the potential danger radius of 2,000 feet. However, it is not possible to give all-inclusive advice concerning the degree of risk which should be taken to fight the fire in such accidents because there are so many variables involved. For example, there may be tank car fires in the vicinity of hospitals, schools, or other occupied premises which cannot be evacuated quickly."

3/ NTSB Safety Recommendation R-71-38 issued December 27, 1971.

In the accident report 4/ the Safety Board also recommended that:

"The National Fire Protection Association, and similar standard-setting organizations, establish documented quality standards and quality control procedures for developing recommended practices to combat transportation emergencies which involve hazardous materials. These standards and procedures should include a requirement for a technical safety analysis of their applicability and the risks associated with their use. (Recommendation No. R-72-45)"

Although NFPA indicated that it was actively pursuing the goals suggested by the Safety Board's recommendations, there were no indications that the firefighters at this accident had been apprised of the relevant information. The New York Public Utility Commission in 1970 disseminated useful information on transportation fires to firefighters, but it appears that it did not reach those firemen involved in this accident.

CONCLUSIONS

1. D&H train NWB-4 was being operated according to company procedures as it entered the 3° 30' curve.

2. No. 1 track in the area of the derailment probably met Federal track safety standards.

3. Inspections made in Binghamton and in Oneonta and observations of the train en route did not detect the defect in Car 4, because the cracked center sill was not visible to inspectors.

4. The fracture in the center sill started at a rivet hole and progressed across the vertical web of the sill.

5. The center sill was deflected downward by weight and vibration in the vicinity of the crack which raised the coupler on the north end allowed it to pull over the coupler of Car 3. Consequently, the train separated.

6. The emergency brake application following the train separation was the normally expected action under the provisions of 49 CFR 232. The force which overturned the east rail was the lateral component of a longitudinal compressive force in the train, generated by more effective emergency brake application at the locomotives.

7. Whether two or three spikes were used to secure the rail to each tie on the 3° 30' curve could not be determined.

4/ Railroad Accident Report NTSB-RAR-72-6, Derailment of Missouri Pacific Railroad Company's Train 94 at Houston, Texas, October 19, 1971.

8. The number of defective ties, if any, on track No. 1 in the 3° 30' curve could not be determined.

9. The east rail of No. 1 track was canted eastward as the locomotive of NWB-4 moved northward around the curve, which resulted in wide gage.

10. The fire in the derailment resulted from the ignition by an unknown source, of escaping LPG from the crushed tank of the 21st car.

11. The violent rupture of four tanks was a result of impingement of fire on uninsulated tank sheets which heated and weakened the steel.

12. Regulations have not been promulgated by the FRA which would eliminate or reduce the severity of the problem which arises when tank cars loaded with hazardous materials are exposed to an accident or a fire.

13. Recommendations have not been made by the RPI-AAR Railroad Tank Car Safety Research Test Project that would help to eliminate or reduce the severity of accidents and fires which involve tank cars loaded with hazardous materials.

14. Firemen had not received information from the D & H on matters that would have aided them in combating the fire.

15. Firemen had not been trained to combat fires of such magnitude. Further, they had not been trained for or exposed to information on the hazards that can result when tank cars loaded with hazardous materials are exposed to fire.

16. The propulsion of large portions of tank cars 1,200 feet from the site was a result of rocketing action already displayed by type 112A and type 114A tank cars in previous accidents.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was the inability of the track to resist the lateral forces which canted the outside rail outward and widened the gage of the track. These forces which were induced at the third locomotive unit resulted from the emergency application of the brakes when the train was separated between the third and fourth cars as it entered the 3° 30' curve. The train separated as a result of the broken center sill on the fourth car.

RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Federal Railroad Administration (FRA) insure that inspection efforts of railroads to find defects on other cars having a center sill design similar to that which failed in this accident, are continued in periodic inspection until all such cars have been inspected. (Recommendation R-74-31)

2. The FRA reevaluate the Federal Track Standards to determine whether the spiking and crosstie requirements for tracks on curves are adequate to prevent the rails from spreading when subjected to the lateral forces produced by an emergency application of train brakes from trains of a wide range of consists and operating speeds. (Recommendation R-74-32)

3. The FRA employ the information developed by their tank car studies and by those of the RPI-AAR Railroad Tank Car Safety Research and Test Project and expedite the promulgation of regulations that will eliminate or reduce to manageable dimensions the severity of the possible losses to communities which develop when tank cars of the general type of 112A and 114A loaded with hazardous materials are exposed to a railroad accident or a fire. (Recommendation R-74-33)

4. The FRA promulgate regulations to require railroads to provide pertinent lading information to crewmembers on both the locomotive and caboose regarding those cars transporting hazardous materials. The information could be presented in a manner similar to that required for explosives in 49 CFR 174.589(f). In addition, these notices should contain the name of the commodity and its hazard rating. (Recommendation R-74-34)

The Safety Board reiterates and emphasizes the importance of the following recommendations made in previous accident reports which have not been fully implemented and are applicable to this accident:

Railroad Accident Report, Southern Railway Company, Laurel, Mississippi, January 25, 1969:

"5. The Safety Board recommends that the Association of American Railroads and the American Short Line Railroad Association develop plans that will result in the fire chief of each community through which the track of a member road passes knowing where immediate information can be obtained, describing the location and characteristics of all hazardous materials in any train involved in a train accident that affects a community. This recommendation can be accomplished in a relatively short time regardless of the level of training which may be achieved later by fire departments." (Recommendation No. R-69-22)

Railroad Accident report NTSB-RAR-70-2, Illinois Central Railroad Company, Glendora, Mississippi, September 11, 1969:

"2. The Federal Railroad Administration initiate research and development to provide prototype models of freight train braking systems

(a) capable of providing shorter stopping distances which nearly approach the theoretical limits under all conditions of loading and length of trains;

(b) capable of stopping a train in the emergency applications now required by regulations without internal collisions, train separations, or damage to the train or its lading;

(c) capable of propagating brake application, both service and emergency, throughout the length of train more expeditiously and surely;

(d) capable of more rapid application of the full intended stopping force to the rails at each car after the application signal is received at each car." (Recommendation No. R-70-16)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

October 18, 1974