

PB 284 817



NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

USHER TRANSPORT, INC.,
TRACTOR-CARGO-TANK-SEMITRAILER
OVERTURN AND FIRE
STATE ROUTE 11
BEATTYVILLE, KENTUCKY
SEPTEMBER 24, 1977

REPORT NUMBER: NTSD-NAR-78-4

UNITED STATES GOVERNMENT

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16. Abstract About 9:35 a.m., e.s.t., on September 24, 1977, an Usher Transport, Inc., tractor-cargo-tank semitrailer was descending a 12.6-percent, 720-foot-long grade approaching a left curve and a railroad/highway grade crossing on Kentucky State Route 11 in Beattyville, Kentucky. The truck, which was hauling 8,255 gallons of gasoline, crossed the tracks against the flashing red lights and in front of an approaching train, and struck buildings adjacent to the edge of the road. It then overturned on top of a parked car. Escaping gasoline ignited and the fire destroyed 6 buildings and 16 parked vehicles. Seven persons died in the fire. The National Transportation Safety Board determines that the probable cause of this accident was the loss of vehicle control because of speed excessive for highway geometry. Contributing to the accident was the truckdriver's lack of judgment when he failed to respond to the warnings and obey the rules of the road.					
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Adopted: July 6, 1978

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SEMITRAILER OVERTURN AND FIRE
STATE ROUTE 11
BEATTYVILLE, KENTUCKY
SEPTEMBER 24, 1977

SYNOPSIS

About 9:35 a.m., e.s.t., on September 24, 1977, an Usher Transport, Inc., tractor-cargo-tank semitrailer was descending a 12.6-percent, 720-foot-long grade approaching a left curve and a railroad/highway grade crossing on Kentucky State Route 11 in Beattyville, Kentucky. The truck, which was hauling 8,255 gallons of gasoline, crossed the tracks against the flashing red lights and in front of an approaching train and struck buildings adjacent to the edge of the road. It then overturned on top of a parked car. Escaping gasoline ignited and the fire destroyed 6 buildings and 16 parked vehicles. Seven persons died in the fire.

The National Transportation Safety Board determines that the probable cause of this accident was the loss of vehicle control because of speed excessive for highway geometry. Contributing to the accident was the truckdriver's lack of judgment when he failed to respond to the warnings and obey the rules of the road.

INVESTIGATION

The Accident

About 9:30 a.m., e.s.t., on September 24, 1977, a tractor-cargo-tank semitrailer (truck), transporting 8,255 gallons of gasoline, approached Beattyville from the north on Kentucky State Route 11. The truck crested an upgrade and began the 720-foot descent down a 12.6-percent grade.

The driver stated that when he reached the top of the downgrade, he stopped to see if the signal at the railroad crossing at the bottom of the hill was flashing. He said that during other trips over the route he would stop at the top of the hill and wait there if a train was on this crossing. Since there was no train on the crossing, he started down the hill in first gear. After he started down the hill, the railroad light signal began to flash and he heard a train whistle. He pushed hard on the footbrake, but the truck did not slow. He pulled the trailer

brake hand valve, but the truck seemed to accelerate. He continued to push hard on the foot brake and pulled the tractor protection system valve; he could not remember if he applied the spring brakes. He sounded the air horn four or five times and noticed that his air gauge registered 90 to 100 psi; the tachometer read 2,400 rpm. He saw the train approach from his left when he came to the crossing. He did not remember anything further until he felt heat on his back, and found himself lying on his back on the right side of the cab; he was not wearing the available lap belt.

A motorist who was driving up the hill passed the truck just as it began its descent; he estimated the truck's speed at 25 mph. He did not see the truck stop. The witness said that when he was half way up the hill, he became aware of the railroad warning lights flashing behind him.

Two other witnesses, who were in the yard at the corner of the State Route 11 and East Main Street, heard a train whistle and almost immediately heard the sound of an air horn from the southbound truck. The air horn continued to blow and they surmised that the truck was out of control. The truck went past their driveway at an estimated speed of 55 to 60 mph. According to these witnesses, as the truck crossed the tracks in front of the train, the front axle of the tractor jumped up into the air; when the trailer crossed the tracks, its wheels were bouncing. After the combination vehicle crossed the tracks, the rear of the trailer swung to the right and tore through the front of an appliance store (Building A, figures 1 and 2).

The train engineer, who was standing on the right side of the locomotive cab, said that when the locomotive contacted the pre-empt device which activated the flashing lights he could not see the crossing because he was going around a right curve. When the crossing came into view, he saw the flashers operating and the truck approaching the northernmost rail. When the truck crossed the tracks, he did not see a driver in the cab; he stated that the front end of the tractor jumped up into the air and the trailer seemed to roll from side to side as it bounced across the rail. The trailer swung to its right and struck the first building south of the tracks. The trailer appeared to turn over onto its right side. He stated that as the front of the building caved in, the back of the trailer became engulfed in fire.

South of the crossing, 16 cars had been parked in front of 7 buildings, which were built immediately adjacent to the sidewalk at the edge of the road. The rear of the tank semitrailer had slid to the right and struck the middle of the first building, rolled over onto its right side on top of a car parked in front of the buildings, and slid to a stop after striking a second automobile. (See figure 1.) Gasoline had escaped from the cargo tank and the fumes ignited. A bright yellow plume of smoke and fire rose

BEATTYVILLE, KY.
Sept. 24, 1977

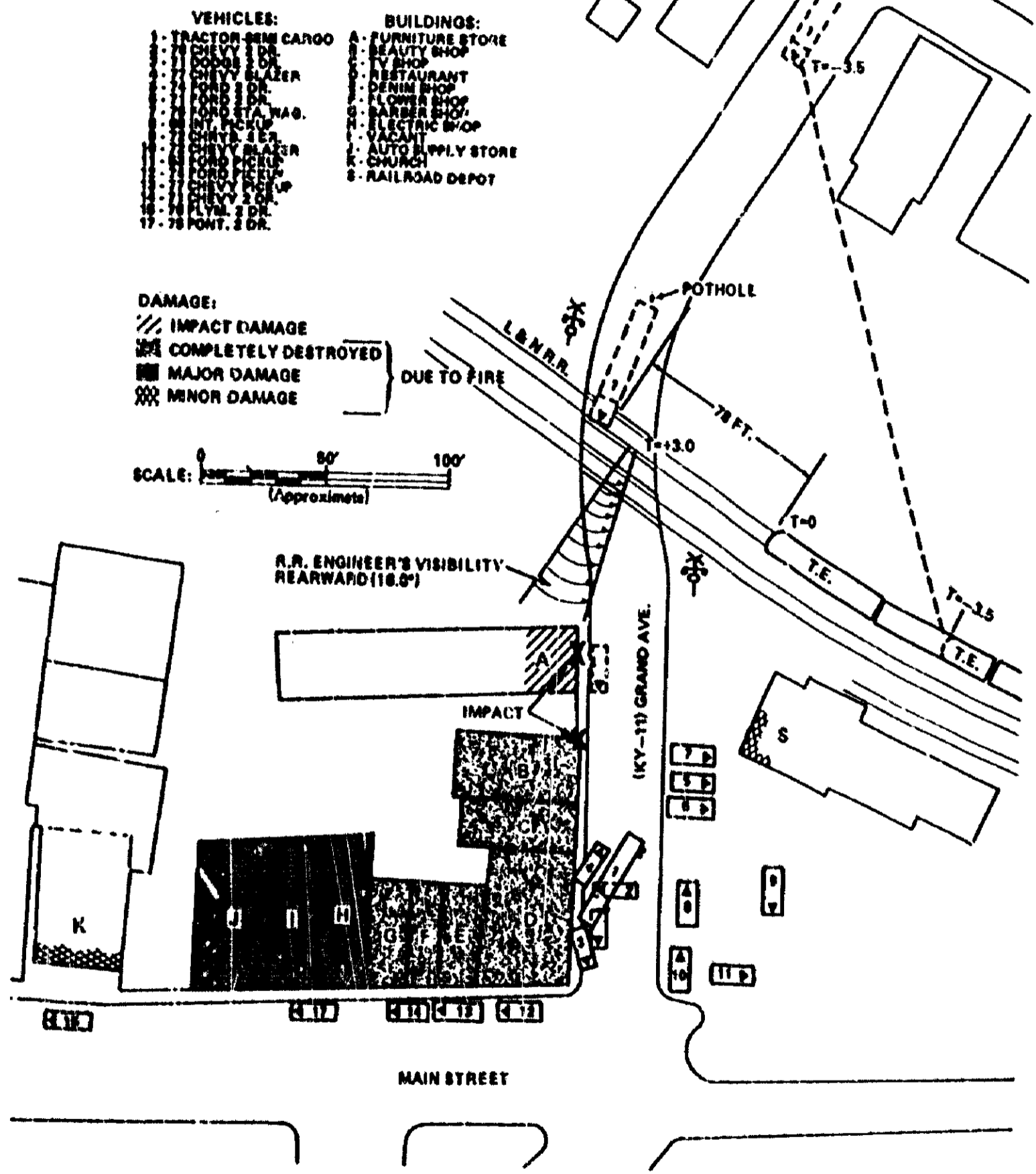


Figure 1. Location of Buildings and vehicles.

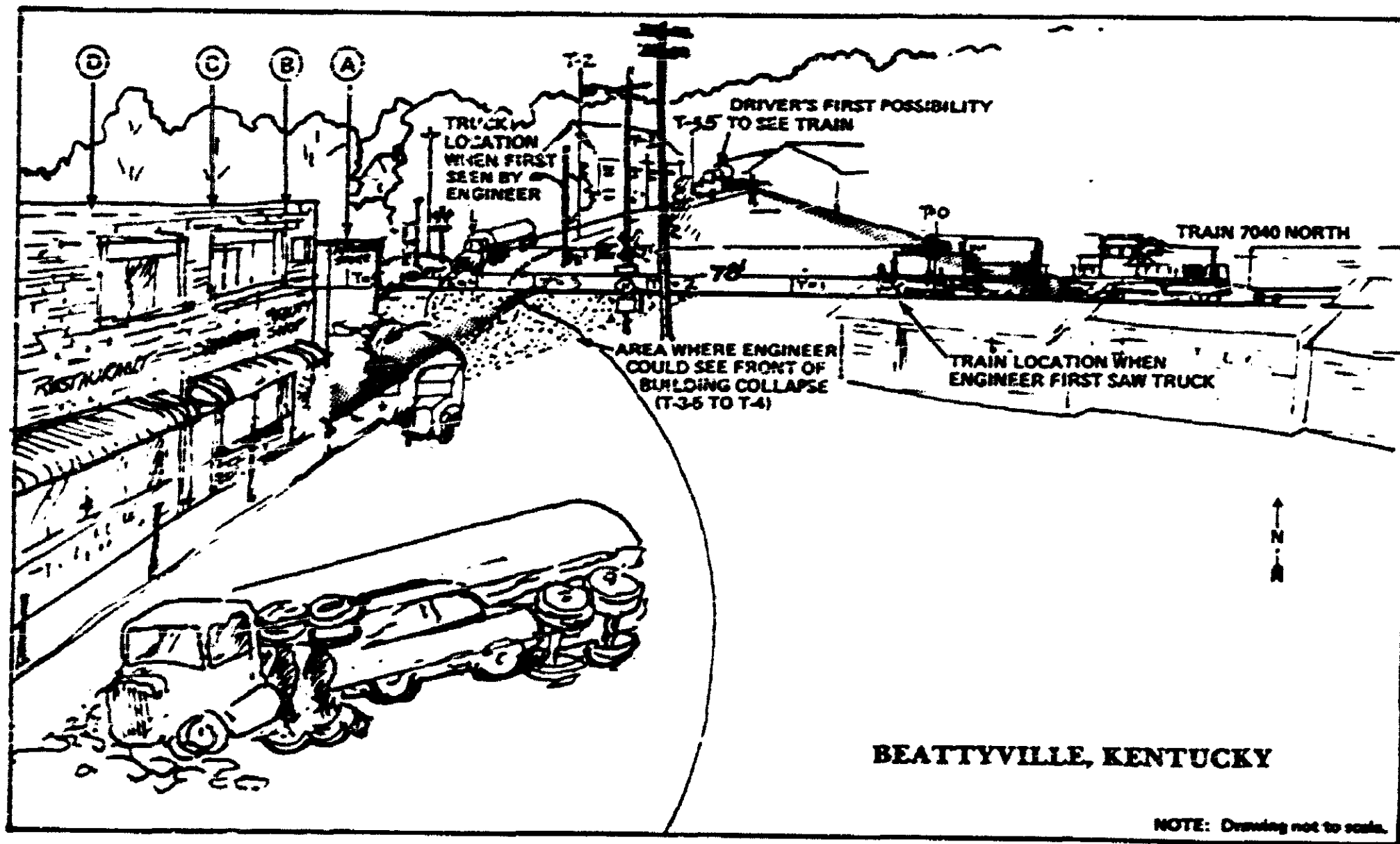


Figure 2. Artist's conception of accident site.

100 feet into the air around and above the buildings. Gasoline ran down the street and sidewalk for about 400 feet before it entered an underground drain. The gasoline resurfaced 100 feet from the underground drain in an alley at the intersection of Main Street and McGuire Avenue. The fire rapidly engulfed a 100-foot by 150-foot area, destroying the buildings and the parked vehicles. Several other buildings were burned.

Several buildings were destroyed (letter A through G, figures 1 and 2). Buildings A, B, C, and D were located on Grand Avenue; Buildings E through G were on Main Street. The buildings were of concrete construction with brick fronts. Building A was a single-story building. The two-story buildings contained businesses on the first floor and apartments on the second. Building A was erected 8 feet from the curb, while Buildings B, C, and D were 4.6 feet from the curb. Two patrons in Building A saw the truck headed for the building, alerted four other occupants, and exited out a rear door. The bodies of five females were recovered from the beauty salon (Building B). A resident and two infant children in a second floor apartment above the beauty salon escaped when the grandmother lowered the infants to rescuers and then jumped to safety.

There were seven occupants in Building D. One escaped through the flaming front door; five escaped through a side window; the remaining occupant appeared to panic and ran in a different direction. Her body was later found in the building. The body of an occupant of a second-floor apartment of Building D was later found inside the doorway on the first floor of the building.

Seven persons died as a result of the fire. The truckdriver survived with assorted injuries, none of which were burns.

At the time of the accident, the sky was overcast with no precipitation. The sun was not a factor.

Injuries to Persons

<u>Injuries</u>	<u>Driver</u>	<u>Passenger</u>	<u>Building Occupants</u>
Fatal	0	0	7
Nonfatal	1	0	0
None	0	0	0

Survival Aspects

The Beattyville Volunteer Fire Department received a call around 9:38 a.m. reporting that Building D was on fire. One unit was dispatched. Firefighters approached the scene and saw a wall of flames 20 feet high advancing down Main Street into a 2.5-square-foot drain opening located 400 feet from the corner of Main Street and Grand Avenue. They successfully pushed the fire back to the corner and fought the fire in the burning trailer. By 10:00 a.m., firefighting units arrived from Jackson City, Estell County, Bonaville, Pond Fork, Powell County, and Wiser Oil Company and fought the fire with foam. The major structural fires were contained and the trailer fire was extinguished at 2:30 p.m.

Lee County set up a Civil Defense Coordination Headquarters two blocks from the accident site. There, State personnel provided information, directed recovery of bodies, and interviewed key witnesses.

Vehicle Information

The Combination Vehicle -- The combination vehicle, owned by the Usher Transport, Inc., (Usher), consisted of a tractor and a cargo tank semitrailer. The gross combination weight (GCW) was 74,255 pounds at the time of the accident.

The tractor was a 1974 White tractor cab behind engine type model RBM 64T Road Boss. It was powered by a 290 hp Cummins diesel engine with RT 910 (Fuller) 10-speed road ranger transmission and Eaton tandem drive axles. The rear axle ratio was 4.11 x 1. The steering axle wheels had 10.00 x 20 tube type tires and were not equipped with brakes. The drive axle wheels were equipped with 10.00 x 22.5 tubeless tires. The drive axles were equipped with air mechanical S-cam-type brakes. Although the speedometer was not functioning and had been inoperative since July, the tractor had a functional tachometer.

The semitrailer, Company No. 250, was a 1974 Trailmobile, MC306AL, serial No. K40806. It was equipped with eight 11.00 x 22.5 tubeless tires and air mechanicals cam-type brakes. The semitrailer was equipped with a brake interlock system for applying the trailer brakes while loading. The 4-compartment cargo tank had a nominal capacity of 9,000 gallons. The tank was equipped for bottom loading with float sensors and a vapor recovery system.

At the time of the accident, the cargo tank was loaded with 8,255 gallons of gasoline. The driver said that all the compartments were full except the No. 2 compartment. The No. 2 compartment, which had a normal capacity of 1,900 gallons, at the time of the accident contained 1,151 gallons. The gasoline was being transported from Gulf Oil Corp., Louisville, Kentucky, to the Gulf Oil Products Distributor in Beattyville, Kentucky.

The Train -- The train was westbound Louisville and Nashville Railroad Company Freight Train No. 7040. It had a crew of four--an engineer and brakeman in the locomotive cab and a flagman and a conductor in the caboose. The train was en route from Hazard to Ravenna, Kentucky. The train's speed was 15 mph.

Vehicle Damage

Tractor -- The tractor was examined on September 26, 1977, at the Kentucky State Police Supply Facility in Frankfort. Examination revealed that all flammable and most metal components, other than those constructed of iron and steel, had been destroyed by the fire. The interior of the cab and all instruments were destroyed. Both channel section side rails between the back of the tractor cab and the fifth wheel showed evidence of having been twisted counterclockwise. The extreme front end of the left side rail had been twisted counterclockwise.

The cab shell had been slightly deformed by heat, but there was no evidence of physical or mechanical denting. Both cab door-mounted rearview mirrors were in their preimpact position. The right door had separated from the cab. The brake linings on the drive axles showed little wear, and all linings had been exposed to severe heat. Heat damage would have obliterated any evidence of glazing that may have existed. The tractor protection valve and service brake application valve had been destroyed. The air reservoir was removed, cut open, and examined; no foreign matter was disclosed.

All brake chamber aluminum pressure plates had been destroyed by fire. The spring brakes on the front tractor bogie axle were missing. Without the brake chamber pressure plates, conventional means of determining brake adjustment were not possible.

Before the brake drums were removed from the truck, the travel of the push rod on each axle was measured by pulling each slack adjuster until the brake linings contacted the drums. The distance from the center of the push rod at the slack adjuster clevis pin to the front of the brake chamber (non-pressure plate) was measured along with the thickness of the brake lining.

The results were as follows:

Tractor tandem	Left (inches)	Right (inches)	Brake Lining Thickness (inches)	
			Left	Right
Front	1/4	1/4	3/4	5/8
Rear	0	0	3/4	5/8 - 11/16

Trailer				
Front	1	3/4	3/8	1/2
Rear	1/2	1/2	3/8	3/8

The push rod for the right front bogie axle brake measured 7 3/4 inches instead of the standard 5 1/2 inches. The brake lining on the right rear bogie axle brake had a considerable accumulation of grease on the brake linings.

These estimated adjustment are unquestionably closer than the actual preimpact adjustments. However, they do suggest that all of the adjustments, except the right front tractor bogie, were within the acceptable 2-inch stroke.

All valve train mechanisms were removed from the engine and examined. No discrepancies were discovered. The forward engine head was removed to determine if the valves had contacted the pistons. No such evidence was observed.

The cover was removed from the transmission to provide access to the inside of both the main transmission and the range box. The main shaft first-reverse speed sliding clutch was in the first or sixth position, depending upon the position of the range box positioning gear. The range box sliding clutch and the control valve piston were found in the high-range position. Therefore, the transmission was in sixth gear. According to the police report there was no evidence that the gear positions had been tampered with after the accident and before this inspection. All air lines attached to the control valve had been destroyed by fire.

The following table was prepared listing the engine rpm and mph ranges for each of the 10 transmission ratios for the tractor:

Road Speeds at Various Engine Speeds for the 10 Transmission Ratios				
Gear	Total Gear Ratio	R O A D S P E E D		
		Governed		Engine damage
		2,400 rpm	2,100 rpm	2,700 rpm
		(mph)	(mph)	(mph)
1	33.89	8.64	7.56	9.71
2	25.87	11.05	9.66	12.42
3	20.51	13.94	12.19	15.67
4	16.23	17.62	15.40	19.80
5	13.15	21.75	19.01	24.44
6	10.32	27.71	24.22	31.05
7	8.10	35.31	30.86	39.68
8	6.41	44.62	39.00	50.15
9	5.10	56.08	49.02	63.03
10	4.11	69.59	60.83	78.20

Semitrailer -- Examination of the trailer's brake system did not reveal any defects that may have contributed to the accident. The internal valve control lever for No. 1 compartment was not equipped with a fusible link. A steel nut had replaced the original fusible link. The internal valve control fusible link for compartments Nos. 2, 3, and 4 had melted during the fire.

The trailer relay emergency valve was examined and no defects were discovered other than those resulting from the fire. The air reservoir was removed and cut open, and no foreign matter was discovered. Because of fire damage to the trailer, no other components of the brake system could be inspected.

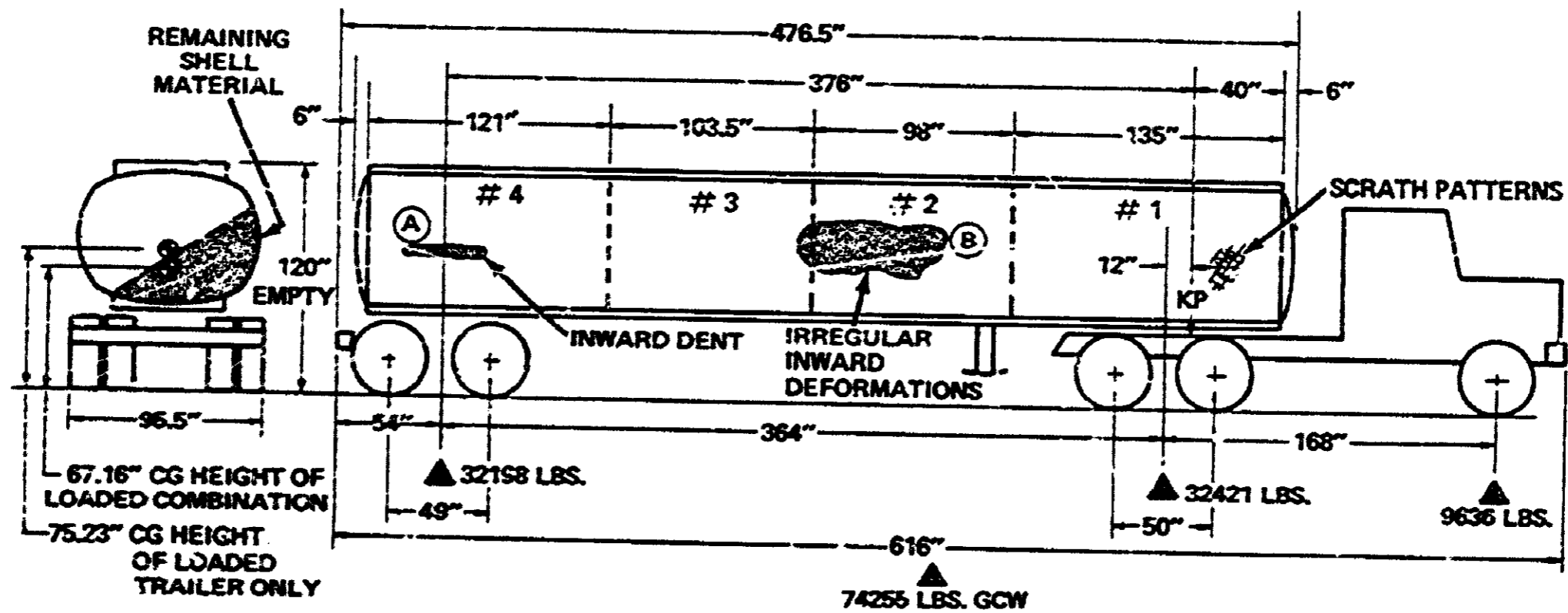
About 1/3 of the tank shell heads and bulkheads and all steel components survived the fire. The aluminum tank parts which survived were from the right side.

There was a 41-inch-long by 6-inch-wide longitudinal dent at the right rear side of the tank shell. (See figure 3, item A.) This dent was 16 inches forward of the rear shell to head weld. A rod material was embedded in the aluminum at the forward end of the dent. A series of irregular inward deformations were located between 18 1/2 feet and 25 feet forward of the rear head seam. (See figure 3, item B.) There was no indication of mechanical puncture or other type rupture in the remaining sections of the tank material. The inside surface of the remaining shell material about 6 inches to 8 inches inboard of the edge of the melted surface was sooted; the remaining inside material was rot.

All steel underbelly piping was still in its approximate normal position with evidence of only minor physical deformation that could be attributed to accident dynamics. The trailer cargo tank was equipped with bottom loading vapor return lines. The truckdriver said that on September 9, 1977, he had reported to the Usher Terminal Manager that the 3-inch threaded cap was missing from the vapor recovery system line. This had previously been reported to Usher's terminal manager who said he would get one, but never did. The truckdriver said that gasoline vapor was coming out of the opening at the time of the accident.

The cargo tank was equipped with four manholes as required by HMR 178.341-3 -- "Closures for fill openings and manholes." The tank was also required to have a pressure-activated vent set to open at not less than 3 psig and to close when pressure drops to 3 psig or less. Hazardous Materials Regulation 178.341-4(d)(2) requires that these vents shall be designed to prevent leakage of liquid past the device in case of surge or vehicle upset, except they shall function in case of pressure rise under any condition of vehicle rollover attitude. Because fire had destroyed the manhole gaskets, attached materials, and the vent mechanism, inspection or evaluation was impossible.

The upper coupler assembly was not deformed and remained attached to the underside of the forward shell material. There was no indication of preimpact deformations to either the legs or the sand shoes of the trailer supports.



Vehicle Combination Sketch

Figure 3. Drawing of tractor-cargo-tank semitrailer showing dimensions and damage areas.

The Driver

The 40-year-old truckdriver had been employed by Usher since July 29, 1977; he had previously been employed by Usher as a truckdriver for 4 months in 1975. He had driven commercial vehicles since May 1975. The driver held a valid Kentucky chauffeur's license and a current medical examiner's certificate, which indicated that he was physically qualified to drive in interstate commerce as required by the Federal Motor Carrier Safety Regulation (FMCSR) 391.43. His State traffic record and carrier personnel file revealed no chargeable accidents or violations.

He attended a 5-week truckdriver training course in 1974. His on-the-job training involved driving with a senior driver for 1 week before operating a unit alone. He had driven the tractor for 2 months before the accident and the semitrailer for 1 week before the accident.

Since the truckdriver claimed that he did not remember any details of the accident after seeing the train, the Safety Board examined his medical records for indications of his physical and psychological background. After the accident, the truckdriver's examining physician's report concluded that the truckdriver experienced a "syncopal episode -- cause undetermined." Based on available evidence, the medical diagnosis that the truckdriver experienced a syncopal episode is consistent with the medical findings. Syncopal episode is a temporary suspension of consciousness. During his military service in Viet Nam, the truckdriver had suffered a head injury but there was no evidence of any after effects of unconsciousness or "blackouts" before this accident.

Events Preceding the Accident

The truckdriver stated that he had hauled gasoline over this same route at least six times a week for the past 2 months. At 6:50 a.m. on September 24, 1977, the truckdriver completed loading and departed the Gulf Oil terminal in Louisville. He said that he had experienced some delay in braking while driving this unit on other occasions. However, there is no written record to indicate that he reported the problem or otherwise caused it to be corrected. On the day of the accident he said that he experienced no problems with the unit before descending the grade in Beattyville. The truckdriver's log indicated that he had driven for 3 1/2 hours over a distance of 152 miles from Louisville to Beattyville. An examination of the driver's logs indicated that he had been on duty 67 1/2 hours during the past 8 days and had driven for 3 1/2 hours following his last consecutive 8 hours off duty.

Highway Information

Kentucky State Route 11, a part of the Federal-aid primary and State primary system, is classified as a rural minor arterial highway. Its alignment

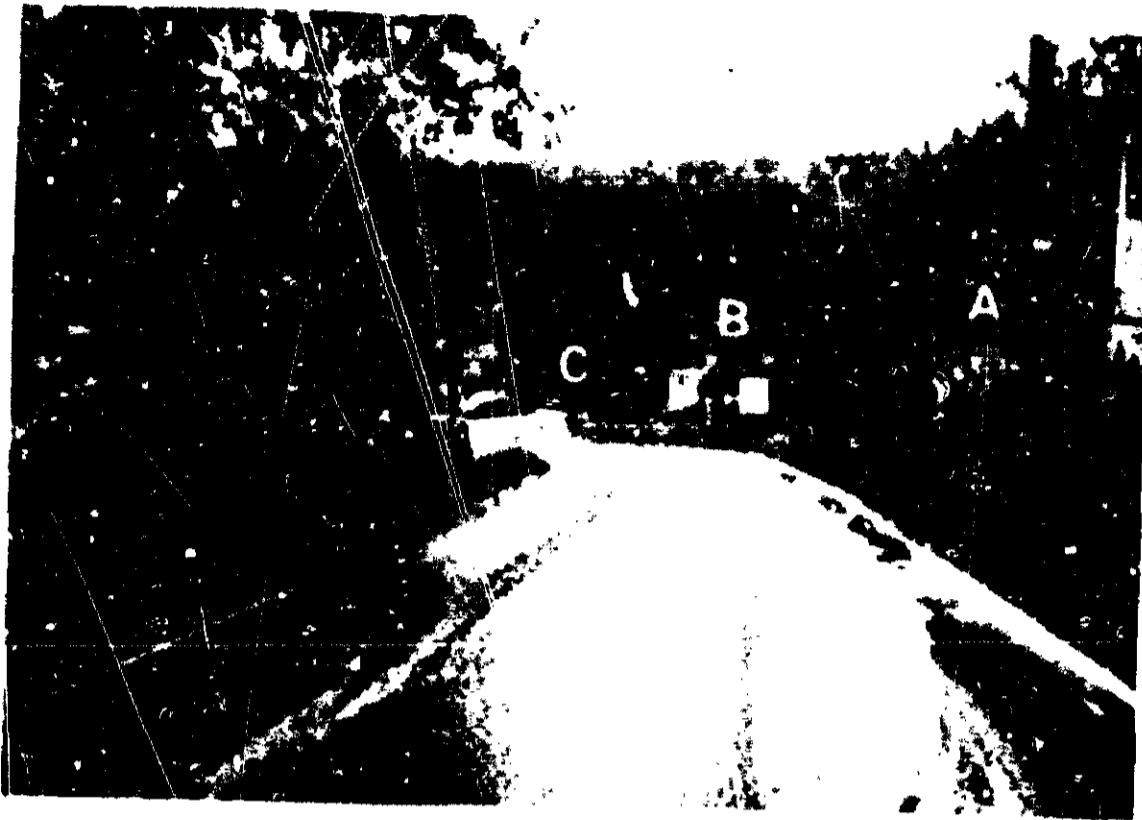


Figure 4. KY 11, view to the south. A-25 mph speed limit sign; B-RR flashing lights; and C-Railway grade crossing.



Figure 5. KY 11, view to the south. A-Advance warning sign and B-25 mph speed limit sign.

before the steep downhill section leading to the accident site meanders along a narrow ridge. The roadway has numerous substantial horizontal and vertical curves. The average daily traffic volume is about 3,300 vehicles, 12 percent of which is heavy trucks.

The two-lane, two-way road varies from 18 feet to 23 feet wide and has 3-foot to 7-foot-wide improved shoulders on each side. (See figures 4 and 5.) The asphalt concrete road surface is composed of Kentucky Class I mix, the standard mix used on Kentucky highways. The last resurfacing of this section of roadway was completed in November 1970. The surface was dry, worn, and travel polished. The lanes are divided by a double yellow centerline and bounded on the outside by a white edge line. There was a large pothole on the centerline of the roadway located 43 feet 6 inches north of the grade crossing. (See figure 6.) Tire marks on the road suggested that the truck may have straddled this hole in the center of the road. (See figure 7.)

At the crest of the hill, a southerly 12.6-percent downgrade begins and extends for 720 feet into a left curve across a two-track railroad/highway grade crossing and then continues in an easterly direction until it intersects with Main Street -- an east-west thoroughfare. The downgrade varies from 12.00 percent to 13.12 percent from just below the crest to a point 75 feet north of the crossing. In the last 75 feet to the crossing, the grade changed from 13.12 to 5.48 percent. Where the road crossed the tracks, the percent of grade was -0.6. Then, in 25 foot increments, it changed from 5.71 percent to 3.08, and then to 5.68 percent at its intersection with Main Street.

At the beginning of the downhill segment, the road is lined on each side by stone walls, which are 8 feet to 10 feet from the shoulder. There are utility poles in front of the walls. (See figure 1.) About 175 feet north of the crossing, the 167-foot radius curve begins decreasing to an estimated 100-foot radius, 50 feet north of the crossing. Overall, it is about a 140-foot radius curve.

The critical speed ^{1/} of the 140-foot radius curve was calculated to be 36 mph. An examination of the road surface in the curve revealed 170 feet of dual tire scuff marks, beginning 43 feet north of the track, straddling the centerline, and continuing south through the left (northbound) lane and across the crossing. These scuff marks cut through the inside of the curve and back into the southbound lane across the crossing.

In this curve, the superelevation for the southbound lane as it approached the crossing was +.016 ft/ft, 75 feet from the crossing; at 50 feet, it was a -.043; at 25 feet, +.044, and at the crossing, it decreased to +.008. (These measurements were obtained through field surveys.)

^{1/} Critical speed is the speed at which a particular highway curve, or curve demand by the driver, cannot be negotiated by the vehicle without yaw.



Figure 6. KY 11 view to the south. A-pothole, B-RR flashing lights, C-RR crossing, and D-Building hit by trailer.

The road leveled off at the crossing and then progressed in a southeast direction in front of the buildings, which had been built adjacent to a 4.6-foot-wide sidewalk. The sidewalk abutted and ran parallel to the roadway and was separated from the roadway by only a concrete curb. The curb was deteriorated and sunken, leaving a 0- to 2-inch reveal. From the buildings, it was another 113 feet to the intersection of Main Street.

The railroad/highway grade crossing was 28 feet wide and was paved with wooden planks adjacent to the rails with areas of asphalt in between. (See figure 8.) The crossing was 35 feet wide on the diagonal traversed by the truck. The crossing was rough. The planking contained numerous gouge marks that may have been made by other vehicles. The crossing was protected by an advance warning sign 680 feet north of the crossing, and 8 3/8-inch railroad/highway flashing lights mounted on a railroad cross-buck sign 12 feet north of the crossing. Attached to the crossbuck was a sign announcing "2 tracks." The red flashing lights were activated by a pre-empt contact located 1,113 feet east of the crossing. The red flashing signals were visible to and recognized by the driver when he created the grade from the north. Witnesses stated that the signals were flashing before the truckdriver started his descent.



Figure 7. Railway/highway grade crossing view to the north of tire marks left by right dual tires of truck.

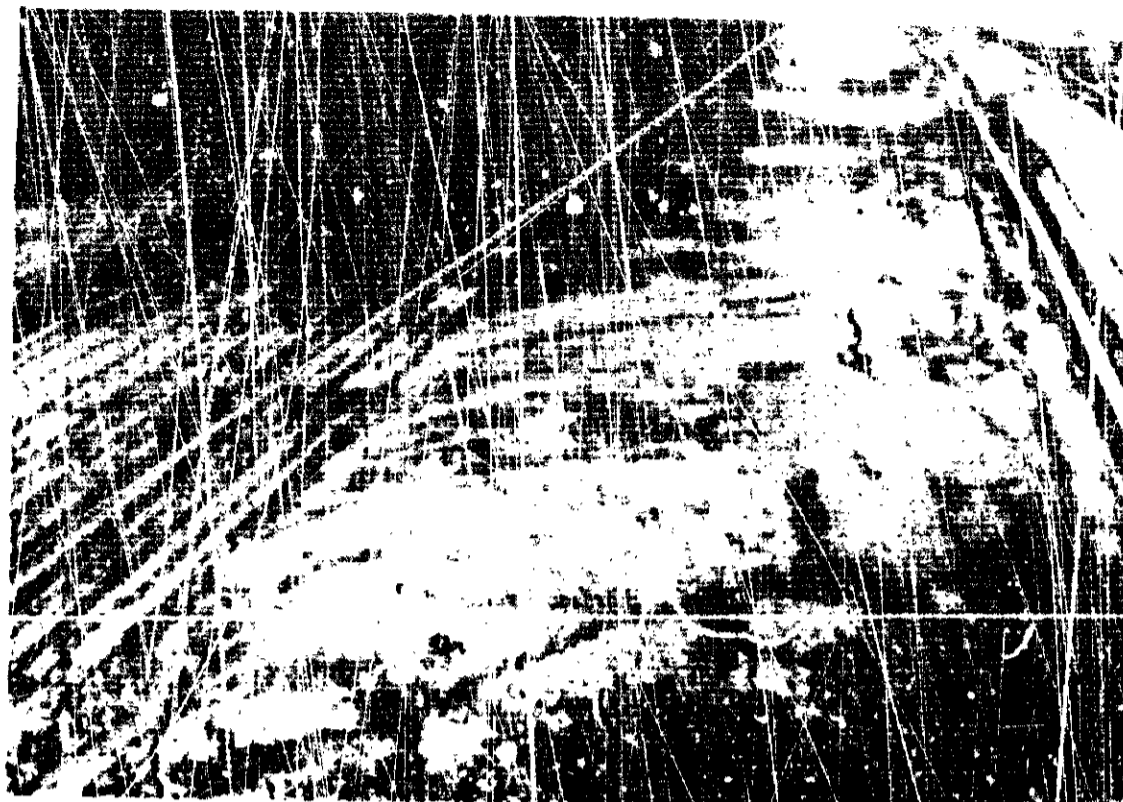


Figure 8. Railroad/highway grade crossing on KY 11, view to the west.

The train was traveling west at 15 mph. The speed limit for this segment of track was 15 mph. The engineer stated that he began to sound the train whistle at the whistle post, 521 feet from the crossing.

At 15 mph -- 22 feet per sec -- the flashing lights would have been activated for about 50.6 secs before the train reached the crossing. The engineer estimated that the train was 78 feet, or 3.5 secs, from the crossing when the truck crossed in front of the train. The red warning lights had been flashing for about 47 secs before the truck reached the bottom of the hill. The train's whistle was sounded about 20 secs before the truck reached the crossing.

Since a house located on the east side of the railroad tracks (Building L, Figure 1) would have limited the truckdriver's view of the approaching train, the earliest possible time he could have seen the train was after he passed this house. However, he had seen the flashing light at the top of the 720-foot grade and at this point, he had been aware for 565 feet that there was an approaching train even though he couldn't see it.

The road was signed by advance warning signs, including a posted 35 mph-speed limit sign and a "Hill" sign at the top of the grade. (See figures 5 and 9.) About 180 feet north of the crossing, a 25 mph speed limit sign had been placed; this sign was followed by another 25 mph speed



Figure 9. KY 11, view to the south from .25 mile north of RR crossing. Note HILL signs.

limit sign 106 feet from the crossing. All installed signs conformed to the Manual on Uniform Traffic Control Devices (MUTCD). ^{2/}

Residents in the area recalled five accidents during the past 8 years at this site. About 2 years before the accident, a coal truck struck a locomotive on the crossing. The other four accidents involved vehicle upsets on the downgrade; no other details were available.

Kentucky State records included two accidents: In 1976, the driver of an automobile struck a utility pole to avoid striking a train, and in 1977 an automobile struck a train on the crossing.

Since the accident under investigation, two other trucks have gone out-of-control on the downgrade. On December 15, 1977, a tractor-semitrailer went out of control, spilled its cargo, and damaged several automobiles. On February 2, 1978, a tractor-semitrailer lost its braking capability and overturned on the grade.

Officials of both Beattyville and the State of Kentucky realize the hazards to the property and its occupants, and plan to correct the situation.

^{2/} Federal Highway Administration Manual on Uniform Traffic Control Devices for Streets and Highways.

As early as January 22, 1975, citizens of Beattyville had requested the State to study the feasibility of another approach for KY 11 into Beattyville. During 1975 and early 1976, correspondence was exchanged and meetings on the subject were held. A letter from the Governor of Kentucky dated April 11, 1976, to the city of Beattyville confirmed plans for rerouting KY 11 and indicated that the project was in the early stages of the Federal-aid planning process.

Other Information

Vehicle Operations -- Usher has corporate offices in Paducah, Kentucky, and is an authorized motor common carrier transporting petroleum products and malt beverages throughout most of the eastern United States. It holds authority from the Kentucky Department of Transportation to transport petroleum products throughout the State. Usher is subject to all Federal Motor Vehicle Carrier Safety Regulations and hazardous materials regulations applicable to carriers engaged in interstate commerce.

Invoice/Bill of Lading No. 61302 lists the Gulf Oil Corporation in Louisville as the shipper who hired Usher to carry the shipment of gasoline from Louisville to Beattyville's Bulk Plant on September 24, 1977. The waybill was not signed by the shipper; the shipment is exempt under 49 CFR 172.204(b) from shipper's certification requirements because "the cargo tank was supplied by the carrier."

FMCSR Part 392.10, Railroad Grade Crossings: Stopping Required, requires that "The driver of a motor vehicle hauling flammable materials shall not cross a railroad track or tracks at grade unless he first stops the vehicle within 50 feet of and not closer than 15 feet to the tracks, thereafter listens and looks in each direction along the tracks for an approaching train and ascertains that no train is approaching." When it is safe to do so, he may cross the tracks in a gear that does not require a change of gears. The State of Kentucky law requires similar stops.

Available maintenance records on the tractor and cargo-tank semitrailer indicated that the carrier did not perform systematic inspections required nor had they inspected the cargo tank semitrailer visually within the previous 2 years.

FMCSR Part 396.2, Inspection and Maintenance, requires that carriers systematically inspect and maintain all motor vehicles subject to their control. Hazardous Materials Regulations Part 177.824, Retesting and Inspection of Cargo Tanks, require that every cargo tank used in the transportation of hazardous materials be visually inspected during every 2-year period and records of repairs are required to be retained in the motor carrier's files.

The two vehicles were purchased new by Usher. Usher performed routine inspections and maintenance of the equipment at their Louisville terminal; major repairs were performed by contractors.

Maintenance records on the combination unit revealed the following: On August 15, 1977, new brake linings, slack adjusters, and push rods were installed on all four wheels of the tractor bogie. One brake drum was replaced on September 8, 1977. Four new tires were installed on September 13 and 14, 1977; and the last lubrication service was on September 14, 1977. The cargo-tank-semitrailer was delivered to Usher on January 25, 1974, and its vapor recovery system was installed on January 30, 1975. The last brake adjustment was on March 19, 1977, and six new tires were installed in June and July 1977.

The Carrier's Safety Director said that it was their practice to service the tractors once every 10,000 miles and to inspect tractors and trailers once every 30 days. However, the last record of inspection on the tractor was June 25, 1976; the only record of inspection in the maintenance file for the trailer was October 1974, which had been the visual inspection and test required by Part 177.824 of the Hazardous Materials Regulations. The trailer had been inspected by the Bureau of Motor Carrier Safety (BMCS) on June 27, 1977, and a violation of Part 177.824 was noted on the inspection report, which indicated that the visual test was past due from October 1976. Although the carrier signed and forwarded the driver/equipment compliance check certifying that all violations noted on the report had been corrected, the carrier's files did not contain any records of compliance.

The Louisville terminal manager and the carrier's safety director said that they thought the visual test had been made by the AG&H Trailer Repair Company in Louisville, Kentucky. The Safety Board contacted the firm, which recalled having made the inspection; however, a written record of the test was not available.

ANALYSIS

The Accident

In order to understand the accident sequence, the Safety Board attempted to reconcile the truckdriver's statements, witness statements, and physical evidence. The truckdriver stated that when he reached the top of the hill, he stopped, saw no red lights flashing, and proceeded to descend in first gear. The tachometer was reading 1,000 to 1,200 rpm (speed of 7.5 to 8.5 mph). According to the truckdriver after he began his descent, the signal at the railroad crossing activated and he heard a train whistle. He pressed the service brake pedal all the way down, but was unable to slow the truck.

If the truck had been in first gear as claimed, little braking would have been required to stop the vehicle on the grade. In addition, the truck would not have made scuff marks as it rounded the curve. A witness driving up the hill said he did not see the truck stop and as he passed

the truck just below the crest of the grade, the truck was traveling at an estimated speed of 25 mph. Halfway down the grade, two witnesses in a yard adjacent to the roadway estimated the passing truck's speed at 50 to 55 mph. Also, the absence of evidence of engine damage indicates that the truck was not operating in first gear.

Because of extensive fire damage to the brake lining and other parts of the brake system, it was not possible to determine conclusively that the brakes did not fail. However, based on the driver's experience with the equipment earlier in the trip and postaccident examination of available components, there is little evidence to support his contention that his brakes failed. The last 2 miles of the 152-mile trip from Louisville to the crest of the hill included three 8-percent grades, three 7-percent grades, and one 6-percent grade. These grades varied from 400 to 800 ft long. Although an accumulation of grease was found on the brake lining of the right rear wheel, it probably resulted from failure of seals in the rear axle bearing during the fire. Gravity would have caused the grease to flow along the axle housing and onto the brake lining. Since grease was not on the lining before the accident, it did not interfere with braking action. Although the right front push rod measured 7 3/4 inches instead of the standard 5 1/2 inches, this did not affect the torque input to the right front bogie brake. The other seven wheel brakes were operable and would have provided ample torque for braking to stop the vehicle combination.

There was adequate air pressure to operate the brake system. The truckdriver said that the air gauge indicated between 90 and 100 psi. Another indicator that air pressure was available was the fact that the driver blew the air horn a number of times during the descent. Additionally, any significant loss of air pressure would have caused the spring brakes and eventually the trailer brakes to automatically activate and the vehicle would have stopped.

The police reported finding the truck in sixth gear at the accident scene. Had the truck been in sixth gear and experienced a complete brake failure, it would have accelerated to over 50 mph and would have overturned in the curve. Also, the engine would have been severely damaged, and it was not. In view of the foregoing the Safety Board concludes that the truckdriver's recollection is erroneous and that brake failure neither caused nor contributed to this accident. In addition, the Safety Board believes that the truck was being operated in eighth gear based on witness' speed estimates and the lack of physical damage to the engine.

The Safety Board believes that the truck traversed the 140-foot curve in a shorter radius and at a speed of 36 mph or less. This contention is supported by the tire scuff marks left by the truck. As a result of this maneuver, a second curve was created, the critical speed of which was less than the speed of the truck, and the truck overturned. The circumstantial

evidence tends to indicate that the truckdriver was trying to beat the train and lost control of his vehicle, because he was driving too fast for roadway geometry.

When the truck passed in front of it, the locomotive was 78 feet from the crossing. At 15 mph (22 ft/sec) it took the train 3.5 secs to reach the crossing. During that time the engineer had the truck in view, for about 2.8 secs. In this approximately 2.8 secs, the truck traveled about 150 feet and struck Building A. Using this time frame and the distance traveled by the truck, calculations indicate that the average speed of the truck was approximately 29 to 36 mph.

The truckdriver said he didn't remember anything from the time he entered the crossing until he felt heat on his back from the fire. Medical opinion indicates that the truckdriver could have frozen or fainted as the truck crossed the tracks. This is further supported by the statement of the locomotive engineer who said he saw no one in the cab as the truck entered and crossed the tracks. However, conscious or not, some steering input was made to keep the truck on its course as it crossed the tracks and traveled 150 feet until it struck Building A.

Tank Integrity

There is evidence that the rate of cargo spill was rapid. The location of the three victims in Building B suggests that they did not have time to react and flee to the rear of the store. From the time the train crossed the grade crossing it traveled an additional 90 feet (4.1 secs at 22 ft/sec) before the engineer saw the plume of fire and smoke. This indicates that the cargo spilled, ignited, and formed the large plume of smoke and fire within 4.1 secs.

The postcrash inspection of the remaining 1/3 of the tank shell disclosed no evidence of a breach or rupture. The vents and manhole cover seals were destroyed. Consequently, the cargo could have escaped through any one of several sources. The severe impact of the tank with Building A and B loaded the tank beyond its design range. Any one or all four manhole covers could have failed; the opening left by the missing 3-inch cap or any failure of the vapor recovery lines or the bottom loading and unloading piping, or all, could have provided an outlet. Since the cargo tank had been bottom loaded and had not as yet delivered any product, it is highly probable that the underbelly piping was still full of gasoline. This piping would contain an estimated 50 gallons of gasoline which could have leaked and become a primary fuel source for the fire. However, since evidence was destroyed any discussion of the source of escape is speculative.

Following its investigation of a previous accident ^{3/} the Safety Board recommended that the BMCS conduct an investigation designed to

3/ "Highway Accident Report: Tank-Truck Combination Overturn Onto Volkswagen Microbus, Followed by Fire, U.S. Route 611, Moscow, Pennsylvania, September 5, 1971," NTSB-HAR-72-6.

resolve the overturn stability problems (H-72-45). Also as a result of the accident on the New Jersey Turnpike on September 21, 1972, ^{4/} the Safety Board recommended that the BMCS study the existing regulations, 49 CFR 178.337, regarding more explicit rulemaking toward reducing the likelihood of leakage and subsequent catastrophic failure of hazardous materials cargo tanks in accidents (H-73-37). A resultant study for the FHWA by Dynamic Science, Inc., ^{5/} presented data showing that in 43 cargo tank overturn accidents, the shell leaked in 30 percent of the accidents and the manhole and fill openings failed in 21 percent of the accidents. On page 177, the study concludes that the specifications of MC 306 cargo tank standards need to be improved so that the frequency of overturn accidents can be reduced. On page 189, the report states that "the results of the cargo tank test program indicate that maintenance of cargo tanks needs to be improved."

Road Signing and Restrictive Roadside Areas

The road signing on the approach to the crest of the grade and on the downgrade did not adequately warn an unfamiliar driver of the percent and length of the grade or of the presence of the curve and railroad crossing at the foot of the grade. Since this truckdriver had traveled the route six times a week for the past 2 months and was thoroughly familiar with this grade, curve, and crossing, signing was not a contributing factor in this accident. However, the two accidents on the grade since this accident did involve truckdrivers who were not familiar with the area. In the interest of safety, motorists should be provided with the appropriate hazard information far enough in advance to permit them to safely negotiate the grade and grade crossing. For example, the speed limit of 35 mph should be reduced to 25 mph at the crest of the hill instead of half way down the hill; all advance warning signs should be located far enough in advance of the crest of the hill to permit drivers to read and understand them and get their vehicles under control, in the proper gear ratio, and to a safe speed before beginning the descent; and the hill sign should have supplemental plates or there should be additional signs stating "TRUCKS USE LOWER GEAR", and "13 Percent Grade Ahead--Prepare to Stop." In addition, the geometry and conditions call for advance railroad/highway "GRADE CROSSING" and "TURN" warning signs to be installed ahead of the hill's crest.

Since this accident, additional "HILL" signing has been installed and the road was "grooved." A stop sign has been placed at the top of the hill with appropriate warning signs in advance. Also, 12-inch flashing red beacons have been placed by the stop sign. The passive railroad sign has been moved to the crest of the hill. The downgrade is scheduled to be resurfaced within the next year.

^{4/} "Highway Accident Report: Multiple Vehicle Collision Followed by Propylene Cargo Tank Explosion, New Jersey Turnpike Exit 8, September 21, 1972," NTSB-HAR-73-4.

^{5/} FHWA Study, "Analysis of Cargo Tank Integrity in Rollovers, Final Report, October 1977," by Dynamic Sciences, Inc., FHWA Contract DOT-FH-9193.

Current FHWA guidelines provide 20-foot-wide clear roadside areas along high-speed highways to facilitate the recovery of errant vehicles. The FHWA is also monitoring projects at the State level to develop truck escape ramps on long steep grades. However, neither of these solutions to runaway vehicle problems is applicable or possible at such short steep grades with restricted roadside areas, as found at this accident site. Some type of energy-absorbing device should be developed for use where land constraints restrict construction of larger, more conventional escape ramps.

By allowing the construction of buildings in proximity to thoroughfares carrying heavy traffic flows, including hazardous material cargoes, and providing no protection to pedestrians or occupants of the buildings, a catastrophe such as this is made possible. Also, permitting cars to park on KY 11 in front of these buildings further restricted the flow of through traffic. If the cars had not been parked in front of Buildings A and B, the accident kinetics may have been different and possibly less severe.

CONCLUSIONS

Findings

1. The truckdriver did not stop the truck before starting down the grade.
2. The truckdriver was familiar with this route of travel -- the steep grade, the curve, and the railroad/highway grade crossing.
3. The truckdriver knew he was supposed to stop the truck at all grade crossings.
4. The truck descended the grade in eighth gear.
5. It is unlikely that the truck's brakes failed.
6. The average radius of the left curve at the foot of the grade was about 140 feet; however, the path of the truck was of a somewhat lesser radius.
7. The truck was traveling between 29 and 36 mph as it traversed the curve and entered the crossing.
8. The railroad flashers were activated for about 50.6 secs before the train reached the crossing and were visible to the truckdriver as he crested the grade 720 feet north of the crossing.
9. All installed traffic control signs were in accordance with the MUTCD.

10. Previous truck accidents have occurred under similar conditions at the same site, indicating the risks to life, health, and property there.
11. Signing was not adequate to warn an unfamiliar driver of the roadway conditions.
12. Buildings were located too close to the roadway to provide the desired level of safety to their occupants.
13. Energy-absorbing devices should be developed for use where land constraints construction of larger, more conventional escape ramps.
14. Possibly, the truckdriver was unconscious or "frozen" when the truck crossed the tracks.
15. The truckdriver may have been dislodged from his seat behind the steering wheel as the truck crossed the rough tracks because he was not wearing the available seatbelt.
16. There is no evidence to suggest that the driver was fatigued before the collision.
17. The gasoline escaped from the cargo tank rapidly. The source of escape could not be determined.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the loss of vehicle control because of speed excessive for highway geometry. Contributing to the accident was the truckdriver's lack of judgment when he failed to respond to the warnings and obey the rules of the road.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board has recommended that the city of Beattyville work jointly with the State of Kentucky to:

"Ban all parking on the west side of KY 11 from the L & N Railroad tracks to Main Street. (Class I, Urgent Action) (H-78-33)

"Coordinate with the citizens of Beattyville actions necessary to assure the prompt completion of the realignment of KY 11. (Class I, Urgent Action) (H-78-34)"

---to the State of Kentucky:

"Place an activated advance railroad warning sign, extend the 25 mph zone, determine through application of current technology the safest traversable speed for the curve, and then post a turn sign and an advisory speed plate, before the crest of the 12.6 percent grade on KY 11. (Class I, Urgent Action) (H-78-35)

"Improve the surface of the rail/highway grade crossing, the skid resistance properties of the hill, and, simultaneously, the superelevation of the curve. (Class II, Priority Action) (H-78-36)

"Develop a policy to prohibit parking adjacent to roads where restrictive geometric conditions exist. (Class III, Longer-Term Action) (H-78-37)

"Review similar downgrade to assure that the most restrictive features on or adjacent to steep downgrades are indicated before the descent begins. (Class III, Longer-Term Action) (H-78-38)

"Work jointly with Beattyville to ban all parking on the west side of KY 11 from the L & N Railroad tracks to Main Street and to expedite acquisition of land in the area of the demolished buildings if the new alignment is to pass through this area. (Class I, Urgent Action) (H-78-39)"

On July 19, 1978, the Safety Board further recommended that:

--the Federal Highway Administration:

"Expedite the implementation of the findings of the FHWA study, 'Analysis of Cargo Tank Integrity in Rollovers.' (Class II, Priority Action) (H-78-51)

"Research the feasibility of installing energy attenuating devices capable of decelerating large runaway vehicles on steep grades where the use of adjacent property prohibits the installation of truck escape routes. (Class II, Priority Action) (H-78-52)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ ELWOOD T. DRIVER
Member

July 6, 1978