RAILROAD ACCIDENT REPORT

SOUTHERN RAILWAY COMPANY
TRAIN 154
DERAILMENT WITH FIRE AND EXPLOSION
LAUREL, MISSISSIPPI
JANUARY 25, 1969

ADOPTED OCTOBER 6, 1969

U.S. NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON, D. C. 20591

FOREWORD

The field investigation of this accident was conducted by representatives of the Federal Railroad Administration (FRA) under the supervision of the National Transportation Safety Board. This investigation was supplemented by a public hearing which was held by the Safety Board in Jackson, Mississippi, on March 4, 5, 6, and 7, 1969, and in Washington, D. C., on March 24, 25, and 26, 1969. This report of facts and circumstances and determination of cause by the Safety Board is based on the facts developed in the field investigation and public hearing.

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I. SYNOPSIS

Southern Railway train 154 was wrecked at Laurel, Mississippi, on January 25, 1969, at about 4 15 a.m., when 15 tank cars of liquefied petroleum gas derailed. The train with four diesel-electric locomotive units, 139 cars and caboose was moving northward at about 30 miles per hour when the west wheel on the lead truck of the 62nd car in the train broke. The wheel which broke as it was passing over the crossing of the Gulf, Mobile, and Ohio Railroad, derailed about 256 feet north of the crossing, and the train continued northward for about 2,146 feet before the 62nd car and 14 loaded tank cars behind it were derailed and wrecked.

The general derailment mechanically damaged most of the tanks involved, resulting in an immediate violent eruption of fire and explosion. The first explosion awakened many of the residents in the surrounding community and started fires near the tracks. The occupants of the dwellings near the wreck began evacuating the area while some of the train crewmembers went into the town to arouse the people and to stop traffic from entering the area.

For about 40 minutes after the derailment there were continued explosions which set fire to many dwellings and did extensive damage by concussion. Pieces of tank cars ranging in size from three-fourths of a tank to small parts were hurled up to 1,600 feet from the wreck, igniting dwellings and commercial buildings as well as inflicting mechanical damage.

During these explosions the crewmembers on the head-end of the train used the locomotive to pull away those cars still on the track. A road foreman of engines (hereinafter called "road foreman") then went back from the locomotive to determine the condition of a car of hydrocyanic acid, a deadly poison, which he feared may have been involved in the wreck. The last car on the rails was the 61st car which was standing about 20 carlengths north of the burning tanks and the hydrocyanic acid was in the 27th car.

The road foreman then proceeded to where the rear-end crew and an off-duty switchman were attempting to move the undamaged cars in the rear of the train away from the fire. Using a yard locomotive, the cars south of the wreck were moved southward in two cuts, leaving one fully loaded tank car (77th car) within 20 feet of the fire. The road foreman, the flagman, and the off-duty switchman went back with the yard locomotive and pulled this car away successfully.

The residents were evacuated from an area about 10 blocks square. The Laurel Police Department, with help from surrounding communities and the Mississippi National Guard, did an effective job in evacuating and securing the area. The Laurel Fire Department with help from many surrounding communities spent most of its time preventing the spread of the fires in the buildings. The Salvation Army and the American Red Cross, assisted by over 200 volunteers, did an effective job in attending to the vital needs of the evacuees. The local radio station was very effective in communicating to the confused and frightened citizens and was instrumental in mobilizing the local National Guard units.

A total of 54 residences was substantially destroyed and over 1,350 residences suffered some degree of damage. Several local businesses were totally destroyed or badly damaged, and many store windows in the downtown area were broken. Six public schools and five churches were damaged.

On Sunday morning, January 26, after two remaining tank cars were vented by a U. S. Army Explosive Ordnance Disposal team using shaped explosive charges, the fire in the wreck area was quickly brought under control. Residents were allowed to return to the area around noon, and the Southern Railway opened the track for slow-speed service about 5 30 p.m.

Two fatalities resulted from injuries caused by the fires and explosions after the wreck, 33 persons were hospitalized and numerous others treated at aid stations and clinics.

The Southern Railway estimated damage to track and equipment at $334,675, to lading, $45,000. Total damage in all categories is estimated at about $3,000,000.

The broken wheel which initiated the derailment was manufactured by Armco Steel Corporation at Butler, Pennsylvania, in June 1962 and had been in service since that time. The break was a brittle fracture which originated in the back of the plate in a roughly machined area. The fracture was initiated by a concentration of stresses in the back of the plate, resulting from sudden lateral loading as the wheel traversed the G. M. & O. Railroad crossing. The tread-worn-hollow condition of the wheel and the out-of-level condition of the crossing contributed to the lateral loading of the wheel.

The data developed allows definite conclusions regarding the behavior of some tanks involved, but not all. The mechanical puncturing of the tanks furnished the initial fuel which started a chain of events resulting in the violent explosions for 40 minutes. The mechanically damaged shells and the heat-weakened metal in conjunction with increased internal pressures led to the tank failures. At least three tanks literally rocket-propelled over long distances and started fires where they came to rest, expanding the extent of the disaster. There was no evidence of violations of standards or specifications regarding tank construction and use of safety valves, the standards or specifications did not control the existing situation.

Comprehensive tests are being made of steel samples from the damaged tanks; however, these results are not available at this time. Tests of the safety relief valves did not indicate any malfunction or failure of the valves in so far as the valve setting was concerned.

II. DETAILED AND GENERAL CONCLUSIONS

(The page number after each conclusion relates that conclusion to the facts and analysis which led to it.)

1. The speed of the train at the time of the derailment was between 28 and 35 miles per hour. There was no device on the locomotive to record the speed of the train. (Page 20)

2. The variations in the track condition in the accident area were not abnormal for track restricted to speeds of 30 miles per hour. There was no evidence to indicate that the track in general was unsafe for this speed. The Southern Railway follows the recommended practices for track maintenance of the American Railway Engineering Association which do not provide a specific objective measure of track cross level. Decisions as to adequacy of track condition on the Southern Railway are dependent upon the judgment and interpretation of track standards by individuals. The Board has noted in the report of the accident at Dunreith, Indiana, January 1, 1968, that the standards did not provide objective measures of condition. (Page 21)

3. Telephones in the tower and hand signals are not adequate means of communications to convey information quickly to the crew that an operator has noted an unsafe condition in the train. (Page 23)

4. The L-3 wheel of the 62nd car, ACSX 932003, broke as it was traversing the G. M. &O. crossing and resulted in the initial derailment at a point about 256 feet north of the center line of the G. M. &O. crossing. (Page 23)

5. The gross weight on rail for loaded tank car ACSX 932003 did not exceed the maximum allowable load under A. A. R. Interchange Rules. (Page 25)

6. Although the Laurel Fire Department and fire departments from neighboring communities responded rapidly and performed in an excellent manner, they could not control the massive LP-gas fire and explosions. (Page 28).

7. In this disaster, telephones alone proved inadequate for communications. The use of radio and television was necessary to mobilize forces required to protect the public. (Page 29)

8. Local volunteer groups and other public and commercial groups responded to the demands of the situation and did an effective job in meeting the immediate needs of the displaced and injured persons. (Page 29)

9. Although venting the intact tank in the vapor space by explosives was successful, experts disagree as to the safety of using this prodecure. (Page 31)

10. The tread-worn-hollow condition of the L-3 wheel did not require it to be condemned under the Rules of Interchange of the Association of American Railroads, which are based upon measurement of flange height. There is no A. A. R. gage to indicate a tread-worn-hollow contour for wrought steel freight car wheels, although the need for such a gage has been recognized by A. A R. for many years. (Page 38)

11. Though not condemnable by high-flange condemning limits, wheels with substantial hollow-worn treads may produce, under certain normal circumstances, significant stresses which were not considered in the development of the wear-limit rules. (Page 38)

12. The A. A. R. specification for finish is not specific as to surface finish because the words "workmanlike finish" are undefined and their interpretation merely a matter of opinion. This specification does not function as a safety control. (Page 38)

13. The chemical composition of the steel of the L-3 wheel met the requirements of the A A. R. specification. (Page 40)

14. The corrective machining of the plate of the L-3 wheel resulted in a torn surface with resulting discontinuity in the area of the break. (Page 40)

15. The discontinuities in the machining of the plate of the L-3 wheel made the wheel more subject to impact fracture in the machined area at low metal temperatures similar to air temperatures existing on the day of the accident. (Page 40)

16. The first fracture of the L-3 wheel originated near the hub in the area of rough machining on the back of the plate. (Page 42)

17. The L-3 wheel failed in the back plate near the hub because of suddenly applied lateral forces. The suddenly applied lateral forces came from the change in stress when the tread-worn-hollow wheel traversed the 35° 20' crossing frog, and from the pressure on the back of the flange by the guardrail because of the depressed east rail. The rough machining of the plate provided a notch effect and a stress concentration which reduced the ability of the wheel to withstand impact. The FRA reported the failure of a wheel for a similar reason in the accident at Cold Springs, Ohio, January 8, 1968, but has no authority to require any changes. (Page 44)

18. Although the A. A. R. became aware, through inspection, that Armco's Butler plant over a period of years was producing wheels whose finish, in A. A. R.'s opinion, did not comply with the specifications, similar wheels were sold and put into service on A. A. R. member roads, some of which had no knowledge that such wheels had been criticized. A large number of these wheels may be in use. (Page 46)

19. Lacking an objective standard for surface finish, there is no current basis by which to inspect wheels and determine which are too rough. Essentially all wrought steel freight car wheels are subject to rough finish and potential breakage because of the nonspecific specifications which have been in effect for many years. (Page 46)

20. Title 49 CFR 174.506 delegates to the Bureau of Explosives of A. A. R. the responsibility for protecting the public from the dangers of hazardous materials accidents but fails to specify the Bureau of Explosives' authority or relationship

with the carriers or Federal agencies regarding this function. (Page 47)

21. All tanks involved in the wreck were constructed in compliance with DOT and A. A. R. specifications.(Page 50)

22. At present the A. A. R. Committee on Tank Cars develops all new proposed tank car tank specifications for handling hazardous materials and submits them to the Department of Transportation which has the statutory responsibility for issuing and enforcing regulations regarding these specifications. Relative to this accident, recommendations by the A. A. R. Committee on Tank Cars to construct a tank car without external heat insulation to transport LP-gas, and a car without continuous center sills, were approved by the Interstate Commerce Commission without change as proposed by the A. A. R. (Page 48)

23. Much of the initial mechanical damage to the tanks was caused by couplers of cars which became uncoupled in the derailment. The use of interlocking couplers on these cars would have increased the probability of the couplers remaining in line after the derailment and decreased the probability of puncture damage. (Page 50)

24. According to the Certificates of Construction, the tanks involved in the wreck were constructed of the material meeting the specifications. Test results indicate the need for additional and continued research and tests to determine the best combination of design and materials to withstand the effects of derailments. (Page 50)

25. Tests and service experience indicate that the design of the 30,000-gallon tank car without a continuous center sill is adequate for normal conditions of transportation. However, research or analysis to determine the effect of well known classes of accidents on this kind of tank loaded with flammable compressed gas have not been accomplished. (Page 51)

26. The flight of two of the tanks over long distances resulted from the exhausting of the rapidly expanding and burning gas from the open end of the ruptured tank in which the liquid gas served as an energy reservoir, and the open

ruptured end approximated the functions of a rocket nozzle. The flight of these tanks was thus rocket-propelled. (Page 57)

27. The investigation did not develop sufficient evidence to determine conclusively the full scope of causes of the numerous tank ruptures. However, it is evident that mechanical damage to the tanks reduced substantially the bursting strength of the tank shells in a number of cases. Intense heat on the metal around the vapor space seriously weakened and thinned the metal in some cases. Under these conditions, the abnormal pressure produced by overheating the vapor space, or the sudden increase in pressure when large volumes of LP-gas flashed to vapor, could have caused some of the tank ruptures. (Page 59)

28. The basis upon which safety relief valves are sized for undamaged tanks has been proven to be sound by research and experience; however, in actual accidents, safety valves sized in this manner do not account for changes in the strength of tanks due to structural damage or localized heating of tanks. Such safety valves did not have sufficient venting capacity to accomodate the physical damage or fire-caused weakness which the tanks received in this accident. (Page 60)

General Conclusions

This accident illustrates the consequences which may ensue when, in the carriage of large quantities of hazardous materials through popu lated areas, supposedly effective safety controls do not work. Many of the failures of safety controls are attributable to ineffective planning design, and management of safety controls involving Government and private industry.

Safety controls of private industry were involved in the factors surrounding the initial derailment. These controls relied upon voluntary specifications, voluntary communications between agencies, and implementation by economic self-interest of an informed purchaser. Some specifications involved in this phase of the accident were specifi were followed and were not causally involved. However, the controls over the most determinative factors, namely, the specifications for wheel surface finish and wheel tread wear limits failed to be specific. A method of numerical specification of surface finish was available, but had not been employed. The gaging method for tread wear had been determined to be unsatisfactory but the appropriate method, already in use on similar wheels, had never been specified.

When an attempt was made to enforce the nonspecific surface finish specification by an opinion judgment of an inspector, the attempt was ineffective. The approach made to the manufacturer as a voluntary recommendation did not produce the desired changes and no communication was effected with users of the wheels, or with members of the trade association whose economic interest might have prevented the wheels from going into use.

The slight out-of-level condition of the crossing, a routinely measured and easily specified matter which might have been included in the industry self-regulatory recommendations of the American Railway Engineering Association, is not included in that industry document. As pointed out by the Board in the report of the accident at Dunreith, Indiana, that AREA document cannot be a basis for any forceful industry mechanism of enforcement.

Thus, in this case, three different forms of safety control involved in the wheel breakage were inadequate as to engineering specificity, although the state of the art allowed specificity, and two of the controls (cross level of track and surface finish of wheel) were unenforceable within the industry pattern of self-regulation, even if they had been adequately specified.

The writing of these safety-controlling documents and the arrangements for their application involved a number of professional engineering task committees and review groups of the industry whose work output was required to be technically competent and properly organized into a safety control structure in order to be effective. The documents produced under committee organization, however, must be judged incompetent as pieces of professional engineering work because they did not employ the available necessary engineering specifications. Also, the fact that these documents could not be enforced further raises the question whether reliance upon these voluntary methods to control safety of the public should be continued.

The Safety Board has noted other instances of vagueness, nonspecificity, and loose control in the self-regulated areas of railroad safety in its reports of the New York Central Railroad collision which occurred May 22, 1967,[1] and the Pennsylvania Railroad accident at Dunreith, Indiana, January 1, 1968.[2]

The second phase of this accident involved the large-scale spread of fire, rupture of tanks, and the extension of fire over long distances through rocket propulsion of the ruptured tanks. The field of tank car safety has long been a statutory Federal responsibility -- first, under the Interstate Commerce Commission, now, under the Department of Transportation -- as enacted under the Transportation of Explosives and Other Dangerous Articles Law (sections 831-835 of Title 18, United States Code, as amended). The law allows, but does not require, the assistance of carriers and shipper associations in the formulation of regulations. In practice, virtually all the regulations relating to tank cars originate in the Committee on Tank Cars of the Association of American Railroads, and the specifications of that organization are cited in regulations to be the controlling specifications for certain purposes not detailed by the regulations.

Two of the changes in tank car regulations related to this accident (a preceding abandonment of requirements for external heat insulation, and approval of new design high-capacity tank cars without a continuous center sill) were originated by the Committee on Tank Cars of the A. A. R. and adopted as Federal regulations without change. The abandonment of heat insulation is related to the development of hot spots and metal thinning in a fire which can produce explosive rupture. The high-capacity tank cars without a continuous center sill have shown the phenomenon, new to railroads, of tanks which become rockets when a fire occurs.

The responsibility of the Federal Government, when such regulation changes are proposed, should extend to the determination of

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1/ NTSB Report of Head-on Collision of New York Central Trains 1/NY-4 and ND-5 at New York, New York, on May 22, 1967; Released January 24, 1968.

2/ NTSB Railroad Accident Report No. SS-R-2, Adopted December 18, 1968.

possible dangerous side effects produced, regardless of the supposed competence of the source of the proposal. As the Board has recommended, these determinations should include the effects produced in full-scale tests which simulate accidents. However, neither the Interstate Commerce Commission nor the Department of Transportation has had sufficient technical capability to make such independent technical tests or analyses to guide regulations, nor have they ever had the necessary expertise to evaluate independently hazardous materials regulations in general.[3] In effect the tests were made at Laurel, Mississippi. The observations of new phenomena and recommendations, which could have come far earlier, have now been developed as investigative findings of a major accident. This procedure, of course, involves far higher cost to the public not only in dollars, but in death, disability, and suffering.

The costly results of this accident and the weakness of preceding efforts at safety control by both Government and private industry indicate that regulatory authority is necessary, but authority alone is not enough. It is also crucial that there be adequate fund support for research and development in support of regulations and sufficient budgeted technical capability in Government to insure that all regulatory actions will improve safety and none will, through ignorance, approve new hazards.

3/ See, for example, testimony of William H. Jennings, Director of Office of Hazardous Materials before Subcommittee on International Organizations and Movements of the Committee on Foreign Affairs, House of Representatives, Ninety-First Congress, First Session, May 8, 13, 14, and 15, 1969, printed for the use of the Committee on Foreign Affairs.

III. CAUSE

The cause of the initial derailment in Southern train 154 was the broken L-3 wheel on the 62nd car in the train.

Contributing causal factors were the rough machining on the plate of the wheel, the tread-worn-hollow condition of the wheel and the sudden lateral loading on the wheel as it crossed the G.M. &O. crossing. The sudden lateral loading was caused by the tread-worn-hollow condition with an unknown degree of contribution of the slight out-of-level condition of the crossing under load.

The cause of part of the spread of the fire beyond the immediate site was the projection of large parts of the tank cars long distances by rocket propulsion as the liquefied gas changed to vapor and was expelled through the ruptured open ends of the tanks. A contributing causal factor to this jet propulsion effect was the unhindered propagation of circumferential cracks in the rupture of two of the tanks which configured the open end of the tanks in a manner similar to that of a wide rocket nozzle.

Contributing causal factors to the fire and explosions at the site were the large volume of propane released and set fire by the punctured tanks, tank shells weakened by mechanical damage and abnormal heat, and the absence of a pressure-relief system that would provide adequate safety release under such conditions.

IV. RECOMMENDATIONS

(The number after each recommendation relates that recommendation to the conclusions which led to it.)

1. The Safety Board recommends that the Federal Railroad Administration take the necessary steps to impose regulations requiring all mainline trains to be equipped with devices to record the speed of trains. (Conclusion 1)

2 The Safety Board reiterates the recommendation made in its Dunreith report issued December 18, 1968, that " . . . the American Railway Engineering Association revise their track inspection and maintenance standards or recommended practices for track construction and maintenance so that they provide objective measures of conditions and definite criteria for correction." (Conclusion 2)

3. The Safety Board recommends that employees required by carriers to observe passing trains for defects be provided with means of rapid direct communications with personnel on the train. (Conclusion 3)

4 The Safety Board reiterates the recommendation made in its report covering the derailment and collision of Pennsylvania Railroad train PR-11A and SW-6 in Dunreith, Indiana, on January 1, 1968, " . . . that the Department of Transportation study means of improving the training methods available to local fire departments so that they can upgrade their skills in their handling of emergencies created by the increasing transportation of hazardous materials. The problems of controlling such accidents are especially troublesome because of the daily introduction into commerce of numerous new kinds of hazardous materials The Board believes that local emergency organizations cannot be expected to be conversant with necessary procedures to handle situations involving the many possible emergencies involving the transportation of hazardous materials unless some form of assistance in training is provided, such as a model type training course." (Conclusion 6)

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. (Conclusion 6)

6. The Safety Board recommends that the A. A. R. make a study of the stresses developed in freight car wheels with hollow-worn treads while moving over frogs, switches, and crossings. If increased impact stresses are being developed as a result of the wear and the stresses under the worst possible combination of dimensional and material variations approach the design stress, consideration should be given to changing the wear limits or the wheel design. Further, if new wear limits are determined, beyond-limit wheels should be removed from service as quickly as practicable. (Conclusions 10 and 11)

7. The Safety Board recommends that the A. A. R. conduct physical tests on specimens of wheel steel having a range of surface finishes to determine the best surface finish for a wrought steel wheel and, further, that the resultant surface finish be incorporated in the specification for wheel finish as a specified surface texture measured in microinches. (Conclusion 12)

8. The Safety Board recommends that the American Railway Engineering Association study the design of railroad crossings to produce a crossing design that will lessen impact to wheels and require less maintenance. (Conclusion 17)

9. The Safety Board recommends that the A. A. R. take the necessary steps to give proper notice to the purchases of wheels when inadequacies in manufacturing practices are found, thereby improving enforcement of the specifications to the degree possible under industry self-regulation. (Conclusion 18)

10. The Safety Board recommends that the A. A. R. review the function of the Bureau of Explosives regarding its performance in protecting the public from danger resulting from railroad accidents involving hazardous materials and take the necessary action to develop an effective, cooperative program with the carriers to accomplish the intended purpose of the responsibility delegated to the Bureau of Explosives by Title 49, Code of Federal Regulations, Section 174.506. The Board endorses the FRA's proposed amendment of the regulations which will provide that reports of incidents and accidents involving hazardous materials presently

made to the Bureau of Explosives by rail carriers will also be filed with the FRA. (Conclusion 19)

11. The Safety Board reiterates and emphasizes the recommendation made in its report of the railroad accident which occurred on the Pennsylvania Railroad at Dunreith, Indiana, on January 1, 1968, which reads as follows "... that the Federal Railroad Administration include in its current study of an improved coupler design, the problem of keeping cars coupled and in line with the track and with each other after a derailment occurs. In order to attain an integrated organization of track and rolling stock features that could limit the aftereffects which can now follow a simple derailment, the Federal Railroad Administration should also study related technical approaches to control interference with traffic on adjacent tracks and wayside structures during derailments, such as means of limiting the lateral excursion of wheels, and separation of trucks from cars." (Conclusion 26)

12. The Safety Board recommends that the Department of Transportation develop a cooperative program with the A.A.R., manufacturers of tank cars, and producers and shippers of hazardous materials aimed at determining a full range of technical improvements for railroad transportation of liquefied petroleum gas and other hazardous liquids. This program should include a comprehensive study of the causes of the tank rocketing phenomenon, causes and weakening effects of accident damages to tanks, and means of guarding against explosive ruptures of tanks under the types of conditions actually encountered in accidents. The study should be supplemented by engineering development work and full-scale testing under conditions known to exist in service. The Board also recommends that the FRA develop and impose suitable regulations to correct any identified deficiencies. The Board further recommends that regulations for hazardous materials tank cars require, in all cases, a demonstration of satisfactory performance under test conditions which reflect the full scope of accident conditions known to be encountered in service. (Conclusions 9, 23, 24, 25, 26, 27, 28, and 29)

V. FACTS AND ANALYSIS

A. Location and Method of Operation

The accident occurred at Laurel, Mississippi, which is about 145 miles north of New Orleans. Laurel is located on the Crescent Division of the Southern Railway System's Western Lines between New Orleans, Louisiana, and Meridian, Mississippi.

The railroad through Laurel is a single-track line running north and south. A single-track line of the Gulf, Mobile, and Ohio Railroad crosses the Southern Railway tracks on grade at a 35° angle 1,866 feet north of the Laurel depot. An interlocking station stands adjacent to the tracks in the southwest angle of the crossing. The station is manned by an operator who is a joint Southern Railway-G. M. &O. Railroad employee. The operator has communication with Southern Railway operating personnel by means of a railroad dial telephone, a direct telephone circuit to the Southern Railway dispatcher's office at Hattiesburg, and a regular commercial dial telephone. There are also telephones for communication with G. M. &O. Railroad offices. There were no radio communications in the tower.

Approaching the G. M. &O. crossing from the south, the track is tangent to a point 325 feet north of the crossing, then, a 1,591-foot 2° curve, followed by tangent track to a point beyond the site of the general derailment. The grade of the track changes from descending to ascending south of the crossing and continues on a slightly ascending grade through the accident area.

Measuring northward from the G. M. &O. crossing, there is a trailing-point switch to the east at 964 feet; Kingston Street grade crossing at 2,080 feet, and a facing-point switch to the west at 2,400 feet.

The areas on both sides of the Southern Railway's 200-foot right-of-way are primarily residential with a few small businesses and stores. A city water well is located on the west railroad right-of-way line about 1,550 feet north of the Kingston Street crossing.

In the accident area, the three main north-south streets east of the railroad are Meridian Avenue (closest to the tracks), Joe Wheeler Avenue, and Amaranth Avenue. These are intersected at right angles by Kingston Street between 10th and 11th Streets, with 11th Street north of Kingston Street. Front Street and the G. M. &O. tracks lie west of the accident area.

In this area, Southern Railway trains operate in both directions on single track by indications of an automatic-block signal system. Movement of trains over the G. M &O. crossing are by signal indications of home signals controlled by the operator in the interlocking station.

On the day of the accident, an operating bulletin restricting the speed of all trains between mileposts 56 and 58 to 30 miles per hour was in effect. Mileposts are numbered southward from Meridian and milepost 56 stands about 60 feet north of the G M &O. crossing.

In 1967, officials of the City of Laurel and Southern Railway met and agreed orally upon a maximum allowable speed of 30 miles per hour About this same time but unrelated to the foregoing, the City employed an independent firm to codify and publish its City Ordinances. When the completed Code was delivered in February 1969 after the accident, it was discovered that an ordinance adopted in 1910, and still on the books, set the speed limit through Laurel at 6 miles per hour. This ordinance had not been enforced in recent years. On March 3, 1969, after the accident, a new ordinance was passed by the City of Laurel setting the speed limit for trains at 30 miles per hour.

The initial derailment occurred 256 feet north of the G M &O crossing, and the general derailment and resulting wreck occurred at the facing point switch 2,402 feet north of the crossing. (See the diagrammatic sketch, Figure 1, on page 18)

The weather on the morning of January 25, was clear with a brisk northwest wind. The temperature was about 35° F.

B. Description of the Accident

1. Train and Crew

Southern Railway train 154 was a first-class, northbound, freight train which originated at Oliver Yard, New Orleans, Louisiana. The train left Oliver Yard at 12 10 a.m., c.s.t., January 25, 1969, with 76 loads, 37 empties, and a caboose. The locomotive was made up of four diesel-electric units, numbers 2116, 2142, 3137, 3148, coupled in multiple-unit control.

The train had a five-man crew under the supervision of a road foreman of engines. The engineer was operating the locomotive from the west side of the lead unit because the unit was being operated in

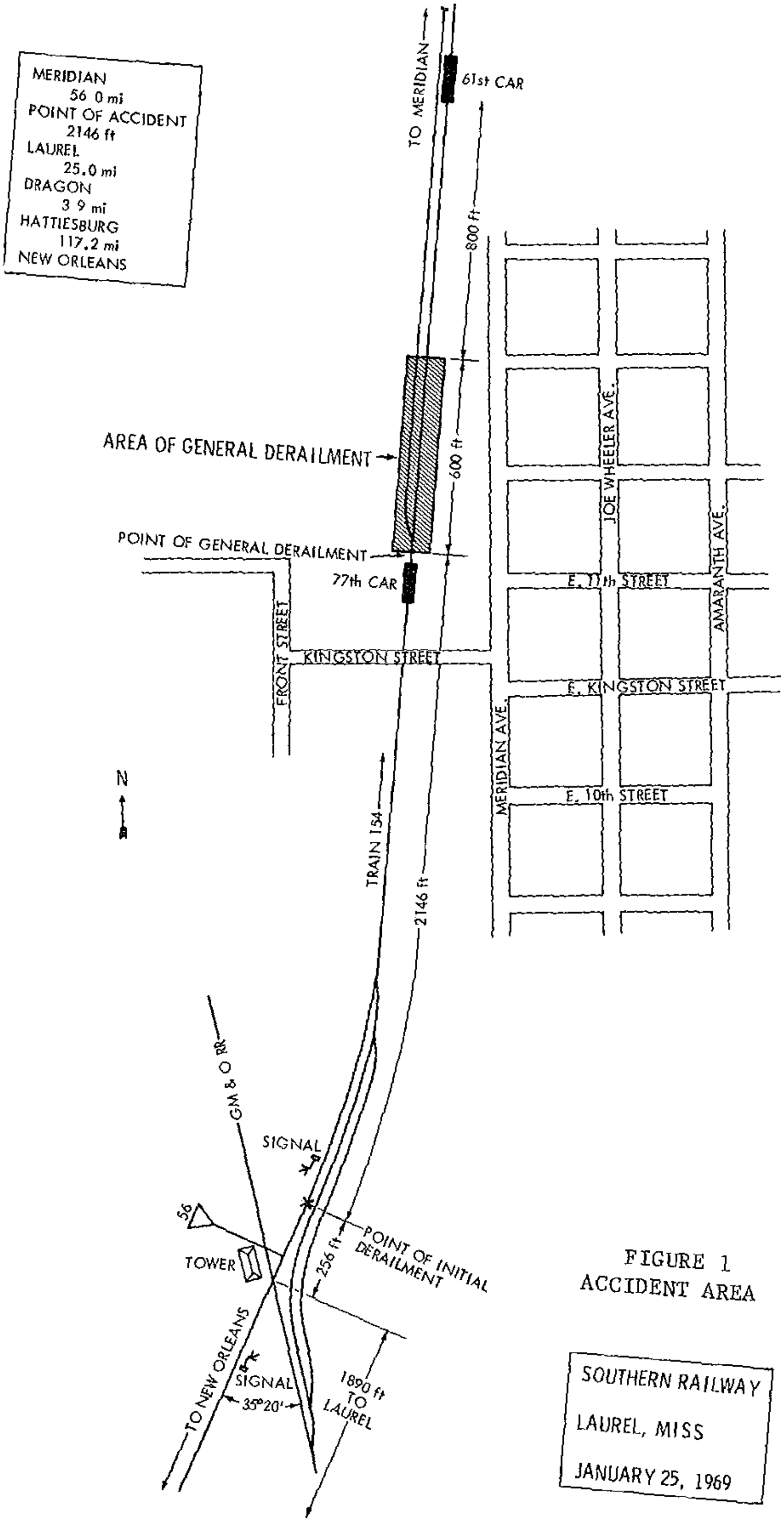


FIGURE 1
ACCIDENT AREA

SOUTHERN RAILWAY

LAUREL, MISS

JANUARY 25, 1969

reverse direction, and the fireman was occupying the normal position on the east side of the lead unit. The brakeman was riding in the second unit on the east side and the road foreman was on the west side of this unit. The conductor and flagman were in the caboose.

The locomotive and caboose were equipped with radios for communication between train and engine crews, with crews of other trains, and with land stations. Portable radios were available for use by the crewmembers.

The locomotive was equipped with a speedometer but did not have a device for recording the speed on a tape. The engineer verified the accuracy of the speedometer by checking the running time between mileposts at several points between New Orleans and Hattiesburg. The speedometer was calibrated during the first half of January 1969 and again during the first half of February and was found to be within acceptable tolerances.

The rest and hours of service of all members of the train and engine crews met the requirements of the Hours of Service Law. The required terminal brake test was made at Oliver Yard, and there was no indication of malfunction of brakes en route.

Leaving Oliver Yard, train 154 had seven cars of hazardous materials located in its consist, as noted below

Location in Train	Initial and Number		Contents
4	SP	101723	Ammonium Nitrate Fertilizer
5	UTLX	96260	Anhydrous Ammonia
27	GATX	72380	Hydrocyanic Acid
54	SHPX	82411	Isopropanol
57	ACSX	932182	Liquefied Petroleum Gas
58	POTX	188	Liquefied Petroleum Gas
92	UTLX	55171	Benzol Benzene

2. Trip from New Orleans to Laurel

The crew of train 154 had instructions to pick up 26 tank cars of LP-gas at Dragon, Mississippi, and put them in the train behind the 60th car. Dragon is 114 miles north of Oliver Yard and 25 miles south of Laurel.

All of the tank cars involved were DOT specification 112A340W or 112A400W tanks with a nominal 30,000-gallan capacity. The inspection, loading, placarding, and shipping papers complied with the applicable Federal regulations.

The 26 tank cars were loaded with liquefied petroleum gas, placarded, and the shipping papers properly executed by the shippers. The waybills for these cars were received by the conductor as the caboose passed the station at Hattiesburg.

The brake test, made by the crew after they made the train complete at Dragon, did not fully comply with the applicable Federal regulation.

Leaving Dragon, train 154 with a total tonnage of 10,486 tons consisted of 102 loads, 37 empties, and caboose. The location of the crewmembers and road foreman on the train was the same as previously described.

Train 154 made the run from Dragon to Laurel in the normal manner, arriving at Laurel about 4 15 a.m. There was no indication of malfunction of train brakes during the trip. There was no recording of the speed of the train as it crossed the G.M.&O. crossing, however, testimony indicated that the speed of the train four-tenths of a mile south of the crossing was between 28 and 30 miles per hour. There was some testimony that the train possibly could have been traveling as much as 35 miles per hour, but this was not substantiated. The presence on the locomotive of a recording device would have furnished the exact speed of the train. The investigation of any train accident requires that the speed of the train be determined so that it can be considered or eliminated as a causal factor.

3. Track at Laurel

The Southern Railway's track on both sides of the G.M.&O. crossing was of 100-pound rail of 39-foot lengths, jointed by 36-inch, six-hole joint bars, fully bolted. The rail was laid new in February and March of 1950 on 12-inch, double-shoulder tie plates. The rail was fastened by four rail-holding spikes to 7-by 9-inch treated, hardwood crossties, spaced 23 ties per 39-foot rail. There were the normal 12 rail anchors per rail. There was adequate slag ballast to a depth of 9 inches below the ties.

The G.M.&O. crossing was made up of standard 132-pound, two-rail, manganese insert, 35° 20' crossing frogs with integral base design. This 132-pound crossing was installed new in 1960. In

December 1967, two of the frogs were replaced by new ones, and the other two were built up by an electric welding process. In October of 1968, the G. M. &O. completely reballasted and surfaced the crossing. Since that time it received periodic inspections and general maintenance such as tightening of bolts. The crossing is owned and maintained by the G. M. &O. Railroad under an agreement originally made between the predecessors of the two railroads. The agreement requires the G. M. &O. to maintain the crossing to the satisfaction of the Southern Railway. The Southern Railway's Chief Engineer stated that the crossing was maintained to his satisfaction. The photograph in Figure 2 is a view of the crossing looking northward along the Southern Railway track.

Track measurements were made after the derailment. Visual observations by experienced track engineers and a staff member of the Safety Board revealed no significant faults in the alignment approaching the point of general derailment. The track gage varied from a minimum of 56 inches to a maximum of 56-7/8 inches in an irregular pattern. Variations in surface and cross level often found in track where low-speed service is in effect were observed. The greatest variations in cross level occurred at the G. M. &O. crossing where the east rail was considerably lower under load than the west rail. From the joint at the south end of the crossing to the joint at the north end of the crossing, under load, the east rail settled 1/2 to 1-1/4 inches lower than the west rail.

The Southern Railway has no published manual of track maintenance standards by which the track condition can be objectively measured, however, they follow the recommended practice of the American Railway Engineering Association (AREA). The Board, in its report on the Pennsylvania Railroad train accident at Dunreith, Indiana, on January 1, 1968, noted that the AREA's standards were not specific and recommended that they be revised so that they provide objective measures of conditions and definite criteria for correction. On the Southern Railway, those responsible for track maintenance determine the requirements for maintenance based upon judgment and experience.

4. Observations by the Operator

The operator, after displaying the train order signal and putting up the train order for train 154, stood between the tower and the G. M. &O. tracks to inspect the train as it passed. Rule 714, Southern Railway System Operating rules, requires that the operator look for

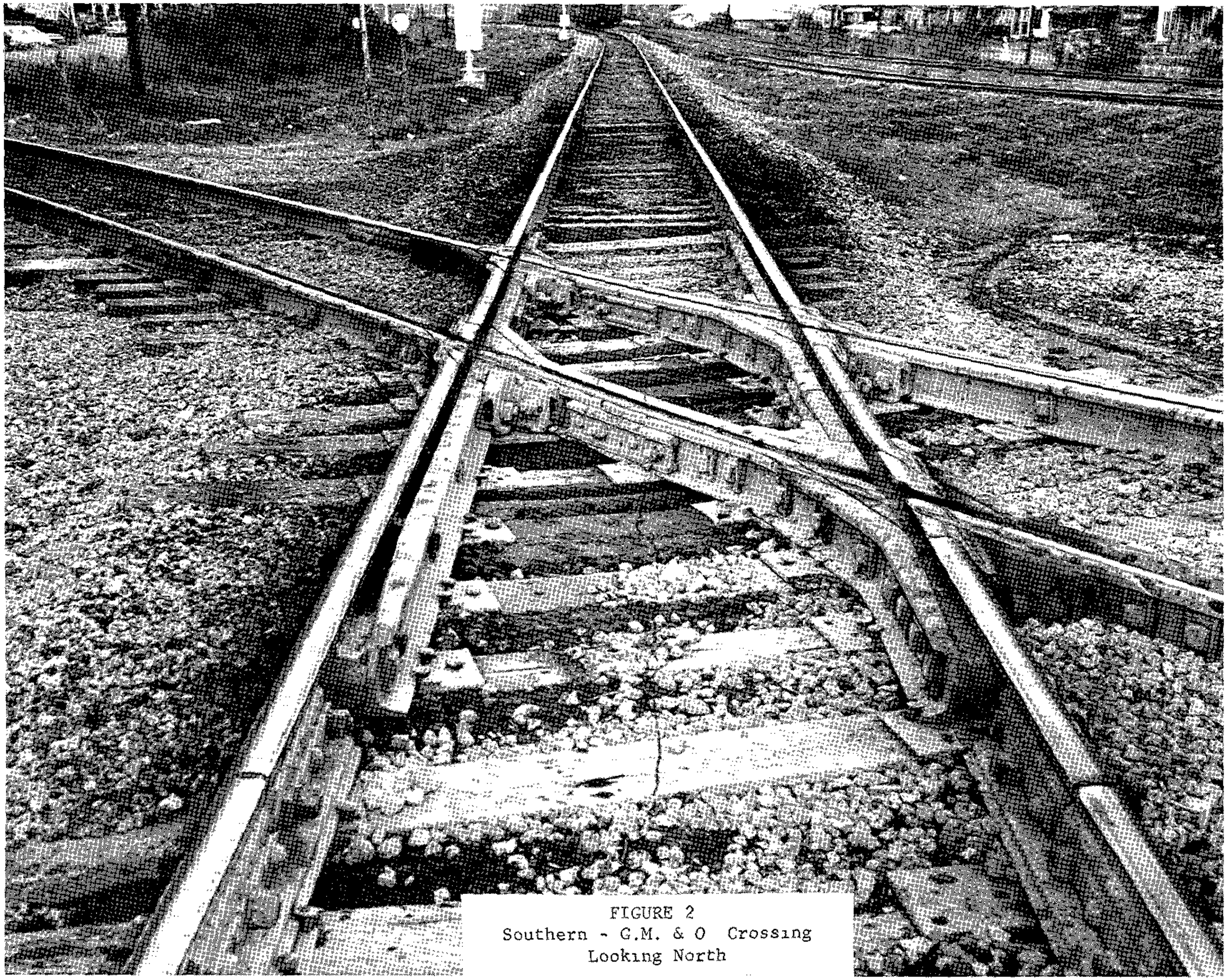


FIGURE 2
Southern - G.M. & O Crossing
Looking North

defects when a train is passing, and if required, take the necessary action to stop the train

Immediately after the first of the 26 tank cars (61st car) passed the crossing, the operator heard a loud noise and saw sparks and fire around the front truck of a tank car later identified as the 62nd car. He immediately looked southward and saw that the caboose was not close enough to receive a stop signal from him. Then he went into the tower to notify the dispatcher at Hattiesburg to stop train 154, but before he could do this, the general derailment with fire and explosions occurred north of the crossing. At this time, he was not able to contact the dispatcher by telephone because all three of the telephones had been made inoperative

5. The Broken L-3 and R-4 Wheels

The noise and sparks observed by the operator were the results of a piece breaking out of the trailing wheel of the lead truck on the west side (L-3 position) of the 62nd car in the train, ACSX car 932003. (See Figure 3.) The piece of wheel marked "B" broke as it was traversing the crossing and came to rest near the tower, pieces "C" and "E" were found on the east side of the track about 250 to 255 feet north of the crossing. When these three major pieces were assembled, it was apparent that they came from the same wheel, and other smaller pieces fitted inside these as shown in Figure 3. North of the trailing-point switch, parts of a second wheel were found, and it was later determined that they came from the east side of the lead pair of wheels on the same car (R-4 position). The pieces of the two wheels were marked, crated, and sent by railroad baggage to the Southern Railway's testing laboratory at Alexandria, Virginia The analysis of the tests made by Southern Railway, Armco Steel Corporation, and the Illinois Institute of Technology Research Institute appears in the section entitled "Analysis of the Broken L-3 Wheel" on page 33.

Marks on the east rail indicated the broken L-3 wheel continued for 256 feet before derailing the mate wheel. This derailed wheel continued northward on the ties inside and adjacent to the east rail until it struck the curved closure rail of the trailing-point switch, bounced over the closure rail, and continued northward to the point of switch where the lead pair of wheels of the same truck derailed. The R-4 wheel on the east side of the lead axle broke at about this point It is not known which occurred first, the breaking of the R-4 wheel or derailment of the lead pair

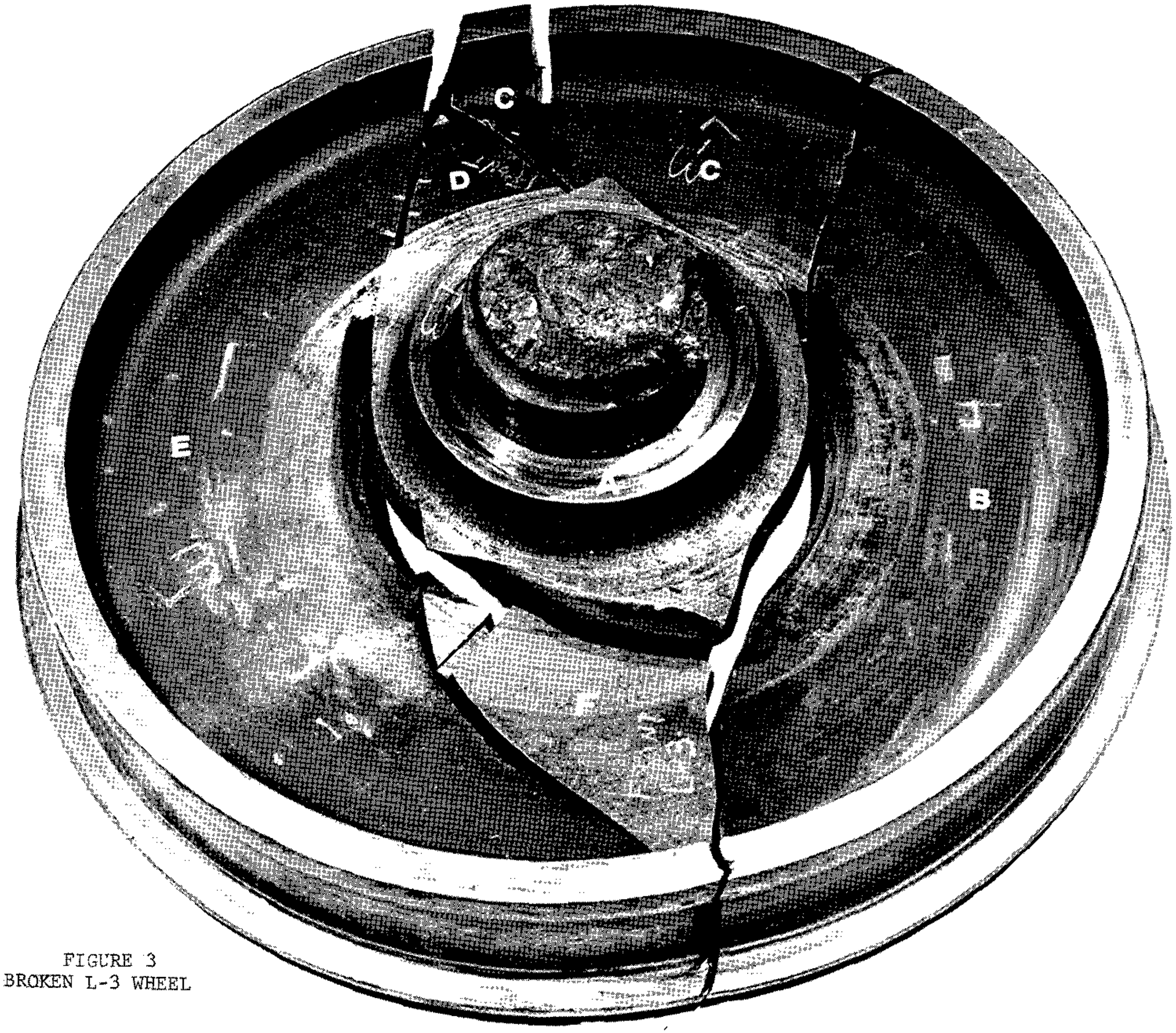


FIGURE 3
BROKEN L-3 WHEEL

ACSX car 932003 was equipped with four wheel trucks with 6 1/2 by 12-inch A. A. R. standard, raised wheel seat axles. The maximum total weight on rails for this car, as specified by A A. R. Interchange Rules, is 263, 000 pounds At the time of the derailment, ACSX car 932003 was loaded with 30, 104 gallons of propane with a specific gravity of 0. 505, resulting in a gross weight of 249, 089 pounds.

The derailed tank car continued northward to the facing point switch about 300 feet north of the Kingston Street grade crossing. The derailed truck apparently followed the curved closure rail of the facing point switch to the left, resulting in damage to the switch and separation of the train. It was at this point that the brakes were applied in emergency and the following 14 loaded tank cars derailed

6. Description of General Derailment

Fourteen of the derailed tank cars, totaling about 850 feet in length, were piled into a space about 400 feet in length, while the first car that derailed stopped upright 200 feet north of the general pileup. (See Figure 4) The first 61 cars remained on the track and stopped with the 61st car about 800 feet north of the first derailed car. The rear 63 cars remained on the track with the 76th car stopping about 20 feet from the southernmost derailed cars.

The tank of the 64th car remained intact. There was a relatively small puncture in the tank of the 62nd car, but the remaining 13 tanks were badly punctured, ruptured, or exploded violently in the accident. The types and patterns of failures in the tank shells varied.

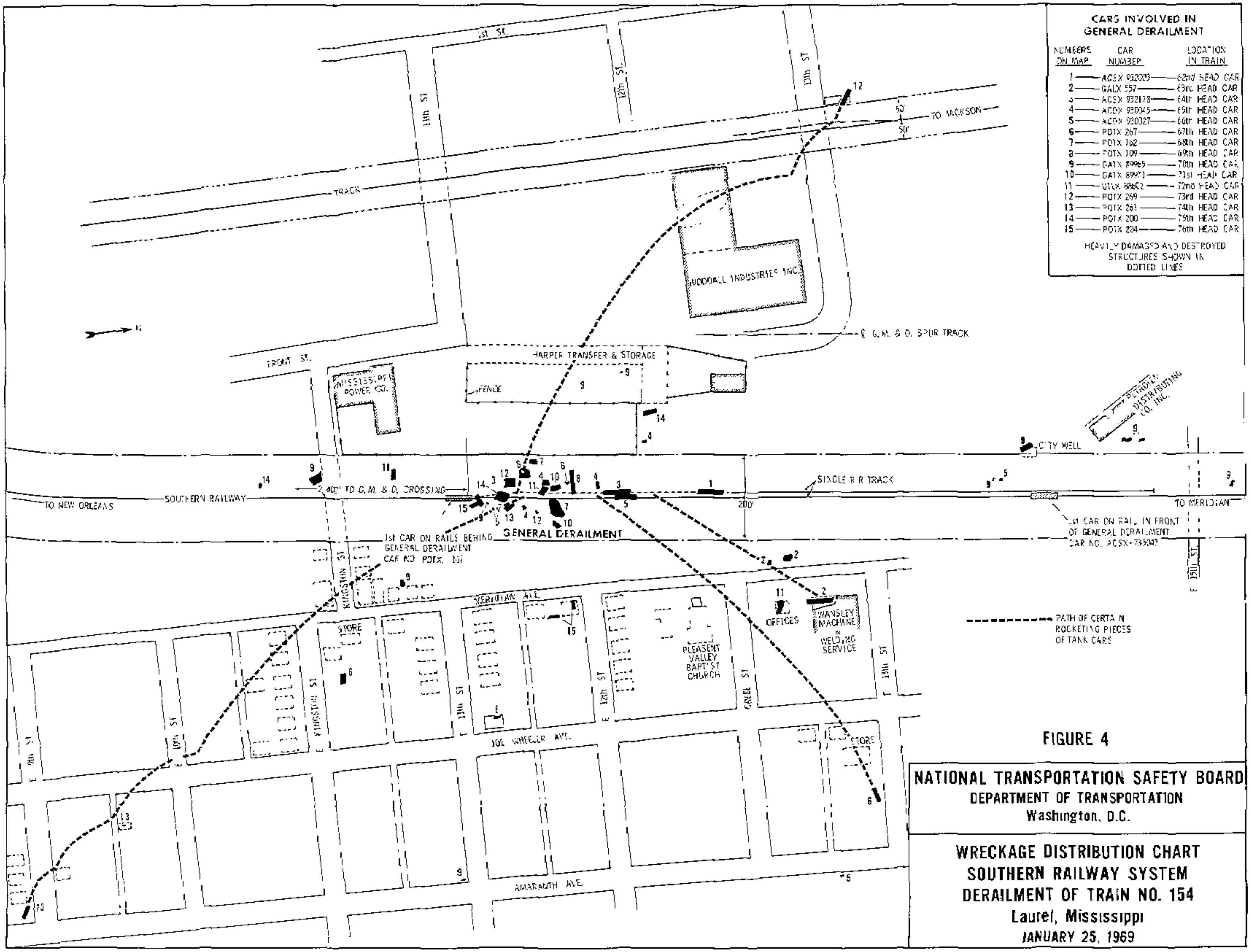
Violent eruptions of fire occurred immediately after the wreck, shooting large mushrooms of flaming propane several hundred feet into the air and over both sides of the right-of-way. Large pieces of tank cars were propelled varying distances up to 1, 100 feet, inflicting impact and fire damage to the town.

At least 19 pieces of tanks large enough to be destructive to physical property were hurled off the right-of-way.

C Postcrash Activities

1 Actions of Head-End Crew

When the locomotive was approaching the 55th milepost, the engineer felt a slight jerk and reduced the throttle. Before this had



CARS INVOLVED IN GENERAL DERAILMENT

NUMBERS ON MAP	CAR NUMBER	LOCATION IN TRAIN
1	ACSX 932020	62nd HEAD CAR
2	GALX 557	63rd HEAD CAR
3	ACSX 932178	64th HEAD CAR
4	ACDX 930045	65th HEAD CAR
5	ACDX 930027	66th HEAD CAR
6	POTX 267	67th HEAD CAR
7	POTX 102	68th HEAD CAR
8	POTX 109	69th HEAD CAR
9	GATX 89965	70th HEAD CAR
10	GATX 89971	71st HEAD CAR
11	UTLX 88602	72nd HEAD CAR
12	POTX 269	73rd HEAD CAR
13	POTX 261	74th HEAD CAR
14	POTX 200	75th HEAD CAR
15	POTX 224	76th HEAD CAR

HEAVILY DAMAGED AND DESTROYED STRUCTURES SHOWN IN DOTTED LINES

FIGURE 4

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
Washington, D.C.

WRECKAGE DISTRIBUTION CHART
SOUTHERN RAILWAY SYSTEM
DERAILMENT OF TRAIN NO. 154
Laurel, Mississippi
JANUARY 25, 1969

any effect, the train brakes applied in emergency automatically. When members of the crew looked back, the train was engulfed in flames a considerable distance behind the locomotive.

When the locomotive fireman looked back in an attempt to determine the cause of the emergency brake application and saw the train engulfed in flames, he notified the dispatcher at Hattiesburg by means of radio that it "looks like the whole world was on fire." The brakeman was instructed to uncouple the locomotive so that it could be moved out of danger.

By the time the train stopped, the brakeman was on the ground ready to uncouple the locomotive. The engineer moved the locomotive about 10 carlengths away from the train and stopped. The brakeman went across the street paralleling the tracks and began knocking on doors to awaken the residents. He told them to prepare to leave and telephone any neighbors to alert them. He also stopped traffic on the street and sent people in automobiles back to warn residents.

While the brakeman was alerting the people, the road foreman walked toward the fire on the east side of the train to determine how many cars remained on the track. He was primarily concerned about the tank car of hydrocyanic acid about which the conductor had informed the crew before leaving Oliver Yard. When he came to the car of hydrocyanic acid and saw that the derailed cars were beyond, he radioed the engineer to couple the locomotive to the train and await a signal to move the cars away from the fire. The road foreman found that the last car on the tracks was separated from the fire by about 20 carlengths. During this time there were periodic explosions and violent eruptions of fire. While the road foreman was closing the angle cock on the south end of the 61st car, a necessary action to release the brakes, an explosion generated such an intense heat that he had to cover his head with his coat.

The road foreman instructed the crew to take the 61 cars to side track north of Laurel and return with the locomotive to await further instructions. He then radioed the dispatcher and requested that someone transport him in an automobile to that part of the train south of the wreck. He had been monitoring the activities of the conductor and flagman by listening to the conversation on the radio. The station agent picked up the road foreman at the corner of East 15th Street and Meridian Avenue at approximately 5 00 a.m. and carried him to a point near the caboose of the train.

2. Activities of Employees on the Rear of the Train

Immediately after the emergency brake application occurred, the conductor saw evidence of fire ahead. After the train stopped, he could not communicate with the dispatcher because of radio failure. The conductor and flagman walked northward to the G. M. &O. tower but found that the telephones there were inoperative. Because of his concern for the car of hydrocyanic acid, the conductor tried unsuccessfully to contact the engineer, or anyone who could hear him, on the portable radio.

One explosion occurred while the conductor and flagman were walking toward the G. M. &O. tower and an unusually severe explosion occurred while they were at the tower. As a result of this big explosion, the conductor, flagman, and operator went southward into the residential area to alert residents and stop traffic.

The conductor successfully contacted the dispatcher at Hattiesburg on the portable radio about 20 minutes after the emergency stop. Arrangements were made for the conductor and flagman to use the Laurel yard engine to pull those cars still on the track southward away from the fire.

With the road foreman operating the yard engine, an attempt was made to pull back those cars south of the wreck. The cars standing south of the wreck were separated into three cuts and moved southward to a side track. These movements were made with the assistance of the conductor, flagman, and an off-duty switchman who volunteered his services. The third cut was the 77th car in the train and was standing within 20 feet of the fire before it was moved, about 8 00 a.m.

3. Activities of Fire Department

The major activities of the Fire Department were in limiting the fire as much as possible in the residential area. One piece of tank car was hurled into a pumphouse of a city well and cut an 8-inch water main, reducing the pressure on the east side of the tracks to about 20 pounds per square inch. The fires in the residential area were under control by 11 00 a.m., 6-1/2 hours after the wreck occurred. The Laurel Fire Department was assisted by fire departments from nine neighboring communities.

There was no effective liaison between the Southern Railway and the City of Laurel prior to the accident relative to the proper handling of emergencies involving accidents with hazardous materials. While the Fire Chief met the conductor by chance, and they deduced that there was LP-gas burning, there was no prior knowledge by the Fire Chief as to whom to contact to determine quickly what commodities were involved.

4. Activities of Police Department and National Guard

At 4 20 a.m., the Chief of Police was called and he issued instructions to seal off the area and evacuate as much of the area as necessary.

An operations center was set up at City Hall and requests for assistance were sent out to the Jones County Sheriff's Department, Mississippi State Highway Patrol, and Jasper County Sheriff's Department. The use of the National Guard was approved by the Governor and units were quickly activated because it was feared that the Laurel General Hospital, four blocks from the wreck, might have to be evacuated. There was a short period of general confusion because of the lack of telephones and electric lights in parts of the city.

The local radio station, WNXL, which was off the air at the time of the derailment, began broadcasting on standby power. This radio station was instrumental in mobilizing the local National Guard and in communicating general information to the public. It was of great aid in uniting members of families and in directing displaced persons to aid stations and shelters.

An emergency planning session was held immediately with the Sheriff and State Highway Patrol to arrange for securing the affected area. Another planning session was held about 9 30 a.m., at which time security of the inner perimeter was assigned to the National Guard, and the police units handled the other police matters.

5. Activities of Other Organizations and Individuals

Within 1-1/2 hours after the derailment, the Salvation Army and American Red Cross units were functioning. There were over 200 volunteers, both individuals and civic organizations, assisting in the collection and distribution of clothes and food, and furnishing other necessities of life. In addition, numerous churches and homes were used to house and feed the displaced persons. A local hardboard manufacturer distributed hundreds of sheets of hardboard to cover broken windows and to repair other damage.

Governor John Bell Williams and party arrived in Laurel before 10 00 a.m. to determine the extent of the damage and the needs of the people. Local Civil Defense units from three counties assisted as needed.

The President of the Southern Railway System and his senior officials were on the scene before noon, in addition to the local General Manager and Division Superintendent and staff who arrived soon after the derailment.

6. Condition and Disposition of Tank Cars After Wreck

None of the witnesses recalled hearing or seeing any explosions after 5 00 a.m. After the explosions and major fires subsided, two tank cars containing large volumes of LP-gas remained relatively intact. The first car that derailed, ACSX 932003, was lying on its left side and was burning around a puncture in its south end. The frostline on the car indicated that the car was about half full of LP-gas. The third car that derailed, ACSX 932178, was almost upright but was burning around its dome. The safety relief valve on ACSX car 932178 was venting about every 20 minutes and exhausting burning gas about 75 feet into the air with a great amount of heat and noise. The presence of these two cars in this condition still represented a hazard to the community and a deterrent to the railroad in its efforts to clean up the wreck and resume operations over this line.

Because of the danger represented by the tank car whose safety relief valve was venting, there was much concern and discussion about how to dispose of it. After several conferences which included the senior officers of the National Guard, city officials, railroad officials, hazardous materials experts, and a three-man explosive ordnance disposal (EOD) team from Fort McClellan, Alabama, it was decided to vent the tank by the use of shaped explosive charges. The Bureau of Explosives agent advised against this procedure. The decision was finally made by the Southern Railway's General Manager to vent the tank near the top in the area occupied by propane vapor. The decision was made late in the afternoon of January 25, and at another conference at City Hall at 6 00 p m., it was decided to pierce the tank at 9 00 a.m. the next morning, 28 hours after the wreck.

Bureau of Explosives Pamphlet No. 22, "Handling Collisions and Derailments involving Explosives, Gasoline and other Dangerous Articles," contains the following "recommended good practice" "No attempt should be made to puncture or rupture the shell of a tank car involved in a fire. This is an unwarranted and dangerous procedure likely to increase rather than decrease the seriousness of the situation since any opening made in a tank will only serve to liberate more flammable liquid and extend the fire."

Testimony of witnesses knowledgeable in the characteristics of LP-gas in fire-impinged tanks indicated that venting the vapor area with shaped charges cannot be considered a safe procedure. The Southern Railway's General Manager, who made the decision to vent the car, did so after many consultations with those available who could advise him The use of water to extinguish the blaze and cool the tank was ruled out because it could not be determined definitely whether all of the gas was escaping solely from the safety valve.

The National Guard cleared the area early the next morning, January 26, while the EOD team was preparing the shaped charges. The charges were detonated at 8 57 a.m., and the gas ignited immediately with a sound described as "like a jet plane taking off." The flame persisted for 15 to 20 minutes. Within an hour, the EOD team blew holes in the bottom of this car at each end and at the north end of tank car ACSX 932003 to release more gas. Within another half hour, the fire was considered under control, and the area was declared safe for people to return about 10 30 a.m. Radio and television stations broadcast the news. The Southern Railway began cleanup operations about 11 30 a.m., January 26, and the main line was ready for train operation at about 5 30 p.m.

After this wreck, which was the third catastrophic LP-gas wreck on the Southern Railway since January 12, Southern Railway issued instructions limiting the speed of trains carrying LP-gas to 45 miles per hour in open country and 15 miles per hour through heavily populated areas.

D. Casualties and Damages

The fire and explosions which followed the derailment immediately set fire to those buildings, primarily residences, between the wreck and Meridian Avenue. The concussion from the explosions caused structural damage to buildings in the vicinity, and broken windows were numerous and widespread. The Fire Chief testified that broken windows were reported as far as 3 miles west of Laurel. The majority of the broken glass was in the downtown area about 8 blocks away. The damage shown in the photograph on page 32 , Figure 5, is on the east side of Meridian Avenue and illustrates the type of damage that resulted from concussion. The tank shown was the major part of UTLX car 88602, the 11th tank car that derailed.

FIGURE 5
A Part of One Tank Shell and
Damage to Church and Business
East Side of Meridian Avenue,
Laurel, Mississippi

Parts of the tank cars which were hurled through the area set fire to buildings in some instances as well as inflicting impact damage. Explosions spewed burning propane over a large area, setting fire to many buildings. A number of automobiles were destroyed by fire in the vicinity of the accident. There were 54 residences destroyed and over 1,350 residences suffered varying degrees of damage.

A large transfer and storage company warehouse and its contents were almost totally destroyed by fire and a wash-and-dry laundry was totally destroyed. The structures of four other industries and businesses were heavily damaged a hardboard fabricating plant and the Mississippi Power Company, west of the tracks; a machine shop and a wholesale grocer, east of the tracks.

Six public schools and five churches were damaged. The total damage to churches was estimated at $150,000.

Two fatalities resulted from the wreck. A 65-year old minister died on February 1 as a result of burns and a 17-year old girl died about a month after the wreck. There were 33 persons hospitalized and numerous others treated at aid stations and clinics for minor injuries. A month after the wreck, five persons had been transferred to the University Medical Center at Jackson and 12 persons remained in the hospital in Laurel.

The Southern Railway estimated damage to track and equipment at $334,675 and damage to lading, $45,000. The estimate of damage in all categories will be about $3,000,000. (See Figure 6 for aerial photograph of accident scene.)

E. Analysis of Broken L-3 Wheel

The L-3 wheel was a 36-inch, one-wear, wrought steel, class CR wheel. This wheel, serial No. 64553, heat No. 5939, was manufactured by the Armco Steel Company in June 1962. It was made a part of tank car ACSX 932003 when the car was built by General American Transportation Corporation in January 1963. The wheel was manufactured under Specification M-107 from the Association of American Railroads' Manual of Standards and Recommended Practice.

Chemical and metallurgical analyses of the broken L-3 wheel were made by the Southern Railway at Alexandria, Virginia, by the Illinois Institute of Technology Research Institute (IITRI) at Chicago, Illinois, and by Armco Steel Corporation at Butler, Pennsylvania, and Middletown, Ohio. An A.A.R. Consulting Engineer on Wheel Plants inspected the

FIGURE 6
AERIAL VIEW OF PART OF
DISASTER AREA

broken L-3 wheel and an A. A. R. Mechanical Inspection inspector gaged the wheel for wear.

1. A.A.R. Specifications for Wheels

There is no Federal statutory authority over freight car running gear. Specifications for new railroad freight car wheels are developed and promulgated by the Association of American Railroads (A. A. R.). The only way to insure compliance with these specifications by manufacturers would be through refusal of purchasers to accept wheels which, in their opinion, do not meet specifications. The current specifications are said to be the outgrowth of years of experimentation, wheel service experience, and recommendations by members of the A. A. R. Wheel and Axle Committee. These specifications are amended by letter ballot of the Committee members. The Wheel and Axle Committee members are all employees of railroads. The recommended amendment goes to the General Committee of the Mechanical Division, and if it is an item requiring a letter ballot action of the members, it is submitted to the membership for vote. The number of votes is governed by the number of cars that a member road owns, there are no representatives of the general public on these committees.

Specifications M-107-67, Appendix 1, cover the requirements for wrought carbon steel wheels and include among other things, design, manufacture, chemical requirements, physical requirements, finish, and inspection. Specifications M-107 have been in the A. A. R. Mechanical Division's Manual of Standards and Recommended Practices for many years and were in effect when the L-3 wheel was manufactured.

In 1964, the A. A. R. started a program of inspection of steel wheels to insure that "control practiced by manufacturers is effective in maintaining a constant standard of quality to meet the requirements of A. A. R. specifications and service conditions to which the wheels are subjected." (See Appendices 2 and 4.) At the time that the L-3 wheel was manufactured, there was no inspection in manufacturing plants by A. A. R. inspectors. Prior to 1964, inspection of finished new wheels was left to the discretion of the purchaser.

Measurements of the wheel after the derailment indicated that this wheel was within all the requirements of the Association of American Railroads, however, the wheel had substantial hollow tread wear. There were rough machining marks on both the front and back faces of the plate in the area around the hub.

	L-3 Wheel	A.A.R. Interchange Rules Condemning Limits	A.A.R. New Wheel Standards
Rim thickness	1-1/4"	3/4"	1-1/4 min.
Flange thickness	1-1/32"	15/16"	1-3/8 +1/32" -3/32"
Flange height	1.492"	1-1/2"	1" +1/16 -0
Plate thickness N1 (near rim)	1-1/16"		3/4"
Plate thickness N2 (near rim)	1-3/16"		1"

FIGURE 7

MEASUREMENTS OF L-3 WHEEL

The limits to which wheels in service can wear before they are condemned are specified in the A.A.R.'s Rules of Interchange. There are no requirements for maximum allowable hollow tread wear on wrought steel freight car wheels. The measurement of flange height is used as a criterion of tread-worn-hollow condition.

The measurements of the L-3 wheel compared to the A.A.R. standards for new wheels and to the requirements of the Rules of Interchange are shown in Figure 7, page 36. It will be noted that the L-3 wheel was not condemnable under these requirements; however, the wheel was worn to within 0.008 inches of the condemning limit for a high flange. This measurement was the result of a substantial tread-worn-hollow condition, observable, but not measurable because of the lack of a gage for wrought steel freight car wheels.

When the L-3 wheel went from a narrower rail to a wider rail or frog, such as when traversing the G.M.&O. crossing, the wheel suddenly carried its load entirely on the outer rim. This change in wheel-rail relationship resulted in a simultaneous impact and change in stress pattern in the wheel at every entrance to a wider section. The impact occurs again when the wheel spans the flange ways of the crossing frogs. Figure 8, page 38, compares the profiles of the L-3 wheel and a new wheel.

The acceptable wear limits of a wheel should be compatible with the wheel's design characteristics insofar as its ability to withstand dynamic loads induced by the worn condition. (See Appendix 4.)

2. Wheel Plate Finish

The L-3 wheel was a wrought steel wheel which was forged from open hearth steel ingots. After wheels are rolled, there is usually need for corrective machining, and in the case of the L-3 wheel, corrective machining was performed on the plate of the wheel. The machined area extended outwards 5-1/4 inches from the hub on the front face and 4-3/4 inches on the back face. The machined area was rough with chatter marks and surface discontinuities. The finish was too rough to be measured with conventional profile equipment where a scribe is drawn across the surface, however, it was found that the surface irregularities (peak to valley) varied from 5,000 to 10,000 microinches with tool gouges 0.035 inches deep. (See Figure 9, page 39.)

The A.A.R. Specification (Appendix 1) makes general recommendations about the finish, but the acceptance standards depend upon individual interpretation. Specification M-107, paragraph 15(c) states, "They shall have a workmanlike finish and must be free from defects

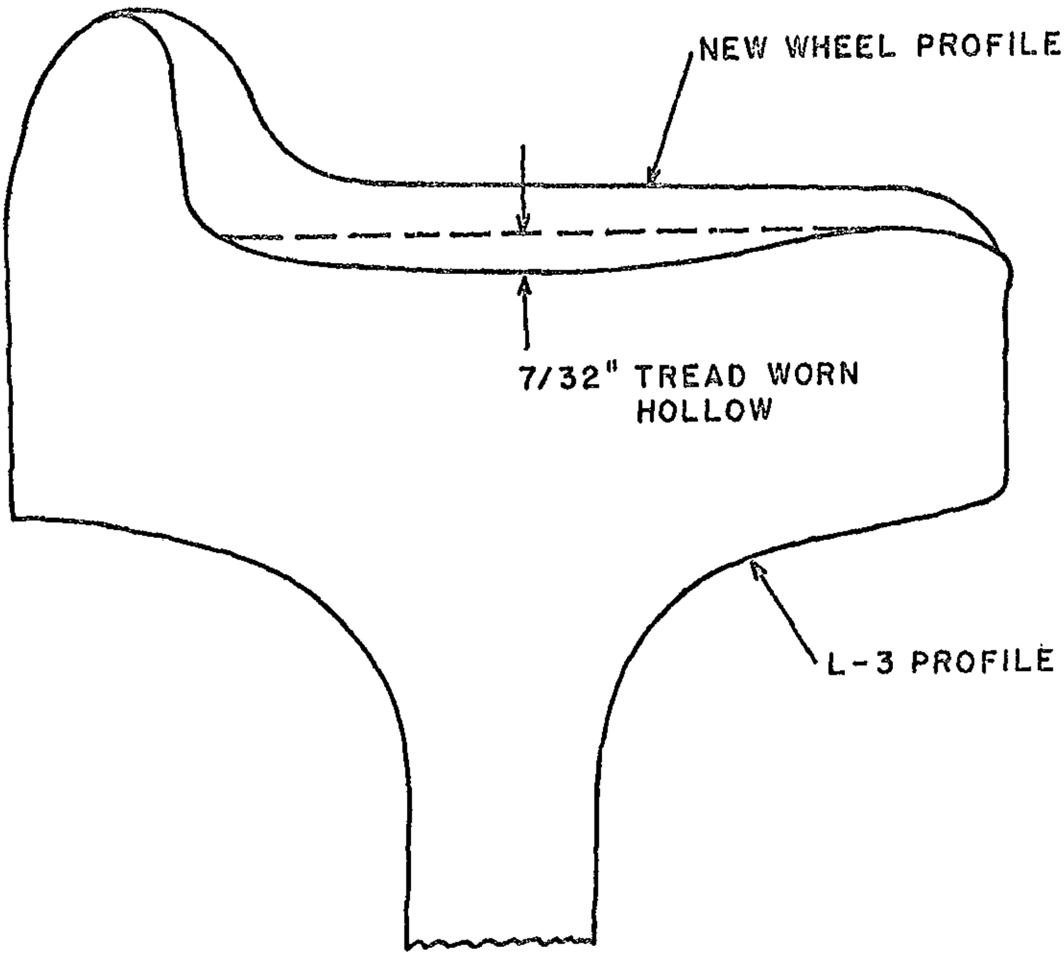


Fig. 8 - Rim Profile of the L-3 Wheel.

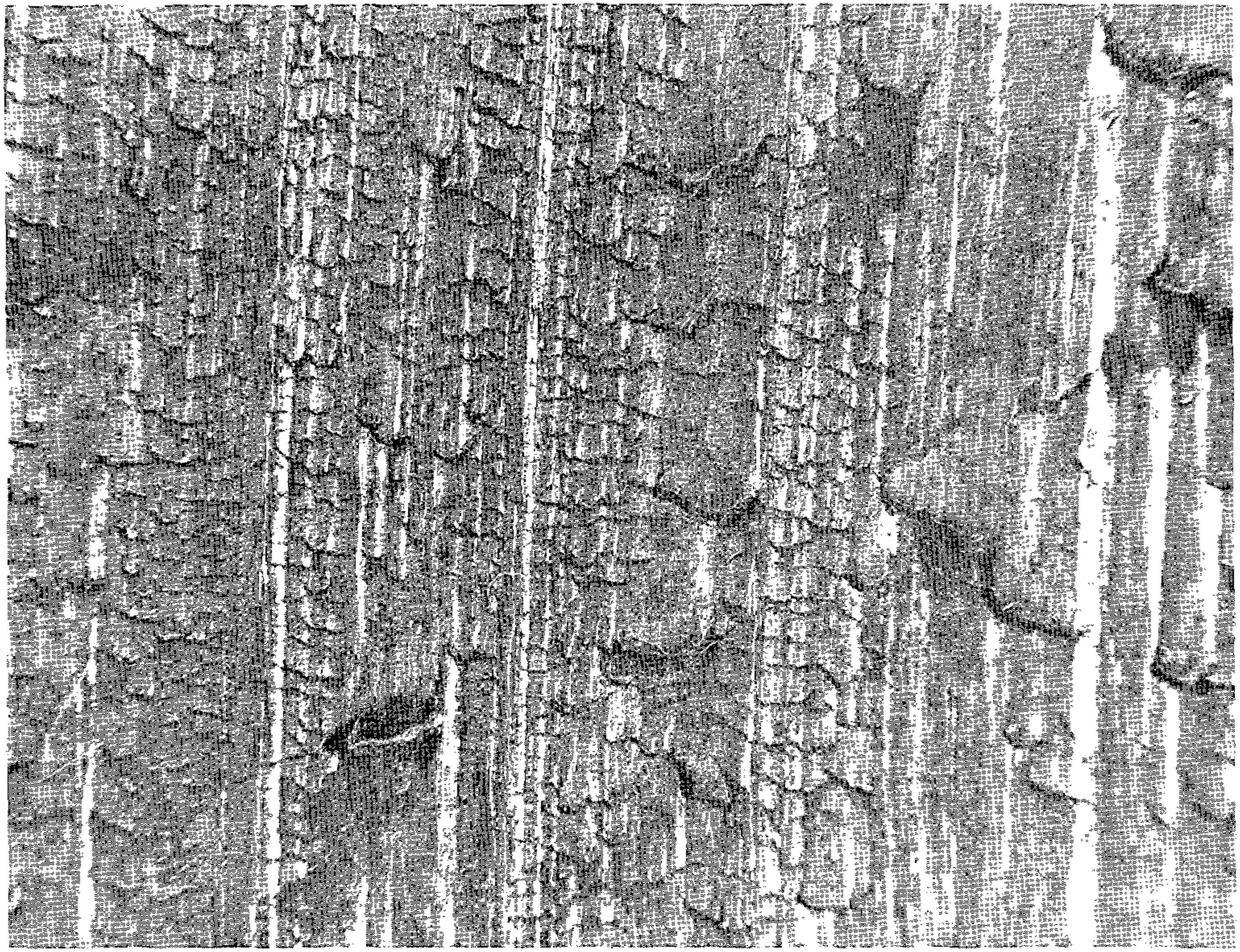


FIGURE 3
MICROGRAPH OF ROUGH MACHINING

liable to develop in or cause removal from service." It is noted that there was in existence at the time of the last revision of the specification, 1967, surface finish measuring equipment for routine methods of specifying surface finish. This noncontrolling specification was under the technical supervision of the A.A.R. and was not subject to public regulation.

The discontinuities in the machined areas can act as stress concentrations or notches which would initiate cracks under a suddenly applied load.

3. Chemical Analysis

The chemical composition of wheel steel is specified by the A.A.R. (See Appendix 1.) The carbon content varies according to the classification of the wheel. A class C wheel must have a carbon content between 0.67 to 0.77 percent with a permissible variation of minus 0.02 or plus 0.03 percentage points. As the carbon content of steel increases, the hardness increases and the ductility decreases.

Chemical analyses of steel from the C-3 wheel by Southern Railway, IITRI, and Armco Steel Corporation indicated a carbon content of 0.78 percent, 0.76 percent, and 0.74 percent, respectively. While this met the A.A.R. requirements, the carbon content was near the upper limits of the allowable range.

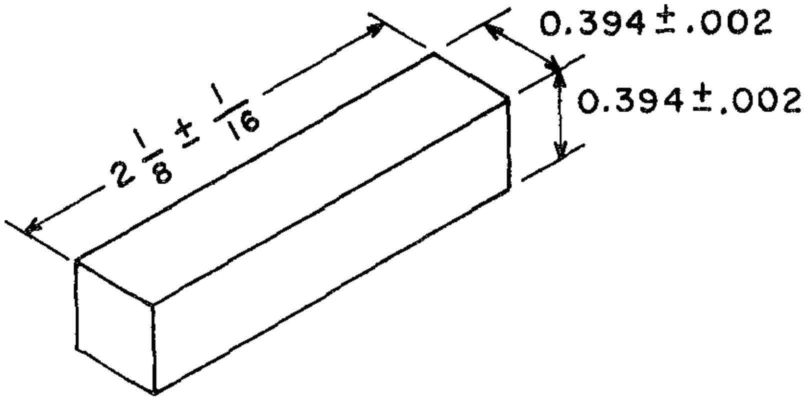
4. Metallurgical Analysis

All tests for hardness indicated that the steel of the L-3 wheel was within the A.A.R. specification of 321-363 Brinell.

There was general agreement in the evidence that the machined surface of the L-3 wheel exhibited a layer of cold-worked metal with tool tears resulting in discontinuities.

IITRI performed Charpy impact tests on 14 specimens from piece D of the L-3 wheel. Seven of the Charpy specimens had the rough machining on one surface and seven were ground smooth on all surfaces. (See Figure 10, page 41.) Charpy tests were made at temperatures of 75°F., 32°F., and 0°F.

Results of these tests indicated that the specimens with the fine-machined surfaces had not entered the transition stage of 0°F. The rough-machined finish caused the transition to be far advanced



UNNOTCHED TEST SPECIMEN

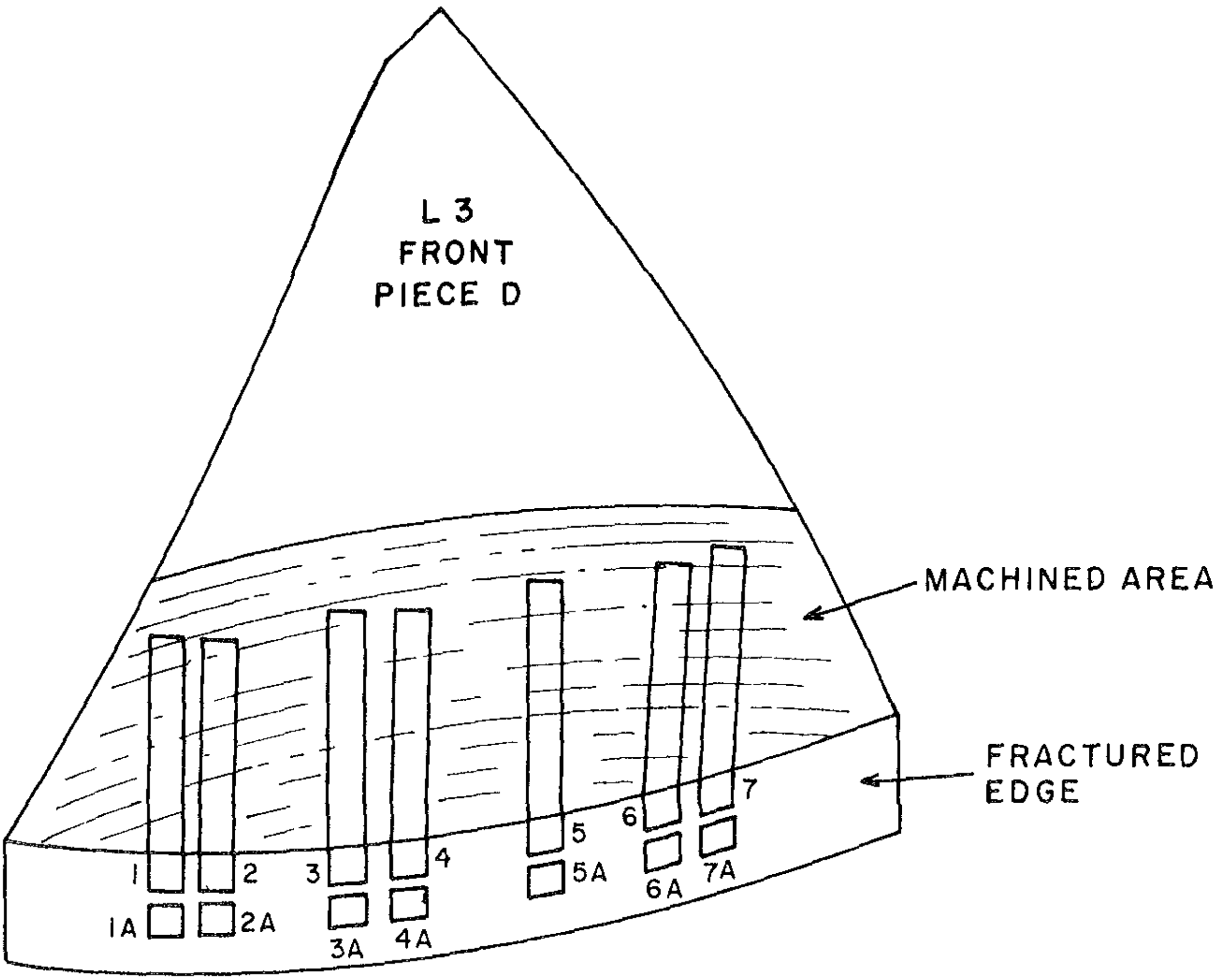


Fig. 10 - Schematic Diagram of Test Piece Locations.

at $0^{o}F.$, showing that the rough surface behaved like a relatively sharp notch with consequent reduction in the ability to resist impact.

The air temperature at the time of derailment was $35^{o}F.$ The wheel temperature would not have been appreciably higher.

5. Description of Fractures

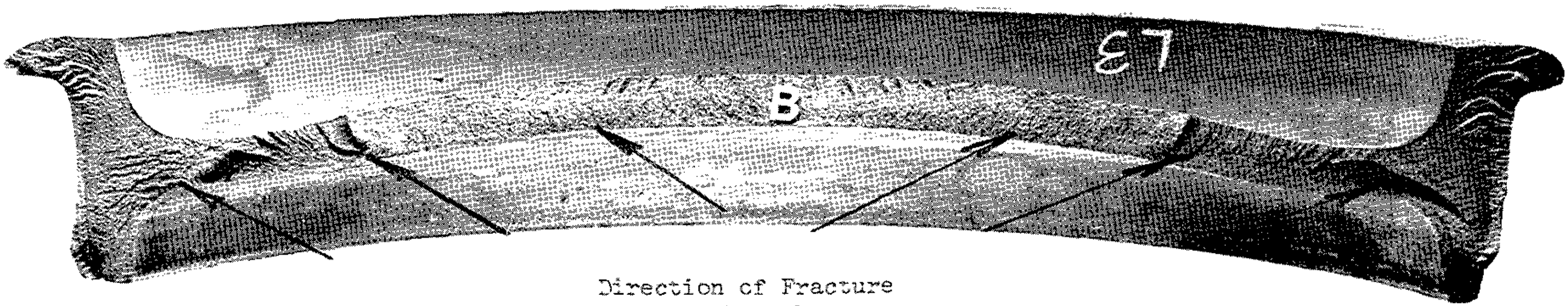
When the pieces of the L-3 wheel which were recovered after the derailment in Laurel were examined, it was deduced that section B was the first piece to break out. (See Figure 2.) This piece was undamaged except for the fracture. After section B detached, piece E continued to rotate and was battered as it struck the rail, until pieces E and C broke out.

Examination of the fracture indicated that the fracture was brittle and originated at a point near the hub and propagated in each direction toward the rim. The actual point of failure was near the hub on the back of the plate (inside). The origin was described by the metallurgist from IITRI as being "on the top corner of the B" in Figure 11, page 43. The chevron pattern definitely indicated it was in that area. Once started, the crack propagated rapidly and the failure was complete in a fraction of a second. The Southern Railway did not challenge IITRI's description of the origin of the fracture, however, Southern Railway's analysis of the fracture indicated it may have originated in the front of the plate.

6. Factors Contributing to Wheel Fractures

It is obvious from the rim profile of the L-3 wheel, shown in Figure 8, that it has a substantial tread-worn-hollow condition. The relationship between a new wheel and the rail is quite different from that of the L-3 wheel when its flange is away from the rail or when traversing frogs, switches, or crossings. When the L-3 wheel was riding on its outer rim, the contact point moved outward from the plate, thus changing the stress pattern in the plate of the wheel. Under this condition, the point of maximum stress would have been near the hub on the back of the plate.

It appears that the condition of maintenance of the G. M. &O. crossing probably contributed to these lateral forces. Since the east rail approaching and passing over the crossing was substantially lower than the west rail when under load, the L-3 wheel would have been bearing hard against the left-hand guardrail. This would have introduced lateral



Direction of Fracture
as shown by
Chevron Pattern

FIGURE 11
FRACTURE OF L - 3 WHEEL
SHOWING PROBABLE ORIGIN

forces in the same direction as those caused by the tread-worn-hollow condition of the L-3 wheel, adding to the maximum stress in the back of the plate near the hub.

While under this increased stressed condition, the wheel received the impacts from the crossing. In traversing the 35° 20' crossing frog, the wheel had to span flangeways provided for G. M. &O. traffic measuring 4-1/8 inches. The first impact was a lateral one imparted by the back of the flange striking the point of the guardrail beyond the flangeway. A fraction of a second after this, the outer rim struck the running rail beyond the flangeway at a 35° 20' angle. This angle tends to guide the wheel to the left, adding lateral forces to those generated by the abnormal change in tread contact point and the pressure on the back of the flange. These impacts resulted in increased stresses on the back of the plate in the hub area. Traversing a flangeway at this angle, a wheel with a hollow worn tread would be guided to the left more than one with a full contour tread. This added lateral forces to those generated by the abnormal change in tread contact point and the pressure on the back of the flange by the guardrail.

The point of maximum stress was in the area of rough machining. Rough machining in a highly stressed part is considered by engineers to be a serious defect. The discontinuities in the machined areas can act as stress concentrations or notches which would initiate cracks under a suddenly applied lateral load.

The steel of which the L-3 wheel was made normally has a low impact strength at low temperatures. Because of the notch effect mentioned above, resistance of the wheel to impact was substantially lower at 35° F., probable metal temperature at the time of failure, than at a higher temperature.

On January 8, 1968, a New York Central freight train derailed at Cold Springs, Ohio, because of a broken 33-inch one-wear, wrought steel wheel. The FRA (Railroad Accident Investigation Report No. 4141) found "The wheel broke in the plate due to tooling discontinuities or flaws residual from wheel rolling operations in manufacture." This wheel was manufactured by the Armco Steel Company in August 1961, and the plate of the wheel had rough machining similar to that found in the L-3 wheel at Laurel. The air temperature at the time of the Cold Springs accident was -12°F.

Report No. 22.9/7818 of the Technical Research Center of the Canadian National Railways covers another service failure of a one-wear wrought steel wheel. This wheel was manufactured by Canadian Steel Wheel Limited in December 1960 and failed in service on December 4, 1964. The report concluded that the failure of the wheel was due to sudden ruptures which originated in a martensitic layer on the machined surfaces of the plate of the wheel. Further, "the martensitic layer resulted from the use of dull cutting tools in the machining operations during manufacture of the wheel."

7. Manufacture of the L-3 Wheel

The L-3 wheel was manufactured by the Armco Steel Corporation in June 1962 at its Butler, Pennsylvania, plant. At the time of its manufacture, there was no effective requirement by the A. A. R. regarding quality control in the manufacture of wrought steel wheels.

The quality control program at the Butler plant in 1962 was described by Armco Steel Corporation as one of "standard practice instructions, where every variable" that could be controlled was listed and checked. The quality control program was under the control of the metallurgical department.

The machining on the plate of the wheel was performed in order to correct imperfections left by the rolling operation. The lathes employed had a maximum table speed of 12 revolutions per minute. The tool was made of high-speed tool steel. This type tool steel had been used by Armco for this kind of machining for many years.

Prior to 1965, no inspections of wheels were made at the plants by A. A. R. to determine whether wheels were being made according to specifications. During the latter part of 1964, the A. A. R. began a program of inspections of wheel manufacturing plants. The purpose of these inspections is to check the manufacturing processes and make suggestions for improving quality control. These inspections are made by a consultant employed by A. A. R. in the plants of the major wheel manufacturers twice a year. The first inspection of this type at the Butler plant was January 12 and 13, 1964, at which time no exceptions were noted.

The report of inspection dated May 19 and 20, 1965, stated "that machined surfaces on the plates, hubs and undercut rims was often excessively rough." The inspector made references to rough machining on subsequent reports of inspections made at the Butler plant in reports dated January 5 and 6, 1966, September 15, 1966, and January 9, 1967. The report dated September 27, 1967, indicated improvement in the "repair machining" and extension of ultrasonic testing to all wheels. Subsequent reports noted continued improvement and the use of carbide tools on all 33-inch one-wear wheels. In the report of February 14, 1969, the following was stated, "The finish resulting from use of high-speed tools was observed to be generally improved. In some cases this finish was entirely satisfactory but numerous examples were seen where the finish was somewhat rough and torn although not to the extent that has existed in the past. Further improvement is desirable in this area."

The inspector testified that, in his opinion, the rough machining found on wheels manufactured at the Butler plant and referred to in his reports between May 1965 and January 1967 did not meet the specification for finish in Specification M-107, paragraph 15(c). This judgment had to be based on opinion because of the nonspecific nature of the specification referred to on page 37. This A.A.R. specification regarding finish of wheels has not been changed since 1962.

Copies of the reports were sent to Armco's Director of Quality and Metallurgy. While the information in the reports is made available directly to the Wheel and Axle Committee, it is not circulated to the member roads in any form. A.A.R. has no enforcement authority over the wheel manufacturers. Implementation of the specifications is possible by purchasers refusing to purchase those wheels which do not comply.

The condition noted in Armco's Butler plant regarding rough machining in wheels was not restricted to Armco's operation. Testimony indicated that similar conditions were found in other wheel manufacturing plants. These conditions can be expected under the nonspecific specification for surface finish found in A.A.R. Specification M-107, paragraph 15(c).

Since the L-3 wheel was made in 1962, the Armco Steel Corporation has replaced the old lathes which were responsible for the rough machining. The Butler plant now employs carbide tools on all 33-inch wheels. While high-speed steel tools are still used on 36-inch wheels, the finish has been improved. All wheels from this plant are ultrasonically tested before leaving the plant. (See Appendix 4.)

F. Analysis of Tank Cars in the Wreck

1. Bureau of Explosives

The Department of Transportation (DOT) is authorized by statute[4/] to issue and enforce regulations for the safe transportation within the United States of explosives and other dangerous articles, including, among other things, liquefied petroleum gas. The statute also provides that DOT may utilize the services of carrier and shipper associations, including the Bureau for the Safe Transportation of Explosives and other Dangerous Articles, more commonly referred to as the Bureau of Explosives.

As the regulations are now written, DOT must rely on information from the Bureau of Explosives in order to fulfill its function under the law. The Bureau of Explosives approves containers and tank cars for the transportation of hazardous materials, and Bureau of Explosives recommendations in a large measure determine the final approving action by DOT. The Bureau of Explosives' rules for the safe transportation of hazardous materials formed the basis of the original Federal regulations when they were established.

Although Federal regulations require that carriers report incidents and accidents involving hazardous materials to the Bureau of Explosives, there are no specifications regarding the disposition of these reports. The Federal Railroad Administration (FRA) does not normally receive copies of these reports unless they are specifically requested. The degree of Federal control of the functions of the Bureau of Explosives regarding the responsibilities delegated to it by regulations is nominal. Proceedings are underway to amend 49 CFR 175.506(a) to require carriers to make an immediate report also to the FRA on certain emergency matters now required to be reported to the Bureau of Explosives.

The function of the Bureau of Explosives is one of advising and educating rather than enforcement. The Bureau of Explosives is called upon by shippers and carriers in highway and air transportation as well as the railroads. The field function is performed by Bureau of Explosives inspectors throughout the United States. The Bureau of Explosives also maintains a chemical laboratory where materials are classified for regulatory purposes.

The Bureau of Explosives acts as an advisory member of the A.A.R. Committee on Tank Cars as well as advisor to a number of other groups.

4/ Sections 831-835 of Title 18, United States Code, as amended.

The Bureau of Explosives was represented at the scene by an inspector and, later, the Director. Neither of them agreed with the decision to use shaped charges to vent the tanks, but they did not advise the General Manager of the Southern Railway not to vent the tanks in that manner.

2. Tank Car Specifications

The A.A.R.'s "Specifications for Tank Cars" is published as a manual by the Mechanical Division of the Association of American Railroads. This manual includes DOT tank car specifications in addition to other A.A.R. standards regarding tank cars.

The builder of a tank car for the transportation of hazardous materials must apply for approval of design, materials, and construction. This application must be submitted in prescribed form to the Secretary, Mechanical Division, A.A.R., for consideration by its Committee on Tank Cars and other appropriate committees.

According to the Certificates of Construction, all the tanks involved in this accident were designed and constructed according to requirements for the transportation of LP-gas by rail. Each tank was equipped with a safety valve designed to limit the pressure in the tank to a small fraction of the designed bursting strength of the tank. The tests of the safety valves indicated that there is no tangible evidence that any of the safety valves failed to function in the manner for which designed.

Approvals or rejections of Applications for Construction, based on appropriate committee action, are issued by the Secretary, Mechanical Division, A.A.R. When, in the opinion of the Committee, the tanks are in compliance with effective regulations and specifications of the Department of Transportation, the Application for Construction will be approved.

An Application for Construction for tanks to be built to any new specification may be submitted with proposed specifications. Justification for the new specification, including the properties of the lading and the method of loading and unloading, must be submitted. The Subcommittee on Specifications reviews the proposed specification and reports its recommendation to the Committee on Tank Cars. The Secretary of the Mechanical Division reports the Committee's recommendation to DOT. It appears that the recommendation of the A.A.R.'s Committee on Tank Cars is generally determinative of the action by DOT. The Committee's recommendations in the following cases were approved by the Interstate Commerce Commission, DOT's predecessor in this area (1) construction of a tank car without insulation to transport LP-gas and anhydrous ammonia (ICC 112A400W), (2) construction of a tank car without a continuous center sill (ICC 111A100W), and (3) construction of a 33,000-gallon ("jumbo") tank car for transporting LP-gas and anhydrous ammonia (ICC 112A400W).

Before a tank car is placed in service, the builder assembling the completed car must furnish to the Bureau of Explosives, to the Secretary, Mechanical Division, A.A.R., and to the car owner, a Certification of Construction in the prescribed form certifying that the tank, equipment, and car complete, comply with all requirements of the applicable specifications. When tank cars identical in all respects are built in groups, one certificate suffices for each group.

3. A.A.R. Committee on Tank Cars

As previously explained, the Committee on Tank Cars reviews and approves designs for construction, alteration, conversion, and repairs of tank-car tanks and their appurtenances. The Committee maintains and revises specifications covering the various types of tank cars required by the different ladings. In the case of explosives or other dangerous articles covered by DOT regulations, the Committee handles such specifications subject to DOT's final approval. The Committee also has responsibility for the certification of all facilities handling construction and repairs of tank cars to verify that such facilities conform to Section X of the ASME Code for Boilers and Pressure Vessels.

The Committee on Tank Cars is composed of six members employed by railroads and five members from railroad-related industries (suppliers and shippers). The railroad members represent their industry on a geographical basis rather than as company memberships. The nonrailroad members represent various trade and professional associations and not individual companies. While the Bureau of Explosives has no representative on the Committee, it acts as an advisor to the Committee.

In voting on recommendations to the Mechanical Division, each member has one vote regardless of whether he is employed by a railroad.

4. Tank Cars in the Wreck

The immediate fire following the general derailment indicated that a considerable quantity of fuel was involved. Subsequent observation of the tank parts by numerous qualified persons indicated that most of the tanks suffered punctures from external sources. All of the punctures did not necessarily occur in the derailment. Violent movement of tanks resulting from explosions after the derailment could have accounted for some of the punctures. In about 50 percent of the cases, indications were that there was combination puncture and rupture damage. In only two cases, POTX car 162 and GATX car 89971, were the tanks reported to have ruptured without prior damage by puncturing; however, in both cases these tanks were reported to have received considerable dents and were severely burned.

Many of the heads of the tanks showed dents or actual punctures which apparently were made by couplers during the derailment. This again emphasizes the problem of postderailment damage which results from failure to keep the derailed cars coupled and aligned with the track. The tanks in this wreck were not equipped with interlocking couplers. (See Appendix 4.)

Federal tank car specifications require tank shells to be of carbon steel open-hearth boiler plate, flange or firebox quality, having a carbon content not exceeding 0.31 percent. The material must comply with one of the ASTM specifications for the material in 49 CFR 179.100-7, and with the indicated minimum tensile strength and elongation in the welded condition. According to the Certificates of Construction, all the tanks were made of ASTM A-212 Grade B or AAR TC128 Grade B steel.

The results of analyses of steel samples from the tanks are reported in the A.A.R. Research Department's Report No. MR-453, "Report on a Study of Metal Specimens Removed from Tank Car Tanks Involved in a Derailment & Explosion at Laurel, Mississippi."

Although very little brittle fracture was involved at Laurel, correlation of the nil-ductility transition temperature (NDTT) with the fracture behavior at Laurel is reported to be excellent. A.A.R. Sample #6 which contained both shear (ductile) and brittle fracture, exhibited an NDTT of 40°F., in close agreement with the 35°F. ambient temperature at Laurel at the time of the derailment. A.A.R. Sample #7, with an NDTT well below the ambient temperature at Laurel, showed only shear fracture.

In all plates where comparisons were made, the A.A.R. report indicated that "the welds were stronger and tougher than the parent plate."

There was substantial evidence of failures at high temperatures, such as extreme metal thinning, heat discoloration, and statements of observers. The A. A. R. report stated "that specimens from the two baseline plates showed what is considered reasonable elevated temperature tensile properties for this material, with no unusual behavior .... Some hardness and metallographic evidence has prompted the tentative estimate of 1,050° to 1,400°F. as the range for the samples examined."

The results of tests indicate that the physical and chemical properties of the steel tested generally conformed to the current specification requirements.

All of the tank cars in the wreck were of the design which does not have a continuous center sill. There are no Federal regulations which require the presence of a continuous center sill on tank cars. In spite of tests which indicated satisfactory compliance with A. A. R. requirements by 10,000-gallon[5/] and 30,000-gallon[6/] tank cars without continuous center sills, there is some feeling by those who have had experience with these 30,000-gallon tank cars with noncontinuous center sills that the aftereffects of a derailment are more devastating to the tanks than with smaller tank cars with continuous center sills. While there are no conclusive data available, there may be a greater tendency for the large non-center-sill cars to be mechanically damaged in accident situations. An important area of concern to the Board is the possible violations of the structural integrity of this type tank car, resulting from the dynamic loadings being applied to the stub sills and transmitted through the tank which must also retain the product under pressure. Since none of the cars had continuous center sills, the results of this wreck offered no comparison.

5. Reaction of the LP-Gas and Tanks in the Wreck

For a maximum time of 40 minutes after the general derailment, there were a number of violent explosions. Several sections of tanks over 30 feet in length were propelled great distances.

5/ A. A. R. Report No. MR-270, Investigation of New Design Tank Car Without Underframe or Expansion Dome, 1956.

6/ Report of Experimental Stress Analysis of the 30,000-Gallon Tank Car, General American Transportation Corporation, Sharon, Pennsylvania, 1963.

A 37-foot section of POTX car 261 was propelled through the air in a southeasterly direction, striking the ground three times before it came to rest. It struck the ground first about 1, 000 feet from the wreck. After the first bounce, it carried another 300 feet over some residences without striking them, bounced again for 200 feet, and again for 100 feet coming to rest atop a dwelling at 9th Street and Amaranth Avenue, 1, 600 feet from the wreck center. The resulting fire where the tank came to rest destroyed three houses. This piece of tank had to be cut into two pieces before it could be hauled back to the track. The two pieces marked 24A and 24B on the left of the photograph (Figure 12) were a one-piece section during the flight described above. The piece of tank to the right carrying the number "6" was found about 100 feet from the track. The tank car ruptured in a single, neat, circumferential crack. The section of the least weight, about one-fourth of the tank, was thrown 100 feet. The section of the greatest weight, about three-fourths of the tank, flew 16 times as far as the lighter portion.

A 37-foot section of POTX car 269 was propelled through the air in a northwesterly direction striking the peak of the roof of a mill 800 feet from the wreck. This section then struck in the parking area and bounced end over end successively 100 feet, 200 feet, and 50 feet before coming to rest in a reversed position on the rear of a dwelling on East 13th Street about 1, 100 feet from the wreck. (See Figure 13, page 54.)

The flight of these tanks was not observed by any trained witness. However, trajectories of these tanks suggests that a propulsive force other than that of blast forces at the location of the initial explosion was involved. In the first case, the flight through the air was 1, 000 feet. The initial velocity necessary to sustain a flight of this length by inertia carry-through after a blast explosion would have been quite high, and the explosive pressure upon the tank shells necessary to develop a high velocity by a blast-like explosion would also have been quite high. The ability of tank shells to withstand external pressure without becoming distorted or destroyed is limited. Yet the shell of this tank, which is thin in comparison with its overall size, is relatively undistorted. It appears impossible that this tank was subjected to a short, severe external blast force as the means by which it was propelled to that great distance.

A similar condition is seen in the 37-foot section of POTX car 269, Figure 13. These tanks were not propelled to high velocity by any explosion-like external force.

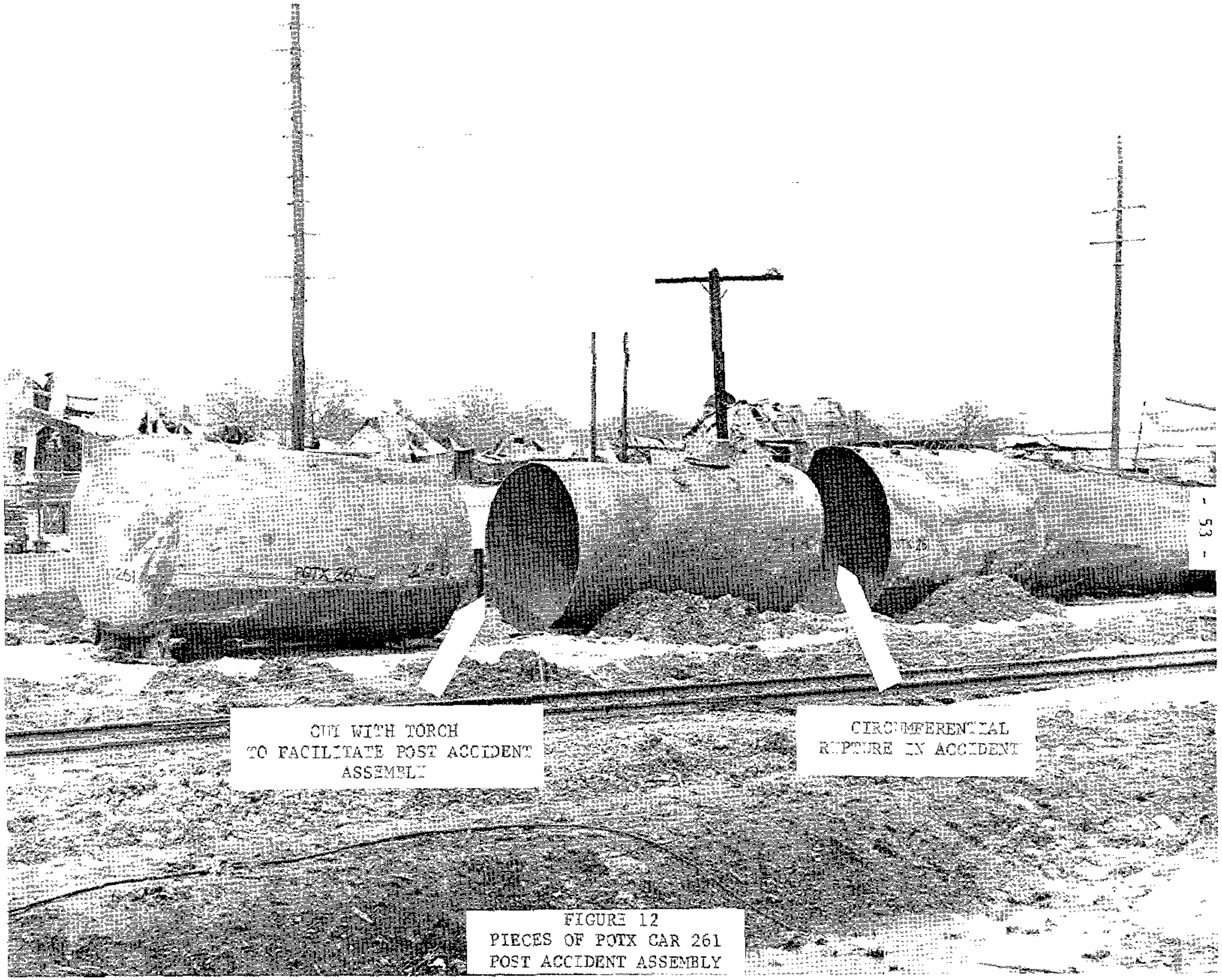


FIGURE 12
PIECES OF POTX CAR 261
POST ACCIDENT ASSEMBLY

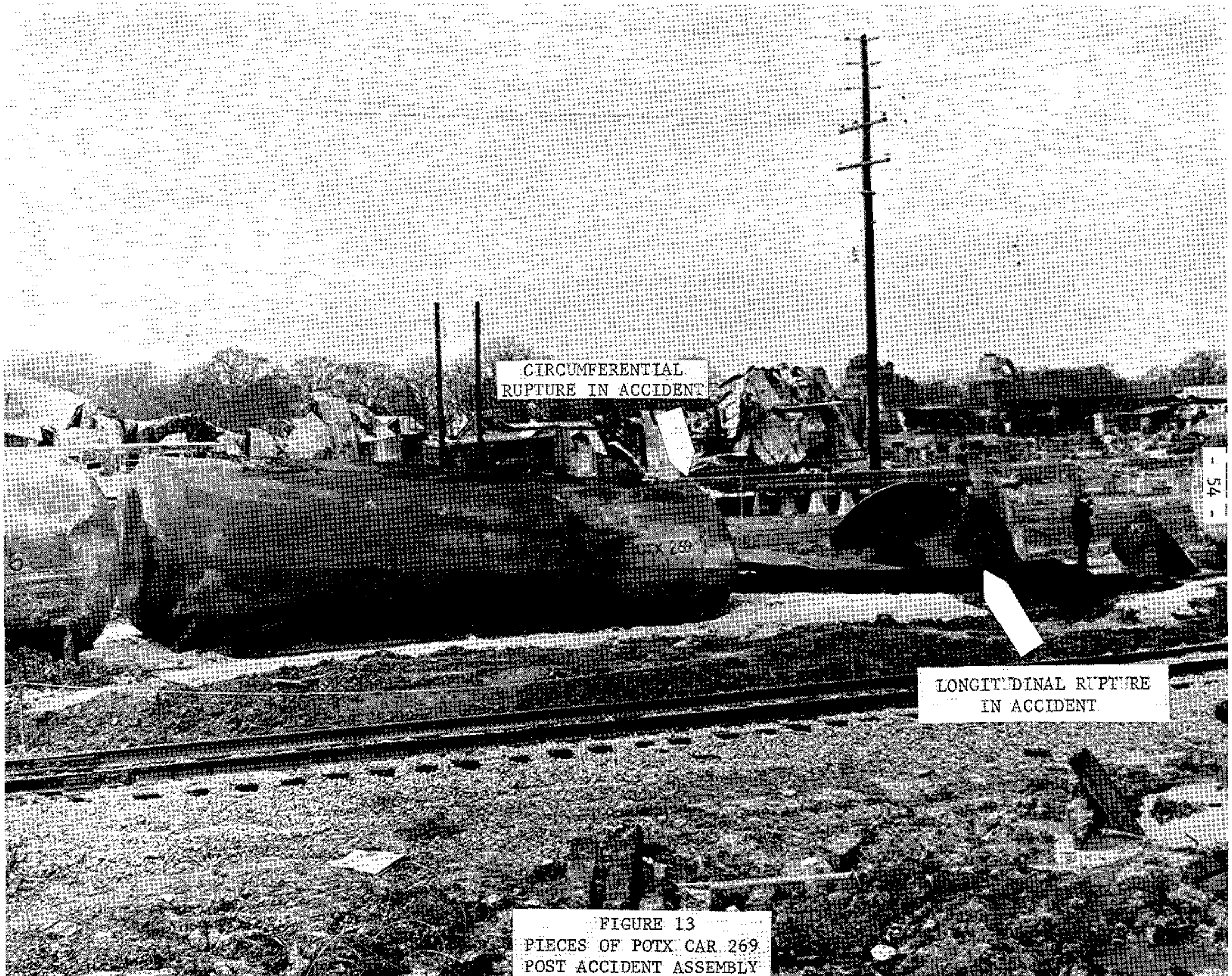


FIGURE 13
PIECES OF POTX CAR 269
POST ACCIDENT ASSEMBLY

Numerous other pieces of tank cars of various sizes reacted similarly but not necessarily for the same reasons. With the great amount of data which was produced by the investigation, there is still not conclusive evidence as to the exact reactions which occurred. All of the large pieces of tanks which were propelled significant distances from the wreck had been partially or totally burned. Most of the fracture surfaces exhibited characteristics of typical ductile fractures. There were several tangible examples of brittle fractures and metal thinning.

Another phenomenon that was evident in the wreck is shown in the photograph, Figure 14, page 56. The piece of tank head and section shown on the left was propelled intact about 200 feet, while the remaining 50-foot section was opened along a longitudinal line, flattened, and remained in place. The same phenomenon is seen in car POTX 269, Figure 13. The flat section to the right, about one-fourth of the tank, opened longitudinally and stayed in place. The three-fourths of the tank to the left, far heavier, opened circumferentially and was projected 1,100 feet.

These phenomena of longitudinal fractures and circumferential fractures accompanied by rocketing of large parts of tanks was described in a report of a disastrous fire and explosion which occurred in the Warren Petroleum Marine Terminal at Port Newark, New Jersey, on July 7, 1951.[7/]

Logic rules out the possibility of a blast-like external explosion picking up these tanks and throwing them through the air; therefore, the question becomes how they traveled such long distances. The answer may lie in the combination of the manner of rupture and the results when pressure was lost on the liquefied petroleum gas. The gas requires pressure to remain in liquid state. When pressure is lost the gas changes from a liquid state into a gaseous state resulting in a very rapid expansion of the contents of the tank. When a tank ruptures longitudinally, the gas bursts out laterally through an almost infinite area. The gas immediately expands into the air with no restriction or any particular direction, except the constraint of the ground and the heat rising tendency.

7/ Warren Petroleum Corporation Propane Fire and Explosion, Port Newark, New Jersey, July 7, 1951. Report by the National Board of Fire Underwriters and the Fire Insurance Rating Organization of New Jersey.

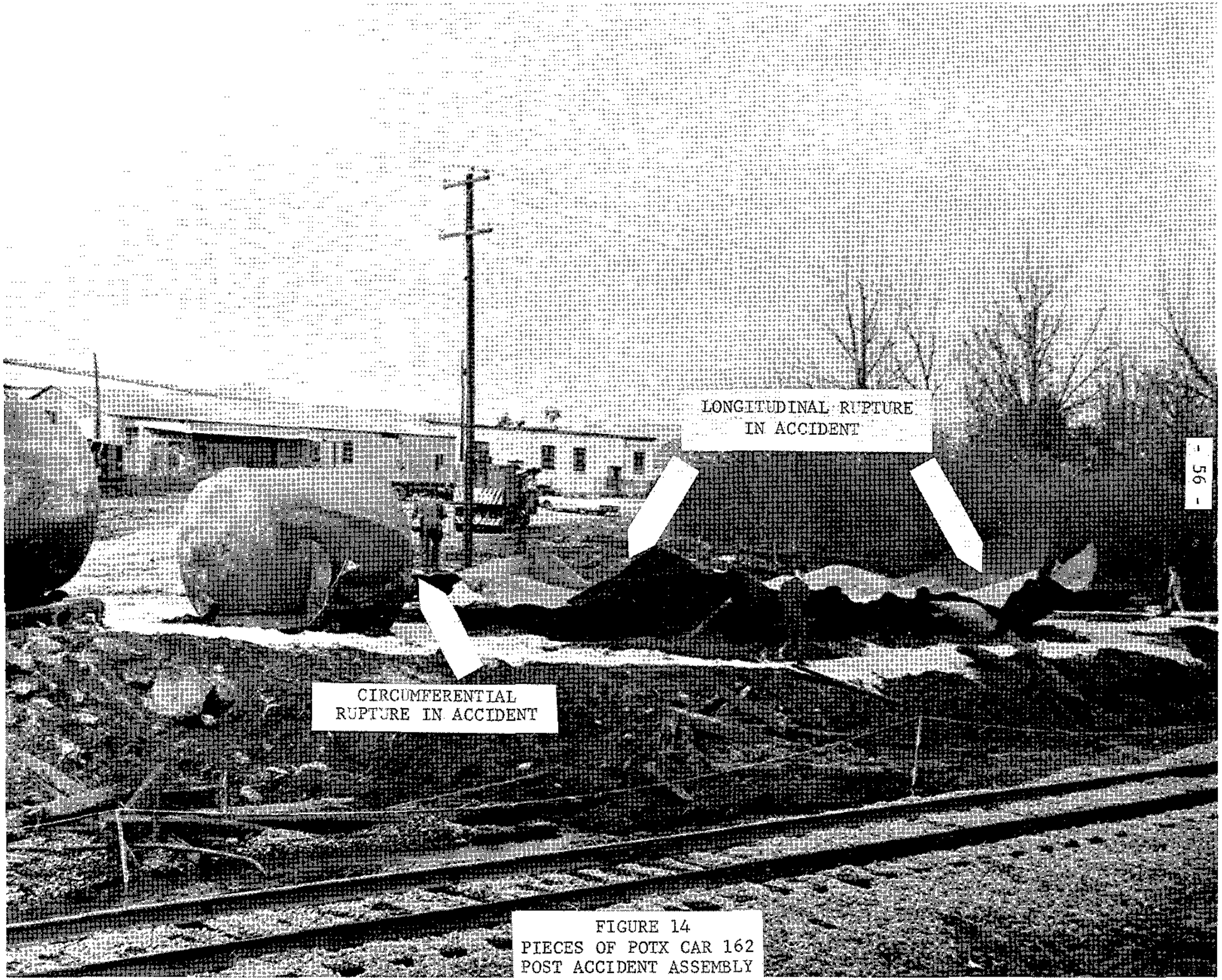


FIGURE 14
PIECES OF POTX CAR 162
POST ACCIDENT ASSEMBLY

On the other hand, when the tank ruptures circumferentially, the escape of the gas is outward from the open end, and if the break is clean, the average flow will be along the axis of the tank. This flow, due to the expansion, must produce a thrust reaction of the same basic nature as that found in a jet or rocket engine. On a smaller scale, the reaction from a carbon dioxide gas cartridge which is punctured to power a child's boat or toy airplane is similar.

This mechanism explains why, in these two cases, the longer and heavier end of the tank was projected great distances, while the lighter and shorter ends traveled a relatively short distance. The expanded liquid being converted to gas was exhausted quickly from the short ends, but the thrust reaction lasts longer in the 37-foot-long sections, evidently providing a buildup to a higher velocity. (As discussed later, both cars ruptured along the same weld line.)

The reactive force available to drive the longer tank ends in these two cases cannot be calculated because of the complexity of the phenomenon, but it is clear that the force must have been high and of a duration of at least several seconds in order to account for the trajectories.

It may also be significant that the trajectories of these two tanks were low, as indicated by the shallow angle of descent between the roof of the L-shaped building and the next contact in the yard behind the building, which is apparent from photographed evidence. Such a shallow angle is thought to be consistent with the application of thrust during the flight of the tank. A blast-like explosion could have produced such a long flight only via a high trajectory, which was not present.

The mechanism of rocket propulsion is most clearly demonstrable in the case of cars POTX 261 and POTX 269, it is also suspected in the case of GALX 557, which suffered a similar mode of failure and traveled about 700 feet, but apparently did not rise into the air.

The cars POTX 261 and POTX 269, Figures 12 and 13, suffered an identical mode of circumferential failure near the same circumferential welds. The rupture crack paralleled the circumferential weld at a short distance ranging up to 2 inches.

The important question is what can be done to prevent the spread of devastation to long distances by such rocketing tanks. Several general principles are apparent. First, the design of these tanks does not seek to control the direction of rupture or to limit the spread of cracks, should ruptures occur.

As demonstrated above, there are good reasons why a longitudinal rupture is much less likely to produce a rocketing tank car than a circumferential rupture. Thus design and test efforts could be based upon insuring longitudinal rupture rather than circumferential rupture.

Second, the tanks do not include any dual or redundant structure which could sustain the pressure load but into which a crack cannot propagate. Such structures are well known in engineering and include the use of longitudinal strapping in welded merchant ships and redundant riveted strapping in pressurized cabins of transport aircraft.

Third, the tank car does not include any structure which could hold the two ends in reasonable proximity in case of circumferential rupture, or which could insure that the reaction thrust would produce a confined motion of the tank. These tank cars consist essentially of a large tank mounted on trucks at each end. The loss of the trucks (they are free to fall away with little resistance) meant that the center of gravity of the tank car was nearly the same as that of the tank alone. The rocket thrust reaction from the expanding gas in these tanks was along the axis of the tank and thus passed very near the center of gravity of the entire mass. This may explain why the two tanks took a relatively straight course, and traveled a considerable distance, even though not steered.

It is also clear that a separate underframe or sill could serve the function of holding the ends of a circumferentially ruptured tank, although it would not serve in event of the rupture of the head of a tank. (See Appendix 4.)

In addition to the above reasoning, the Safety Board takes notice of the fact that it is not customary to test hazardous material tank car designs by fire under full-scale conditions, but to employ heat input assumptions from earlier tests. The Board also notes that this accident has resulted in the discovery of a failure phenomenon which is hazardous to the public, but was previously undefined even though the safety of the tank cars was under Federal regulatory authority. Tests of pressure vessels under accident damage conditions are required in the aircraft field, the outstanding example being the dropping of a knife-edged guillotine into a pressurized air transport fuselage to demonstrate whether induced cracks can propagate. Such a test upon these pressurized tank cars would almost certainly have resulted in explosive rupture.

Other rupture phenomena also were found. Opinions were expressed by a chemist and a tank car specialist with many years experience with petroleum products that some of the violent ruptures were the results of punctures in the vapor space allowing substantial volumes of the liquid to immediately flash into vapor. With the reduced bursting strength because of mechanical damage to the shells, the sudden increase in pressure could have ruptured the tanks in the manner described. This mechanism is similar to that found in a steam boiler explosion.

The burned parts of some tanks also indicated the possibility that intense rapid heating of the vapor space could have increased the pressure sufficiently to cause the mechanically damaged and over-heated tanks to rupture. Without the liquid to absorb the heat and conduct it away from the heated zone, the metal surrounding the vapor space becomes hot rapidly and weakens. The presence of insulation on these tanks may have reduced the heat input to the level where it could have been accommodated by the safety valves. Expert testimony indicated that in these cases, because of incomplete combustion of the gas burning outside the tanks, sufficient heat could not have been produced to raise the temperature of the liquid so that temperatures required to increase the internal pressure to the start-to-release pressure of the safety valve. This testimony also indicated that larger safety valves to vent larger volumes of gas might not have prevented some of the ruptures, although valves venting at lower pressures might conceivably be designed to meet fire conditions.

None of the tanks were equipped with internal baffles. Since the tanks were not filled to capacity by volume of LP-gas, the movement of the tanks in the derailment would have created violent sloshing movement of the liquid in the tanks. The nature and magnitude of the forces created by the movement of the liquids in this accident is not known, however, it is apparent that these forces may have contributed to the mechanical damages to the tanks.

6. Safety Valves

DOT Tank Car Specifications (49 CFR 179) requires 112A340W and 112A400W tanks to be equipped with one or more safety relief valves with a total discharge capacity sufficient to prevent building up pressure in the tank in excess of 90 percent of the tank test pressure. The start-to-discharge pressure for 112A340W tank must be 280.5$\pm$ 8.4 p.s.i., for a 112A400W tank, 330$\pm$10 p.s.i. The formula used to determine the required relieving capacity to protect tanks against overpressure is derived from the formula adopted by the National LP-Gas Association, the National Fire Protection Association, the U. S. Coast Guard, and the Compressed Gas Association. It is based on work done by John H. Fetterley and reported in a Bureau of Explosives report dated November 27, 1928. Using certain assumptions, Fetterley arrived at a formula to obtain the required area of the safety valve to discharge the contents of the container without exceeding the pressure at which the safety valve is set to open, based upon assumed heat input to a tank. This was the basis for sizing relief valves in the DOT regulations.

Numerous studies and analyses by several different experts since 1932 and experience have verified the soundness of the conclusions based upon assumptions made by Fetterley[8/] insofar as those assumptions can be presumed valid. Since Fetterley's formula was difficult for the layman to use and only developed required valve area, not flow efficiency of the valve, the formula previously described was developed.

Aside from collision damage, the most serious hazard a tank may be subjected to is exposure of the tank shell to fire. The formula used to determine the required relieving capacity of a safety valve assumes a heat input value of 34,500 BTU/hr/sq. ft. This is based upon heat input measurements in fire tests under controlled conditions.

Internal reactions of certain chemicals have been known to rupture tanks violently while the safety valve was operating at its maximum capacity.[9/] It is not known whether adequate protection by safety valves in this situation is technically feasible. The degree of necessary venting has never been determined.

It is not known whether any of the safety relief valves operated on any of the tank cars except ACSX car 932178, which was subjected to less heat than other cars and vented satisfactorily until its discharge was accelerated by explosives. Tests on the safety valves taken from

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8/ How to Size Safety Relief Devices, Frank J. Heller, Phillips Petroleum Company, Bartlesville, Oklahoma.

9/ ICC Railroad Accident Investigation Report No. 4036, December 13, 1964. NTSB Railroad Accident Report, adopted December 18, 1968.

the cars were conducted at the Milton, Pennsylvania, shops of the American Car and Foundry. The results of these tests did not indicate any malfunction nor failure of any safety relief valves insofar as the valve pressure setting was concerned.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

Adopted: October 6, 1969

ASSOCIATION OF AMERICAN RAILROADS

OPERATIONS AND MAINTENANCE DEPARTMENT
MECHANICAL DIVISION

SPECIFICATIONS
M-107-67
WHEELS, WROUGHT CARBON STEEL

ADOPTED, 1962, TO SUPERSEDE PREVIOUS STANDARD SPECIFICATIONS FOR ONE-WEAR AND MULTIPLE-WEAR WHEELS; REVISED, 1963, 1964, 1965, 1966, 1967

1 **Scope.**—(a) These specifications cover one-wear, two-wear and multiple-wear wrought carbon steel wheels for locomotives and cars—Class U, untreated, and classes A, B and C heat treated wheels

(b) The service for which the various classes are intended generally is as follows:

Class U —General service where an untreated wheel is satisfactory

Class A —High speed service with severe braking conditions, but with moderate wheel loads

Class B —High speed service with severe braking conditions and heavier wheel loads

Class C —(1) Service with light braking conditions and high wheel loads
(2) Service with heavier braking conditions where off-tread brakes are employed

2 **Design**—Standard and temporary standard designs and tread and flange contours for wrought steel wheels shall be as shown in Section G — Wheels in the A A R Manual of Standards and Recommended Practices Application for approval of designs not shown in Section G shall be addressed to the Secretary of the Mechanical Division, A A R, for submission to the Committee on Wheels and Axles

MANUFACTURE

3 **Process**—The steel shall be made by any of the following processes: Open hearth, electric furnace, or basic oxygen process *

*Basic oxygen process is defined as the steelmaking process in which molten iron is refined to steel under a basic slag in a cylindrical furnace lined with basic refractories, by directing a jet of high-purity gaseous oxygen onto the surface of the hot metal bath

4 **Discard**—A sufficient discard shall be made from each ingot to insure freedom from piping and undue segregation

5 **Temperatures.**—During the manufacture, necessary care in the regulation of temperature gradients shall be exercised to obtain the physical properties to be expected from the chemical composition and mechanical work and to prevent the development of faulty structure All wheels immediately after the last hot fabricating operation (coning or dishing), shall be allowed to cool to a temperature below the critical range The cooling shall be controlled to prevent injury by too rapid cooling below the critical range

6 **Heat Treatment**—(a) For classes A, B and C wheels, the heat treatment shall consist of treatment of either the rim only or of the entire wheel, unless purchaser's order indicates preference

(b) Rim Quenching Treatment—The wheels shall be uniformly reheated to the proper temperature to refine the grain and then the rims shall be quenched Following quenching, the wheels shall be charged into a furnace for tempering to meet the requirements of Section 9, and subsequently cooled under controlled conditions

(c) Entire Wheel Quenching Treatment—The wheels shall be uniformly reheated to the proper temperature to refine the grain and then shall be totally immersed in a quenching medium Following quenching, the wheels shall be charged into a furnace for tempering to meet the requirements of Section 9, and subsequently cooled under controlled conditions

CHEMICAL REQUIREMENTS

7 **Ladle Analysis**—(a) The steel shall conform to the following chemical requirements:

		Per Cent
Carbon	Class U	0 65—0 80
	Class A, not over	0 57
	Class B	0 57—0 67
	Class C	0 67—0 77
Manganese		0 60—0 85
Phosphorus, not over		0 05
Sulfur, not over		0 05
Silicon, not less than		0 15

(b) An analysis of each heat of steel shall be made by the manufacturer to determine the percentage of the elements specified in Section 7 This analysis shall be made on a test specimen taken during the pouring of the heat The chemical composition thus determined, together with such identifying records as may be desired, shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 7

8 **Check Analysis**—An analysis may be made by the purchaser from a wheel block or from a finished wheel selected from each heat by the purchaser's representative The chemical composition thus determined shall conform to the requirements specified in Section 7, with a permissible carbon variation of minus 0 02 or plus 0 03 percentage points Samples from wheel blocks shall be drilled from the end of the block midway between the center and outside. When a finished wheel is used, the sample shall be obtained from the rim face or the hub in a manner which will not impair the usefulness of the wheel No drilling of the finished wheel plate shall be permitted Each sample from any one block or wheel shall be thoroughly mixed together and shall be clean, and free from scale, oil and other foreign substances

PHYSICAL REQUIREMENTS

9 **Brinell Hardness**—(a) The hardness of the rim, when measured in accordance with the requirements of Section 9 (b) shall show the following values:

Class	Minimum Hardness	Maximum Hardness
A	255 BHN	321 BHN
B	277 BHN	341 BHN
C	321 BHN	363 BHN

(b) Method of Measurement—Measurement shall be made on the front face of the rim with the edge of the impression not less than 3/16 inch from the radius joining face and tread Before making the impression, any decarburized metal shall be removed from the front face of the rim at the point chosen for measurement The surface of the wheel rim shall be properly prepared to permit accurate determination of hardness

(c) Hub Hardness —When so specified in order to facilitate machining, the maximum hardness on hub face of wheels which are entirely quenched shall not exceed 293 BHN at any point not more than ½ inch from bore

10 **Number of Tests** —(a) Where continuous heat treating furnaces are used, Brinell hardness measurements shall be made on 10 per cent of the wheels from each heat Where batch type heat treating furnaces are used, Brinell hardness measurements shall be made on 10 per cent of the wheels from each heat treatment lot, provided that at least one (1) wheel is selected for test from each heat represented in the heat treatment lot For either process, when there are less than twenty (20) wheels from a heat, a minimum of two (2) wheels shall be checked for hardness except when there is only one (1) wheel from a heat, in which case a Brinell hardness measurement shall be made on the one wheel

(b) If all the wheels tested meet the requirements of Section 9, all of the wheels represented shall be accepted

(c) If any wheel tested fails to meet the requirements of Section 9, it shall be checked by making two (2) additional hardness measurements, one on each side of the point first measured and each approximately 1 inch from that point If both of these check measurements meet the requirements of Section 9, the wheel shall be considered to have met the requirements of Section 9

(d) When continuous heat treating furnaces are used, should any of the wheels tested fail on check test to meet the requirements of Section 9, the manufacturer may test for individual hardness measurements all of the wheels of that heat in the lot submitted for inspection and those meeting the requirements of Section 9 shall be accepted Where batch heat treating furnaces are used, should any of the wheels tested fail on check test to meet the requirements of Section 9, the manufacturer may test all of the wheels in the heat treatment lot for individual hardness measurement and those meeting the requirements of Section 9, shall be accepted

11 **Retreatment.**—Any wheel failing to meet the requirements of Section 9, may be retreated and tested in accordance with Section 10

Mating

12 **Mating.**—Wheels shall be measured and marked to one-half tape sizes and shipped in pairs of the same measured tape size

Permissible Variations in Dimensions

13. **Gages.**—The gages and tapes shall conform to and be used as required by the Standards of the Mechanical Division, Association of American Railroads

14 **Permissible Variations** —(a) The wheels shall conform to the dimensions with tolerances as specified in Section G—Wheels, in the A A R Manual of Standards and Recommended Practices

(b) Where the individual design sheets allow a certain per cent of the wheels to vary from standard dimensions for tape size by a given amount, the percentage of such wheels shipped by any manufacturer shall not exceed this per cent during a calendar year No individual purchaser may receive more than this per cent of his daily shipments of such wheels except by agreement with the manufacturer

A—1968

Finish

15 **Finish.**—(a) Wheels shall be rough bored and shall not have black spots in the rough bore Front hub face of wheels (1-W, 2-W and MW) shall be parallel to the plane of the vertical reference line and may be smooth forged or machined The back hub face may be smooth forged or machined

(b) The contour of tread and flange shall be as shown in the A A R Manual of Standards and Recommended Practices and shall be machined and finished smooth without excessive tool chatters

(c) Wheels shall be given a thorough surface examination and gaging at the place of manufacture before being offered for inspection They shall have a workmanlike finish and must be free from defects liable to develop in or cause removal from service

(d) Wheels shall not be covered with any substance to such an extent as to hide defects

(e) Supplementary requirement S-1 shall only apply when the removal of mill scale from the wheel is to be done by the manufacturer

Marking

16 **Marking**—(a) Identification markings shall be legibly hot stamped on the back rim face as shown in Fig 1 When the original hot stamping on wheels for freight service is removed it shall be cold stamped on the back hub face as shown in Fig 2 Repairs to illegible hot stamped characters may be made by cold stamping Passenger car and locomotive wheels may be hot or cold stamped on the back rim face At the option of the purchaser locomotive wheels may be cold stamped on the front hub as shown in Fig 2

(b) The tape size of all wheels shall be stencilled on back plates with chrome yellow paint in characters at least one inch high

Inspection and Rejection

17 **Inspection.**—(a) The inspector representing the purchaser shall have free entry, at all times while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of wheels ordered The manufacturer shall afford the inspector, free of charge, all reasonable facilities and necessary assistance to satisfy him that the wheels are being furnished in accordance with these specifications Tests and inspection shall be made at place of manufacture prior to shipment, unless otherwise specified

(b) The purchaser may make tests to govern the acceptance or rejection of the wheels in his own laboratory or elsewhere Such tests shall be made at the expense of the purchaser

(c) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works

18 **Rejection**—(a) Wheels represented by samples which fail to conform to the requirements of these specifications will be rejected

(b) Wheels which show injurious defects subsequent to original inspection and acceptance at the manufacturer's works, or elsewhere, will be rejected, and the manufacturer shall be notified

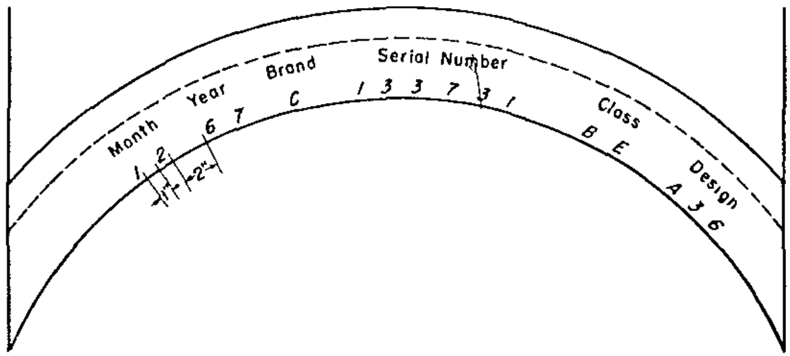
19 **Rehearing.**—Samples tested in accordance with this specification, which represent rejected wheels, shall be held for a period of fourteen (14) days from date of the test report In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time

Supplementary Requirements

The following supplementary requirements shall apply only when specified by the purchaser Details shall be agreed upon by the manufacturer and the purchaser

S1—Wheels for use under locomotives other than steam shall have all mill scale removed from the entire wheel prior to final inspection

MARKING OF WROUGHT STEEL WHEELS—RIM STAMPING



Note 1 *Stamping to consist of date of manufacture, brand of manufacturer, manufacturer's* serial number, class and type of heat treatment if heat treated and design designation Stamping on locomotive wheels is limited to 13 characters and the design designation shall be stencilled on the back plate with chrome yellow paint with characters at least two inches in height

Note 2 Stampings to be spaced a minimum of one inch between characters and two inches between groups, located not less than 1/8 inch from inner edge of rim On locomotive wheels the stamping shall be located not less than 1/4 inch from the inner edge of the rim

Note 3 Brand limited to one initial: A-Armco; B-Bethlehem; C-Carnegie (Pittsburgh Plant); E-Edgewater; G-Illinois (Gary Plant); J-Sumitomo Metal Industries; P-Steel, Peech and Tozer; S-Standard; T-Taylor Bros and Co , Ltd ; Z-Canadian Steel Wheel, Ltd

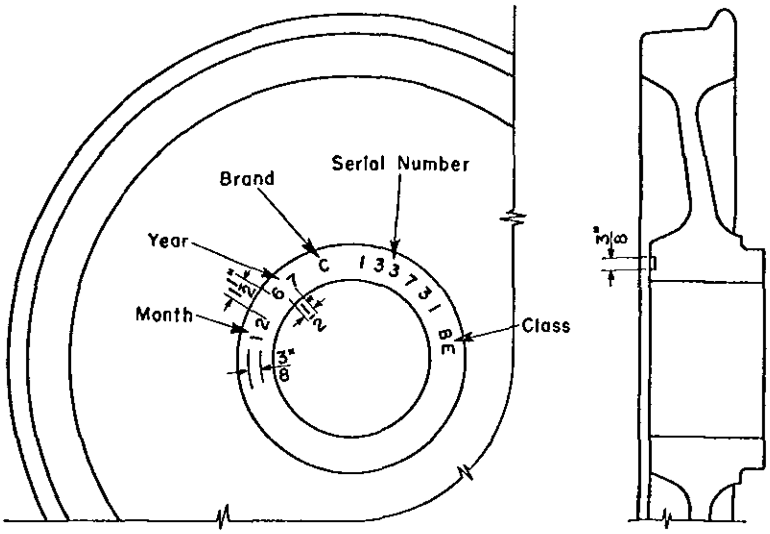
Note 4 Dies used to produce characters shall be 1/2 inch nominal height at crest and hot stamping shall be nominally 5/32 inch in depth Italicized characters *(sloped upward to right), shall be used*

Note 5 Class markings as follows:

- A – Class A, rim treated
- AE – Class A, entire wheel treated
- B – Class B, rim treated
- BE – Class B, entire wheel treated
- C – Class C, rim treated
- CE – Class C, entire wheel treated

Untreated wheels (Class U) are not marked for class

ALTERNATE MARKING OF WROUGHT STEEL WHEELS— HUB STAMPING



Note 1 Locomotive wheels are stamped on the front hub face and wheels for freight service are stamped on the back hub face

Note 2 Stamping to consist of date of manufacture, brand of manufacturer, manufacturer's serial number, class and type of heat treatment if heat treated and design designation. Stamping on locomotive wheels is limited to 13 characters and the design designation shall be stencilled on the back plate with chrome yellow paint with characters at least two inches in height

Note 3 Stampings to be spaced approximately 1/2 inch between characters and approximately 1 1/2 inches between groups and located approximately central of the hub face

Note 4 Steel stamps used to produce characters shall not be less than 3/8 inch in height

Note 5 Class markings as follows:
- A - Class A, rim treated
- AE - Class A, entire wheel treated
- B - Class B, rim treated
- BE - Class B, entire wheel treated
- C - Class C, rim treated
- CE - Class C, entire wheel treated

Untreated wheels (Class U) are not marked for class

50061.3

PROCEDURES FOR A.A R MECHANICAL INSPECTION OF STEEL WHEELS

Standard

ADOPTED, 1964; CORRECTED, 1966

1 **Object**—An A A R Mechanical Division Inspector to periodically inspect steel wheels to ensure that control practiced by manufacturers is effective in maintaining a constant standard of quality to meet the requirements of A A R Specifications and service conditions to which the wheels are subjected

2 **General**—Present operating conditions on railroads make it imperative that high quality is maintained in all wheels Processes used by individual manufacturers differ in many details but all have been developed to produce wheels which will meet the specification requirements.

3 **Duties**—The duties of an inspector shall be:

(a) To obtain definite information concerning plant facilities and manufacturing processes and obtain a general knowledge of manufacturing procedure

This should not imply that the inspector should require detailed information of melting practice or of any other processes adopted by a manufacturer He should determine:

(1) if steel is basic or acid

(2) if steel is melted in electric or open hearth furnaces or by basic oxygen process

(3) pouring practice

(4) if ingots produce individual or several wheels

(5) method of converting ingots to billets or blocks

(6) type of heating furnaces

(7) method of forging, rolling and casting

(8) method of cooling and heat treatment

(9) type of machines

(10) types of wheels surface-cleaned

(11) inspection procedures

(12) shipping procedures

(b) To inspect typical wheels the manufacturer has released for shipment

b 1 The inspections shall be in accordance with the requirements outlined in the Wheel and Axle Manual and the Material Specifications

b. 2 Following are listed defects in detail that through past experience have been found to be detrimental to the performance of wheels in service

APPENDIX 2

Defects	Rims	Plates	Hubs
Inclusions (sand/slag)	x	x	x
Cracks (hot tears/cold shut)		x	
Laps/Seams	x	x	x
Deep or Numerous Pits (insufficient stock)	x	x	x
Deep Chuck Marks (extending to edge of back rim)	x		
Abrupt Change in Section		x	
Poorly Blended Machine Sections	x	x	x
Improper Stamping	x		

b 3 Defects not readily visible to the naked eye are usually detected by magnetic particle and ultrasonic testing Such tests may be used in the manufacture of wheels as a part of mill quality control procedures They may be requested by the A A R Inspector on sample lots for the purpose of determining compliance with Section 15 (c) of A A R Specifications M-107 and Section 13 (c) of Specifications M-208 which concern defects liable to develop in or cause removal from service

(c) To report to the Mechanical Division of the A A R and to the manufacturer on the results of the inspection

Exhibit 1-D

UNITED STATES OF AMERICA
NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON, D. C.

In the Matter of Investigation of Accident Involving Derailment with Subsequent Fire and Explosions of Southern Railway Train at Laurel, Mississippi, on January 25, 1969	Docket No. SS-R-4

DESIGNATION OF PARTIES

The following corporations or associations are hereby designated Parties in Interest for the public hearing ordered in connection with the above matter:

1. Southern Railway Company
   Southern Railway Building
   15th and K Street, N. W.
   Washington, D. C. 20013

2. Gulf, Mobile and Ohio Railroad Company
   104 St. Francis Street
   Mobile, Alabama 36601

3. Association of American Railroads
   American Railroads Building
   1920 "L" Street, N. W.
   Washington, D. C. 20036

4. Allied Chemical Corporation
   40 Rector Street
   New York, New York 10006

5. Armco Steel Corporation
   P. O. Box 600
   Middletown, Ohio 45042

6. Railway Labor Executives Association
   Railway Labor Building
   400 First Street, N. W.
   Washington, D. C. 20001

This designation permits those named to participate in the public hearing on the subject matter in accordance with the General Rules of Practice in Surface Transportation Safety Hearings.

Dated this 7th day of February, 1969.

John H. Reed
Chairman
Board of Inquiry

ASSOCIATION OF
AMERICAN RAILROADS
LAW DEPARTMENT
AMERICAN RAILROADS BUILDING WASHINGTON, D C 20036

EDWARD G HOWARD
General Attorney

June 2, 1969

Honorable John H. Reed
Chairman, Board of Inquiry
National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Re: Laurel Accident

Dear Governor Reed:

The Board, I believe, will be interested in recent actions of the AAR that relate to safety questions raised in connection with the Laurel Accident. They are summarized below:

1. The Committee on Wheels and Axles has recommended to the Mechanical Division that specifications for both cast and wrought steel wheels be changed in two respects:

a. Ultrasonic testing of all such wheels at the time of manufacture to be mandatory for the purpose of detecting internal defects not apparent to visual inspection; and

b. A precise roughness standard (not to exceed 500 micro-inches) to be established for forged or machined surfaces of all such wheels.

These proposals will be submitted to the Mechanical Division for approval on July 1-2, 1969. Upon approval they will be submitted to letter ballot of member roads, and if approved thereby would normally become standard on March 1, 1970. We have no reason to anticipate any disapproval; and we will take steps to make the new specification effective shortly after approval rather than at the normal time.

2. In cooperation with representatives of the wheel manufacturing industry, the Committee on Wheels and Axles is studying possible revision of current wheel condemning limits. This study will include research on the strength of wheels worn to the established limits.

3. The General Committee of the Mechanical Division has approved for letter ballot this year (for which see Item 1 above) a requirement that all new tank cars in interchange be equipped with F-type interlocking couplers. If the expected approval is received, this requirement will become effective January 1, 1970.

APPENDIX 4

4. The Committee on Freight and Passenger Car Construction, with the cooperation of tank car builders, has arranged for tests of tank cars without center sills to determine what revisions in the specifications for such cars should be adopted to improve safety and stability.

5. Metallurgical and other tests of samples taken from tank car tanks involved in the Laurel Accident are now being made by the Illinois Institute of Technology, with the cooperation of the AAR Research Center. It is expected that a final report will be available about July 31, 1969. Copies will be sent to the Board.

6. Tests of the safety valves taken from certain of the tank car tanks involved in the Laurel Accident and the Springville Accident have been made. These tests were made under the auspices of the DOT, but had the full concurrence and cooperation of the AAR.

7. Various other aspects of tank cars and their specifications remain under study by the Tank Car Committee through subcommittees and working groups.

8. On April 9, 1969, the AAR appointed a full-time Director of Safety. His first assignment is to formulate and implement a program to bolster industry safety programs.

Sincerely,

Edw G Howard