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RAILROAD ACCIDENT REPORT

HAZARDOUS MATERIALS ACCIDENT AT THE SOUTHERN PACIFIC TRANSPORTATION COMPANY'S ENGLEWOOD YARD HOUSTON, TEXAS SEPTEMBER 21, 1974

NATIONAL TRANSPORTATION SAFETY BOARD

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Washington, D.C. 20594
REPORT NUMBER: NTSB-RAR-75-7

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. NTSB-RAR-75-7	2.Government Accession No.	3.Recipient's Catalog No.
4. Title and Subtitle Railroad Accident Report - Hazardous Materials Accident at the Southern Pacific Transportation Company's Englewood Yard in Houston, Texas, September 21, 1974		5.Report Date May 21, 1975 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. 20594		10.Work Unit No. 1547 11.Contract or Grant No.
12.Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13.Type of Report and Period Covered Railroad Accident Report September 21, 1974 14.Sponsoring Agency Code

15.Supplementary Notes

This report contains Railroad Safety Recommendations R-75-28 through R-75-30.

16.Abstract About noon on September 21, 1974, 2 loaded "jumbo" tank cars, cars 17 and 18 of a 145-car complement, were uncoupled as a unit at the crest of the gravity hump in the Southern Pacific Transportation Company's (SP) Englewood Yard at Houston, Texas. The two cars passed through the hump master retarder and group retarder without being slowed and accelerated as they moved down the grade into bowl track 1. At a speed of 18 to 20 mph, the two tank cars impacted an empty tank car. Upon impact, the coupler of the empty tank car rode over the coupler of car 17 and punctured the tank head. Butadiene spilled from the car and formed a vapor cloud, which dispersed over the area. After 2 to 3 minutes, the varpor exploded violently; as a result, 1 person died and 235 were injured. Total damages amounted to about $13 million, which included the destruction of 231 railroad cars and substantial damage to 282 others.

The National Transportation Safety Board determines that the probable cause of the overspeed impact was the failure of the retarding system to slow the two coupled tank cars and the absence of a backup system to control cars which pass through the retarders at excessive speeds. The failure of the retarding system was caused by foreign substances on the wheels of the two cars that preceded the two tank cars through the retarders.

Contributing to the accident was the failure of the Southern Pacific Transportation Company to enforce procedures to exclude cars with a foreign substance on their wheels from the humping system, and the Shell Oil Company's failure, after notification of the hazard, to eliminate spilled epoxy resin from the flangeways of their track.

17.Key Words	18.Distribution Statement
Railroad accident, railroad safety, hump, classification yards, hazardous material accident, tank car puncture, car inspection procedures, butadiene explosion.	This document is available to the public through the National Technical Information Service, Springfield, Va. 22151.

19.Security Classification (of this report)	20.Security Classification (of this page)	21.No. of Pages	22.Price
UNCLASSIFIED	UNCLASSIFIED	39	

NTSB Form 1765.2 (11/70)

FOREWORD

The accident described in this report has been designated a major accident by the National Transportation Safety Board under the criteria established in the Safety Board's regulations. The report is based on facts obtained from an investigation conducted by the Safety Board. Information was also provided by the Southern Pacific Transportation Company, Shell Oil Company, General Railway Signal Company, and the City of Houston. The conclusions, the determination of probable cause, and the recommendations are those of the Safety Board.

TABLE OF CONTENTS

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SYNOPSIS

About noon on September 21, 1974, 2 loaded "jumbo" tank cars, cars 17 and 18 of a 145-car complement, were uncoupled as a unit at the crest of the gravity hump in the Southern Pacific Transportation Company's (SP) Englewood Yard at Houston, Texas. The two cars passed through the hump master retarder and group retarder without being slowed and accelerated as they moved down the grade into bowl track 1. At a speed of 18 to 20 mph, the two tank cars impacted an empty tank car. Upon impact, the coupler of the empty tank car rode over the coupler of car 17 and punctured the tank head. Butadiene spilled from the car and formed a vapor cloud, which dispersed over the area. After 2 to 3 minutes, the vapor exploded violently; as a result, 1 person died and 235 were injured. Total damages amounted to about $13 million, which included the destruction of 231 railroad cars and substantial damage to 282 others.

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FACTS

The Accident

On September 21, 1974, a Southern Pacific Transportation Company (SP) crew began switching 145 cars over the hump at Englewood Yard in Houston, Texas. The first 14 cars were humped without incident. Cars 15 and 16, though destined for the same track, were humped separately so that car 15 could be weighed. These two cars emerged from the master retarder at an excessive speed, and before the operation could be halted, the pin-puller uncoupled cars 17 and 18 as a unit, and car 19.

At the time the retarder operator determined that car 15 was moving at an excessive speed, car 16 was entering the master retarder. He immediately set the control levers for the lower units of the master retarder and the group retarder to "manual heavy" in an attempt to stop, or slow, car 16. Car 16 also came through the master and group retarders without slowing.

By this time, cars 17 and 18, which were destined for bowl track 1, were approaching the master retarder. The operator set the "entering-end" control levers of the master retarder and the controls for the group retarder to which these cars were routed to "manual heavy." The master and group retarders failed to decelerate cars 17 and 18.

In the meantime, car 19 proceeded at an excessive speed toward the group retarder which accommodates bowl track 50, the track to which cars 15 and 16 had been routed. The operator diverted the car to track 51 to avoid its coupling to the cars in the curve on track 50. Car 19 entered track 51 and coupled at an excessive speed.

The 17th and 18th cars continued into bowl track 1 for about 1,300 feet at about 18 to 20 mph, as estimated by witnesses. There they overtook car 10, an empty tank car, which was not coupled to the car ahead. It could not be determined whether car 10 was moving or standing. At impact, the coupler of car 10 overrode the coupler and penetrated the tank head of car 17, and the coupler shank of car 10 broke off.

The retarder operator gave the first warning of the impending catastrophe when he saw the butadiene vapor dispersing from the punctured tank car. He warned employees in the area by his loud-

speaker system and via the intercom. He then ran down the stairs of the control tower and a violent explosion occurred just after he reached the ground -- an estimated two to three minutes after the puncture. The time of the explosion was 12:03 p.m.

The Houston Fire Department responded to the scene soon after the explosion. A command post was established and railroad personnel assisted the fire department in identifying and moving cars. Both parties cooperated fully as previously planned.

The fire was brought under control at about 9 p.m. although some cars continued to burn for days. Other cars of hazardous materials contributed to the fire; however, there were no subsequent tank car explosions or abrupt ruptures. The only injury during the rescue operations was a minor one -- a fireman fell from a freight car.

An engineer, who was operating a locomotive on bowl track 17, died as a result of burns received in the accident. He was about 600 feet from the location of the impact between cars 10 and 17 and his locomotive probably was the source of ignition of the butadiene vapor cloud. Two hundred thirty-five persons, who worked or lived in the surrounding area, were injured. Fifteen required hospitalization.

The explosion and fire destroyed 231 railroad cars and substantially damaged 282 others. (See Figure 1.) Considerable fixed railroad property also was destroyed or damaged.

Commercial property and private residences in the surrounding area incurred structural damage. Glass was broken within a 20-square-block area. About 1,700 persons were evacuated from the area.

The SP estimated the cost of the accident as follows:

Railroad equipment	$ 4,897,875
Lading	1,735,210
Railroad fixed plant	1,231,000
Third-party damage including personal injury liability	5,500,000
Total	$ 13,364,085

Figure 1. Some of the wreckage on the day following the accident.

The Accident Site

Englewood Yard includes 64 classification tracks bounded on the north by 10 receiving and departure tracks and on the south by 13 receiving and departure tracks. The 64 classification tracks are divided into 8 groups of 8 tracks each. The track designations are numerical, beginning with bowl track 1 on the north and ending with bowl track 64 on the south. (See Figure 2.) The yard is within the Houston city limits and is surrounded by some light industrial buildings and private residences.

The weather at Houston at noon on September 21 was partly cloudy, 87° F., and the wind was from the east at 11 mph.

The Hump System

The hump -- A hump is located at the east end of the yard. The hump is about 27 feet higher than bowl track 1 at the location where the impact between cars 17 and 10 occurred. The grade for the hump varies from 5.78 percent near the crest to 2.70 percent near the exit from the master retarder. The grade through the group retarder for bowl track 1 is 0.61 percent.

The retarders -- The hump retarder system is comprised of a 297-foot master retarder and 8 group retarders, each 99 feet long. All of the retarders operate automatically under normal conditions. There were no emergency backup facilities, such as skates or additional retarders, for handling overspeed cars at the east end of the yard. However, each bowl track was equipped with an inert retarder at the west end to prevent cars from running out of the yard.

The retarders are Model E-160 manufactured by the General Railway Signal Company (GRS). The master retarder has seven sections and the group retarders have two sections each.

The retarders are electrically operated with rated capacities for controlling 160-ton, 4-axle cars with 38-inch wheels. The retarders provide four retarding forces designated as light, medium, heavy, and extra-heavy (extra-heavy was manual heavy on the console controls). The amount of force applied depends on the car-weight ranges which are as follows:

Figure 2. Aerial view of Englewood Yard on day after accident looking east toward the hump.

Light	0	-	75,000 pounds
Medium	75,000	-	130,000 pounds
Heavy	130,000	-	220,000 pounds
Extra-heavy	Over 220,000 pounds		

Method of operation -- The humping operation is performed by a locomotive engineer, a pin-puller, a fieldman, and an engine foreman, who supervises the others during switching. The retarder operator monitors the performance of the retarders and can override the automatic operation if necessary.

A car is humped by uncoupling it at the top of the crest at about 2 1/4 mph. As the car accelerates down the grade, it first passes over a weigh rail which classifies the car into one of the four weight categories. This information then is used automatically to establish the appropriate retarding force for application in the retarders. As the car enters the master retarder its speed is measured by radar units, one for each retarder section. If the car is going too fast, the appropriate force is applied to slow it to the desired speed. If it is going too slow, the retarding force is released and the car allowed to accelerate. The master retarder was set to release cars at about 11 1/2 mph.

The group retarders operate on the same principle as the master retarder. The programmed exit speed from the group retarders was 6 to 8 mph depending on the rollability of the track to which the car was destined. A 3 1/2 to 4 mph coupling speed was the goal.

During the normal humping operation cars were routed automatically in accordance with the cut list prepared before switching began. The engine foreman could reroute a car at the beginning of the hump operation. The retarder operator had this capability until the car reached the detector circuit for the involved switch.

The system was designed so that if a radar speed control unit failed, the retarder would lock in the extra-heavy position. In the event of a power failure, the system would respond similarly, and an alarm would sound; additionally, the hump signal would display "stop." No automatic system alarm was installed to detect cars leaving the retarders at overspeed. The operator had to determine overspeed visually, and no record was maintained of these occurrences.

Operational procedures were established and controlled by general orders, general notices, bulletins, and operating rules. Bulletin books were located where men reported to work and particularly adjacent to the crest car-inspection pits and at the retarder tower. It was each employee's responsibility to read the books daily to stay current on operating procedures.

Before the accident, a maximum of five empty cars or three loaded cars could be humped as a unit without uncoupling. Exceptions to the rule included cars containing sulphuric acid, hydrofluoric acid, acetone cyanohydrin, explosives, and poison gases. In the case of the first three commodities, each car must be humped separately. Federal regulations prohibit the humping of explosives and poison gases. These regulations did not restrict the handling of flammable compressed gases, such as butadiene.

The retarder operator's facilities -- The retarders can be controlled from a console control machine in the retarder tower located at the foot of the hump. The control machine allows the operator to vary the forces which normally are applied automatically at each retarder. He also can open the retarders so that no force is applied to passing car wheels. The console indicates track occupancy and track clearance conditions. It has a speed control which permits the operator to adjust the preset exit speed from the retarders by 2 mph to compensate for weather conditions which might affect the rollability of cars. The retarder operator can communicate via a hump intercom with the yardmaster, the engine foreman, the weighmaster, and two pit car inspectors.

Car Equipment Involved

Description and damages -- The first car in this switching cut which, subsequent to the accident, showed evidence of being involved in an overspeed collision was car 10. Table 1 describes the general circumstances of car 10 and those cars which followed it through the retarders. Car 10 weighed 67,000 pounds and was equipped with a type E, 6 1/4" x 8" straight shank coupler on the end that was impacted by car 17. This coupler was broken off at the shank and the lower coupler's front face was split vertically. The east trucks had been derailed. (See Figure 3.)

Cars 15 and 16 were the first cars in this switching cut which had a foreign substance on their wheels. The inner and outer faces

TABLE I

Car Position Number	Type of Car	Commodity Carried	Capacity or Weight	Bowl Track Location	Exposure to Fire		Evidence of Impact Damage		Other Car Involved in Impact	Foreign Substance on Car Wheels	
					Yes	No	Yes	No		Yes	No
10	Insulated tank	Empty	11,000 gal.	1	X		X		17		X
11	"Jumbo" tank	Ethyl chloride	33,629 gal.	50		X	X		15		X
12	Insulated tank	Alcohol	8,127 gal.	7	X			X	-		X
13	3-compartment tank	"Dangerous chemicals"	88,000 lbs.	19		X		X	-		X
14	"Jumbo" tank	Empty	33,000 gal.	4	X			X	-		X
15	Covered hopper	Bisphenol	194,000 lbs.	50		X	X		11 and 16	X	
16	Box(cushion underframe)	Epoxy resin	202,300 lbs.	50		X	X		15	X	
17	"Jumbo" tank	Butadiene	33,864 gal.	1	X		X		10 and 18		X
18	"Jumbo" tank	Butadiene	33,694 gal.	1	X		X		17		X
19	"Jumbo" tank	Vinyl chloride	26,170 gal.	51		X		X	?	X	

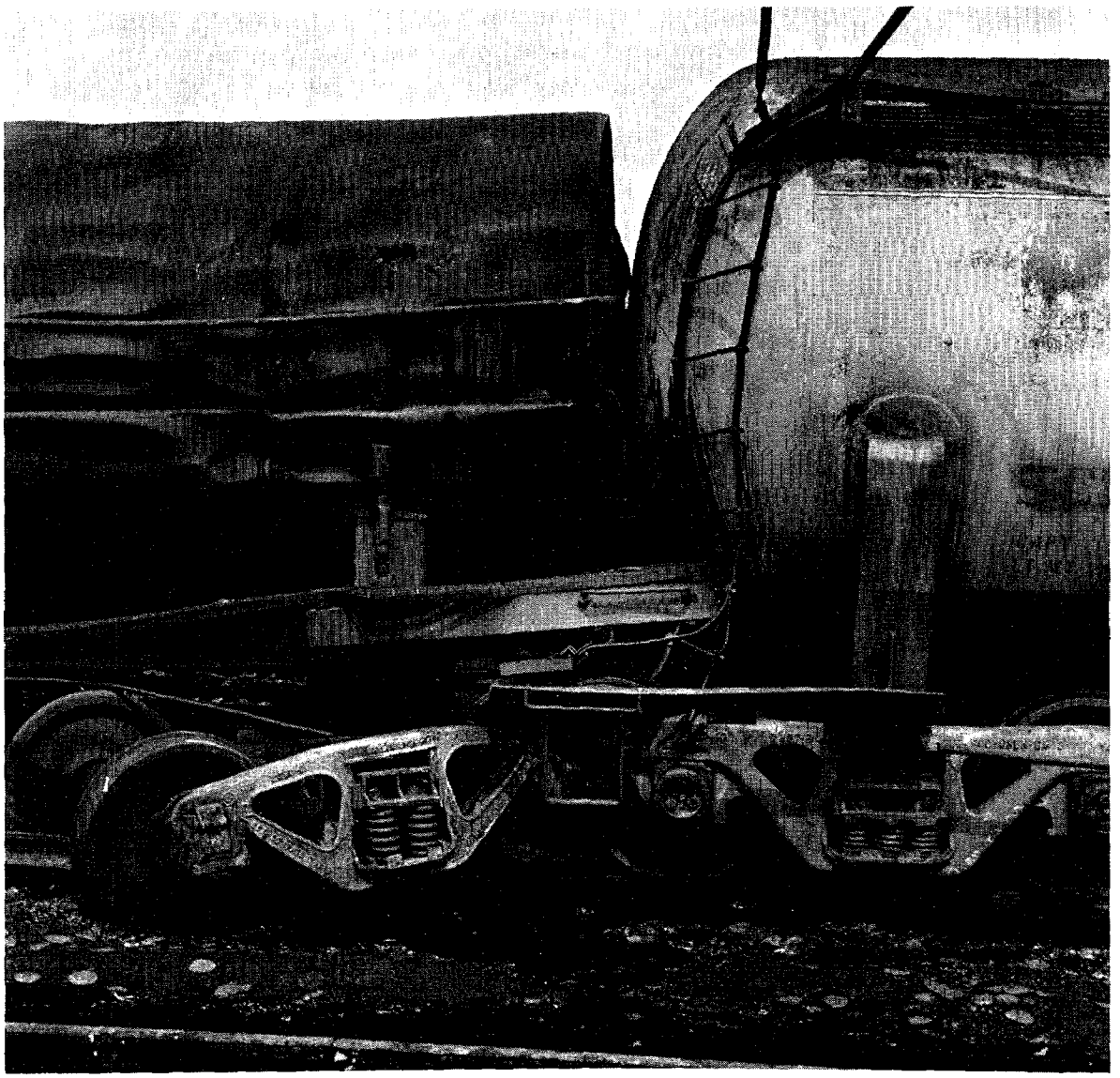


Figure 3. Car 10 (the empty tank car) on the left and car 17 (the punctured car which contained butadiene) on the right.

of all their wheel rims were coated with a dark gummy substance. (See Figure 4.) The coating of foreign substance on the wheels of car 19 was considerably less than that on the wheels of cars 15 and 16.

The epoxy resin in car 16 was loaded in drums which had shifted within the car. Some of the drums had leaked and epoxy resin had dripped from between the car door and the floor.

Cars 17 and 18 had been constructed in accordance with DOT Specification 112A340W. Car 17 was equipped with Ride Control trucks, Hyatt roller bearings, 36-inch wheels, and type E couplers. The tank head had a 17-inch by 55-inch puncture or tear at about the 6-o'clock position. The coupler had been scarred and indented. The combined weight of the coupled cars 17 and 18 was 506,700 pounds.

Car inspection -- Cars 10 through 19 were picked up at the Shell Oil Company's plant at nearby Pasadena the night before the accident. Cars 15 and 16 had been loaded on the tracks near the epoxy resin-loading warehouse within the Shell plant. The other cars came from various other locations in the plant. The conductor, who was in charge of the crew that moved the cars out of the plant, did not look at the car wheels when the cars were picked up, and he did not know that he was supposed to look at them.

When the cars reached Englewood Yard, a car inspector walked alongside them and drained the air from the train line in preparation for humping. He was not charged with inspecting car wheels for foreign substances and did not take exception to any of the cars involved in the accident.

In a below-grade, car-inspection pit about 400 feet east of the crest of the hump, a car inspector on each side of the track inspected cars before they were uncoupled. These inspectors could communicate with the engine foreman and could cause the humping signal to indicate "stop" if necessary. They noted no condition which warranted stopping the operation before the accident.

After the accident, the two inspectors stated that they were supposed to be looking for all car defects as the cars passed them at the 2 1/4-mph speed. When they were shown photographs of the coated wheels on cars 15 and 16, one inspector stated that he believed he would have taken exception to those cars if he had seen their condition. The other inspector indicated that, based on his past practice, he would not take exception to cars with wheels similarly coated.

Figure 4. Inside face of one of the wheels of the 15th car.

Personnel Involved

Car inspectors -- The two car inspectors in the pit had worked for the SP in the car department, one for 9 years and the other for 35 years. They had not received formal training for their duties but they had attended an audio-visual program recently instituted by the SP. This program was intended primarily for new employees, but experienced employees were given the opportunity to attend. They had been on duty 5 hours when the accident occurred.

Retarder operator -- The operator had worked as a retarder operator periodically since 1958. He had 24 years of experience as a switchman, and at the time of the accident he was working as a retarder operator an average of once a week. He had been on duty 9 hours when the accident occurred.

History of Overspeed Cars

On October 12, 1973, an overspeed car derailed in Englewood Yard when it was not controlled by the retarders. The wheels of the car were coated with a gummy substance. The car had been loaded at the Shell plant at the epoxy resin-loading warehouse, and it was determined by the SP that the substance on the car wheels had been picked up from spilled material in the flangeways of the track at that location.

After that accident, SP representatives met with Shell representatives and followed up that meeting with a letter to Shell dated October 15, 1973. (See Appendix A.) These communications were intended by SP to persuade Shell to correct the loading situation. As a temporary corrective action, the SP also verbally instructed its trainmen to reject cars from Shell that had any foreign substance on their wheels. On November 14, 1973, the SP issued written instructions to car inspectors. (See Appendix B.)

A Shell memorandum dated October 23, 1973, stated that following the meeting with the SP, Shell representatives were told by a SP assistant trainmaster that the overspeed accident of October 12 resulted from a power failure which caused the retarders not to function. (See Appendix C.) Shell's corrective action consisted of cleaning up the spilled resin when too much accumulated or spreading sand in the area to improve footing conditions. Shell representatives considered the spilled resin only as a nuisance to traincrews.

After October 1973, various complaints were made by trainmen to Shell representatives and SP supervisors concerning the spilled resin in the area of the Shell warehouse. On August 19, 1974, the SP again wrote Shell concerning spilled resin and other problems. (See Appendix D.) That letter prompted another meeting between SP and Shell representatives, at which the spilled resin problem was discussed.

On August 9, 1974, another derailment resulted from cars' coming out of the retarders at overspeed. In this instance, the cause of two runaway loaded cars was attributed to a heavy foreign substance on the wheels of an empty car that preceded these cars through the master retarder. The empty car had originated at a Mobil Oil plant; however, an inspection of the plant did not disclose the source of the foreign substance.

Other overspeed incidents in Englewood Yard were attributed to foreign substances on car wheels; however, these incidents were not documented and they were infrequent. The yard operating restrictions on the humping of multiple cars containing sulphuric acid, hydrofluoric acid, and acetone cyanohydrin were introduced after overspeed experiences with cars carrying these commodities.

Postaccident Inspections, Tests, and Maintenance

Retarders -- All except one section of the involved retarders were found in the closed position after the explosion. The involved control levers on the console control machine were not open; however, the exact position was not determined. A black, shiny substance was found on the surfaces of the brakeshoes of the group retarders for bowl track 1 and bowl track 50, and on all sections of the master retarder with the exception of the one open section.

The one section of the master retarder was open because it had been disabled by the signal maintainer when a broken chair support in that section was discovered as the previous cut of cars was being humped. Thus, the total braking capability of the retarding system had been reduced by about 10 percent. The gage between some of the retarder brakeshoes was greater than the maximum specified by GRS; however, a representative of GRS indicated that the number of shoes out of tolerance would not have caused the overspeed of cars 15 and 16 if the brakeshoes and wheels had been clean. Calculations by Shell and GRS indicated that the shoe wear

may have reduced the retarding capability of the combined master-No. 1 group retarding system by an additional 10 percent. However, the retarder rating was adequate to control the cars involved even though its capability was reduced.

SP maintenance crews repaired the broken chair support and renewed the worn retarder brakeshoes. The retarders functioned properly when humping resumed. Speed tests were conducted subsequently and the exit speeds of various weights and groups of cars were within tolerable limits even with the one section of the master retarder disabled.

The foreign substances -- Samples were taken from the brakeshoes of the master retarder, the two involved group retarders, and from the wheels of cars 15, 16, and 19. The samples contained epoxy resin similar to that produced by Shell and that loaded in the warehouse area where the spilled resin was on the tracks. It also was similar to the epoxy resin loaded in drums in car 16.

Shell performed various laboratory tests on the samples, on their epoxy resins, and on other materials. The tests indicated that the physical properties of the recovered samples did not change under simulated retarder conditions of sliding velocity, temperature, and pressure. The coefficients of friction for all of the substances tested (Appendix E) exceeded 0.08, which GRS stated was the average exhibited between the retarder brakeshoes and car wheels. This value had been established empirically.

ANALYSIS

Failure of the Retarding System

The testimony of the witnesses and the impact marks on the various cars all indicated that cars 15 and 16 were the first overspeed cars. Cars 17 and 18 also went through the retarders without noticeable braking, but the group retarder they passed through was not the one used by cars 15 and 16. However, the same group retarder used by cars 17 and 18 had been used by five previous cars in this switching cut without incident. The group retarder used by cars 15 and 16 had been used by three cars in this switching cut.

The above suggests that something occurred to affect the braking capability of the three individual retarders. Postaccident inspections

revealed no evidence of equipment malfunction. Other evidence supports the statements of the retarder operator -- the only man whose actions could have contributed to the accident.

The foreign substance was found on all three of the retarders' brakeshoes. The material also was identified in substantial quantities on the wheel rim faces of cars 15 and 16, and there were traces of resin on the wheels of car 19. Car 15 was the first car in the switching cut on which this material was observed.

Thus, the overspeed cars, the foreign substances on their wheels, and the failure of three retarders suggest that cars 15 and 16 had carried sufficient foreign material into the master retarder to counteract the intended braking of these cars and the three cars that followed. Sufficient foreign material was deposited on the master retarder brakeshoes to cause cars 17 and 18 to pick up and carry this material into the group retarder. The braking capability of that retarder was reduced, as was that of the group retarder which handled cars 15 and 16.

The tests performed by Shell after the accident indicated that epoxy resins as well as many other materials lower the coefficients of friction of the dry metal surfaces of car wheels and retarder brakeshoes. Those tests also indicated that the coefficients of friction of all substances tested were greater than 0.08; therefore, the retarders should have stopped the cars even though the wheels were coated and the retarder capability had been reduced by about 20 percent by the worn shoes and the out-of-service section. Shell's findings suggest that other factors, such as equipment malfunction or human error, would have had to affect three retarders simultaneously. The Safety Board believes that the probability of such an occurrence is minute.

The one factor common to all three retarders that would promote this apparent inconsistency was the stated coefficient of friction. GRS had not used the coefficient of friction as a criterion for design for their retarders, but instead established this coefficient empirically. The coefficient of friction had not been substantiated through field tests of cars with wheels coated with substances with known properties. Instead, it was recognized that some materials on car wheels could reduce the braking effects of retarders, but the materials were not described. Likewise, Shell's laboratory tests have not been correlated with field tests to assure

that they depicted actual retarder performance. Therefore, the types of contaminants that can cause a runaway car are still uncertain and need to be defined. Similarly, the margins of retarder performance under various operating conditions have not been systematically set forth.

The Source of the Foreign Substance

The epoxy resins identified on the car wheels and on the retarder brakeshoes were similar to those produced at the Shell plant in the area where cars 15 and 16 were loaded. There were no other locations en route from the Shell plant to Englewood Yard where the material might have been picked up. The resin was similar to that leaking from car 16, but the leaking resin could not be traced back from track 50. The shifted load which caused the resin to leak must have resulted from the overspeed impact between cars 15 and 16 on track 50. Therefore, the foreign substance on the wheels of cars 15 and 16 must have been picked up from the flangeways of the track adjacent to the Shell warehouse where the epoxy resin had been spilled.

Emergency Procedures

At Englewood Yard, 10 to 12 percent of the cars handled were classified as hazardous materials. Handling of flammable compressed gases as if they were explosives consistent with the Safety Board's recommendations R-74-29 & 30 (Appendix F) reduces risks; however, a runaway car is unpredictable, and its effect on other cars within a yard presents a hazard. For example, the October 12, 1973, runaway resulted in a collision between the overspeed car and cars on a switching lead that were not involved in the humping operation.

If occasional overspeed cars are to be tolerated in retarder design or operation, then a means of safely handling these overspeeds should be provided. Even if hazardous materials are not handled, runaway cars affect the safety of yard employees and may affect the safe operation of over-the-road transportation if the car damages are undetected.

There are various devices or facilities that could act as backup when there is a failure in the basic car retarding system. In addition, the retarder operators could be trained in exact procedures for various emergency situations. It also is necessary that the extent of

previous damage be known to all involved. This can be accomplished only through the documentation of past accident experiences or near-misses.

Handling of the Previous Overspeed Incidents

The October 15, 1973, letter from SP to Shell clearly indicates that the potential catastrophic effects of the spilled resin were known by the SP and were clearly explained to Shell. However, Shell personnel continued to regard the spilled resin only as an irritant to the trainmen who worked in the area.

After October 15, 1973, no apparent consideration was given to the possible effects of the spilled resin on the retarder operation at Englewood Yard. The lessons that should have been learned from the minor accident of October 12, 1973, were ignored.

The spilled resin on the loading tracks continued to exist to varying degrees. The individual circumstances necessary to cause another reportable overspeed accident during switching operations at Englewood Yard did not combine until September 21, 1974.

SP's action of instructing its trainmen to reject cars that had a foreign substance on their wheels was ineffective. For example, the conductor who supervised handling cars 15 and 16 at the Shell plant the day before the accident was not aware of any instructions pertaining to rejecting cars or any requirement for him to inspect cars.

The car inspectors who looked over cars 15 and 16 before they moved over the hump stated that they had not seen the written notice of November 14, 1973, before the accident. Their personal interpretations of the wheel conditions which could cause overspeed cars were different. Thus, the implementation of the written instructions was ineffective in preventing an overspeed recurrence.

On August 9, 1974, another overspeed car went through the retarder and the accident was attributed to a foreign substance on car wheels. Yet, no followup was performed to determine why this car was not discovered by the carmen who inspected it or by the trainmen involved in picking up the car. The letter of August 19 and meeting of August 23 followed this accident, and it was recognized that the spilled epoxy resin in the warehouse area was

still a problem. However, the catastrophic accident potential was not reiterated even though it again had been demonstrated.

Inadequate followup on the part of the SP management occurred after the previous overspeed accidents since the various requests and instructions were neither understood nor implemented.

Car Inspection Procedures

Although the car inspectors were experienced, they were not shown specific examples of wheel conditions that could reduce the effectiveness of retarders. It is known throughout the industry that foreign substances on car wheels can adversely affect the braking performance of car retarders. One purpose of car inspectors on the crest was to insure a safe humping operation. The cars involved were to have received a subsequent outbound inspection in accordance with Federal regulations before their departure.

There are a number of car defects that a car inspector normally looks for; however, there are a limited number of defects that he can detect when cars are moving past him at 2 1/4 mph in all kinds of weather. The critical defects which could affect the hump operation were not understood by the inspectors. Instead they were attempting to find all defects on all cars.

Safety Controls

Federal regulations were not violated at Houston. As a result of a similar accident at East St. Louis, Illinois, 1/ the Safety Board recommended that FRA "establish a requirement that railroad carriers handle switching operations of cars containing large shipments of hazardous materials with a danger range beyond railroad property boundaries, in the same manner as they handle switching operations of cars containing explosives." FRA implemented the general intent of this recommendation through Emergency Order No. 5, dated October 27, 1974, which was after the Safety Board had reiterated it on October 11, 1974. (See Appendix F.)

1/ NTSB RAR-73-1, Hazardous Materials Railroad Accident in the Alton and Southern Gateway Yard in East St. Louis, Illinois, January 22, 1972.

FRA published regulations effective July 23, 1974, which required head shields on all DOT 112A and 114A tank cars by the end of 1977. The railroad and tank car industries generally favored the installation of top and bottom shelf couplers rather than head shields. In this instance, the shelf coupler may not have prevented the override and puncture, or head tear. The coupler on the empty tank car broke, this also could occur with the shelf coupler design. Had a head shield been present, it is likely that the head would not have been punctured since the energy would have been dissipated over a greater area and the striking edge of the coupler or coupler shank would have been blunted.

It also is significant that the combined losses of the two 1974 accidents at Decatur, Illinois, and Houston, Texas, approximated $31.8 million. This exceeds the 6-year (1965-1970) loss figure of $23.3 million for all types of tank car punctures. That figure was used by the Railway Progress Institute/the Association of American Railroads to determine the cost-effectiveness of tank car safety.

CONCLUSIONS

1. The failure of the retarders to control the cars was not caused by human error or the malfunction of the equipment.

2. The foreign substances discovered on the brakeshoes of the master retarder and the group retarder which served bowl tracks 50 and 51 were deposited there by the wheels of cars 15 and 16. The foreign substances discovered on the brakeshoes of the group retarder which served bowl track 1 were carried there by the wheels of cars 17 and 18, which had picked up the material from the brakeshoes of the master retarder.

3. The foreign substances on the wheels of cars 15 and 16 were picked up from the flangeways of the track adjacent to the warehouse in the Shell plant where the epoxy resins were loaded.

4. Although one of the seven sections of the master retarder had been removed from service and the brakeshoes on the various retarders were worn, sufficient capacity remained to retard cars 15 through 19 if no foreign substances had been on the retarder brakeshoes and car wheels.

5. The two tank cars containing butadiene (cars 17 and 18) collided with the empty tank car (car 10) while it was freestanding or moving slowly. The collision speed was about 18 to 20 mph, as estimated by witnesses.

6. The puncture of the head of the loaded tank car by the coupler of an empty car was generally consistent with the circumstance of accidents that occurred at Decatur, Illinois, and East St. Louis, Illinois.

7. The damage done by the explosion was consistent with a detonative open-air explosion rather than deflagration.

8. Shell Oil Company management failed to heed the clear warnings of the Southern Pacific representatives issued in 1973 that the spilled epoxy resin at Shell's plant offered the potential for an accident involving hazardous materials at Englewood Yard.

9. The Southern Pacific management recognized that foreign substances on car wheels could nullify the braking capabilities of the retarders, however, actions taken to prevent a recurrence were ineffective. The various requests and instructions initiated were either not received, not understood, or were ignored by the recipients. No followup action was taken by the Southern Pacific management although there was reason to suspect that these various communications were not being obeyed.

10. Southern Pacific car inspectors had not been taking exception to foreign substances on car wheels even though such substances had contributed to previous accidents in Englewood Yard.

11. The retarders were not able to brake cars with the frictional characteristics that were said to be within the retarder's capability. The coefficient of friction had not been the basis for judging retarder performance, as an occasional runaway car was tolerated.

12. Car journal oil, grease, epoxy resins, and various combinations of these mixed with other contaminants exhibited similar coefficients of friction when subjected to simulated retarder conditions. The exact effect on retarder operations of these materials and many other substances that are common to car wheel surfaces is not known.

13. There were no violations of Federal regulations by the carrier or the shipper.

14. Top and bottom shelf couplers probably would not have prevented the tank head puncture since the coupler on car 10 broke.

15. A head-shield on the car which released the butadiene probably would have prevented the puncture of the tank head by the overriding coupler of the empty tank car.

16. Although there had been instances of overspeed cars in switching operations at Englewood Yard, there were no emergency procedures or facilities for handling these overspeed incidents.

17. The efficient handling of the fire emergency resulted from the joint preaccident planning and training by the Southern Pacific and the Houston Fire Department.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the overspeed impact was the failure of the retarding system to slow the two coupled tank cars and the absence of a backup system to control cars which pass through the retarders at excessive speeds. The failure of the retarding system was caused by foreign substances on the wheels of the two cars that preceded the two tank cars through the retarders.

Contributing to the accident was the failure of the Southern Pacific Transportation Company to enforce procedures to exclude cars with a foreign substance on their wheels from the humping system, and the Shell Oil Company's failure, after notification of the hazard, to eliminate spilled epoxy resin from the flangeways of their track.

RECOMMENDATIONS

The National Transportation Safety Board recommends that:

The Southern Pacific Transportation Company:

(1) Review the design of the hump at Englewood Yard and make those changes necessary to insure that all cars brought to the hump for classification will be controlled properly. This review should include a systematic analysis of the interrelated effects of grades, retarders, controls for switching and maintaining programmed speed, separate provisions for backup to halt overspeed cars, constant monitoring of overspeeds, car inspection procedures, and a prediction of the reliability of the system with cars actually using it. (Recommendation R-75-28) (Class II)

The Federal Railroad Administration:

(2) In cooperation with the Association of American Railroads, do the necessary research, and then develop minimum performance standards for retarding systems in gravity switching yards. (Recommendation R-75-29) (Class III)

(3) Issue regulations superseding Emergency Order No. 5 that will require railroads to handle the switching of cars containing large shipments of hazardous materials, with a danger range beyond railroad property boundaries, in the same manner as they handle operations of cars containing explosives. (Recommendation R-75-30) (Class II)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

Francis H. McAdams, Member, did not participate in the adoption of this report.

May 21, 1975

APPENDIX A

COPY

SOUTHERN PACIFIC
TRANSPORTATION COMPANY
913 Franklin Ave., P. O. Box 1319
Houston, Texas 77001

October 15, 1973

Mr. E. S. Martin
Plant Manager
Shell Chemical Company
P. O. Box 2633
Deer Park, Texas 77536

Dear Mr. Martin:

Friday morning, October 12, car TLCX 38025 was tendered to us under the shed on Track 12.

Later in the day, during switching operations at Englewood, this car moved through the retarders at a speed sufficient to collide with other cars in the track, shoving them into the side of cars being handled on the lead at the West end of the Bowl.

Investigation developed wheels had been covered with a resinous substance. Further investigation developed resin in the vicinity of the loading operations where, in loading, the substance had overflown, inundating the rails sufficiently to permit wheels to pick it up, lubricating them to the extent retarders were completely ineffective.

Our investigation further developed that this is not the first time this situation has occurred, and in each of the preceding instances, we were assured that corrective action was being taken. However, it does not seem that, as of Friday morning, the situation had been corrected.

In view of the extremely sensitive nature of commodities originating not only in your plant, but in the greater Houston area, which must be handled through our Englewood facilities, it is imperative that all steps be taken to control a spillage which could result in a recurring situation of this nature.

Recognizing that there are occasional product losses from uncontrollable causes, it follows that such a situation should be brought to our attention whenever a car may be suspected of running through this resinous product in such manner as to lubricate it sufficiently to nullify our retarder system.

Appreciate your assurance that the situation is recognized and that your people will make every effort to control it, and in event of spill, timely information will be given us so that car wheels may be given appropriate attention.

Yours truly,

/s/ D. R. Kirk

cc: Mr. J. W. Bohenheimer
Manager District Facilities and Services
Shell Chemical Company
No. 1 Shell Plaza
Houston, Texas 77002

Mr. George Nemetz
Manager Transportation Operations
Shell Chemical Company
No. 2 Shell Plaza
Houston, Texas 77002

bcc: Mr. L. A. Patterson (2)

C O P Y

APPENDIX B

C O P Y

Englewood - November 14, 1973
580.5

CAR INSPECTORS: BOWL, CREST, NORTH YARD, SOUTH YARD, ONE SPOT, TOFC

MESSRS: LWH CRH PLM LLL CDL BEH BGT JCD DVG AJN CRF TDD LEJ JMC BBL JDM JME SAH IEL RK FLF EWA LMG JJB

We recently had an accident at Englewood when a car was crested in the Bowl Tracks with excessive speed which was due to a foreign substance being on the wheels that affected retardation.

Investigation developed that car in question had been loaded in a chemical plant where the track was submerged under oily substance resulting in coating the wheel. This is a condition that we occasionally experience and for this reason, it is very important that our car inspectors, particularly on the Crest, be alert for wheel conditions of this kind, notifying the Crest when such conditions are found. We have a great deal involved and it is extremely important that this matter be closely followed up on so that prompt corrective action may be taken before cars are crested.

J. C. Wells

JCW:bjd

cc: DLJ TBR KEH DFF

APPENDIX C

COPY

SHELL CHEMICAL COMPANY

Date: October 23, 1973

To: Houston Plant - Polymers - Superintendent (2)

From: Shipping Department - Manager - Houston Plant

Subject: Southern Pacific Discussion Polymers Railroad Tracks No. 11 & 12

Mr. L. A. Patterson called Friday, October 12, indicating BPA Hopper Car CELX 776 shipped ex Shell October 11 had gone over the hump at Englewood Yards and the retarder brakes failed to slow the car causing it to hit a string of cars and turn over. SP personnel advised him there was a substance on the sides of the wheel and he questioned if I knew what this could be. I responded that both resin and BPA get on the wheels of cars from this area.

The next call on this subject was from J. S. Nicholson, Trainmaster, located at Strang Office, Monday morning, October 15, asking if he, with R. G. McWhorter, Assistant to L. A. Patterson, and R. R. Swift, SP Safety Supervisor, could inspect Track 11 and 12. We delayed this until 5:15 pm to avoid interference with heavy construction in progress.

After ca. 45 minutes of disparaging remarks relative to our operation in this area, Mr. McWhorter addressed me saying if this was anyone but Shell and in consideration of the gross revenue they received from this plant, he would spike our switches and leave them. However, he would give us a chance provided the area was completely cleaned and all resin removed from car wheels to their satisfaction.

He then proceeded to instruct Mr. Nicholson that any time a conductor felt the area was not suitable to be entered, he was not to enter, advise SP management, immediately, who in turn would notify Shell. Additionally, it would be their responsibility to reject any car for shipment with resin on the sides of all wheels. McWhorter felt that if half the wheels were free of resin, this would provide sufficient braking capability for the SP retarder.

On the afternoon of the 15th while I met with SP personnel here, Jack Donner went to Englewood Yard to see the extent of resin build-up on the car in question. CELX 776 as originally quoted was not the car

in question. TLCX 38025 also shipped from here on October 11 was the car that allegedly could not be stopped and it struck CELX 776 which was in another string of cars. This car was not available for inspection as it was forwarded on to St. Louis over the weekend. The most significant fact that came out of Jack's inspection trip was his discussion with Mr. Hendley, Assistant Trainmaster at Englewood. He advised the cause of the accident was a power failure which rendered the SP retarder brakes ineffective.

At this time I have not questioned SP personnel regarding his statement. I did ask if any of the personnel in our discussion personally went to Englewood and if they could advise their findings - no one had. All information was by telephone although they indicated they received scrappings from the wheels of the car involved.

I advised the SP that while we would make every reasonable effort to work on housekeeping in this area, that I felt their approach was extreme in the fact that the particular problem with their braking had never been discussed previously and that conditions were of long standing. They suggested further that all railroad impairments next to the warehouse should be corrected.

/s/ E. E. Stringfellow

sw

cc: ESM
EES
JWD
GFB

C O P Y

APPENDIX D

SOUTHERN PACIFIC TRANSPORTATION COMPANY

Houston, Texas
August 19, 1974
520.01.1

C O P Y

Mr. E. Stringfellow
Traffic Manager
Shell Chemical Co.
P. O. Box 2633
Deer Park, Texas 77536

Dear Mr. Stringfellow:

We are getting concerned about the number of incidents occurring within your plant as reported by our train crews. I understand each of these has been reported to you or your people either at the time or shortly after they occurred. As these matters have been reported to the General Chairman of the United Transportation Union, I must be in position to quickly explain what is or will be done regarding them. The following is reported:

(1) Very slow action taken when the footing around Tracks 11 and 12 becomes saturated with the glue-type chemical contained in tank cars with the normal clean up consisting of some sand placed after the substance is scraped and that within a day or two, the sand is saturated to the point it is unsafe to handle the rail cars.

(2) Approximately 3:30 AM, July 27, some unauthorized person pulled the pins at five different locations on a cut of 42 cars assembled as shipouts and several hand brakes throughout the cut were applied and the angle cocks turned.

(3) Continue to have problems of crews being gassed in West Yard in the vicinity of the Stone Spur, last report being extremely bad Thursday night, August 15.

(4) About 6:55 AM, Friday, August 9, while crew was switching over crossing, a pick-up truck with three men came from towards Site 3 and stopped at the crossing. One of the men (the white man, the other two were colored) got out of the car and started verbal attack on the crew with threats of

Mr. E. Stringfellow 8/19/74

physical attack. Crew states acts seemed to be deliberate in that that was the purpose of trip. One of the men went to the cars and attempted to pull pins; however, could not do so because there was no slack in the couplers.

(5) Several of the tank cars used for storage and intra-plant switches have bad order safety appliances, including hand brakes, cut levers, pins, running boards and sill steps. Also car wheels are completely covered and coated with the glue-type chemical.

(6) At approximately 4:00 AM, Saturday, August 17, crew left two cars in Track 4, E Yard, with hand brakes tightly applied. Later they noticed cars moving and both hand brakes had been released. Just after that, they drug all cars in Track 3, E Yard, westward and made a cut leaving several cars, set three cars out and came back to Track 3 and started pulling cars again and found that a pin had been pulled on the north side of the cars near the middle of them causing the knuckle to open on the west end of the car.

As we cannot require our people to work in unsafe footing, handle cars with bad safety appliances or work in areas with uncontrolled chemicals in the air, I will appreciate your comments on what is and will be done regarding these conditions.

Yours very truly,

/s/ L. A. Patterson

cc: Mr. Bryan Suthers
Superintendent, Operations
Shell Chemical - Deer Park

Mr. Bob Verhoef
Asst. Dept. Mgr., G&EC
Shell Chemical Co. - Deer Park

RGM/mb

C O P Y

APPENDIX E

COAST-DOWN TEST RESULTS, THICK FILM[a]

	Coefficient of Friction Contact Pressure, psi					
	100	500	1000	2000	6000	10000
Car Journal Oil	0.13	0.12	0.12	0.12	0.10	0.13
Spirax HD-90[b]	0.15	0.14	0.13	0.12	--	--
Rail and Flange Grease	0.10	0.12	0.12	0.12	0.10	--
Retarder Scrapings[c]	0.21	0.19	0.17	0.16	--	--
EPON -828[d]	0.20	0.16	0.15	0.14	0.11	0.18
EPON-828 + 25% Sand	0.32	0.14	0.15	--	--	--
EPON-828 + 25% BPA	0.37	0.21	0.18	0.15	0.10	--
Glue Box Material[e]	0.20	0.16	0.15	0.14	0.10	--
EPON-1001-A-80[f]	0.43	0.27	0.18	0.15	0.12	--
Bis Phenol A (BPA)[g]	0.28	0.20	0.18	0.19	--	--
Wheel Scrapings (soft)[h]	0.49	0.35	0.32	>0.26	--	--
Wheel Scrapings (hard)[h]	0.36	0.31	0.34	--	--	--
Wheel Scrapings (leached)[h]	0.32	--	0.16	0.14	0.10	--
TLCX 38022 Scrapings[i]	0.41	0.31	0.29	--	--	--
50% TLCX 38022 + 50% Carbonized EPON-828[j]	--	--	0.41	0.34	--	--
Water	0.32	--	--	--	--	--
Dry Surfaces	0.61	--	--	--	--	--

a. Coast-down from 500 to 0 rpm. Film thickness before load applied 1/16 inch.
b. An extreme pressure automotive hypoid lubricant.
c. From top of outer master retarder at ICG RR, E. St. Louis, Ill.
d. Lowest molecular weight resin.
e. Track washings ex Shell Deer Park loading area. Contains EPONS plus solvent.
f. Highest molecular weight resin.
g. Starting material for EPON manufacture.
h. Wheel scrapings from EPON storage cars at Deer Park. Soft=softened with solvent to "mushy" condition. Hard=as received. Leached=diluted with solvent, liquid decanted, dried, and tested.
i. Same material as on butadiene car wheels. TLCX 38022 did not go through retarders, however.
j. EPON 828 carbonized by heating, mixed with TLCX 38022 scrapings, diluted with solvent, dried before testing.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX F

ISSUED: October 11, 1974

Forwarded to:

Honorable John W. Ingram
Administrator
Federal Railroad Administration
Washington, D. C. 20590

SAFETY RECOMMENDATION(S)

R-74-29 & 30

On July 19, 1974, a tank car was punctured during switching operations in the Norfolk and Western Yard at Decatur, Illinois. On September 21, 1974, a tank car was similarly punctured during switching operations in the Southern Pacific Englewood Yard, near Houston, Texas. Both tank cars contained heavier-than-air compressed flammable gases, which, as a result of the punctures, leaked and exploded. Several persons were killed and many were injured.

On January 22, 1972, a similar accident occurred in the Alton and Southern Gateway Yard in East St. Louis, Illinois. Each of these accidents produced injury and damage well beyond the confines of railroad property.

Following the 1972 accident at East St. Louis, the Safety Board recommended that:

> "The Federal Railroad Administration establish a requirement that railroad carriers handle switching operations of cars containing large shipments of hazardous material, with a danger range beyond railroad property boundaries, in the same manner as they handle switching operations of cars containing explosives." (Recommendation No. R-73-2.)

There had been no similar accident on record, and only one occurrence of the explosion of liquefied petroleum gas by detonation in open air. The Board, however, considered that

this accident demonstrated the possible results from the release of hazardous material having a danger range far beyond the boundaries of railroad property, and that precautions should be taken to prevent errors in switching from impinging upon the community. The background of the recommendation in the report showed that "minor accidents" were being tolerated in many instances in railyards and that a small percentage of cars were being subjected to switchyard impact above 10 mph.

The FRA reply said essentially that a wide range of materials would have to be included under a recommendation designed to confine damage to the railroad property, and gave the opinion that it would be more cost-beneficial to prevent overspeed impacts in all railroad hump yards than to require controlled movements on the subject cars by locomotive.

The accident at Decatur, Illinois, on July 19, 1974, demonstrated that detonation of LPG gas in open air, following a switching accident, could recur. This accident involved switching in a flatyard rather than humping operations, and also involved free-rolling cars. Improvements to humping could not have prevented this accident.

The Hazardous Materials Regulations Board, over signature of the Administrator, FRA, on August 9, 1974, issued a Notice of Proposed Rulemaking which would implement the Board's 1973 recommendation that evolved from the East St. Louis accident. The proposal also mentioned an accident at Wenatchee, Washington, on August 6, 1974, which is currently being investigated by the Safety Board. In that accident a large scale explosion occurred with effects far beyond the railroad yard. It is not yet determined whether the Wenatchee accident involved switching.

The FRA proposal would in effect, prohibit switching of all freight cars placarded "dangerous," without a locomotive attached, and would prohibit the same placarded cars from being coupled by free-rolling car impact during switching. This proposal contemplates essentially the same scope of definition of hazardous materials which was described by the FRA in its earlier reply to the Board's initial recommendation.

While this notice (Docket No. HM-120; Notice No. 74-11) was still open for comment, the accident occurred at the Englewood Yard at Houston. This accident involved the same detonation-in-open-air explosion mechanism as in the accidents at Decatur and East St. Louis, Illinois. It also involved a puncture in the head of a tank car by an opposing coupler similar to those found in the Decatur and East St. Louis accidents. The cars involved had been humped, as at East St. Louis.

Whereas the Board's original recommendation sought to cover the full range of disastrous effects on the community which might arise from free switching of large quantities of any hazardous material, the Decatur and Houston accidents have drawn attention more specifically to the escape of heavier-than-air compressed flammable gases. The occurrence of open air detonation of such gases in a railroad yard environment, thought to be unique in 1972, is now considered to be a probability. As the East St. Louis accident report pointed out, the mechanism by which the normally expected flashfire becomes an explosive detonation is as yet unknown. The compressed gases released in the three accidents were not the same, propylene having been released at East St. Louis, isobutane at Decatur, Illinois, and butadiene at Houston. Nevertheless, all three cases exhibited the phenomenon of open air detonation in a railroad yard. Although the three accidents carry no statistical significance a question is now raised as to whether there is some undetected reason for such detonations to occur in railroad yards.

The Safety Board believes that since these three accidents involved compressed flammable gases, the final FRA rule should include this category of hazardous materials. The later accidents have not only increased the predictability of a recurrence, but have also focused attention on compresed flammable gases in free-rolling switching operations. Therefore, the problem of detonation of compressed flammable gaees must be dealt with at this time, to prevent recurrence of this type of accident.

The time allowed to respond to the NPRM has been extended 30 days beyond the original date of September 20, 1974.

Consequently, at least 30 days will pass before any action will be taken to prevent recurrences.

The Safety Board believes that prompt action is required and that the emergency powers provided to FRA under the Federal Railroad Safety Act of 1970 were intended to cover such new situations. These emergency powers should be employed to prevent tank cars containing compressed flammable gases from rolling-free during switching operations or from being struck by or coupled to other free-rolling cars.

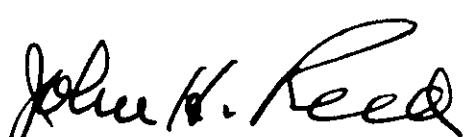
In view of the above, the National Transportation Safety Board recommends that the FRA

1. Through its emergency powers, issue an order to prohibit switching of tank cars containing compressed flammable gases unless the tank cars are under the control of a locomotive and prohibit such tank cars from being coupled by other free-rolling equipment.

2. To assure conformance with such an order, issue a list of the compressed flammable gases that are normally shown on waybills.

These recommendations are temporary pending the adoption of regulations pursuant to Notice 74-11, Docket HM-120.

REED, Chairman, McADAMS, THAYER, and BURGESS, Members, concurred in the above recommendations. HALEY, Member, did not participate.



By John H. Reed
Chairman

cc Secretary Brinegar