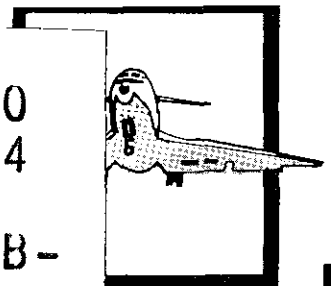

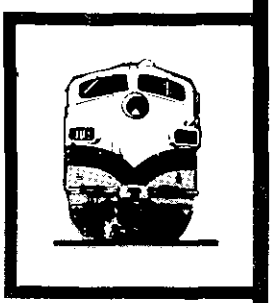

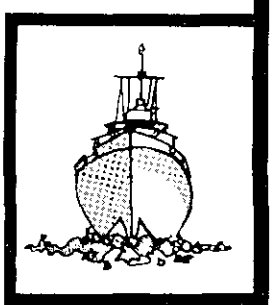

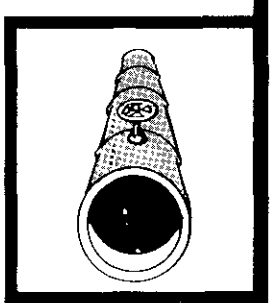

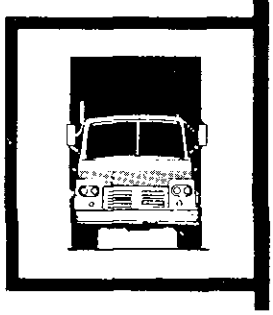

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD/HIGHWAY ACCIDENT REPORT

**COLLISION OF
AN AMTRAK/ATCHISON, TOPEKA AND SANTA FE
RAILWAY TRAIN AND A
TRACTOR-CARGO TANK SEMITRAILER**

MARLAND, OKLAHOMA

DECEMBER 15, 1976

REPORT NUMBER: NTSB-RHR-77-3

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1 Report No	2 Government Accession No.	3.Recipient's Catalog No
NTSB-RHR-77-3		

4 Title and Subtitle	5 Report Date
Railroad/Highway Accident Report - Collision of an Amtrak/Atchison, Topeka and Santa Fe Railway Train and a Tractor-Cargo Tank Semitrailer, Marland, Oklahoma, December 15, 1976	December 15, 1977
	6 Performing Organization Code
7 Author(s)	8 Performing Organization Report No.
9 Performing Organization Name and Address National Transportation Safety Board, Bureau of Accident Investigation Washington, D.C. 20594	10.Work Unit No. 2237
	11 Contract or Grant No
	13 Type of Report and Period Covered Railroad/Highway Accident Report December 15, 1976
12.Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D C. 20594	14 Sponsoring Agency Code

15 Supplementary Notes

16 Abstract

About 8:58 a.m., c.s.t., on December 15, 1976, Amtrak passenger train No. 15, operating on the Atchison, Topeka and Santa Fe Railway, collided with an oil-laden tractor-semitrailer (tank) at the Kay-Noble County Line Road grade crossing near Marland, Oklahoma. The truckdriver and 2 train crewmembers were killed; 11 other persons on the train were injured. The truck and its lading were destroyed. Two locomotive units and two cars of the train were damaged. Total accident damage was estimated to be $880,700.

The National Transportation Safety Board determines that the probable cause of this accident was the lack of adequate warning of the approach of a high-speed train to enable the truckdriver to ascertain when it was safe to enter the crossing. Contributing to the accident was the crossing's unsuitability for joint use by high-speed trains and heavily loaded trucks.

17 Key Words	18 Distribution Statement
Grade crossing accident; passenger train; single-main operation; SDP-40F locomotive; vehicle design; vehicle doors; CTC operation; horn/whistle use; automatic train stop; crossing protection; human judgment; hazardous materials; cargo-tank semitrailer; highway use; fog.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19.Security Classification (of this report)	20 Security Classification (of this page)	21 No. of Pages	22 Price
UNCLASSIFIED	UNCLASSIFIED	26	

NTSB Form 1765.2 (Rev. 9/74)

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD/HIGHWAY ACCIDENT REPORT

Adopted: December 15, 1977

COLLISION OF AN AMTRAK/ATCHISON, TOPEKA AND SANTA FE RAILWAY TRAIN AND A TRACTOR-CARGO TANK SEMITRAILER MARLAND, OKLAHOMA DECEMBER 15, 1976

SYNOPSIS

About 8:58 a.m., c.s.t., on December 15, 1976, Amtrak passenger train No. 15, operating on the Atchison, Topeka and Santa Fe Railway, collided with an oil-laden tractor-cargo tank semitrailer at the Kay-Noble County Line Road grade crossing near Marland, Oklahoma. The truckdriver and 2 train crewmembers were killed; 11 other persons on the train were injured. The truck and its lading were destroyed. Two locomotive units and two cars of the train were damaged. Total accident damage was estimated to be $880,700.

The National Transportation Safety Board determines that the probable cause of this accident was the lack of adequate warning of the approach of a high-speed train to enable the truckdriver to ascertain when it was safe to enter the crossing. Contributing to the accident was the crossing's unsuitability for joint use by high-speed trains and heavily loaded trucks.

INVESTIGATION

The Accident

At 8:47 a.m. on December 15, 1976, Amtrak passenger train No. 15 departed Ponca City, Oklahoma, on the single-track line of The Atchison, Topeka and Santa Fe Railway Company (AT&SF) for Houston, Texas. The brakes had been tested at the initial terminal and had functioned properly en route. The train had been running in extremely dense fog for about 10 miles. Visibility was reported to have been less than 700 feet. The Ponca City station agent stated that when the train departed, it was displaying two stationary white headlights on bright and had its white oscillating headlight operating.

The engineer was operating the train from the right side of the lead locomotive unit and the fireman was seated on the left side as the train approached a gravel road crossing 8.6 miles south 1/ of Ponca City. As the train passed the whistle post for southbound trains, located 1,924 feet north of the crossing, the engineer began to sound the standard crossing whistle signal. This signal is, successively, two long blasts, a short blast, and a long blast, with the last blast sounded continuously until the locomotive occupies the crossing.

A tractor-semitrailer (tank) loaded with about 9,600 gallons of crude oil was moving west on the gravel Kay-Noble County Line Road and approached the crossing at low speed. There were no automatic signals to warn the truckdriver of the train's approach. Evidence indicates that the truck stopped short of the track and then moved onto the crossing in low gear.

The train was moving at 89.6 mph, according to the tape of the speed recorder, as it approached the crossing about 8:58 a.m., and had reached a point about 700 feet, or 5 seconds, from the crossing before the engineer was able to see the truck. The train brakes were applied either by the engineer just before the accident or as a result of the collision. This action did not materially reduce the speed of the train prior to the accident. The locomotive struck the semitrailer at about its midpoint.

The cargo tank ruptured on impact causing crude oil to be sprayed over the vehicle, the train, and into the locomotive cab. The oil ignited immediately. The truckdriver, locomotive engineer, and the fireman were killed by the impact or the ensuing fire. There were no surviving eyewitnesses to the accident or to events immediately preceding it.

The tractor-semitrailer was thrown clear of the crossing with the trailer coming to rest in the southeast quadrant and the tractor in the southwest quadrant of the crossing. The train was not derailed and continued southward for 4,900 feet before stopping.

Approaching the crossing, a southbound train moves from a long tangent into a 1°00' curve to the left which begins 2,005 feet north of the crossing and ends 1,077 feet beyond the crossing. Over this distance there is an ascending southbound grade of 0.15 percent. The single main track is elevated about 3 to 4 feet above the surrounding terrain. With unlimited visibility, a train approaching from the north is first visible

1/ Actual compass direction is used throughout this report. The AT&SF Middle Division Time Table designates direction on the Oklahoma District as east-west and describes train No. 15 as westbound.

when it reaches a point 2,300 feet from the crossing. An average of 15 trains are operated daily over this line, including 2 passenger trains. The passenger trains, one in each direction, pass the crossing about 12 hours apart. (See figure 1.)

The county-maintained road runs east-west, averages 18 feet in width, and is surfaced with gravel. This road begins at State Route 156, about .4 mile west of the crossing, and ends about 65 feet east of the crossing. The angle of intersection in the northeast quadrant of the crossing is about 52°. A westbound vehicle on the road ascends a grade of about 5 percent over the 65 feet immediately east of the crossing. The west approach to the crossing is almost level. A single standard crossbuck railroad crossing sign is located in the southwest quadrant.

The east end of the county road is the junction of two dead-end, single-lane dirt and gravel roads, each of which serves a single farm. One extends northward for about 4,000 feet and parallels the railroad for much of this distance. The other is an extension of the county road reaching a farm about 1,000 feet east of the crossing. There is no through traffic. The Oklahoma Department of Transportation estimates that an average of 20 motor vehicles use the road daily. Other than residents of the farms, the principal user of the road is a tank truck which, for at least 5 years, has been coming once weekly to remove crude oil from storage tanks located near producing wells at the ends of the farm lanes. The truck is always empty going to the storage tanks and fully loaded when it returns to the State highway. About 1 hour is required to load the truck at the storage tanks. The location is always serviced during daylight hours, but the time of day and day of the week will vary depending on the production volume of the wells.

Injuries to Persons

Injuries	Driver	Passengers	Traincrew
Fatal	1	0	2
Nonfatal		9	2
None		106	13

Vehicle Damage

The lead locomotive unit's cab was heavily damaged by fire as far back as the electrical cabinet wall. Both the outer and inner nose doors were torn loose from their hinges and the cab windows were broken. The second locomotive unit and two leading cars were damaged by fire. The exteriors of the other cars were slightly damaged by fire.

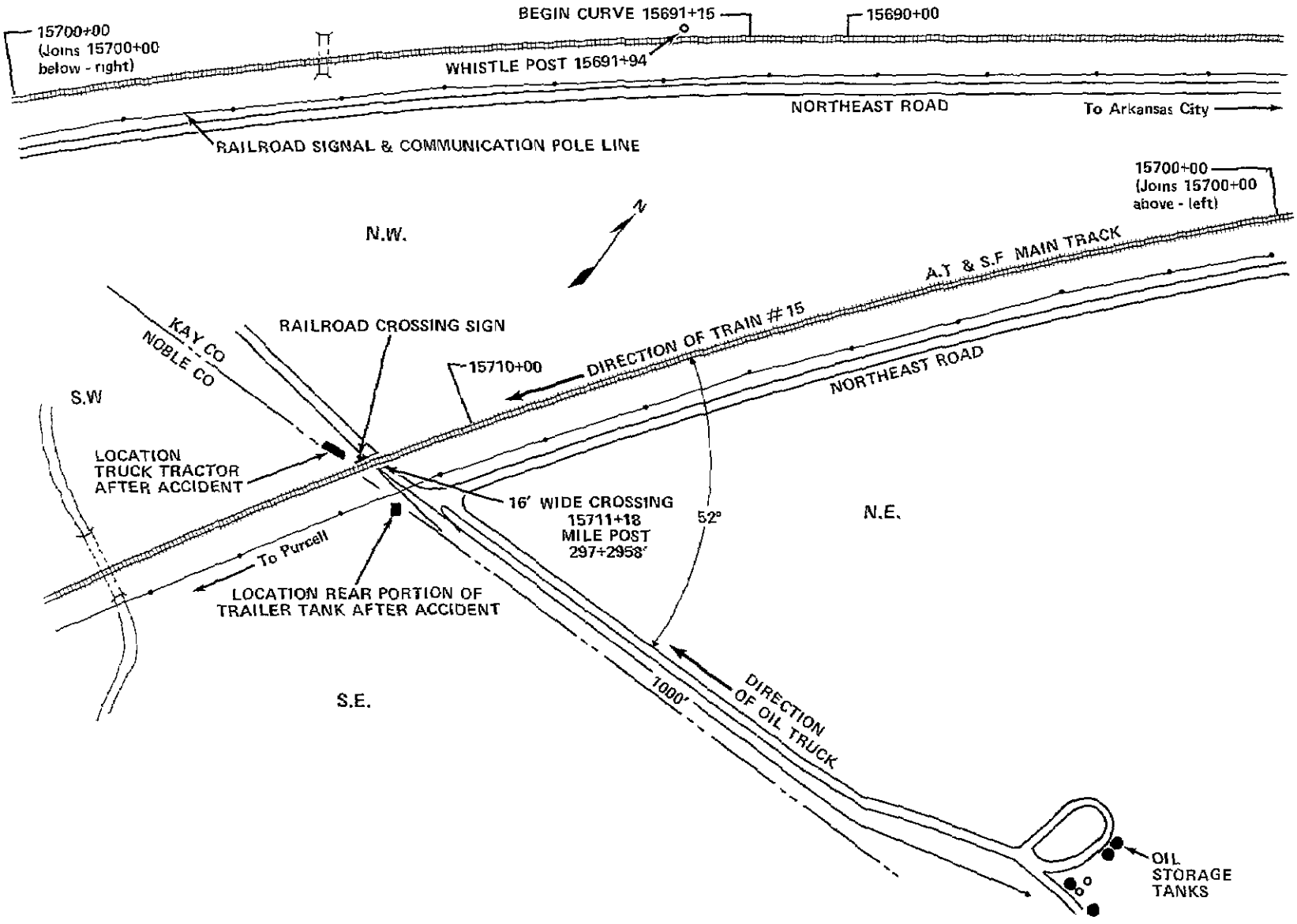

Figure 1. Plan view of accident site.

The tractor-cargo tank semitrailer, as well as the crude oil lading in the trailer, were destroyed by the collision and ensuing fire.

Damage was estimated as follows:

Train equipment	$811,200
Tractor-semitrailer	57,500
Lading	3,000
Track, crossing	9,000
Total	$880,700

Vehicle Information

The train consisted of two General Motors Model SDP-40F locomotive units, two baggage cars, and seven passenger-carrying cars. The lead locomotive unit had a pilot skirt and a latch-secured door in the nose which provided access to the cab. The units were equipped with speed indicators, speed recorders, automatic train stop inductors, and alerter-type safety control. When actuated, the alerter produces a full service brake application and reduces the engine to idle position.

The tractor was a 1976 Kenworth Model W-900 with 204-inch wheelbase and a Cummins NTC 290 diesel engine. It had been in use less than 6 months. The tractor was equipped with airbrakes and rearview mirrors on both sides of the cab. The tank trailer was a type MC-307-AL manufactured by Vim Trailer Company in 1972. The tank was 41 feet 3 inches long, 8 feet in diameter, and had a capacity of 9,870 gallons. Overall length of the combination vehicle was 54 feet 7 inches. The total gross weight with cargo was about 95,200 pounds. It was owned and operated by the Koch Oil Company of Wichita, Kansas.

Operator Information

The 52-year-old truckdriver held an unrestricted commercial chauffeur's license first issued by the State of Oklahoma in 1962. The driver had a 14-year safe-driving record, although he was cited twice for operating overweight trucks and was involved in an accident with another vehicle in 1975 for which he was not charged.

Acquaintances of the driver stated that he wore glasses but did not need them to pass the driver test. A company physical on January 7, 1976, produced the following evaluation of the driver's eyesight:

Without glasses - Right 20/15; Left 20/25
With glasses - Right 20/13; Left 20/13

The truckdriver had no known hearing defect. No toxicological test was possible due to the effect of the fire. The driver had operated over the route involved for about 5 years.

The 58-year-old engineer was regularly assigned to the train involved and had been on duty about 45 minutes before the accident. He was hired as a fireman in 1941 and was promoted to engineer in 1949. The engineer was last examined on the AT&SF operating rules on March 8, 1976, and received a company physical examination on October 11, 1976. Neither examination resulted in any restrictions or exceptions.

Method of Operation

Amtrak trains are operated on the AT&SF by its crews and rules. Trains operate over this single-track line of the AT&SF Oklahoma District by signals of a traffic control system combined with inductive automatic train stop. The maximum authorized speed for passenger trains is 90 mph. Approaching railroad/highway grade crossings, the engineer is required to begin sounding the prescribed whistle signal at the whistle post and to continue sounding the signal until the locomotive has occupied the crossing. A rule requires that the white oscillating headlight be operated in addition to having the stationary headlight burning when approaching crossings. (See appendix A.) AT&SF rules do not require reduction in train speeds in weather conditions which restrict visibility.

Federal regulations (49 CFR 392.10) and Oklahoma law require that a vehicle transporting flammable liquid must be stopped short of a railroad crossing -- within 50 feet but not less than 15 feet from the nearest rail of the crossing. After stopping, the driver must "listen and look in both directions for any approaching train... and shall not proceed until he can do so safely." Further, the law requires that the vehicle cross in low gear and prohibits the driver from shifting gears while crossing the track. (See appendix B.) Maximum permissible speed on the county road was 55 mph. The Koch Oil Company employed the driver and owned the combination vehicle. The company's rules require that a full stop be made at all railroad crossings. Nothing in the rules applies to situations of limited visibility. (See appendix C.)

Meteorological Information

The temperature was about 32°F and it was dry. The weather had been mild and stable with relatively clear skies for about 30 hours before the accident. Temperatures ranged from the previous day's high of 59°F at 4:00 p.m. to a low of 30°F at 8:00 a.m. the morning of the accident. There was a drop of 24 degrees between 4:00 p.m. and 9:00 p.m. on December 14 resulting in scattered ground fog throughout north-central Oklahoma during the night. Due to dense fog, ground visibility was reported to be less than 700 feet in the crossing area at the time of the accident. Under clear skies, the fog dissipated rapidly and the temperature rose to 57° by 4:00 p.m. Winds were northwesterly up to 6 mph The National Weather Service reports that ground fog is fairly common in this area during the fall and early winter months.

Survival Aspects

The truckdriver could not have survived this accident. The design of the locomotive unit cab and nose door, which did not prevent penetration of the flammable liquid into the operating compartment, substantially reduced any chance of survival for the enginecrew. However, the train's continued high-speed movement through and beyond the fire area prevented significant intrusion of fire into the passenger-carrying cars. Eleven persons in the cars received emergency medical attention. One passenger had minor burns on the hands and three passengers were treated for shock. Two crewmembers and four passengers received minor cuts, bruises, and sprains. One passenger was treated for a back injury.

Tests and Research

It was established that from a point 15 feet east of the track, the truck would have had to travel about 85 feet to clear the crossing. Considering the gear ratio and horsepower of the truck tractor, the approximate gross weight of the combination vehicle, and the grade and surface of the road, the truck's manufacturer calculated that the truck required about 23 seconds to travel the distance. This conclusion also was based on the fact that the vehicle would have started in first gear and remained in that gear until the crossing was cleared. Maximum speed attained would have been about 4.9 mph. Representatives of the trucking company reported that in a postaccident test a similar vehicle required only 14 seconds to clear the crossing. However, the test was not observed by accredited witnesses. Also, it is not known whether the applicable stopping law was strictly observed nor whether the various vehicle factors were the same as those involved in the accident.

At 89.6 mph, a train can travel the 1,924 feet from the whistle post to the crossing in 14.6 seconds. The sound of the initial blast of the whistle sounded at the whistle post would travel no faster than 1,056 feet per second and would take at least 1.8 seconds to reach the crossing. Thus, a driver would have no more than 12.8 seconds from the earliest time he could possibly hear the whistle to the time the locomotive reaches the crossing. Tests have shown, however, that the sound level produced by the locomotive whistle would not be sufficient to overcome the noise of a truck's engine and to cause a driver to react before the locomotive was about 6 seconds, or less than 800 feet, from the crossing. 2/

2/ Based on test data and conclusions contained in "The Visibility and Audibility of Trains Approaching Rail-Highway Grade Crossings," Federal Railroad Administration Report No. FRA-RP-71-1, May 1971) and confirmed by tests made at the Kay-Noble County Line Road grade crossing following the accident. The tests were made with a similar tractor with cab windows closed.

The locomotive's automatic brake valve handle was found after the accident in "handle off" position, which would have provided a full service brake application, overriden the application of any safety devices, and depleted trainline air pressure to zero.

Physical evidence in the form of tire marks and piled gravel indicated that the driver had stopped short of the crossing as required by state law and the trucking company's rule.

Other Information

The Oklahoma Department of Transportation has sole jurisdiction over the application of warning devices at all railroad/highway grade crossings in Oklahoma. There are 5,775 such grade crossings. Only 834 are protected with "active" warning devices, such as gates and flasher lights, that are automatically train-activated. There are 4,743 crossings with "passive" protection, including crossbucks or stop signs. The remaining 198 crossings are unprotected. Only 17 percent of Oklahoma crossings have advance warning signs compared with 40 percent nationally. Two-thirds of the State's crossings are classified as rural; two-thirds have average daily highway traffic of 250 vehicles or less; and two-thirds involve railroad lines with five or less trains daily. 3/ The precise number of crossings in the State with railroads having maximum timetable speeds of 80 mph or higher is unknown, but probably is very small. Only 878 of the 219,000 grade crossings in the United States fall into this category. Most of those in Oklahoma are on the line involved in this accident.

Prior to September 1977, the Oklahoma Department of Transportation used a simple "modified New Hampshire" formula for determining grade crossing protection priority. The formula was based on volume of highway traffic, train frequency, and existing protection. Maximum timetable speed, angle of intersection and other crossing characteristics, accident experience, and use by vehicles carrying hazardous materials were not taken into consideration. The present criteria include all of these factors except the consideration of hazardous materials.

3/ From "Summary Statistics of the National Railroad-Highway Crossing Inventory for Public At-Grade Crossings," Federal Railroad Administration Report No. FRA-OPPD-77-8, June 1977.

ANALYSIS

The crossing was constructed many years ago to provide ordinary vehicular passage over the railroad as part of an access route between the farms and the main highway. As such, the crossing was ordinarily safe for transit by automobiles and light commercial vehicles. However, the development of oil wells on the farms created a need to transport the oil produced to bulk terminals. The use of the farm crossing by heavy trucks loaded with flammable oil poses a serious hazard to truck-drivers, traincrews, and train passengers. This hazard was not contemplated when the crossing was opened and there has been no improvement to the crossing's characteristics and protection since the use by the oil trucks began.

Under the prior Oklahoma formula the Kay-Noble County Line Road crossing was not a likely candidate for improved crossing protection. Although in the top 15 percent in terms of train frequency, it was used by only an average of 20 vehicles per day. The three most critical factors in the case of this crossing -- high train speed, severe crossing characteristics, and use by trucks hauling hazardous materials -- would not have been considered under the State's grade crossing safety program. The transportation department probably could not have recognized the crossing's hazards unless some complaint or petition had been initiated by the country, railroad, trucking company, or the oil producers. There is no record that any of these parties ever took exception to the characteristics of the crossing, the use by oil-hauling trucks, the protection provided, or the speed of the trains.

Under the conditions that prevailed at the time of the accident, the truckdriver had to depend on two means of detecting an approaching train -- sighting the train or hearing its crossing warning whistle signal. The earliest that the driver could have heard the whistle was 12.8 seconds before the train reached the crossing, even if he heard the initial sound of the whistle 1,924 feet away. At that point, the driver already would have committed to cross the track and could not have avoided the collision. If the driver had been looking toward the train when it first became visible through the fog, he might have been able to see it 700 feet, or 5 to 6 seconds, before the train arrived at the crossing. The outcome would have been the same.

Approaching the crossing from the west, there is virtually no ascending grade. An empty eastbound truck can accelerate easily from the statutory stop and clear the crossing quickly. Because of track curvature, the clear sight distance in both directions along the track is greater than it is from the east side of the crossing. The angle at which the road intersects the track is favorable. But approaching the crossing from the east, a vehicle must be stopped short of the track and

started up on a steep ascending grade with an unstable gravel surface. Sight distance in both directions is reduced. The track curvature combined with the sharp angle of intersection makes it necessary for the driver to literally look over his shoulder to see a train approaching from the north.

Without adequate automatic warning devices or some form of positive assurance that a train is not approaching, a fully-loaded truck cannot safely traverse the crossing, even under conditions of maximum daylight visibility. From the east approach to the crossing, a southbound train can be seen first when it is 2,300 feet away. At 90 mph, the train requires less than 17 seconds to cover this distance. Based on the truck manufacturer's computations, the vehicle could not fully comply with the statuatory stopping requirement and clear the crossing in less than 23 seconds under optimum conditions. Even if the 14 second crossing time of the unsubstantiated post-accident test is accepted, a collision would be avoided by only 3 seconds. The driver might look north, not see a train, and then look south. Again seeing nothing, he would start forward unaware that in the interim a southbound train had entered the sight zone. Greater load, loose gravel, smooth tires, wet or icy road surface, power loss, or panic-induced break in acceleration also could cause a critical delay in clearing the crossing.

After a driver starts forward to cross the track, he must have sufficient warning of the approach of a train to allow his vehicle to clear the crossing before the train arrives. This is true regardless of visibility. Therefore, if vehicles are going to cross tracks at grade safely, there must be adequate warning of the approach of trains.

In a maximum visibility situation, the train's engineer might be able to take sufficiently effective braking action to give a truck more time to clear the track. However, such a hypothesis is hardly a proper gauge of a crossing's safety because an engineer does not initiate braking simply because he observes a truck approaching a crossing. Moreover, a train being rapidly slowed by emergency braking could still strike the truck, ignite its cargo, and come to a stop with its passenger-carrying cars exposed to ensuing fire.

In 1968, as the result of the investigation of a grade crossing accident at Waterloo, Nebraska, 4/ the Safety Board recommended that the Federal Railroad Administration (FRA), Penn Central Railroad, Association of American Railroads, Union Pacific Railroad, and the Office of High Speed Ground Transportation of the U.S. Department of Transportation "...consider the implications of this accident analysis for logical and necessary train operating speed reductions under restricted visibility wherever train tracks cross unprotected grade crossings."

4/ NTSB Report: "Waterloo, Nebraska, Public School School Bus/Union Pacific Railroad Crossing Freight Train Accident, Waterloo, Nebraska, October 2, 1967," (NTSB-SS-R/H-3).

The recommendation was opposed by all recipients and no positive action resulted. Therefore, the problem of insufficient visual warning of the approach of a train to allow a motor vehicle to cross safely still exists today at an unknown number of unprotected and passively protected railroad/highway grade crossings.

It is intolerable to expect drivers to cross tracks at grade under conditions of train speed and perception of train approach which do not allow them reasonable chance of doing so safely. It is equally intolerable to require engineers to operate trains under the same conditions, particularly when the motor vehicle may be a truck loaded with flammable liquid. Therefore, it is incumbent on both railroad and highway users to devise procedures governing the use of those crossings which cannot qualify for active warning devices under current criteria.

The track, train, highway, motor vehicles, those who operate and use them, and all of their interfaces make up the system in which this accident occurred. The solution to the problem lies in a complete system safety analysis with the final decision being made cooperatively between the representatives of the users of both the railroad and the highway.

The truckdriver had a good driving record and had a reputation as a safe and careful driver. The truckdriver had been physically examined in connection with his employment less than a year before the accident. The investigation did not develop any indication of physical or mental impairment on the part of the driver which might have contributed to the accident.

Both occupants of the locomotive cab were killed instantly. With visibility estimated at less than 700 feet, the enginemen were probably unaware of the impending collision until about 5 seconds before it occurred. As there was no derailment and the collision impact did not greatly reduce the speed of the train, the enginemen probably were killed by the flaming oil which entered the cab. Both the outer and inner nose compartment doors were insufficiently secured to resist the impact and explosive ignition of the oil. Both were blown inward off their hinges and with the broken cab windows permitted immediate and massive entry of flaming oil into the cab.

The locomotive unit was fitted with a pilot skirt which resisted the impact/explosion and forced the separated tractor and trailer away from the track. This action probably was significant in preventing derailment of the train and assured that the passenger-carrying cars would proceed well beyond the fire area. Had a general derailment occurred at the crossing, it is likely there would have been serious injury to other crewmembers and passengers.

The problem of flammable liquids entering a locomotive unit's control compartment was pointed out by the Safety Board in its report on a grade crossing accident at Loda, Illinois, in 1970. 5/ In 1971, the Safety Board recommended that the FRA:

> ...consider possible changes in the design of locomotive control compartments, such as the shielding of the compartment against direct penetration of fire, the use of fire resistant materials, protection of air inlets and vents, and the strengthening of doors, that would provide greater protection to the occupants of the locomotive when a tank truck carrying flammable material is struck by the train. Such studies should include the development of escape plans and the assurance of their performance by tests. Until such regulatory changes can be implemented, the Association of American Railroads and the Federal Railroad Administration should consider interim changes to locomotives exposed to truck traffic at grade crossings that would improve the chances of fire survival of the occupants of the locomotive.

FRA organized a Locomotive Control Compartment Committee with the intent of developing criteria for and means of preventing, among other things, the penetration of flammable liquids into the locomotive control compartment. In 1974, a contract was awarded for a study in connection with the safety problems related to the locomotive control compartment. There is no evidence that FRA or the Locomotive Control Compartment Committee, which is still in existence, have done anything positive about correcting the problem.

The nose areas of some diesel locomotives in Canada have been completely closed to exclude the frigid Canadian air in wintertime. That change has effectively precluded the possibility of flammable liquids entering the control compartments through front doors under circumstances similar to this accident.

Although the blast of the exploding tank in this accident might have blown out the windows and windshields as well as the front door, it was technically feasible to design against such damage before the SDP-40F locomotive units were manufactured. All parties involved in the design, construction, and purchase of the units should have been aware of this.

5/ "Railroad/Highway Accident Report: Illinois Central Railroad Company Train Collision with Gasoline Tank Truck at South Second Street Grade Crossing, Loda, Illinois, January 24, 1970," (NTSB-RHR-71-1).

CONCLUSIONS

Findings

1. Amtrak train No. 15 was being operated in accordance with AT&SF rules.

2. AT&SF operating rules do not require reduction in train speed in weather conditions which restrict visibility.

3. The train whistle could not have been heard earlier than 12.8 seconds before the train reached the crossing; the train could not have been seen earlier than 6 seconds before the train reached the crossing.

4. The truck, from a standstill, could not have crossed the track in less than 23 seconds. The heavy load, steep grade, and unstable surface of the east approach affected the truck's acceleration and adversely affected the time required to clear the crossing.

5. It was not safe for the loaded tractor-semitrailer to use the crossing without some form of positive assurance that a train was not approaching.

6. It is questionable if this crossing could be safely used by heavily loaded trucks even under optimum weather conditions.

7. It is probable that neither the users of the crossing, the county, nor the Oklahoma Department of Transportation recognized that the use of the crossing by oil trucks was hazardous.

8. Grade crossing protection criteria used by the Oklahoma Department of Transportation do not include use by trucks carrying flammable oil and gas. No studies have been made to identify crossings where the combination of such use and high train speeds creates a hazardous situation.

9. Because of limited visibility, the enginecrew did not have sufficient time to slow the train or to escape from the locomotive cab after becoming aware of the truck at the crossing.

10. The methods used to hinge and secure the locomotive nose doors were inadequate to resist the force of impact and explosion which allowed immediate entry of burning oil into the locomotive cab.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the lack of adequate warning of the approach of a high-speed train to enable the truckdriver to ascertain when it was safe to enter the crossing. Contributing to the accident was the crossing's unsuitability for joint use by high-speed trains and heavily loaded trucks.

RECOMMENDATIONS

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

.....to the U.S. Department of Transportation:

"Require all head-end locomotive units to be designed to prevent serious injury to crewmembers from penetration of flammable substances into control compartments. (Class II, Priority Action) (R-77-37)

"In cooperation with the States, identify those grade crossings where inadequate warnings do not permit the prudent and careful driver to cross without risk of injury or death. (Class II, Priority Action) (R-77-38)

"Undertake a program to protect the crossings which have been so identified. Consideration should be given to adequate protection or reduction of train speeds in conditions of reduced visibility and/or signals that meet real train movement situations. (Class II, Priority Action) (R-77-39)"

.....to the National Railroad Passenger Corporation (Amtrak):

"Strengthen and improve its locomotive units' operating compartments so that they effectively resist impact forces and deter entry of flammable liquids into locomotive cabs. (Class II, Priority Action) (R-77-40)"

.....to the State of Oklahoma Department of Transportation:

"Initiate studies of those railroad/highway grade crossings in Oklahoma that are used by high-speed trains as well as vehicles transporting oil, gas, and other hazardous materials, to establish whether such joint use is safe in view of existing crossing characteristics and protection. (Class II, Priority Action) (H-77-33)

"Enlarge its grade crossing safety criteria to include use by trucks carrying flammable oil and gas, and other hazardous materials. (Class II, Priority Action) (H-77-34)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ KAY BAILEY
Acting Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ JAMES B. KING
Member

PHILIP A. HOGUE, Member, did not participate.

December 15, 1977

APPENDIX A

Excerpts from Operating Rules of The Atchison, Topeka and Santa Fe Railway Company

BELL AND WHISTLE SIGNALS

*****

19 The whistle must be sounded at all places where required by rule or law, or to prevent accidents The sound of the whistle signal should be distinct, with intensity and duration proportionate to the distance signal is to be conveyed The unnecessary use of the whistle or bell is prohibited In the event of a whistle failure, the bell must be rung continuously while train is enroute and every precaution taken to prevent an accident

Where in these rules the term whistle is used, it includes either horn or whistle The whistle signals prescribed below are illustrated by "o" for short sounds, and "——" for longer sounds:

SOUND	INDICATION

*****

(L) — — o —	Approaching public crossings at grade, to be prolonged or repeated until crossing is occupied by engine or cars This signal must also be sounded approaching tunnels, curves, and other obscure places; approaching a train standing on an adjacent track; approaching private crossings at grade within shop or industrial areas

TRAIN SIGNALS

22(A) The headlight must be displayed to the front of every train by day and night, except that it must be extinguished:

(1) When a train is stopped clear of main track to meet another train

(2) When a train is standing at a junction, or at the end of double track or two or more tracks, to meet another train

*****

23(A). The white gyrating light on engines so equipped must be displayed by day and night Should train be stopped suddenly, the red beam must be displayed immediately Trains on adjacent tracks observing red beam must be stopped, and not proceed until it is known that their track is clear Display of red beam does not relieve employes from complying with Rules 99 and 109 Employes should not look directly into the red beam

12 OKLAHOMA DISTRICT — MIDDLE DIVISION

TIME TABLE NO 4 — October 31, 1976

WEST-WARD First Class 15	Capacity of Sidings in Feet	Ruling Grade Ascending Feet Per Mile	STATIONS	Ruling Grade Ascending Feet Per Mile	Mile Post	Communications Turn Tables and Wyes	EAST-WARD First Class 16
Leave Daily							Arrive Daily
AM 7.50		0	ARKANSAS CITY — 0 8	0	263 4	T Y C R	PM ‡11 40
		40 6	SLSF MP Crossing — 11 5	31 7	264 2		
	12185	0	NEWKIRK — 5.2	52 8	276 8		
		0	KILDARE — 7 8	34 4	281 0		
‡ 8.20	32442	0	PONCA CITY — 1 8	35 8	288 9	Y C R	‡11.05
		45 8	CRI&P Crossing — 9 6	40 9	290 7		
	8616	22 0	MARLAND — 6 5	52 8	300 3	C	
	7447	52 8	RED ROCK — 5.9	29 9	306 8	C	
	7993	0	OTOE — 3.6	52 8	312 7		
		52 8	BLACK BEAR SL SF Crossing — 5 3	33 1	316 3		
‡ 8.53	S 3624 N 5515	52 8	PERRY — 6 8	52 8	321 6	R C	‡10.30
	8563	25 1	ASP — 10 4	52 8	328 4		
	10149	52 8	MULHALL — 8 1	52 8	338 8		
	8915	36 2	LAWRIE — 5 4	35 3	347 2		
‡ 9.23	14725	38 6	GUTHRIE — 7 4	16 2	352 6	Y C R	‡10.05
	9735	37 0	SEWARD — 10 0	0	360 1		
	7041	50 1	EDMOND — 6.7	23 9	370 1		
	8029	52 8	BRITTON — 3.8	52 8	376 8		
		48 8	NOWERS — 3 4	45 8	380 6		
‡10.05 10.15		24 0	OKLAHOMA CITY — 1.7	17 6	384 0	Y C R	9.15 ‡ 9.05
	8062	46 3	BURNETT — 3 1	0	385 7		
		38 3	FLYNN — 4 4	46 7	388 8		
	8351	28 5	MOORE — 8.6	48 6	393 2		
‡10.45	6678	46 5	NORMAN — 6 2	32 5	401 8	C R	‡ 8.45
	9075	0	NOBLE — 9 2	52 8	408 1		
‡11.15 AM			PURCELL		417 3	Y C R	8.25 PM
Arrive Daily			(153 2)				Leave Daily
44.8			Average speed per hour				47 1

TCS IN EFFECT:
Main track and sidings:
Arkansas City to Nowers.
Burnett to Purcell.

RULE 251 IN EFFECT:
Nowers to M.P. 383 6 (Oklahoma City).
M P 384 6 (Oklahoma City) to Burnett.

RULE 94 IN EFFECT:
End of Double Track Nowers to end of Double Track Burnett

TRACK SIDE WARNING DETECTORS
HOT BOX AND DRAGGING EQUIPMENT DETECTORS

Detector Location	Locator Location
M P. 279 0	Westward M.P 280.9 Eastward M.P 276.0
M P 304 0	Westward M P 306 0 Eastward M P 302 0
M P 341 5	Westward M.P 343 9 Eastward M.P. 339 1
M P 367 6	Westward M.P 369.1 Eastward M.P. 366.0
M P 405 4	Westward M.P 407 6 Eastward M P 403 2

Dragging equipment will also actuate alarms M P 279 0 M P 304 0, M P 367 6 and M P 405 4
See Special Rule 12.

SHIFTED LOAD DETECTORS

Detector Location	Indicator Location
M P 341 5	Westward M P 343 9
M P. 347 8	Eastward M P 347 8 and M P 346 0
M.P. 407.4	Westward M.P. 409.5

Detectors on both sides of track which will not clear man on side of cars
See Special Rule 12.

SPECIAL RULES

1 SPEED REGULATIONS

(A) MAXIMUM AUTHORIZED SPEED

BETWEEN:	MPH Psgr	MPH Frt.
Arkansas City and Purcell	90	60*

*Maximum authorized speed for freight trains when averaging 85 tons and over per car, or over 5,000 tons total 45 MPH
Maximum authorized speed for freight trains handling one or more empty cars (Cabooses and cars loaded with empty trailers or empty containers are considered loads) 55 MPH

JUNCTION SWITCHES Rule 98 (D)

LOCATION	NORMAL POSITION
Black Bear	Oklahoma District

Trains originating Arkansas City, Nowers and Purcell must secure clearance card before leaving

At Arkansas City, between hand throw crossover M P. 262 9 and interlocked crossover M P 264 1, *maximum authorized* speed on main track is 20 MPH

At Perry, on North siding, maximum authorized speed 20 MPH while head end of train is passing over hand throw switches to engine tie-up track and at both ends of yard

At Guthrie, on siding, maximum authorized speed 20 MPH while head end of train is passing over hand throw switch at west end of tail track

Trains to be operated from Black Bear via SLSF Ry. must secure SLSF clearance card at ATSF Station Perry before leaving ATSF trains will use SLSF tracks between Black Bear and Camp and be governed by SLSF Time Table, Rules and Special Instructions

APPENDIX B

Excerpts from State of Oklahoma Motor Vehicle Laws

MOTOR VEHICLE LAWS Ch 11

ARTICLE VII SPECIAL STOPS REQUIRED

§ 11–701 OBEDIENCE TO SIGNAL INDICATING APPROACH OF TRAIN —(a) Whenever any person driving a vehicle approaches a railroad grade crossing under any of the circumstances stated in this section, the driver of such vehicle shall stop within fifty feet but not less than fifteen feet from the nearest rail of such railroad, and shall not proceed until he can do so safety The foregoing requirements shall apply when:

1 A clearly visible electric or mechanical signal device gives warning of the immediate approach of a railroad train

2 A crossing gate is lowered or when a human flagman gives or continues to give a signal of the approach or passage of a railroad train;

3 A railroad train approaching within approximately one thousand five hundred feet of the highway crossing emits a signal audible from such distance and such railroad train, by reason of its speed or nearness to such crossing, is an immediate hazard;

4 An approaching railroad train is plainly visible and is in hazardous proximity to such crossing

(b) No person shall drive any vehicle through, around or under any crossing gate or barrier at a railroad crossing while such gate or barrier is closed or is being opened or closed (1961)

***11–701. FAILURE TO STOP (OR) IMPROPER STOPPING AT RR SIGNAL (OR) BARRIER, (OR) CROSSING GATE**
FAILURE TO YIELD TO RAILROAD TRAIN

Ch 11 RULES OF THE ROAD 47 § 11–704

§ 11–702 CERTAIN VEHICLES MUST STOP AT ALL RAILROAD GRADE CROSSINGS —(a) The driver of any motor vehicle carrying passengers for hire, or of any school bus carrying any school child, or of any vehicle carrying explosive substances or flammable liquids as a cargo or part of a cargo before crossing at grade any track or tracks of a railroad, shall stop such vehicle within fifty feet but not less than fifteen feet from the nearest rail of such railroad and while so stopped shall listen and look in both directions along such track for any approaching train, and for signals indicating the approach of a train, except as hereinafter provided, and shall not proceed until he can do so safely. After stopping as required herein and upon proceeding when it is safe to do so, the driver of any said vehicle shall cross only in such gear of the vehicle that there will be no necessity for changing gears while traversing such crossing and the driver shall not shift gears while crossing the track or tracks

(b) No stop need be made at any such crossing where a police officer or a traffic-control signal directs traffic to proceed (1961)

***11–702. a.FAILURE TO PROPERLY STOP AT RAILROAD CROSSING.**

Subpart B—Driving of Vehicles

§ 392.10 Railroad grade crossings; stopping required.

(a) Except as provided in paragraph (b) of this section, the driver of a motor vehicle specified in subparagraphs (1) through (6) of this paragraph 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, the driver may drive the vehicle across the tracks in a gear that permits the vehicle to complete the crossing without a change of gears The driver must not shift gears while crossing the tracks

(1) Every bus transporting passengers,

(2) Every motor vehicle transporting any quantity of chlorine,

(3) Every motor vehicle which, in accordance with the regulations of the Department of Transportation, is required to be marked or placarded with one of the following markings:

(i) Explosives A.
(ii) Explosives B.
(iii) Poison
(iv) Flammable.
(v) Oxidizers.
(vi) Compressed Gas.
(vii) Corrosives.
(viii) Flammable Gas.
(ix) Radioactive.
(x) Dangerous
(xi) Combustible (cargo tanks only)

(4) Every cargo tank motor vehicle, whether loaded or empty, used for the transportation of any hazardous material as defined in the Hazardous Materials Regulations of the Department of Transportation, Parts 170–189 of this title

(5) Every cargo tank motor vehicle transporting a commodity which at the time of loading has a temperature above its flash point as determined by § 173.115 of this title.

(6) Every cargo tank motor vehicle, whether loaded or empty, transporting any commodity under special permit in accordance with the provisions of § 170.13 of this title.

(b) A stop need not be made at:

(1) A streetcar crossing, or railroad tracks used exclusively for industrial switching purposes, within a business district as defined in § 390 12 of this chapter,

(2) A railroad grade crossing when a police officer or crossing flagman directs traffic to proceed,

(3) A railroad grade crossing controlled by a functioning highway traffic signal transmitting a green indication which, under local law, permits the vehicle to proceed across the railroad tracks without slowing or stopping.

(4) An abandoned railroad grade crossing which is marked with a sign indicating that the rail line is abandoned,

(5) An industrial or spur line railroad grade crossing marked with a sign reading "Exempt Crossing" Such "Exempt Crossing" signs shall be erected only by or with the consent of the appropriate State or local authority.

(Sec 12, 80 Stat 931; 49 U.S C 1651 note) [33 F R 19732, Dec 26, 1968, as amended at 35 FR 7801, May 21, 1970; 38 FR 1589, Jan 16, 1973; 40 FR 44555, Sept 29, 1975]

APPENDIX C

General Rules of The Koch Oil Company

KOCH OIL COMPANY
MATADOR SERVICE, INC.
TRANSPORTATION DIVISION
DRIVER OPERATING PROCEDURE

The Koch Oil and Matador Service Transportation Division was formed to give efficient and dependable service to the oil industry. The rules set forth in this manual, plus safe driving rules and ICC regulations previously presented to you, are necessary to give safe, efficient, and dependable service to the customers.

You are employed because we believe you have the ability to succeed in your work. How well you do your job depends to a great extent on what you know about company policy, procedures, and upon your attitude toward carrying them out. Each person is expected to perform his duties and accept the responsibilities as outlined herein.

You should always take pride in the appearance of your equipment and good housekeeping habits are expected. A good appearing and carefully operated fleet results in better service and helps our company sell itself to the public, creating better public relations. It also has a tendency to cut operating cost in order for our team to better compete with its competitors. It also helps eliminate damaged equipment, reduce maintenance costs, and the possibility of injury to others and yourself. Any major or minor violations of traffic regulations and careless or discourteous acts can undo all our efforts to earn and retain good public image. The observance and practice of good driving procedures, courtesy, proper speed and road ethics are required of all personnel. Your suggestions for improving the efficiency of our operations will always be welcome. Your honesty, loyalty, and efficiency will help us maintain the type of organization with which we will all be proud to be associated. This will assure our customers that when they are using our service, they are getting the best to which they are entitled.

GENERAL RULES

1. You, the driver, are responsible for the safe operation of the equipment under your care.

2. A driver suffering from illness or fatigue will not be required or permitted to work. Drivers becoming ill or unduly fatigued on the road shall stop in the nearest safe place, contact the district foreman and request any assistance necessary for their well-being and the safety of the vehicle.

3. Drinking alcoholic beverages while on duty or within eight hours of going on duty is prohibited. Drivers violating this rule will be subject to immediate dismissal.

4. Drivers must be familiar with the safety regulations of the Interstate Commerce Commission and the laws of the states, cities and towns through which they operate.

5. Posted speed limits in towns and cities, as well as on the open highway, must be obeyed. Speed shall never be faster than a rate consistent with existing road traffic and weather conditions.

6. Never follow another vehicle so closely that you cannot stop safely and easily if the vehicle ahead makes an emergency stop. Allow at least one vehicle length between you and the vehicle ahead for each ten miles per hour of speed.

7. A full stop is required at all railroad crossings.

8. A safety check of the unit shall be made before each tour of duty and at intervals of not more than 125 miles or three hours of driving time, whichever occurs first. The safety check shall include the items listed below plus any additional inspection required because of unusual circumstances.

    A. Condition of tires and wheels.
    B. Oil level in motor.
    C. Water level in radiator.
    D. General conditions of engine and engine compartment.
    E. Brake connections (on units with hand control valve, set valve in cab and listen for leaks in lines).
    F. Check fifth wheel latch (pintle-hook and safety cables on pup trailers).
    G. Check lights and reflectors. Reflectors must be clean and all lights must be clean and burning.

H. Check tools, safety equipment, and safety accessories.

I. Report defects on equipment to the district foreman by proper form.

9. Driver must report all arrests, traffic citations, and fines to the district foreman.

10. Observe speed limits in school zones. Remember that children cannot be expected to exercise good judgment all of the time.

11. Personal appearance, clean equipment, and well-kept station sites are a real credit to you and the company.

12. Proper handling of your paper work, such as neatness, required information, and mailing time, is a must.

13. Notify foreman if you are going to be absent from work for any reason.

14. Keep foreman advised as to your work load especially if you need help to properly take care of your leases.

15. The log and the vehicle inspection form on the back of the log must be maintained by all drivers. The only possible exception would be a driver who hauls water only, within a radius of 50 miles of his home base.

16. The weekly vehicle inspection must be performed and two copies of the report must be furnished to the district foreman.

17. The 10,000-mile inspection, lubrication and maintenance card must be maintained completely and currently by each driver.

18. Air tanks must be drained daily.

19. Chock blocks must be used when parking or leaving the vehicle, including loading and unloading.

20. Anytime a vehicle is parked or disabled within ten feet of the traveled portion of a highway, it must be properly protected. This would consist of four-way blinkers, flags or reflectors, whichever would apply.

21. Ground cables must be connected before the hatch is opened to load or unload.

22. Keep tank hatches closed at all times when driving. When a tank is pulled into the shop make sure all covers, vents, and manifold outlets are tightly closed.

23. Gasoline or any other flammable liquid is never to be used as a cleaning agent.

24. Motors of tank trucks or tractors shall be shut down during making and breaking hose connections and throughout the loading and unloading operation, unless the engine of the truck is used to operate the loading or unloading pump.

25. The driver of any tank vehicle shall not leave the vehicle while it is being loaded or unloaded.

26. It is the driver's responsibility to report immediately to the district foreman any lease they consider to be unsafe for loading operations.

27. It is the driver's responsibility to watch for conditions which increase fire hazards such as:

    A. Areas in which atmosphere is heavy due to fog and moisture.
    B. Winds in direction of heater tank or operating equipment (truck engine).
    C. Area where there is little or no wind to displace vapors from the immediate area.
    D. Leakage from connections or pump packing.

28. No vehicle shall be loaded in excess of 97% because of the expansion of the contents due to the rise in temperature in transit.

29. Any motor vehicle transporting a flammable liquid whether loaded or empty if stopped for any cause other than necessary traffic stops upon the traveled portion of any highway or shoulder must display emergency equipment.

30. In the event of a leak in a cargo tank to the extent of making further transportation unsafe, the leaking vehicle should be removed from the traveled portion of the highway and every available means employed to keep the liquid from spreading over a wide area.

31. In the event of an accident involving any motor vehicle transporting any flammable liquid every available means shall be taken to prevent individuals, other than those employed in the protection of persons or property, from congregating in the vicinity.

32. No flammable liquid shall be transferred from one tank vehicle to another on any public highway, street, or road except in the case of an emergency.

33. Tank vehicles except in an emergency, shall not be left unattended on any street or highway provided that this shall not prevent the necessary absence from the vehicle for meal and rest stops during the day or night if the vehicle is well lighted at point of parking.

34. Tank vehicles shall not be parked unattended for a period exceeding one hour on any public street or thoroughfare.

35. Any loaded tank vehicle or semi-trailer when parked shall be positioned that the safety relief valve shall communicate with the vapor space of the trailer.