Krall Critique of Texas A&M TTI Heavy Truck Fuel System Integrity Study

MVMA initiated the in-depth planning that led to the implementation of the following TTI post-crash fire study in December 1986: [**Heavy Truck Fuel System Integrity Study by Texas A&M-Texas Transportation Institute- October 1988 Final Report**]. This research study was sponsored by Truck OEMs via MVMA in response to research recommendation No. 4 contained in the **S.217 Truck Occupant Protection Study** December 1986, DOT HS 807 081

This study is considered to be the most focused in-depth accident study ever done to examine the issues of fuel system integrity and fire ignition sources. The stated purpose of the study was to provide truck tractor manufacturers *"some hard facts from in-depth investigation of actual traffic crashes to help them design for increased safety in tomorrow's vehicles."*

The planning effort included an all-day training session for members of the TTI investigation team at the Navistar International truck assembly plant in Springfield Ohio. The study plan focused on screening and selection of specific accidents to be investigated, information to be documented and detailed methodology to be used in collecting pertinent vehicle and crash-scene data. The field documentation work took one to three or more days for each investigation. The study took a period of 18 months to screen a total of 93 accidents to find the 27 accident cases that met the selection criteria established for the study. The selection criteria specified, in part, that the accident had to involve "diesel fuel spill from the truck whether or not a fire resulted from the spill."

Pertinent findings of the TTI study are as follows:

- Of the total of 27 accidents investigated, 10 involved a fire
- 23 of the 27 accidents experienced a loss of structural integrity of the fuel system (at least 17 of the 27 involved cross-over fuel lines, see item below)
- In nine (9) of the 10 fire cases the battery was determined not to be the cause of the ignition source
- In the 10th fire accident (TTI Case No.5) the battery was determined to be "the most probable cause of ignition" even though both the fuel tank (that was not OEM equipment) and batteries were separated from the tractor frame rail, and were both destroyed. The TTI report provides the following additional description of this catastrophic accident: *The impact between the two vehicles knocked the right front wheel from under the Freightliner tractor, separated the right fuel tank from the tractor, demolished the battery box, and distorted the metal on the right front corner of the trailer.*
- *The force of the impact caused the steel pipe cargo on the trailer to shift forward into the rear of the cab. The cab was torn from the chassis and came to rest in front of the rest of the tractor.*

- Above TTI Case No. 5 is the only case with a dislocated front axle that could possibly have contributed to the battery being a fuel ignition source; the battery was not an ignition source in the other 13 accidents that experienced dislocation of the front axle.
- "Friction sparks" were determined to be a possible ignition source in four (4) of the ten (10) fire accidents.
- "Seventeen or more accidents involved fuel spillage from crossover lines or fittings."
- The TTI report states that "Some of the case accidents were catastrophic events dissipating enormous amounts of kinetic energy. Effective means for maintaining the fuel system integrity of a highway vehicle may not exist for energy levels of this magnitude."

The following is a description of the crash severity for each of the ten accidents that involved a fire:

- Case # 05- rear sideswipe of other tractor trailer (see above description of catastrophic vehicle damage)
- Case # 11- ran off road, impacted ditch
- Case # 12- ran off road into bridge rail, over turned
- Case # 15- struck another tractor-trailer
- Case # 19- struck another tractor-trailer
- Case # 21- struck by or struck 3 tractor trailers
- Case # 22- struck by or struck 3 tractor trailers
- Case # 24- struck by or struck 3 vehicles
- Case # 25- ran off road, hit trees, and over turned on right side
- Case #27- crossed center line, plunged into ravine

Most, if not all, of the 10 fire cases would appear to have produced catastrophic vehicle damage. As stated in the report, Krall was one of the manufacturers' representatives who assisted the TTI investigation team in the planning, implementation, and monitoring of the post-crash fire study.

Note: Copy of TTI report is attached to this two-page critique.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY

Summary Report

December 1986-October 1988

MVMA Agreement TTI 8714-C7162 and

TTI 8806-C8162

Texas Transportation Institute
Texas A&M University System

Human Factors Division

November 1988

TEXAS TRANSPORTATION INSTITUTE

THE TEXAS A&M UNIVERSITY SYSTEM
COLLEGE STATION, TEXAS

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Human Factors Division

November 1988

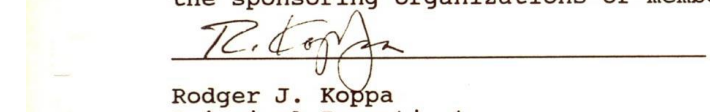
PREFACE

This Summary of Operations report is provided as the final report of this project to document the fuel system integrity aspects of 27 heavy tractor-trailer crashes. The actual case reports are the products of this project, and are incorporated in this report by reference. The project staff was:

Principal Investigator:	Rodger J. Koppa, P.E., Ph.D.
Co-Principal Investigator (Phase I):	King K. Mak, P.E., M.S.
Co-Principal Investigator (Phase II) and Field Team Leader	James R. Lock
Field Investigator:	Randy Cockrell
Field Investigator:	Jere Johnston
Fire Safety Engineer:	John P. Wagner, P.E., Ph.D.
Communications:	Martha J. Kacer
Research Support:	Meera Krishnamurthy Douglas Frick

The support and active participation of the representatives of the vehicle manufacturers and of our sponsors is gratefully acknowledged, particularly our Project Monitor for the Motor Vehicle Manufacturers Association, Mr. Henry Seiff. This report was prepared for the Motor Vehicle Manufacturers Association of the United States, Inc. (MVMA), the American Trucking Associations, Inc. (ATA) and the Western Highway Institute. The project was supported with funds under MVMA Agreements Number TTI-8806-C8162.

The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the sponsoring organizations or members thereof.



Rodger J. Koppa
Principal Investigator
Head, Human Factors Division
Texas Transportation Institute

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INTRODUCTION

The Human Factors Division of the Texas Transportation Institute of the Texas A&M University System, in collaboration with personnel of the Accident Analysis and the Safety Divisions, conducted in-depth investigations of heavy truck accidents in which fuel spillage and/or fire occurred in Texas and in Arkansas. This project was sponsored by the Motor Vehicle Manufacturers Association, the Western Highway Institute, and the American Trucking Associations. The objective was to obtain information on the causal factors associated with fires and the spillage and possible subsequent ignition of fuel in heavy truck accidents.

SUMMARY OF OPERATIONS

Preliminary Activities

The project began on December 1, 1986.

Much time was spent by the TTI team in gathering background material on diesel fuels, heavy truck fuel systems, and sources of ignition.

Traffic law enforcement jurisdictions in Dallas-Ft. Worth, Houston, and San Antonio, which are the major metropolitan areas in Texas, and the Texas Department of Public Safety to which the State highway patrol belongs, were contacted for their support. These jurisdictions, with the exception of San Antonio, agreed to notify the TTI Team whenever a heavy truck incident fitting the criteria of Exhibit 1 occured. To expedite this notification, a Hot Line was set up, and became operational around the clock starting February 15, 1987. Exhibit 2 is the standardized checklist that was used whenever a contact telephoned in.

The format for the field investigation data form was also developed, since none of the existing ones from the National Accident Sampling System of the Department of Transportation or other sources fit our needs.

The Project Team met for an all-day workshop on January 22, 1987 at the Bryan Research and Extension Center. Following this workshop, the Team journeyed to Springfield, Ohio as guests of Navistar International Corp. At the International Truck Plant there, the TTI Team joined with industry representatives and MVMA in an all-day training workshop and demonstration on January 27. At this meeting much insight into manufacturers' data needs was gained, and all attendees thought that the project was off to a good start. After the meeting data sheets and field data collection techniques were further developed, and the accident

investigation phase of the study commenced on February 1, 1987.

Stages of Operation in a Typical Case

Whenever a call met the criteria of Exhibit 1, the manufacturer's representative was the first person contacted after the call was verified. The basic question for the representative (the list is provided as Exhibit 3) was whether or not the Vehicle Identification Number (VIN) of the tractor was authentic, and the vehicle was within the size and age range of interest (Class 8, ten years old or newer). The representative also verified that the vehicle involved was not an after-market "glider" conversion*. He also made a decision as to whether or not he wanted to participate in the investigation. Field researchers were then dispatched to the scene. They rendezvoused with the company representative (if he or someone else elected to come) and began the work of documenting the actual site of the accident, the wreckage itself (almost always at a local yard or storage area), and interviewing investigating officers and other sources as required. This field documentation work took one to three or more days, and might involve multiple visits to the wreckage with different specialists from Texas A&M, if the case was a complex one.

Then the stage of review and analysis of the documentation began, starting with work up of the photographic log and a rough draft of the text of the report. Finalization of the data sheets that complete the data package was also done. For more complex cases, a conference with the field investigators and TTI project staff at College Station was held before the field investigators returned to home base. Otherwise, review of the documentation and further analysis of the information was performed after the investigators drafted the final report. A fuel sample was also dispatched to a laboratory for qualitative analysis.

A typical case ended with the process of refinement of the final report. A draft of the final report of each case was submitted to the Contract Monitor at MVMA in Washington, and simultaneously to the manufacturer's representative for their comments. After discussing the report, usually by telephone, a final version was completed.

The final report on each case included:

(1) Summary of Accident

(2) Detailed Account of Accident

*One investigation was a glider, with manufacturer concurrence. This was Case 20.

(3) Photograph Log which captions each of the typically 50 or more shots included in the report (usually over 100 are taken at the scene and of the wreckage)

(4) Data Sheet Package, comprising forms for the site, environment, tractor, trailer, accident description, fuel system components, and ignition (if any)

Early Cases

After two studies were complete, the contract monitor directed us to not respond to any more accidents unless fire was involved until we had a meeting of the team, MVMA and manufacturer representatives. At this meeting, the first two accident reports would be critiqued by manufacturers and MVMA to assure that the goals of the project would be achieved. Copies of the first two reports were accordingly sent to the manufacturer representatives.

Mid-study Meeting

This meeting took place on April 7 and 8, 1987, in conjunction with a heavy truck crash test at the Texas A&M Bryan Research and Extension Center. At this meeting, the first two accident reports were critiqued by manufacturers and MVMA in great detail, and many valuable lessons were learned by the staff. Attendees included representatives from all participating organizations in the project (Exhibit 3) except for ATA, WHI, and General Motors. Implementation of suggestions made at this meeting was immediately accomplished, and is reflected in all reports from Case 3 on. Some revisions were made to Cases 1 and 2 as well.

Activities Since the Meeting

Cooperation of Texas and Arkansas law enforcement agencies involved in the study continued to be good throughout the project. Those contacts not followed up because either the tractor was too old or other reasons were documented and copies furnished to the respective companies whose equipment was involved.

A brief summary of the 27 investigated cases is provided as Exhibit 4.

Appendix A is a collection of the synopses of the 27 cases. The actual case reports, all of which have been received by MVMA and distributed to participants, are incorporated in this summary report by reference.

Appendix B is a summary of the reports of fuel system integrity that were not investigated further, either because one of the

criteria of Exhibit 1 was not met, or for other administrative reasons.

Overview of Findings

The contents of the individual reports constitute the product of this project, and interested readers should refer to this data repository for detail findings. The following material is provided as a brief summary of those findings. It is based on an oral briefing given to the Medium and Heavy Vehicle Operations Panel of the Motor Vehicle Manufacturers Association on November 10, 1988.

The following table summarizes the investigators' opinions of the dominant cause of each of the 27 crashes. As might be expected, driver-related causes predominate, with 11 of the 27 cases. None of the crashes implicated tractor defects per se as a causal factor. The 5 fog/smoke conditions include the 4 crashes that occurred in Arkansas (Cases 21-24).

CRASH CAUSALITY

	ACCIDENTS
DRIVER-RELATED	
* "Inattentive"/lost control	6
* Faulty evasive action	1
* Turn at too fast speed	1
* Faulty passing maneuver	2
* Incapacitation	1
VEHICLE-RELATED	
* Blowout	1
* Load shift	1
* Brakes locked (trailer)	1
ROAD CONDITIONS	
* Wet/Slippery Pavement	2
* Fog/smoke	5
* Soft shoulder	1
TRAFFIC CONDITIONS	
* Failure to yield (other vehicle)	1
* Opposing traffic	3
* Obstacle in roadway	1

The incidence of seatbelt usage in this tiny sample of cases was reasonably high. Five drivers were definitely wearing their restraints; in most of the cases of fire, seatbelt usage could not be determined.

SEATBELT USAGE

	ACCIDENTS
Definitely Worn	5
Unknown	10
Not Worn	12

Fuel System Damage

Turning from general accident considerations to the objectives of the project, fuel system integrity loss, a number of findings can be highlighted. Tank damage heads this list. Miscellaneous crushing, denting, and other damage (including displacement of the tank in its mountings) were found on 12 of the accidents, and splits along weldments in 9 of the incidents. Only 4 accidents were free of compromise to fuel tank integrity.

TANK DAMAGE

	ACCIDENTS
Split at Seam	9
Ruptured	5
Punctured	6
Other Damage	12
No Loss of Integrity	4

Photos 1 through 12 illustrate the gamut of damage sustained by fuel tanks. Photo 1 shows a crushed tank which has lost integrity in the fold lines, Photo 2 depicts a very typical weld seam separation on an aluminum tank. Structure on the tank that can be caught by other protuberances on the vehicle leads to tears such as that shown in Photo 3. Photo 4 shows another seam separation, this one caused by the exhaust stanchion just to the left of the hole. In contrast, Photo 5 is a sharp puncture, almost like what might be produced with a can opener. Note that the tank has also shifted in its mountings. Photo 6 shows another form of seam separation with other tears also apparent. Photos 7, 8, and 9 graphically illustrate why investigations of actual fires can be so difficult: the tank (especially true of

aluminum tanks) has melted and is simply not there anymore. In Photo 9, it is possible to speculate that the air cleaner case and the torsion bar both penetrated the now-vanished fuel tank. Photo 10 shows a collapsed and punctured tank. Photo 11 is of a seam separation on a steel tank (this case involved fire). Photo 12 is a mysterious clean puncture from an unknown component on the trailer, as jackknife occurred.

Ten vehicles experienced fuel intake (feedline) line damage. In most of these incidents, the feedline parted because the tank was separated from the vehicle.

FEEDLINE DAMAGE

	ACCIDENTS
Severed/Detached	6
Unknown	4
OK	15

Crossover lines were definitely untouched on only 7 of the 27 cases. Seventeen or more accidents involved fuel spillage from crossover lines or fittings. Typically, the loss of integrity occurred at or near the outlet fitting on the lower part of the fuel tank. Most of the crossover hoses were routed along support structures bridging across the tanks from one side to the other of the tractor, and these support structures did a good job of protecting the hose; the area of vulnerability was the point of attachment to the fuel tank, which usually included a protruding valve body and hose attachment fitting.

CROSSOVER LINE DAMAGE

	ACCIDENTS
Severed/detached	17
Unknown	3
OK	7

Photos 13 - 20 illustrate various cases of crossover line damage. Photo 13 illustrates a clean shear of the fitting at the surface of the tank, in contrast to Photo 14 which is a severing of the crossover line itself, with some damage to the valve as well. Photo 15 is also a shear of the fitting (a wooden stick has been

inserted in the tank opening to plug the leak). In Photo 16, an anomalous case is shown. The shutoff valve handle is gone, and only its shaft protrudes to the left in this picture. The upper threaded pipe was installed in the fuel tank. During the accident, this fitting separated from the tank in some manner such that the threads are more or less intact. Note that the crossover hose has been severed. Photo 17 shows a 2-inch crossover line fitting which has fractured at the hose interface. Photo 18 is another case of loss of fuel system integrity through shear of the crossover fitting from the tank. Photo 19 shows a not untypical installation of such a valve and hose in a fuel tank. This assembly is very vulnerable in a crash situation. In Photo 20, the hose was pulled off this fitting during the crash sequence.

Other Components

Like feedlines, return lines accounted for little of the fuel spillage. Where they were detached or severed, the tank was usually not still attached to the vehicle either.

Other fuel system components. such as filters or vents, were involved on a few of the accidents, but were not major contributors to fuel spillage.

RETURN LINE DAMAGE

	ACCIDENTS
Severed/detached	6
Unknown	5
OK	16

OTHER FUEL SYSTEM COMPONENT DAMAGE

	ACCIDENTS
Filter	3
Cap Vent	3

Incidence of Ignition of Spilled Fuel

Ten of the 27 cases involved fire. Causality for ignition was very difficult to determine, impossible in two cases, and uncertain in the other 8 cases. One of the heat sources was burning fuel (gasoline) from a light truck involved in the 11-vehicle crash in Arkansas (Cases 21-24). We were left with the impression that more can be learned from cases in which fuel spillage, but not ignition, occur, because so much more of the vehicle remains for investigation. The typical tractor that has sustained a major fuel fire is reduced to a charred hulk with all aluminum parts melted or distorted, fuel lines gone, and nothing left of the cab, batteries, or even tires. Photos 21 and 22 depict such hulks, and portray the extreme devastation caused by the fire. On the other hand, fuel spillage without fire becomes a "critical incident," from which much can be learned, especially if potential ignition sources and their proximity to the spilled fuel are studied.

FIRE

	ACCIDENTS
No Ignition	17
Ignition	10
Sources (suspected)	
Unknown	2
Friction	3
Engine/heat source	4
Battery	1

One of the hypotheses that formed a background to this project is that fuel ignition occurs in some truck crashes because the fuel is contaminated with gasoline or other adulterants that increase volativity and hence assist cold-weather starting. Sixteen of the crashes yielded usable fuel samples for analysis. None of the fires, naturally, afforded such a sample. One non-fire spill lost all of the fuel. No evidence of adulterants was found in any of these samples.

FUEL ANALYSIS

	ACCIDENTS
Fuel Available	16
No Fuel Available	11
Contaminants Present	0

A Cautionary Note

There are 200,000 or more heavy truck accidents per year in the United States. This set of 27 cases thus represents 0.01 per cent or less. These cases were selected on a non-random basis, since (1) fuel spill had to be involved, (2) vehicles of the participating manufacturers were the only ones included, and (3) tractors had to be 10 years old or newer. Thus, the 27 cases are hardly representative of truck accidents in general. No attempt should be made to extrapolate from this sample, but rather the engineering design implications of the damage that occurred should be the major consideration. Some of the case accidents were catastrophic events dissipating enormous amounts of kinetic energy. Effective means for maintaining the fuel system integrity of a highway vehicle may not exist for energy levels of this magnitude.

EXHIBITS AND PHOTOS

EXHIBIT 1

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY

A RESEARCH PROJECT BY THE TEXAS TRANSPORTATION INSTITUTE
OF TEXAS A&M UNIVERSITY

- When an 18 wheeler is involved in a traffic crash, the diesel fuel system may rupture at some point: tank, lines, filters, or other components
- If there is a fuel spill from such a rupture there will be a fire hazard
- Truck tractor manufacturers need some hard facts from in-depth investigation of actual traffic crashes to help them design for increased safety in tomorrow's vehicles
- Motor Vehicle Manufacturers Association of the United States and Western Highway Institute is sponsoring this preliminary study of selected 18 wheeler accidents

WHAT KIND OF HEAVY TRUCK CRASHES ARE WE INTERESTED IN?

- Tractor-trailer combinations, diesel powered, 1977 or newer
- Diesel fuel spill **from the tractor** whether or not a fire resulted from the spill
- Vehicle wreckage is accessible (not impounded or otherwise not available for inspection and photographs)

WHAT KIND OF INFORMATION DO WE WANT?

- Visual inspection of the damage, especially the fuel system
- Photographs and/or video tape of the damage
- Sample of fuel that spilled, if any still available
- Interview with driver and with other witnesses as needed
- Interview with investigating law enforcement officer
- Visit to crash site

THE INFORMATION THAT OUR INVESTIGATORS GATHER WILL NOT BE PUBLICLY DISCLOSED. THE INFORMATION WILL ONLY BE USED FOR RESEARCH AND ENGINEERING PURPOSES BY THE TRUCK MANUFACTURERS.

For additional information, please call:
HEAVY TRUCK ACCIDENT HOTLINE

(409) 845-9929 24 HOURS A DAY

Rodger Koppa, King Mak, and James Lock, Study Team
Texas Transportation Institute

CASE #
ACCIDENT #_____

NOTIFICATION DATA

EXHIBIT 2

Date and time of call-in:_____

Name of Person taking call:_____

Name of Investigating Officer:_____

Phone Number of Investigating Officer or other law enforcement contact and best time to call: _____ Time: _____ a.m./p.m.

Date and Time of Accident:_____ Time: _____ a.m./xxx

Location of Incident: _____

Fuel Spill (Amount): _____ Cleanup Required? _____

Fuel System Damage: _____
Did the spilled fuel ignite: Yes ( ) No ( )

Brief Description of Incident (narrative): _____

_____

_____ Damage to Truck: TAD Code: _____
Damage to Other Vehicle: TAD Code: _____

Injuries or fatalities:_____I ___F

If ignition, what happened: _____

_____

_____

Make and Model of Tractor:_____ Model year of Tractor _____

License Number of Tractor:_____ VIN Number of Tractor_____

Trailer Cargo: _____

Driver Name/Address: _____

_____ Driver DL# _____

Owner Name/Address: _____

Wrecker Service or Present Location of Wreckage: _____

_____

TTI Notifier (name): _____

Investigator Notification:_____ / _____
Name (Date and Time)

_____

_____

Manufacturer Notification:_____ / _____
Name (Date and Time)

_____

EXHIBIT 3

FUEL SYSTEM INTEGRITY STUDY
~~NOTIFICATION LIST~~ Project RF7072 August 4, 1987
~~UPDATE 3~~ - PLEASE DISCARD PREVIOUS LIST

	Work	Home
TTI PERSONNEL		
1. Rodger Koppa Human Factors Division	(409)845-2521 845-3540	693-0867
2. King Mak Safety Division	(409)845-6375	---
3. James Lock Accident Analysis Division	(409)845-8408	696-0549
4. John Wagner Human Factors Division	(409)845-2741 845-5531	846-7077
FIELD INVESTIGATORS		
1. Randy Cockrell 304 N. Main Monticello, AR 71655	(501)367-6881	367-2081
2. Jere Johnston 304 N. Main Monticello, AR 71655	(501)367-6881	367-5506
MVMA		
1. Henry Seiff	(202)862-3900	
1620 I St. NW Suite 1000 Washington, DC 20006		
2. Ed Good (MVMA Counsel) 300 New Center Bldg. Detroit, MI 48202	(313)872-4311	
AMERICAN TRUCKING ASSOCIATIONS		
1. Larry Strawhorn Director of Engineering American Trucking Associations, Inc. 2200 Mill Rd. Alexandria, VA 22314	(703)838-1845	
WESTERN HIGHWAY INSTITUTE		
1. Mr. Byron Geuy Executive Director Western Highway Institute 1200 Bayhill Drive San Bruno, California 94006		

MANUFACTURERS REPRESENTATIVES

IF TRACTOR IS: CALL:

FORD
Edward Bolcer.....(313)594-0139.....851-3921
Truck Operations
600 Parklane Towers West
1 Parklane Blvd.
Dearborn, MI 48126
or
Don Edelen.....(313)845-3827
Fax .....(313)322-4033

FREIGHTLINER (MERCEDES-BENZ)
Thomas Hutton.....(503)283-8005.....668-3144
P.O. Box 3849
4747 N. Channel Ave.
Portland, Oregon 97208

GENERAL MOTORS (GMC)
Ron Joyner.....(313)680-5112.....
GMC Truck & Bus Engineering
1901-201
1960 Technology Drive
P.O. Box 7057
Troy, Michigan 48007-7057
FAX.....(313)456-6844

KENWORTH
Jim Johnson.....(206)828-5201.....788-3924
P.O. Box 1000
Kirkland, WA 98033
or
Gene Corey.....(206)828-5200
FAX.....(206)822-1161

NAVISTAR (INTERNATIONAL HARVESTER)
Mike Shirley.....(219)461-1865.....665-5418
2911 Meyer Rd.
P.O. Box 1109
Ft. Wayne, Indiana 46801
or
Ron Baughman.....(219)461-1040.....693-9310
or
Farrel Krall.....(219)461-1008.....(419)495-2474
FAX.....(219)461-1813

PETERBILT
Scott Peters.....(415)790-4130.....793-9568
38801 Cherry St.
Newark, CA 94560
or
Arlen Riggs.....(415)790-4131
FAX.....(415)790-4199

WHITE (VOLVO)
Erik Hjelt.....(919)279-2802.....852-7296
201 N. Murrow Blvd.
P.O. Box D-1
Greensboro, NC 27402
FAX.....(919)379-0328

CASE SUMMARY

CASE #	VEHICLE	YEAR	TYPE	CRASH	CAUSE	SEATBELT USAGE	TANKS	FEED	FUEL LINES CROSSOVER	RETURN	FILTER	OTHER	IGNITION	SOURCE	FUEL ANALYSIS	REMARKS
1	FREIGHT	1985	COE	REAR ENDED DUMP TRUCK	FAULTY EVASIVE ACTION	NO	RUPTURED, SPLIT AT SEAM	OK TO FILTER	SEVERED	SEVERED	DAMAGED		NO		OK	SEVERE TRACTOR IN PIECES
2	KENWORTH	1981	LMC	RAN OFF ROAD, MOUNTED GUARDRAIL	DRIVER INATTENTIVE	NO	PUNCTURED, SPLIT AT SEAM	OK	OK	OK	OK		NO		OK	
3	PETERBILT	1977	COE	RAN OFF ROAD, STRUCK MEDIAN BARRIER	TIRE STUCK IN MUD	NO	LEFT CRUSHED	SEVERED	PULLED OUT	PULLED OUT	OK		NO		OK	
4	FREIGHT	1982	COE	OVERTURNED ON EXIT RAMP	TURNED TOO FAST	YES	LEFT DISPLACED REARWARD	OK	OK	OK	OK	CAP VENT LEAK	NO		OK	ONLY LOSS THROUGH CAP VENT, NOT OEM TANKS OR CAP
[redacted]	FREIGHT	1972	COE	REAR SIDESWIPE OF OTHER TRACTOR TRAILER	PASSING SLOW MOVING TRUCK	NO	RIGHT CRUSHED AT SEAM	OK	SEVERED	OK	OK	[redacted] BY REARWARD MOVEMENT OF RIGHT TANK	[redacted]	BATTERY BOX	NO FUEL AVAILABLE	TANKS NOT OEM
6	GMC	1986	COE	SKID & HIT MEDIAN BARRIER	WET PAVEMENT	YES	OK	OK	SHEARED CONNECTOR	OK	OK	BALL CHECH AIR VENT SHEARED OFF	NO		OK	
7	INT'L	1982	COE	SKID & HIT BRIDGE RAIL	WET & OILY PAVEMENT	NO	RIGHT SPLIT AT SEAM	OK	SEVERED	OK	OK	VENT VALVE SHEARED	NO		OK	
8	KENWORTH	1977	LMC	PRIMARY COLLISION WITH CAR; SECONDARY WITH DITCH	CAR FAILED TO YIELD RIGHT OF WAY	NO	RIGHT SPLIT AT SEAM	OK	SEVERED	OK	OK		NO		OK	
9	KENWORTH	1983	LMC	HEAD-ON WITH PICKUP	PICKUP IN WRONG LANE	YES	OK	OK	OK	OK	DAMAGES & LEAKS		NO		OK	
10	FORD	1982	COE	HEAD-ON WITH CAR	CAR IN WRONG LANE	YES	PUNCTURED	SEVERED	SEVERED	SEVERED	OK		NO		OK	
11	KENWORTH	1978	COE	RAN OFF ROAD, IMPACTED DITCH	DRIVER INATTENTIVE	UNKNOWN	RUPTURED, SPLIT AT SEAM	UNKNOWN	SEVERED	UNKNOWN	OK		[redacted]	HEAT SOURCE ON ENGINE OR REEFER UNIT	OK	REEFER UNIT FELL ON TOP OF CAB, BURNED
12	GMC	1987	COE	RAN OFF ROAD INTO BRIDGE RAIL ~~OVERTURNED~~	FRONT TIRE BLEW OUT	UNKNOWN	BOTH TANKS RUPTURED	UNKNOWN	UNKNOWN	UNKNOWN	OK		[redacted]	HEAT SOURCE ON ENGINE	NO FUEL AVAILABLE	ALMOST COMPLETELY BURNED
13	PETERBILT	1985	COE	RAN OFF ROAD INTO SIGN, ~~OVERTURNED~~	DRIVER INATTENTIVE	NO	LEFT DEFORMED	OK	SEVERED	OK	OK		NO		OK	
14	GMC	1987	COE	STRUCK BRIDGE RAILING, ~~OVERTURNED~~	UNKNOWN	UNKNOWN	BOTH TANKS RUPTURED	OK	DETACHED AT BOTH TANKS	OK	DAMAGED		NO		NO FUEL AVAILABLE	

SPARKS HEATED ENGINE OMPONENTS	NO FUEL AVALILABLE	TANKS NOT OEM
	NO FUEL AVAILABLE	
UNKNOWN	NO FUEL AVAILIBLE	


PHOTO
1
3-36


PHOTO
2
7-56


PHOTO
3
10-32


PHOTO
4
11-57

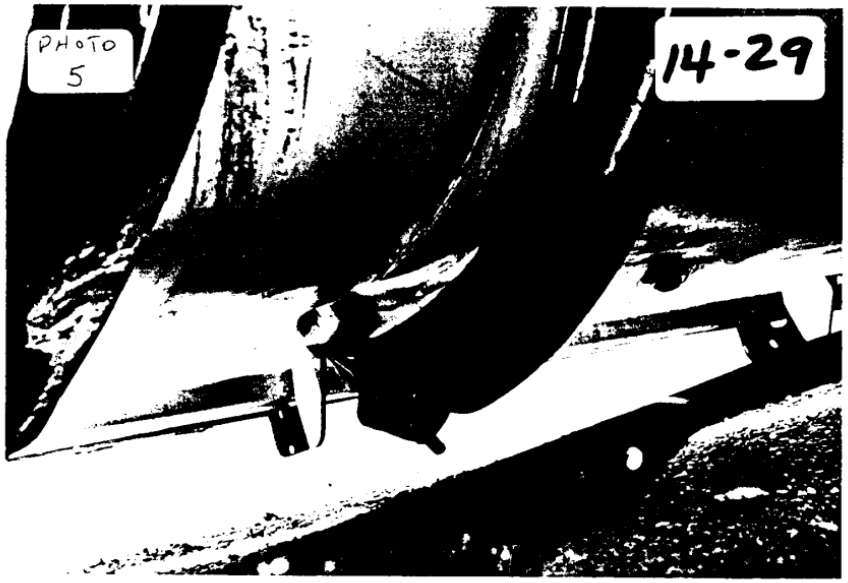
PHOTO
5
14-29


PHOTO
6
14-36


PHOTO
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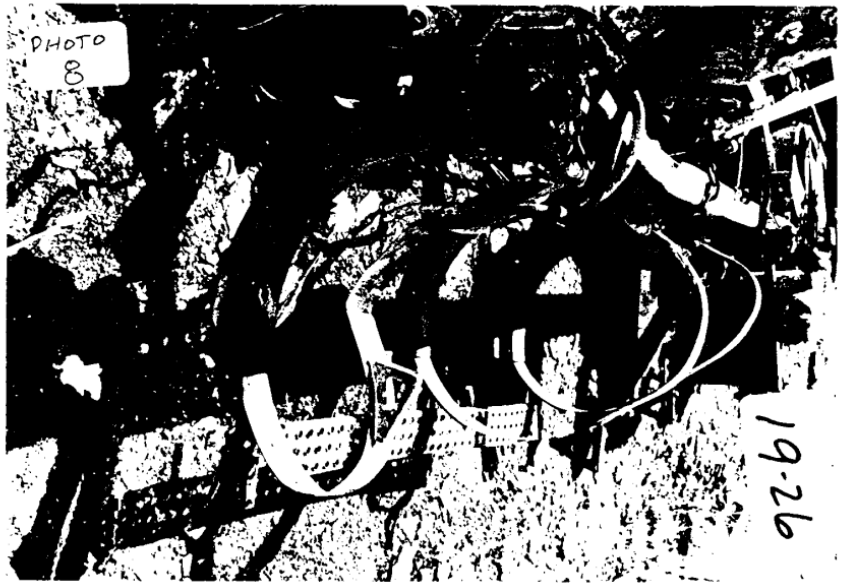
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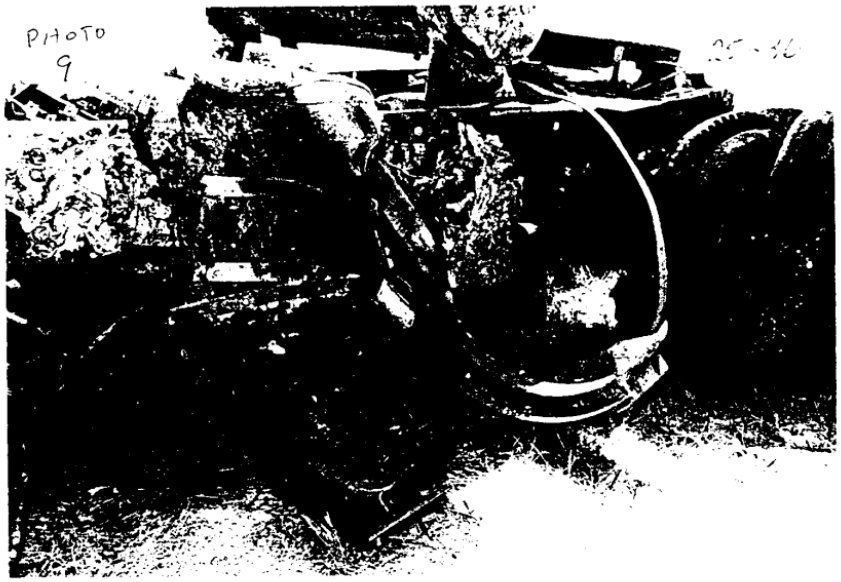
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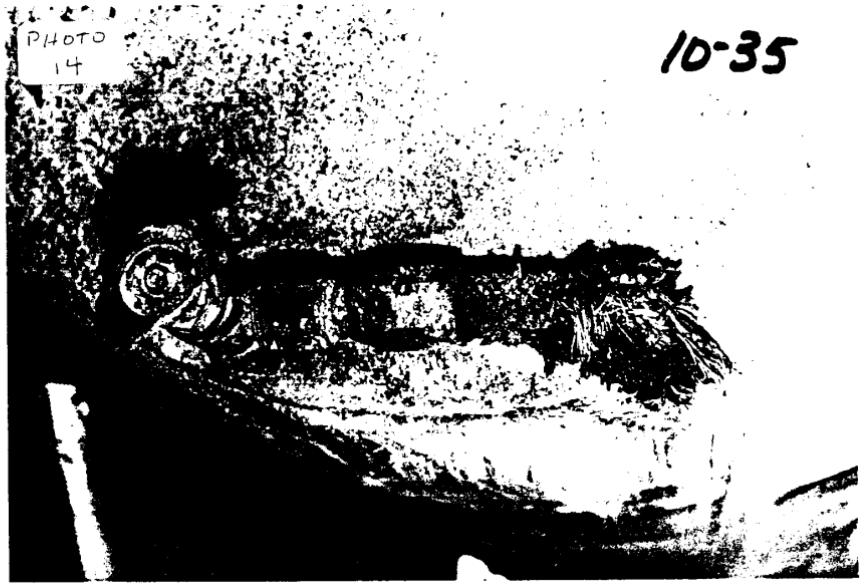
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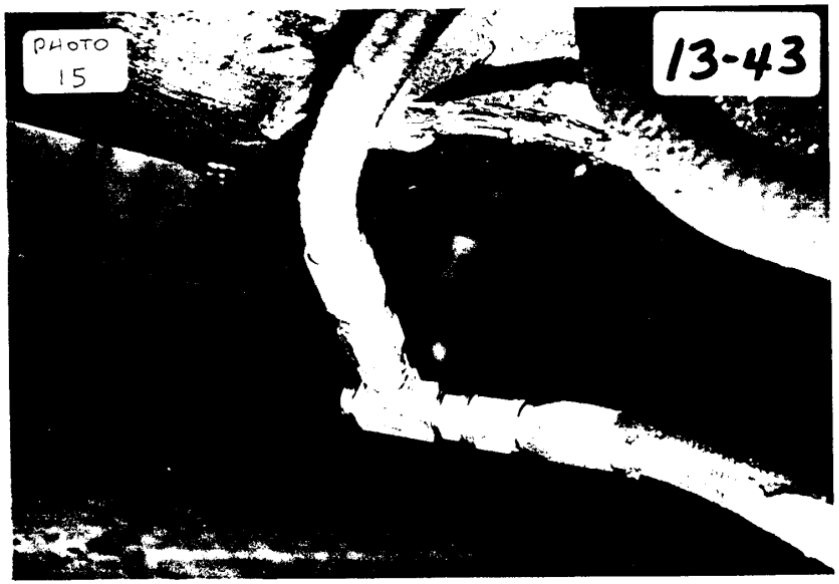
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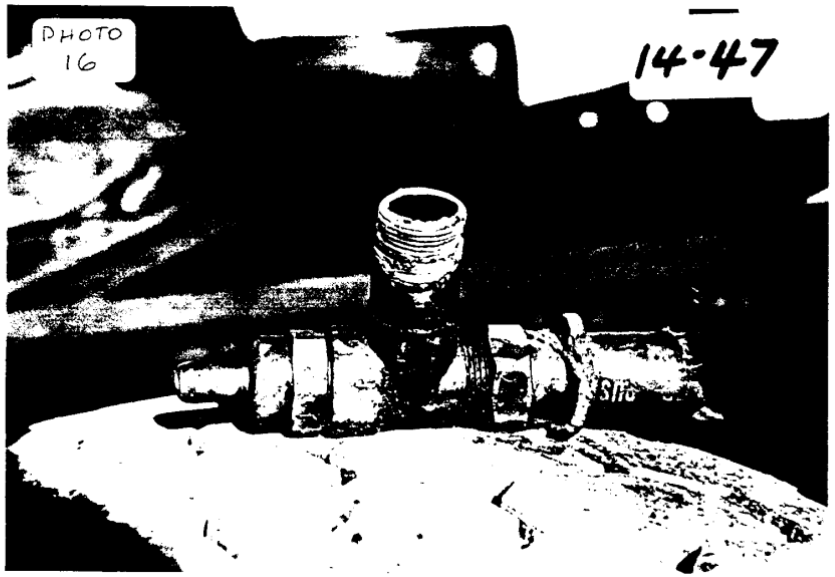
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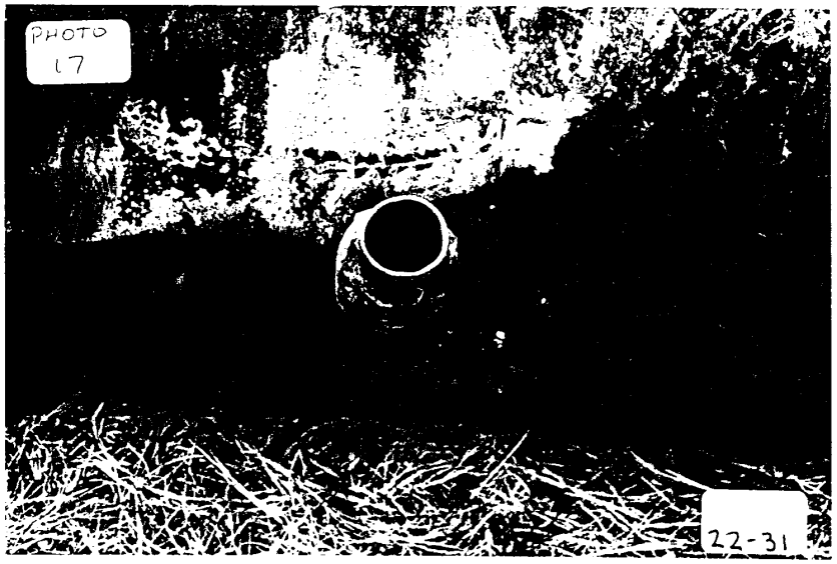
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APPENDIX A

Synopses of 27 Cases

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 1

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Freightliner Cabover, 1985

Trailer Make, Model, Year

Dorsey Van, date not noted

Location of Accident

South of Garrison, Texas on U.S. 59, February 10, 1987.

Description of Accident

The Freightliner was northbound on U.S. 59, approaching a gravel road (County 179) which makes a T-Intersection with the highway to the west. The loaded dumptruck was stationary on the two-lane highway, signally for a Left turn into CR 179. The driver of the Freightliner attempted evasive action, but struck the rear end of the dump truck after skidding a short distance. The dump truck was driven into the southbound ditch on the north side of the intersection, where it overturned and dumped its load of dirt. The twisting of the overturning dump truck and the impact caused the Freightliner to break into 4 peices, (1) the after part of the tractor chassis still attached to the upright van trailer, (2) the forepart of the tractor chassis which was very much deformed and bent, (3) the engine, which detached from its mounts, and (4) the cab, which was largely intact after all wreckage came to rest.

Injuries or Fatalities

The driver of the Freightliner was critically injured but has so far survived the accident, his companion who was in the sleeper berth sustained only minor injuries, as did the driver of the dump truck.

Seat Belt Usage

Restraints were not in use at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

All fuel was dumped from the tanks, except for small residual amounts.

Damage to Components

Left Tank

The left cylindrical aluminum tank shifted in its mounts, but was still attached to the forward piece of the tractor chassis. This tank sustained several punctures.

Right Tank

The right cylindrical aluminum tank mountings appeared to have held, although this tank was later separated from the wreckage by cutting the mounting strap bolts. Leakage from this tank was from punctures and a parted seam.

Lines

The crossover line was sheared from its fittings on both tanks. The fuel return line was also broken off between engine and chassis close to the point at which it was secured to the chassis.

Filters

The first upstream fuel filter outlet fitting was pulled out, but the line from the left tank to this filter was reasonably intact.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 2

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Kenworth Conventional 1981

Trailer Make, Model, Year

Freuhauf Van, date not noted

Location of Accident

Five miles south of Henrietta, Texas on U.S. 287, 12:18 a.m. on February 13, 1987.

Description of Accident

The Kenworth was headed northwest on US 287 in the right-hand lane on a straight downhill section of roadway. For unknown reasons, the vehicle drove off the right side of the road past the shoulder onto the grass and continued to travel approximately parallel with the road on the grassy surface for 350 feet. At this point, the vehicle was approaching a creek that flowed under the highway, which was protected with a W-beam guardrail and a bridge. The truck struck the turndown portion of the guardrail, travelled along the guardrail, and continued to destroy the rail and its wooden supports as this structure passed under the centerline of the vehicle.

Once on the bridge, the vehicle continued to deform the guardrail as the right side wheels of the truck went off the edge of the bridge. At this point the vehicle continued its forward motion and a roll motion to the right as the right side wheels were no longer supported. The vehicle continued to roll off the bridge across the creekbed and impacted the embankment where it came to rest. The tractor and trailer were still intact and attached at the final rest position. The cargo and the top of the trailer had ruptured, and the paint and resin solvent cargo leaked onto the ground.

Injuries or Fatalities

The driver sustained lacerations and contusions primarily on his chest and head. He was treated at the scene by EMS, and then transported to the local hospital for admission. There were no passengers in the vehicle.

Seat Belt Usage

The driver was not using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

All fuel was dumped from the two fuel tanks, except for residual amounts.

Damage to Components

Left Tank

This cylindrical aluminum tank shifted in its mounts, and sustained two punctures, one four inches long, the other two inches long, both in the front end of the tank. The rearend of the tank was dented but not penetrated. The filler cap area was depressed with a large dent around the cap.

Right Tank

This cylindrical aluminum tank was shoved rearward, but remained attached. The front end of the tank was damaged, and the front surface separated at a weld joint. Rearward displacement was limited by the filler cap contacting and deforming the tank attachment strap.

Lines

The crossover line and fittings were in good condition, although the metal crossover support was displaced upward and rearward approximately 8 inches. No other lines were damaged.

Filters

Filters were not damaged.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 3

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Peterbilt Cabover, 1977

Trailer Make, Model, Year

Stoughton van, 1980

Location of Accident

North Little Rock, Arkansas, Intersection I-40 (U.S. 67/167) on April 12, 1987 at 11:58 a.m.

Description of Accident

The Peterbilt vehicle combination was headed west on I-40 (U.S. 67/167) in the the left-hand lane on a slightly curved section of nearly level roadway. The vehicle drove off the left side of the roadway past the shoulder onto the dirt and travelled at a slight angle to the road for a distance of 180 feet. The vehicle then struck a temporary concrete median barrier positioned along the south side of the median. After striking this barrier, the vehicle continued to travel west and overturned onto its left side. The tractor and trailer were still attached at final rest. The top, left side and front of the trailer ruptured and cargo spilled onto the highway. Four eastbound vehicles were damaged by concrete shattered from the concrete median barrier.

Injuries or Fatalities

The driver of the tractor-trailer sustained a possible head injury and a laceration on his right leg. He was transported to a local hospital where it was later determined that he had suffered a cerebral vascular accident (stroke) prior to the accident. There were no passengers in the vehicle.

Seat Belt Usage

The driver was not using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

All fuel was dumped from the left fuel tank, while about on inch of fuel remained in the right tank.

Damage to Components

Left Tank

The left cylindrical aluminum fuel tank was separated from its mounts in the accident sequence. The mounts were sheared from the chassis. The tank received crush damage and had one rupture. A three-inch gash was located on the bottom near the weld seam. The tank filler cap was dented but still in working order.

Right Tank

The right cylindrical aluminum fuel tank was dented on the inboard side, a dent measuring approximately 36 inches with a crush depth of 4 inches maximum. The rear strap attachment was shifted rearward three inches. The tank filler cap on this tank was different than the one on the left tank, and showed evidence of damage predating this accident.

Lines

The fuel pickup, return, and crossover lines were all detached from the left tank. The only line to the right tank, the crossover line, was detached at its fitting.

Filters

The fuel filters and associated lines were undamaged.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 4

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Freightliner Cabover, 1982

Trailer Make, Model, Year

Strick van, year not recorded

Location of Accident

Six miles north of Gurdon, Arkansas, on I-30 at log mile 63 exit ramp, April 28, 1987, at 7:05 a.m.

Description of Accident

The Freightliner cabover combination was headed southwest on I-30. The vehicle exited at the log 63 mile exit ramp at an unknown rate of speed. This exit ramp has an advisory speed of 25 MPH and makes a sharp right hand turn approximately 340 ft after leaving the Interstate. The vehicle put down tire marks from the left side tires as it went off the left side of the exit ramp onto the shoulder. The vehicle continued past the shoulder onto the grass and dirt where the trailer rolled over pulling the tractot over onto its left side also. The tractor-trailer was slightly articulated as the left front corner nosed down into the dirt and slid to final rest.

Injuries or Fatalities

There were no injuries or fatalities in this accident.

Seat Belt Usage

The driver was using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Twenty gallons of fuel leaked from the left fuel tank vent hole in the cap.

Damage to Components

Left Tank

The rear mounting strap/step was bent, otherwise this tank was undamaged.

Right Tank

There was no damage to the right tank.

Lines

There was no damage to any of the fuel lines. The crossover line was disconnected after the accident to prevent fuel flowing from the right tank to the left tank while the vehicle was lying on its side.

Filters

There was no damage to fuel filters or associated lines in this accident.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 5

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Freightliner cabover, 1972

Trailer Make, Model, Year

Great Dane platform trailer, 1984

Location of Accident

Seven miles south of Conroe, Texas on I-45, May 21, 1987 at 4:00 a.m.

Description of Accident

The Freightliner vehicle combination was headed south on I-45 in the right-hand lane on a straight and level section of roadway. A second vehicle, a 1979 Kenworth pulling a platform trailer, was also southbound in the same lane at a slower rate of speed. As the Freightliner approached the rear of the Kenworth, the driver of the Freightliner swerved left in an avoidance maneuver which resulted in striking the lead vehicle in the left rear section of its trailer. After the impact with the Freightliner, the Kenworth left the right side of the highway and crossed a ditch where its trailer rolled over. The impact between the two vehicles knocked the right front wheel from under the Freightliner tractor, separated the right fuel tank from the tractor, demolished the battery box, and distorted the metal on the right front corner of the trailer. The force of the impact caused the steel pipe cargo on the trailer to shift forward into the rear of the cab. The cab was torn from the chassis and came to rest in front of the rest of the tractor.

A fire started near the right rear tractor duals of the Freightliner, resulting in burning of the right rear wheels and the right fuel tank. The right side frame rails and the right side battery box were also fire damaged.

Injuries or Fatalities

The driver sustained a laceration to the forehead, a fractured collarbone, and fractured ribs. He was transported to a local hospital.

Seat Belt Usage

The driver was not using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

No fuel remained in either of the fuel tanks, all either spilled or burned.

Damage to Components

Left Tank

There were two ruptures on this tank, and the filler cap was missing. This cylindrical aluminum tank was not OEM equipment.

Right Tank

The right cylindrical aluminum tank was melted in the fuel fire, after it was ripped from the tractor frame. The front of this tank was crushed and there was a great deal of damage. There was a hole in this tank where the crossover and drain plug casting was partially detached, and the crossover connection was broken. The filler cap for this tank was also missing. Thiks tank was not OEM equipment.

Lines

All fuel lines became detached from their tanks in this accident.

Filters

No damage to filters occurred in this accident.

Ignition

A fire started on the right side of the tractor near the right rear duals. The right fuel tank was against these wheels at final rest, and must have leaked a large amount of fuel. The fire damage was confined to a small area that consisted of the right fuel tank, the dual wheels, the battery box, a tarpaulin that was folded on top of the frame rails aft of the tractor cab, and the right front corner of the trailer. This fire was extinguished by a local fire department before it could spread and cause further damage.

The most probable cause of ignition was a spark or arc from

the batteries as they were destroyed in the impact. As the right fuel tank was propelled rearward into the battery box, both the tank and the box were separated from the tractor frame and fuel spilled from the damaged tank.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 6

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

GMC Astro cabover, 1986

Trailer Make, Model, Year

Fruehauf van, 1978

Location of Accident

Houston, Texas on North Loop 610, 1/4 mile east of the Lockwood overpass, June 9, 1987, at 8:55 a.m.

Description of Accident

The tractor-trailer combination was headed east on North Loop 610 in Houston in the second of four lanes. The vehicle was traveling at approximately 45 MPH. It was raining at the time and the road was reported to be extremely slippery. Apparently the empty trailer began to jackknife behind the tractor and the driver lost control. The vehicle crossed the left shoulder, and struck the concrete median barrier with the right front end of the tractor. At first contact with the barrier, the tractor jackknifed (counter-clockwise) to the left, and continued to jackknife as the sequence of events continued. The right front tire made contact with the median barrier and the tractor climbed up the barrier. When the tractor reached the top of the barrier, the bottom of the trailer contacted the top of the fuel tanks.

Injuries or Fatalities

The driver was only slightly injured, if at all in this accident. No other passengers were in the vehicle.

Seat Belt Usage

The driver was using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Seventy-five gallons of fuel were spilled in this accident.

Damage to Components

Left Tank

The steel rectangular tank was slightly dented, but leakage from this tank was from the "T" fitting where the fuel crossover line connects.

Right Tank

This steel rectangular tank sustained damage to the ball check air vent, which was sheared off during the jackknife sequence of the accident. The drain plug was also sheared off by the top of the concrete median barrier. Major leakage, however, was from the crossover line, parted at the left tank fitting.

Lines

The crossover line was separated from the left tank T fitting. Major spill came from this line.

Filters

No damage to fuel filters.

Ignition

There was no ignition of fuel in this incident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 7

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

International cabover, 1982

Trailer Make, Model, Year

Great Dane van, 1981

Location of Accident

Northbound Loop 610 in Houston, Texas, near the crest of a ship channel bridge. 2:45 p.m., June 12, 1987.

Description of Accident

The International cabover was headed north on Loop 610 on a bridge over the Houston Ship Channel, and was in the right-hand climbing lane. It was raining and the pavement was wet. The vehicle lost traction, and went to its right across the shoulder to hit first the curb and then the bridge guardrail. The trailer jackknifed after the tractor struck the curb and rail, and the rear of the trailer rotated around the tractor on the left side. The left side of the trailer struck the left rear of the tractor.

Injuries or Fatalities

The driver sustained minor lacerations on his head, and reported a sore neck. He was not seriously injured.

Seat Belt Usage

The driver was not using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Approximately 150 gallons of fuel were spilled on the bridge pavement.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was not damaged.

Right Tank

The cylindrical aluminum fuel tank sustained a seam separation rupture during the impact with the bridge rail. The tank vent valve was sheared off, and the crossover line parted close to the tank. The tank was also displaced rearward in its mounting straps.

Lines

The crossover line was parted near the right tank. All other lines remained intact.

Filters

There was no damage to the fuel filters in this accident.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 8

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Kenworth Conventional cab, 1977

Trailer Make, Model, Year

Timpte hopper bottom bulk trailer, 1987

Location of Accident

1.5 miles north of Commerce, Texas on State Highway 50, intersection of SH 50 and Airport Road, 2:45 p.m., July 7, 1987.

Description of Accident

The Kenworth tractor combination was traveling south on Texas Highway 50. At the intersection of Airport Road and the highway, the driver of a 1977 Chevrolet Caprice passenger car on Airport failed to stop at the intersection stop sign. The Caprice entered Highway 50 and was struck on the right side by the Kenworth. After the initial impact, the Caprice rotated counterclockwise and the vehicles side-swiped each other, with the right rear of the car striking the left side fuel tank of the case vehicle. The tractor-trailer combination then travelled across the northbound lane and through the ditch. The vehicle then rolled over on to its right side, coming to rest with the tractor in the field and the trailer across the road, shoulder, and ditch.

Injuries or Fatalities

The drivers of both vehicles suffered only minor injuries and were treated then released at a local hospital. There were no passengers in either vehicle.

Seat Belt Usage

The driver of the Kenworth was not using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

All but a small residue in the left tank was spilled in this accident, approximately 100 gallons.

Damage to Components

Left Tank

The cylindrical aluminum tank was dented in the sideswipe, but did not lose integrity.

Right Tank

The cylindrical aluminum tank was ruptured along a seam in the front when the right front axle mounting bolts were fractured in impact with the ditch, causing the right front tire to be displaced into the tank.

Lines

There was no damage to any of the lines in this accident.

Filters

There was no damage to any of the filters in this accident.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 9

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Kenworth conventional cab, 1983

Trailer Make, Model, Year

Reliable tank trailer (crude oil), 1982

Location of Accident

Texas State Highway 6, in O'Brien, Texas, at 5:10 p.m., on July 6, 1987.

Description of Accident

The Kenworth combination vehicle was traveling south on Texas 6 just inside the city limits of O'Brien, Texas. As the vehicle rounded a left-hand curve, another vehicle, a 1982 Chevrolet pickup truck, was northbound part way across the center line in the southbound lane. The pickup made an avoidance maneuver to the right in an attempt to get back on the right side of the two-lane highway. The driver of the Kenworth slowded in anticipation of the collision, but could not avoid a head-on collision with the pickup. The impact speed was 29 MPH. After the collision, the Kenworth travelled off the road to its left and came to rest with the tractor just beyond the shoulder and the trailer across both travel lanes.

Injuries or Fatalities

The driver of the Kenworth was not injured. The driver of the Pickup was seriously injured, and was hospitalized.

Seat Belt Usage

The driver of the Kenworth was using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Thirty gallons of fuel were lost from the vehicle.

Damage to Components

Left Tank

There was no left tank on this vehicle.

Right Tank

The cylindrical aluminum tank was dented in this collision, but remained intact.

Lines

There was no damage to any of the fuel lines.

Filters

The bottom of the fuel filter/water separator was broken during the accident sequence.

Ignition

There was no ignition of fuel in this collision.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 10

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Ford Cabover 1982

Trailer Make, Model, Year

Monon van trailer, empty

Location of Accident

Nearly 3 miles east of Breckenridge, Texas on U.S. Highway at 12:39 a.m. on July 16, 1987.

Description of Accident

The vehicle was westbound on U.S. 180, when it was involved in a head-on collision with an eastbound 1965 Chevrolet Impala which had crossed the centerline for unknown reasons. The driver of the tractor-trailer attempted evasive action and applied breaks, but to no avail. The collision was right corner to right corner on both vehicles. The car swept along the right side of the tractor, impacting the right front wheel, the battery box, the right side fuel tank, and the front outside tandem wheel. The vehicle jackknifed after collision, and the left side of the tractor contacted the left side of the trailer.

Injuries or Fatalities

The driver of the Kenworth was not uninjured. All four of the occupants in the Impala were injured, a back seat passenger fatally.

Seat Belt Usage

The driver of the Ford Tractor was using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

One hundred gallons of fuel were spilled in this collision.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was dented in the collision, but did not lose integrity.

Right Tank

The cylindrical aluminum fuel tank was torn away from the tractor chassis by the force of the impact with the car. There were numerous ruptures and dents, and the filler neck was broken off. The largest deformation occurred when the Impala made direct contact with the tank.

Lines

The crossover line parted when the right fuel tank was torn away from the vehicle.

Filters

There was no damage to any of the vehicle fuel filters.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 11

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Kenworth Cabover 1978

Trailer Make, Model, Year

Utility refrigerated van trailer, 1979

Location of Accident

Northbound Interstate 35, in Hillsboro, Texas (Hill County) 9:15 p.m., on July 14, 1987.

Description of Accident

The vehicle ran off the west shoulder of I-35 and struck a guardrail at the edge of the shoulder. The vehicle ran over the guardrail and into the median, struck two small trees, then vaulted a ditch running across the median. After the vehicle vaulted the ditch, it struck the north slope of the ditch. The cargo of cantaloupe melons shifted forward and struck the rear of the tractor cab. The vehicle fuel ignited.

Injuries or Fatalities

The driver was treated and released from a local hospital. His passenger was entrapped and burned to death in the vehicle.

Seat Belt Usage

Unknown.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Only 12 gallons of fuel remained in the tanks, but the amount spilled is unknown.

Damage to Components

Left Tank

The cylindrical aluminum tank was deformed from the impact

from the ditch, but lost integrity only from loss of the fuel cap, and from the loss of the fuel shutoff/crossover fitting from the bottom of the tank.

Right Tank

The cylindrical aluminum tank (not original equipment) sustained a seam separation rupture that resulted from being raked by the right side exhaust stanchion. Fuel from this rupture was sprayed over the batteries and right side of the engine.

Lines

Fuel lines were intact, except for the left tank crossover fitting, which was broken off the tank.

Filters

No damage was noted to fuel filters in this accident.

Ignition

There was ignition shortly (a few seconds) after the vehicle came to rest. The entire cab was consumed and right side of the engine and chassis were burned. The diesel powered refrigeration unit landed on top of the cab, and may have contributed to the fire. Fire initiation may have resulted from fuel sprayed on the engine or the truck batteries. Ignition may have occurred from thermal or electrical means in the truck engine area, from sparking or arcing of the batteries, or from electrical or thermal sources associated with the refrigeration unit.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 12

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

1984 GMC 9500 series cabover

Trailer Make, Model, Year

The trailer was not available for inspection.

Location of Accident

The accident occurred 8.6 miles east of Prescott, Arkansas, on Interstate 30 at the east end of bridge number 52.55, at 11:45 a.m. on September 2, 1987.

Description of Accident

The vehicle was westbound when it veered off the right side of the roadway and struck the guardrail at the east end of bridge number 52.55. The right front corner of the vehicle then struck the end of a concrete wingwall, located between the guardrail and the end of the bridge. The vehicle was redirected onto the roadway where it continued on the bridge until it struck the right side of the concrete bridge parapet and the metal rails with the front right corner and right side of the tractor and trailer. The vehicle then went to its left across the center line and struck the left side bridge rail with the front of the tractor. The vehicle rolled 270 degrees and came to rest on its left side. The tractor was engulfed in flames and was completely destroyed. The only part of the trailer to burn was the tires.

Injuries or Fatalities

The driver of the tractor-trailer was treated and released. He stated that he was later admitted to a hospital where he stayed one week, but could only describe his injuries as "being sore all over."

Seat Belt Usage

Unknown.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

According to the driver, approximately 120 gallons of diesel fuel were in the tanks just prior to impact. All of the fuel either leaked or burned in the accident.

Damage to Components

Left Tank

The cylindrical aluminum tank received some crushing damage in the rollover sequence of the accident, but integrity loss appears to be from fire damage which melted the tank.

Right Tank

The cylindrical aluminum tank was damaged in the initial impact with the guardrail and the concrete wingwall. The right front wheel was displaced rearward and came i contact with the front surface of the right tank. The tank itself came in contact with the wingwall as is indicated by the deformation on the outboard surface of the tank. Diesel fuel was found at the scene starting 8 feet from this impact location indicating system integrity loss occurred on impact. This tank was melted by the fire.

Lines

The crossover line was not found, therefore its role in the loss of integrity is unknown. The fuel lines were burned but were not torn or ruptured.

Filters

The fuel filter was detached from the mount. The filter was damaged by the fire.

Ignition

According to the driver, the fire started on impact with the bridge rail. He stated there was an "explosion" on the right side of the tractor and it was burning on the right side when he got out of the vehicle at its final rest point. As he was leaving the vicinity of the tractor, a second explosion occurred on the left side of the tractor. Based on his information, the vehicle inspection, and the scene inspection, the most probable ignition sources are frictionally generated sparks from impacts or heated surfaces, such as the turbocharger body.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 13

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Peterbilt 359, Conventional, 1985

Trailer Make, Model, Year

Barrett, livestock van (loaded), 1981

Location of Accident

1 mile west of Claude, Texas on U.S. Highway 287, at 5:30 a.m., September 23, 1987.

Description of Accident

The vehicle was westbound on U.S. 287, it drifted off the road on the left side and struck a small sign. When the driver attempted to pull back onto the road, he applied a right steer and lost control. The trailer rolled over onto its left side, followed by the tractor rolling over on its left side.

Injuries or Fatalities

The driver of the tractor-trailer was not seriously injured. About a dozen of the 67 head of cattle in the trailer were killed.

Seat Belt Usage

A seatbelt was not available for the driver.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Approximately 50 gallons of fuel were spilled in this accident.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was deformed, and the shutoff valve on the bottom of the tank was loose and dripping

fuel at the time of the vehicle inspection.

Right Tank

There was no damage to the cylindrical aluminum fuel tank itself, however the crossover line fitting on the bottom of the tank was separated in the accident. Most of the fuel loss came from this separation.

Lines

The fitting for the shutoff valve on the left end of the crossover line was loose and dripping fuel and the fitting on the right end of the crossover line was separated. The remainder of the system's lines appeared intact.

Filters

No fuel filter damage was apparent.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 14

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

GMC General Conventional Cab, 1987

Trailer Make, Model, Year

Great Dane Trailers, Inc., Van, 1983

Location of Accident

Approximately two miles east of Glenrio, Texas on Interstate 40, at 6:15 a.m., on October 4, 1987.

Description of Accident

The tractor-trailer combination unit was westbound when it veered off the right side of the roadway and struck an aluminum guardrail. The tractor straddled the turned-down end of the guardrail and traveled on top of it for a distance of 175 feet, knocking down 19 wooden guardrail posts. The vehicle then struck the end of a concrete bridge railing and climbed on top of it, shoving the entire bridge railing 16 feet west of the impact location. After sliding along the top of the bridge railing for approximately 25 feet, the truck rolled over onto its right side, falling to the ground below.

Injuries or Fatalities

Neither the driver or the (right front) passenger were injured in the accident.

Seat Belt Usage

The driver was probably using his belt, but passenger belt usage is unknown.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

225 gallons of fuel leaked from the damaged vehicle.

Damage to Components

Left Tank

There were several areas of deformation to the cylindrical aluminum tank. The most obvious were to the lower front, the bottom, and the rear surfaces. The crossover fitting detached from the tank and served as the major point of leakage. Also, there were two small punctures on the bottom where the mounting brackets penetrated the surface as a result of contact with the concrete bride railing.

Right Tank

The cylindrical aluminum tank was severely deformed in the accident, both form the impact with the bridge railing and from the rollover sequence of the accident. A large rupture was found on the front of the tank where the cab step displaced rearward and penetrated the surface. Another large rupture was located on the rear of the tank where the rear left spring bracket penetrated the rear surface. The crossover fitting was also detached on this tank.

Lines

The crossover line detached at both ends. The right end of the line was torn apart 2 inches from the end, while the left end separated from the attachment fitting. Two fuel inlet lines going into the first fuel filter pulled loose at the filter, and the outlet line was detached at the brass fitting on the filter.

Filters

Both fuel filters were undamaged, except for the lines as stated above.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 15

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

International Cabover, 1984

Trailer Make, Model, Year

Fruehauf open-top van 1979

Location of Accident

3.8 miles north of Pine Bluff, Arkansas on U.S. Highway 79 at 7:30 a.m., on December 2, 1987.

Description of Accident

The driver of the International (case vehicle) southbound on U.S. 79 in the outside lane in heavy fog, failed to observe another tractor-trailer (1987 Mack tractor and Trailmobile trailer) stopped in the outside lane until he was too near to stop. The driver applied his brakes and swerved to his left in an attempt to avoid the other tractor-trailer, but struck the trailer in the left rear. After impact, he continued into the inside lane where his vehicle struck the concrete median barrier and then a Chevrolet Blazer in the rear. This impact pushed the Blazer down the road and into the rear of a Toyota, pushing the Toyota into the rear of a Volkswagen. Diesel fuel from the case vehicle was ignited.

Injuries or Fatalities

The driver of the tractor-trailer was injured and his passenger was killed.

Seat Belt Usage

Unknown.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

An unknown amount of fuel was spilled. No fuel remained after the fire.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank (not original equipment) was damaged extensively in the fire. Approximately 60 per cent of the tank remained at the time of vehicle inspection.

Right Tank

Apparently the right side fuel tank was completely destroyed in the fire. Field investigators were unable to determine any details about the right tank.

Lines

All of the fuel lines were destroyed in the fire.

Filters

None of the fuel filters were found in the wreckage.

Ignition

According to witnesses, fuel ignition occurred immediately upon impact of the International with the Mack-trailer combination. Three vehicles, the International, the Mack, and the Blazer, were destroyed by the fire. The entire cab of the International was consumed and there was fire damage to the frame and chassis. The source of ignition is unknown.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 16

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

International Cabover, 1985

Trailer Make, Model, Year

Trailer was not available for inspection.

Location of Accident

In West Memphis, Arkansas on Interstate 40 - Interstate 55, at 12:00 noon, December 6 1987.

Description of Accident

The tractor-trailer combination unit was westbound in the center lane in a rounding S-curve where Interstate 55 merges with Interstate 40. According to witnesses, the pressed board building products load on the trailer of the case vehicle shifted and the vehicle swerved to the right, across the right lane. The driver steered back to his left and the truck jackknifed counter-clockwise before rolling over onto its right side. The tractor slid across the shoulder on its right side and continued on the roadside for approximately 60 feet until it crossed a small drainage ditch. As the tractor slid across the ditch, it turned back upright and came to rest on its wheels.

Injuries or Fatalities

The driver was transported to a local hospital where he was treated and released.

Seat Belt Usage

Unknown.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Upon inspection, the left tank was approximately 3/4 full while the right tank was 1/2 full. This indicates at least 38 gallons (1/4 of 150 gallons) of fuel leaked from the right tank.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was not damaged in the accident.

Right Tank

The cylindrical aluminum tank was damaged in the accident. Several small areas of deformation were located on the outboard surface of the tank. A large 35-inch long area of pavement abrasions was also found on the outboard surface as a result of rollover damage. However, no fuel leaked from this damage. The top rear sector of the tank received damage from contact with the bottom of the trailer in the accident. This deformation measured 11 inches by 12 inches and was 4.5 inches deep. A small 1-inch rupture was found in this area of deformation. It appears a small amount of fuel leaked from the rupture. The major source of leakage from the right tank was through the crossover fitting as the crossover line detached from the fitting during the accident.

Lines

The crossover line was detached at the right end. The brass fitting broke loose during the accident and served as a source of fuel leakage when the tractor was at its final rest point.

Filters

Both fuel filters were undamaged.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 17

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

International Cabover, 1985

Trailer Make, Model, Year

Dorsey closed-top van, 1984

Location of Accident

Two miles east of Plumberville, Arkansas on Interstate 40 at 3:25 a.m., on January 14, 1988.

Description of Accident

The International (case vehicle), eastbound on Interstate 40 in the rear outside lane, struck another tractor-trailer combination in the rear. After striking the other vehicle, the case vehicle left the road, overturned, and came to rest on the south edge of the roadway.

Injuries or Fatalities

The driver of the tractor-trailer was injured and transported to a local hospital and admitted.

Seat Belt Usage

The driver was using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

An unknown amount, but total loss of fuel resulted from this accident.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was crushed and ruptured along a seam by contact with the pavement when the vehicle

overturned.

Right Tank

The cylindrical aluminum fuel tank was damaged extensively by impact with the other vehicle. It was crushed rearward and torn open near the bottom. The tank was also displaced rearward in its mounts, and punctured by an exhaust stanchion.

Lines

No fuel lines were damaged.

Filters

Neither the fuel filter nor the fuel-water separator was damaged.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 18

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Ford Conventional, 1981

Trailer Make, Model, Year

Unknown make, model and year, flatbed (lowboy) trailer.

Location of Accident

Two miles north of Gould, Arkansas on U.S. Route 65 at 4:06 p.m., on February 2, 1988.

Description of Accident

The Ford tractor and semi-trailer combination were northbound on U.S. 65. A 1981 Mercury Lynx was southbound on U.S. 65 approaching the Ford when the Mercury driver apparently lost control of her vehicle and crossed the center line. The driver of the tractor trailer steered to his right in an attempt to avoid the accident, but struck the Lynx head-on. After the initial impact, the tractor-trailer jackknifed as the tractor rotated clockwise. The jackknifed vehicle then traveled off the northbound shoulder, crossed a concrete culvert and impacted a drainage ditch on the left side of the tractor. This impact resulted in significant damage to the left-side fuel tank and the crossover line.

Injuries or Fatalities

The driver of the other vehicle (1981 Mercury Lynx) was fatally injured in the accident. The driver of the Ford Conventional was injured and was treated and released at the local hospital.

Seat Belt Usage

Seatbelts were not worn by either driver or passenger.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Approximately 100 gallons of fuel were spilled in this

accident.

Damage to Components

Left Tank

The rectangular steel tank was damaged in the ditch impact as the tractor-trailer came to its final rest position. The tank was dislodged from its attachment straps and rotated 90 degrees counter-clockwise (viewed from the front of the vehicle looking rearward) as the lower outboard surface of the tank dug into the ground when the left side of the tractor impacted the ditch. The crossover fitting broke loose as the tank moved from its normal position. However, only a small amount of fuel leaked from the opening created by the severed crossover fitting. After the tank rotated this opening was above the level of the remaining fuel.

Right Tank

The rectangular steel tank was damaged in the jackknife sequence of the impact. The right-front corner of the trailer came in contact with tank as the jackknifed vehicle traveled across the shoulder and off the road. The tank was deformed but no ruptures resulted from this tractor-trailer contact. Fuel leaked from the right tank through the disconnected left end of the crossover line.

Lines

The brass fitting at the left end of the crossover line separated from the left tank at its attachment point. Fuel from the right tank leaked through this disconnected crossover line. The remainder of the fuel lines were intact.

Filters

Both fuel filters were undamaged in the accident.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 19

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

White, conventional with integral sleeper, 1987.

Trailer Make, Model, Year

Unknown make closed-top van, loaded with glassware.

Location of Accident

Interstate 30 in LIttle Rock, Arkansas, approximately 507 feet east of the junction of Interstate 30 and Interstate 440 at 1:08 a.m., on March 31, 1988.

Description of Accident

The White (case vehicle) tractor and semi-trailer combination was traveling east on Interstate 30 in the outside lane. A 1984 Kenworth was also traveling est in the outside lane, ahead of the White. The driver of the Kenworth tractor-trailer combination was slowing his vehicle and attempting to pull off onto the right shoulder. He had slowed almost to a stop, with is vehicle partially on the road. The driver of the White tractor-trailer apparently failed to realize that the vehicle ahead was traveling at a very slow speed and struck the rear of the trailer with the front of the White tractor. After it struck the other vehicle, the case vehicle left the road, overturned, and came to rest south of the roadway. The spilled fuel ignited after impact and caused extensive burn damage to both tractor and trailer.

Injuries or Fatalities

The driver of the case vehicle was injured and the occupant in the sleeper compartment was killed. The driver of the other vehicle was also injured.

Seat Belt Usage

The driver was not using his restraint at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

An unknown amount of fuel was spilled in this accident.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was almost completely destroyed by the fire.

Right Tank

The cylindrical aluminum fuel tank separated form the vehicle and ruptured in several places where the right front wheel and tire were displaced rearward and contacted it. The tank was partially consumed by the fire.

Lines

Most of the fuel lines were burned in the fire.

Filters

One fuel filter remained on the engine, but it was damaged by fire.

Ignition

The fuel from the right front tank was ignited shortly after the White impacted the rear of the trailer of the other vehicle. The most likely source of ignition was spray of fuel from the right tank onto a thermal or electrical source. Another possibility is friction-generated sparks during the final stages of the accident sequence.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO 20

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Kenworth conventional model, 1985 (glider 326801SGL)

Trailer Make, Model, Year

Trailmobile refrigerated van, 1977.

Location of Accident

Approximately 3.3 miles north of Madisonville, Texas on Interstate 45, at 1:15 a.m., on April 12, 1988.

Description of Accident

The Kenworth tractor-tailer combination unit was northbound in the right lane. A Freightliner semi-trailer traveling ahead and out of sight of the Kenworth (case vehicle) had driven off the right side of the road, returned back to the travel lanes, and rolled over 270 degrees onto its left side. The Freightliner combination vehicle had come to final rest across both travel lanes. The Kenworth vehicle combination made a brake application just prior to impact. The Kenworth cab struck the tanker semi-trailer of the rolled Freightliner vehicle. Tractors separated from both units. The final rest position of the Kenworth tractor was in the left lane facing north, still in contact with the Freightliner trailer and upright. The Kenworth's semi-trailer had rolled 90 degrees onto its right side. The Freightliner tractor was once again upright on its wheels and positioned in the left lane, headed north.

Injuries or Fatalities

The front right passenger of the Kenworth (case vehicle) died the day following the accident from injuries received in the accident. The driver of the case vehicle was admitted to Madison County Hospital for treatment of minor injuries. The driver of the Freightliner (the vehicle that had overturned and was struck) was also transported to Madison County Hospital and treated for minor injuries.

Seat Belt Usage

The driver of the Kenworth was not using his restraint at the

time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

125 gallons of fuel leaked from the case vehicle, all from a small hole in the right tank.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was contacted on the front surface by the battery box cover resulting in superficial scratching to the surface. No other damage was noted to the left tank.

Right Tank

The cylindrical aluminum fuel tank was deformed on the front surface from the rearward displacement of the right side tool box/cab step cover. A small puncture was found on the front of the tank where the cab step displaced rearward and penetrated the surface. Another area of contact was found on the top of the right tank where the cab scraped the surface with no residual deformation.

Lines

The crossover line remained attached at both ends and its support was not deformed. No line leaks or failures were noted. Fuel pickup and return was from the right tank.

Filters

The fuel filter was undamaged.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO. 21

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

GMC Astro cabover, 1986

Trailer Make, Model, Year

Unknown make, model and year, closed van refrigerated trailer

Location/Time of Accident

One mile east of North Little Rock, Arkansas on Interstate 40, at 11:45 p.m., June 8, 1988.

Description of Accident

The GMC Astro tractor and semi-trailer combination was eastbound on Interstate 40. As the GMC neared the 162 log mile, it suddenly enter an area completely enveloped in smoke from a burning field. The GMC was then involved in a complicated eleven vehicle chain-reaction accident. Seven tractor-trailers, three passenger cars and one light truck were involved. Three of the tractor-trailers and the light truck burned. The GMC was involved in impacts with at least three other vehicles in both a striking and struck manner. In an initial impact, this vehicle appeared to sustain major frontal damage from striking the rear of another tractor-trailer. Another less severe impact location was to the left side of the tractor involving the left side fuel tank and left front wheel. Direct damage was also noted to the left rear corner of the trailer. Due to the complicated nature of the accident, the exact impact sequencing and objects impacted are not known. At its final rest position, the GMC tractor was located on the right shoulder jackknifed approximately 60 degrees to the trailer. The trailer remained on the roadway with the rear of the trailer in the right lane and the front of the trailer near the right shoulder. The GMC tractor was destroyed by fire. Only the frontal surface of the trailer received fire damage.

Injuries or Fatalities

The driver of the GMC was fatally injured. Three other drivers also died in the accident. Eight other people were injured in the accident and were taken to various local hospitals for treatment. Only one of the injured was admitted.

Seat Belt Usage

Unknown.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel loss

Approximately 75 gallons leaked from the case vehicle. The left tank was empty, while the right tank remained full.

Damage to Components

Left Tank

The cylindrical steel tank was severely damaged in the accident. The front half of the tank was crushed and split open. A large rupture was also located on the bottom surface. Several small punctures were located on the inboard surface. An area of deformation was located on the rear/outboard surface. The tank was separated from its attachment straps and all lines and accessories were detached. The entire tank had evidence of fire damage.

Right Tank

The cylindrical steel tank had small areas of deformation to the outboard surface near the location of the rear attachment strap and on the inboard surface near the front mounting bracket. The tank moved forward in the crash and slipped out of the rear attachment strap. The fuel line sheared off at its attachment point on the top of the tank. No other damage was noted.

Lines

All of the lines connected to the left tank detached during the accident. They were also burned in the ensuing fire. The return line to the right tank was detached from the tank. No fire damage occurred to the right tank or lines.

Filters

Both fuel filters were not located for inspection, and are assumed to have been destroyed in the accident.

Ignition

Fuel from the left tank was ignited immediately following impact. Ignition sources in order of probability include sparking from the impact to the left tank by another vehicle, heat sources such as engine components, and the possibility the fire spread from another vehicle.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO. 22

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

GMC Astro cabover, 1986.

Trailer Make, Model, Year

Utility, closed van, year unknown.

Location/Time of Accident

One mile east of North Little Rock, Arkansas on Interstate 40, at 11:45 p.m., June 8, 1988.

Description of Accident

The GMC Astro tractor and Utility semi-trailer combination was eastbound on Interstate 40. As the GMC neared the 162 log mile, it suddenly entered an area completely enveloped in smoke from a burning field. The GMC was then involved in a complicated eleven vehicle chain-reaction accident. Seven tractor-trailers, three passenger cars and one light truck were involved. Three of the tractor-trailers, including this case vehicle, and the light truck burned. The GMC was involved in impacts with at least three other vehicles. Initially this vehicle appeared to sustain frontal damage from striking the left side of another tractor-trailer. Following that impact the GMC continued eastbound near the center line to impact the rear of two additional tractor-trailer combinations. Due to the complicated nature of the accident, the exact impact sequencing and objects impacted are not known. At its final rest position, the GMC tractor was straddling the center line with its right front corner against the left rear of one trailer and its left front corner against the right rear of another trailer. The trailer remained attached to the tractor and was also straddling the center line behind the tractor. The GMC tractor was destroyed by fire. The trailer and its contents also received major fire damage.

Injuries or Fatalities

The driver of the GMC was fatally injured and pronounced dead at the accident scene. He was found lying on the roadway near the left front of his vehicle.

Seat Belt Usage

The driver was not using his seat belt at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Approximately 150 gallons leaked and burned from the case vehicle. Both tanks were completely empty upon inspection.

Damage to Components

Left Tank

The cylindrical steel tank received only minor deformation in the accident. A small area of deformation was located on the outboard surface at the front attachment strap. Both straps moved rearward in the crash, but remained attached. Damage was also noted to the filler neck and cap. The front edge of the neck was bent and the cap was broken away in the same area. No ruptures were found to the left tank, but the crossover line was detached and burned. The fuel from this tank leaked from this crossover line damage. Fire damage was noted to the inboard surface, top surface, and front surface. The outboard surface and the rear surface sustained very little fire damage.

Right Tank

The cylindrical steel tank was separated from the tractor chassis. The front surface, rear surface, outboard surface, inboard surface, and bottom surface were all deformed. A three inch long "blowout" rupture was found on the front/inboard surface near the seam weld. The crossover line, return line, sending unit, check valve, and filler cap were all damaged or missing. The entire tank sustained major fire damage.

Lines

All of the lines connected to the right tank detached during the accident. They were also burned in the ensuing fire. The lines to the left tank remained attached, but were burned.

Filters

Both fuel filters were completely destroyed in the accident and were not located for inspection.

Ignition

Fuel from the right side tank may have ignited while the

vehicle was still rolling. The strongest possibility is that burning fuel from other vehicles ignited fuel leaking from the right tank after it separated from the vehicle.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO. 23

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Kenworth, cabover with sleeper, 1986.

Trailer Make, Model, Year

Great Dane, closed-top reefer van, 1985.

Location/Time of Accident

Interstate 40, 1 mile east of North Little Rock, Arkansas, approximately 1.8 miles west of the Lonoke County line at 11:45 p.m., on June 8, 1988.

Description of Accident

The Kenworth (case vehicle) tractor and Great Dane semi-trailer combination was traveling east on Interstate 40 in the outside lane. A grain field was burning on the north side of the Interstate and heavy smoke over the roadway reduced visibility to near zero. As the Kenworth neared the 162 log mile, it suddenly entered the smoke covered area. The Kenworth was then involved in a complicated eleven vehicle accident, involving seven tractor-trailer combinations, three passenger cars and one light truck. Three of the tractor-trailers and the light truck burned. Exact details of the impact sequence and objects contacted are not known due to the accident severity and number of vehicles involved. The Kenworth appeared to have been involved in four or five impacts. The most severe of these was the impact with the 1986 GMC Astro cabover (case 7093-21 vehicle). The front of the GMC struck the rear of the Great Dane semi-trailer, and the Kenworth jackknifed into the median. The right fuel tank was impacted by the trailer and ruptured during the jackknife sequence. There were other impacts to the front of the tractor and the left side of the trailer. These impacts appeared to have been with light vehicles. At final rest, the tractor was in the median headed northeast and the trailer was headed north, with the frontal portion in the median and the rear on the roadway.

Injuries or Fatalities

The driver and passenger of the case vehicle were injured but their injuries were not thought to be serious.

Seatbelt Usage

Neither driver or passenger were wearing restraints at the time of the accident.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

The amount of fuel spilled in this accident is unknown.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was not damaged in the accident.

Right Tank

The cylindrical aluminum tank was punctured on the outboard portion of the tank by the right front corner of the trailer during jackknife. The entire side of this tank was crushed inward, and punctured as well. Other parts of the tank were dented but not punctured.

Lines

None of the fuel lines were damaged in the accident.

Filters

There was no damage to the fuel filter.

Ignition

There was no ignition of fuel from this vehicle.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO. 24

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

International, cabover with sleeper, 1985.

Trailer Make, Model, Year

Closed-top van, loaded.

Location/Time of Accident

Interstate 40, 1 mile east of North Little Rock, Arkansas, approximately 1.8 miles west of the Lonoke County line on June 8, 1988 at 11:45 p.m.

Description of Accident

The International (case vehicle) tractor and semi-trailer combination was traveling east on Interstate 40 in the outside lane. A grain field was burning on the north side of the Interstate and heavy smoke over the roadway reduced visibility to near zero. As the International neared the 162 log mile, it suddenly entered the smoke covered area. The International was then involved in a complicated eleven vehicle accident, involving seven tractor-trailer combinations, three passenger cars and one light truck. Three of the tractor-trailers and the light truck burned. Exact details of the impact sequence and objects contacted are not known due to the accident severity and number of vehicles involved. The International tractor -trailer combination appeared to have been involved in at least three impacts. The most severe impact to the International tractor appeared to be the frontal impact with the rear of the trailer pulled by the Freightliner. The most severe impact to the trailer appeared to be the impact to the rear of the trailer by the front of the 1986 GMC Astro (7093-22 case vehicle). The left side and left rear of the trailer also appeared to have impacted the Nissan pickup.

Both fuel tanks were ruptured during the accident sequence. The tractor and trailer were both severely burned in the ensuing fire. At final rest, the International tractor was located just off the south shoulder of the roadway facing southeast. The trailer was on the shoulder and outside eastbound travel lane facing southeast.

Injuries or Fatalities

According to a newspaper article, the driver of the International suffered a broken leg and ankle and minor burns. He was admitted to a local hospital and underwent surgery there. His usage of seat belts is not known.

Seat Belt Usage

Unknown.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

The amount of fuel spilled in this accident is unknown.

Damage to Components

Left Tank

The cylindrical steel fuel tank was punctured in six places in the accident. It remained attached to the left frame rail, but the rail was separated from the rest of the chassis. There was no fuel remaining in this tank at the time of the vehicle inspection.

Right Tank

The cylindrical steel tank was punctured in two places on the inboard portion of the tank. The amount of fuel lost through these holes is not known. No fuel remained in the tank at the time of the vehicle inspection.

Lines

All of the fuel lines were damaged, some were detached by impact and others were destroyed by fire.

Filters

The fuel filter was destroyed in the fire.

Ignition

All of the diesel fuel from the fuel tanks was burned in the fire. This fire was ignited in all probability by burning gasoline from the Nissan pickup truck.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO. 25

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Kenworth cabover, 1977

Trailer Make, Model, Year

Lufkin dump semi-trailer, 1977

Location/Time of Accident

One mile east of Kennard in Houston County, Texas, on Texas State Highway 7, at 6:30 P.M. on July 26, 1988

Description of Accident

The Kenworth tractor and Lufkin semi-trailer combination was eastbound on State Highway 7. The roadway was wet from a recent rain, but no precipitation was falling at the time. For unknown reasons, the Kenworth veered to the left, crossed the center line and continued across the opposing traffic lane and shoulder before crossing a shallow ditch. After leaving the roadway, the vehicle traveled approximately 118 feet to where the left front impacted a large pine tree. The Kenworth continued for another 25 feet and impacted a second tree with its left front. After traveling an additional 21 feet the Kenworth struck a third pine tree with its left front. During these three impacts the left fuel tank was probably ruptured. The right tank was not damaged during these impacts. After the impact with the third tree the vehicle rolled over onto its right side and slid a short distance before coming to final rest on its right side. Final rest of the cab was approximately 50 feet east of the third tree. The Kenworth immediately caught fire and was engulfed in flames before witnesses could rescue the driver.

Injuries or Fatalities

The driver of the Kenworth was pronounced dead at the accident scene. The Police Accident Report listed his injuries as 3rd degree burns over his entire body.

Seat Belt Usage

It is not known whether or not the driver was using restraints.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

All of the fuel from both tanks either spilled or burned following the crash. The amount of fuel in the tanks prior to the accident is not known.

Damage to Components

Left Tank

The single left cylindrical aluminum tank melted in the fire. Impact damage occurred to the left front wheel which in turn contacted the frame mounted air cleaner located between the wheel and the front surface of the left tank. The air cleaner was then shoved rearward into the left tank. After the crash the air cleaner was wrapped around the front mounting strap. The air cleaner contact possibly ruptured the left tank. The front mounting strap had damage that could also be a result of direct contact with a tree, indicating the tank also received direct damage from a tree impact.

Right Tank

The single right cylindrical aluminum tank was damaged by fire and by the truck rolling over onto its right side. An area of deformation was located on the outboard surface near the front attachment strap. No punctures were found in this area. The inboard half of the right tank melted in the fire as the truck was on its right side while it burned. Both mounting straps were deformed rearward from contact with the ground during the rollover.

Lines

All of the lines connected to both tanks were detached by impact or burned by the ensuing fire.

Filters

The fuel filter was not found.

Ignition

Apparently fuel from the punctured left tank was ignited immediately following impact and spread to the right tank, since a witness to the accident stated the truck was on fire as soon as it came to rest. Possible ignition sources include heat sources from engine components, friction from the air cleaner which penetrated the fuel tank, or electrical sources from the damaged batteries when the truck rolled onto its right side.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO. 26

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

Ford, conventional cab, 1979.

Trailer Make, Model, Year

Unknown make closed-top van.

Location/Time of Accident

Interstate 55, 13.0 miles north of Marion, Arkansas at Exit 23B, at 8:10 a.m., on August 11, 1988.

Description of Accident

The Ford (case vehicle) tractor and semi-trailer combination was traveling north on Interstate 55 in the outside lane. The combination vehicle was approaching exit 23B when its trailer brakes locked causing the tractor-trailer to jackknife and leave the roadway on the east side.

Injuries or Fatalities

The driver of the case vehicle suffered minor injuries and was treated and released at a local hospital.

Seat Belt Usage

It is not known whether the driver was using his seat belt.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

Amount of fuel spilled in this accident is unknown.

Damage to Components

Left Tank

The cylindrical aluminum fuel tank was probably not damaged in the accident.

Right Tank

The cylindrical aluminum tank was punctured in two places during the accident sequence, probably by some protuberances on the trailer. There were several dents in the tank and deformation to the step. A small frontal seam tear was also caused by trailer impact.

Lines

None of the fuel lines were damaged in the accident.

Filters

There were two fuel filters and one fuel-water separator present on the tractor. None of these appear to have been damaged in the accident.

Ignition

There was no ignition of fuel in this accident.

HEAVY TRUCK FUEL SYSTEM INTEGRITY STUDY
TEXAS TRANSPORTATION INSTITUTE
CASE NO. 27

SYNOPSIS OF EVENT

SUMMARY OF ACCIDENT

Tractor Make, Model, Year

International Cabover, 1980

Trailer Make, Model, Year

Lufkin, aluminum van semi-trailer, 1985

Location/Time of Accident

2.7 miles south of Mammoth Spring, Arkansas on U.S. Route 63, at 6:50 P.M., on October 7, 1988

Description of Accident

The International tractor and Lufkin semi-trailer combination was southbound on U.S. Route 63. The roadway was dry and the weather was clear. The International was negotiating a right curve with an average degree of curvature of 10 degrees, the roadway also had a negative slope of 6.5 percent. The driver lost control of this truck approximately two-thirds of the way through the curve and suddenly veered to the left. The International crossed the center line and opposing travel lanes before leaving the roadway onto the east shoulder. The vehicle then crossed the shoulder and plunged into a ravine. The vehicle traveled 70 feet off the road to its final rest position approximately 30 feet below the roadway. At its final rest position the tractor was jackknifed to the right in relation to the trailer, with the trailer contacting the tractor. The tractor caught fire and the cab was completely destroyed by the ensuing fire.

Injuries or Fatalities

The driver of the International was fatally injured and pronounced dead at the accident scene.

Seat Belt Usage

Seat belt usage unknown.

SUMMARY OF FUEL SYSTEM INTEGRITY LOSS

Fuel Loss

All of the fuel from both tanks either spilled or burned following the crash. The amount of fuel in the tanks prior to the accident is not known.

Damage to Components

Left Tanks

The single left cylindrical aluminum tank sustained damage from impact and fire. The most severe damage was located on the inboard surface near the front. A large area of deformation with seam separation was noted here. Some melting and scorching was noted along the seam weld separation. A smaller rupture was also noted in this same area on the inboard surface. A small puncture was located on the top surface near the rear of the tank. The fuel pickup line fitting was displaced and the line was burned and the tank vent fitting was broken. The crossover line fitting was also sheared from the bottom of the tank.

Right Tanks

The single right cylindrical aluminum tank was severely damaged by the impact. The front surface was crushed inward resulting in a large seam separation. The rear surface also sustained crushing damage that resulted in two ruptures on the inboard surface near the rear of the tank. The tank vent was sheared off at the tank surface and the filler cap pressure plug was lifted up on one edge. The crossover line was detached, but on inspection appeared to have been unscrewed following the accident. The right tank did not have any evidence of fire damage.

Lines

The pickup line from the left tank was burned, but still attached to the tank. The return line to the left tank remained attached to the crossover fitting and was torn apart approximately 20 inches from the fitting. The crossover line was sheared off at its connection point with the left tank, but appeared to remain attached to the right tank during the impact sequence (it was later removed by wrecker personnel). The crossover line remained attached to the crossover carrier and was still intact.

Filters

The fuel filter was deformed from impact damage but did not sustain loss of integrity.

Ignition

Apparently fuel from the ruptured right tank was ignited immediately following impact and engulfed the cab and engine. The fire spread to the left tank and the trailer. More fire damage was evident to the right side of the cab and engine than the left side. Possible ignition sources include heated engine components such as the turbocharger and exhaust system which were located on the right side of the engine. Another less likely possibility is an electrical source such as the damaged batteries which were, however, located on the left side of the tractor.

APPENDIX B

Summary of Crashes

Reported by Hot Line

(But Not Investigated)

DATE OF ACCIDENT	TIME	TRACTOR MAKE	FUEL SPILL	INTEGRITY LOSS	ACCIDENT REPORTED (Police Report)	INJURIES
1/9/87	400	1980 Mack	Unknown amount	Left tank ruptured	Skidded on wet pavement, jackknifed Empty Van Lines Trailer	Unknown
1/19/87	250	1983 Int'l	Unknown amount	Left tank ruptured	Locked brakes in traffic, jackknifed	3 injuries
1/30/87	728	1984 PB	Unknown amount	Ruptured tank	Swerved & jackknifed in traffic (7 vehicles)	2 injuries
2/6/87	2359	1986 Int'l	Unknown amount	Left tank-punctures	Trailer broke loose	1 injury
2/8/87	2015	1983 Freight	No spill	No damage	Rollover	1 injury
2/10/87	745	1982 Freight	5-10 gals.	Left tank ruptured	Lost control on curve; rolled over	1 injury
2/10/87	800	1975 Int'l	20 gals.	Both tanks ruptured	Hit 10-wheeler in rear	No injuries
2/16/87	730	1986 Int'l	50 gals.	Left tank ruptured	Trailer broke in half, jackknifed, left tank hit	No injuries
2/24/87	1020	1984 Int'l	Unknown amount	Right tank ruptured	Hit guardrail & jackknifed to avoid 10-wheeler when passing	Minor
2/27/87	730	1978 Int'l	Unknown amount	Unknown damage	Rollover on wet road, defective brakes	No injuries
2/27/87	1745	1985 GMC	unknown	Left tank ruptured	Raining, skidded, & jackknifed	No injuries
3/3/87	1559	1980 GMC	40 gals.	Tank ruptured- 2 areas	Drunk driver in car pulled out	No injuries
3/8/87	Unknown	1978 Kenworth	Small amount	Crossover line broke	Slid off slippery road	1 injury
3/10/87	1105	1978 Kenworth	150 gals.	Left tank ruptured	Drove over piece of steel on road	No injuries
3/11/87	100	1983 Kenworth	Unknown amount	Unknown	Hit guardrail, exploded & melted Gasoline tanker trailer exploded	Driver killed
3/14/87	800	1981 Mack	No spill	No fuel damage	Lost control & rolled over	1 injury
3/18/87	355	1975 Mack	No spill	No fuel damage	Hit van that ran stop sign	1 fatal in van
3/18/87	1300	1978 Freight	50 gals.	Ruptured fuel tank	Ice & snow, jackknifed	No injuries
3/26/87	550	1969 PB	Unknown amount	Unknown damage	Unknown, truck exploded & burned	Driver fatal
4/2/87	1955	1981 Freight	Unknown amount	Unknown damage	Struck bull, rolled over & 8000 gal. gasoline tanker exploded	Driver fatal
4/13/87	1415	1981 Kenworth	40 gals.	Right tank ruptured	Jackknifed	1 injury
4/13/87	1155	1987 PB	100 gals.	Right tank ruptured	Hit in right side by car	1 fatal (car)

DATE OF ACCIDENT	TIME	TRACTOR MAKE	FUEL SPILL	INTEGRITY LOSS	ACCIDENT REPORTED (Police Report)	INJURIES
1/9/87	400	1980 Mack	Unknown amount	Left tank ruptured	Skidded on wet pavement, jackknifed Empty Van Lines Trailer	Unknown
1/19/87	250	1983 Int'l	Unknown amount	Left tank ruptured	Locked brakes in traffic, jackknifed	3 injuries
1/30/87	728	1984 PB	Unknown amount	Ruptured tank	Swerved & jackknifed in traffic (7 vehicles)	2 injuries
2/6/87	2359	1986 Int'l	Unknown amount	Left tank-punctures	Trailer broke loose	1 injury
2/8/87	2015	1983 Freight	No spill	No damage	Rollover	1 injury
2/10/87	745	1982 Freight	5-10 gals.	Left tank ruptured	Lost control on curve; rolled over	1 injury
2/10/87	800	1975 Int'l	20 gals.	Both tanks ruptured	Hit 10-wheeler in rear	No injuries
2/16/87	730	1986 Int'l	50 gals.	Left tank ruptured	Trailer broke in half, jackknifed, left tank hit	No injuries
2/24/87	1020	1984 Int'l	Unknown amount	Right tank ruptured	Hit guardrail & jackknifed to avoid 10-wheeler when passing	Minor
2/27/87	730	1978 Int'l	Unknown amount	Unknown damage	Rollover on wet road, defective brakes	No injuries
2/27/87	1745	1985 GMC	unknown	Left tank ruptured	Raining, skidded, & jackknifed	No injuries
3/3/87	1559	1980 GMC	40 gals.	Tank ruptured- 2 areas	Drunk driver in car pulled out	No injuries
3/8/87	Unknown	1978 Kenworth	Small amount	Crossover line broke	Slid off slippery road	1 injury
3/10/87	1105	1978 Kenworth	150 gals.	Left tank ruptured	Drove over piece of steel on road	No injuries
3/11/87	100	1983 Kenworth	Unknown amount	Unknown	Hit guardrail, exploded & melted Gasoline tanker trailer exploded	Driver killed
3/14/87	800	1981 Mack	No spill	No fuel damage	Lost control & rolled over	1 injury
3/18/87	355	1975 Mack	No spill	No fuel damage	Hit van that ran stop sign	1 fatal in van
3/18/87	1300	1978 Freight	50 gals.	Ruptured fuel tank	Ice & snow, jackknifed	No injuries
3/26/87	550	1969 PB	Unknown amount	Unknown damage	Unknown, truck exploded & burned	Driver fatal
4/2/87	1955	1981 Freight	Unknown amount	Unknown damage	Struck bull, rolled over & 8000 gal. gasoline tanker exploded	Driver fatal
4/13/87	1415	1981 Kenworth	40 gals.	Right tank ruptured	Jackknifed	1 injury
4/13/87	1155	1987 PB	100 gals.	Right tank ruptured	Hit in right side by car	1 fatal (car)

DATE OF ACCIDENT	TIME	TRACTOR MAKE	FUEL SPILL	INTEGRITY LOSS	ACCIDENT REPORTED (Police Report)	INJURIES
4/17/87	835	1982 Kenworth	Unknown amount	Right tank ruptured	Hit on side by car	1 injury
4/29/87	1230	1987 Kenworth	Small amount	Left tank ruptured	Hit on side by car	No injuries
5/6/87	2350	1979 Kenworth	15 gals.	Fuel line torn from tank	Ran over cow on road	No injuries
5/14/87	2200	Int'l	Unknown amount	Unknown damage	Drove into ditch, rolled over	No injuries
5/22/87	420	1985 Freight	75 gals.	Unknown damage	Jackknifed in rainstorm	Unknown
5/23/87	Unknown	1977 White	No spill	No fuel system damage	Hit car	4 fatalities
5/31/87	1500	1986 Mack	40 gals.	Left tank ruptured	Car turned ledft in front of truck	2 fatal (car)
6/5/87	1416	1984 PB	150 gals.	Left tank ruptured	Ran over object on road	No injuries
6/14/87	500	1984 Int'l	Unknown amount	Right tank leaking	Hit parked 18-wheeler on shoulder	2 (minor)
6/15/87	122	1986 PB	100 gals.	Leaked from filler cap	High winds blew truck over	No injuries
6/16/87	1800	1981 Freight	75 gals.	Tank split	Jackknifed	No injuries
6/29/87	1945	1978 PB	60 gals.	Ruptured left tank	slid & jackknifed	1 injury
7/1/87	230	1986 Ford	Unknown	Unknown	Fire on impact	unknown
7/5/87	1000	1985 PB	20 gals.	Left tank damaged	Rollover on left side	1 injury
7/9/87	357	1972 Kenworth	Unknown	Left tank struck	Fire, complete meltdown	2 injuries
7/13/87	1115	1985 Freight	Unknown	Fire meltdown	9200 Gal. tanker burned	1 injury
7/20/87	900	1985 Freight	10 gals.	Leaking left tank	Rollover on turn	1 injury
7/20/87	545	1978 Mack	15 gals.	Broke right tank cap	Rollover on turn	No injuries
8/17/87	1145	1983 Int'l	30 gals.	Right tank ruptured	Left road, overturned	1 injury
8/20/87	1115	1987 Int'l	100 gals.	Both tanks damaged	Ran off elevated freeway	1 injury
9/11/87	445	1984 White	100 gals.	Tanks punctured	Ran into ditch	No injuries
9/14/87	550	1984 Mack	150 + gals.	Both tanks ruptured	Driver fell asleep at wheel	1 injury
10/8/98	1436	1980 Peterbilt	125 gals.	Left tank ruptured	Ran over steel spring	1 injury
10/18/87	1100	1984 Kenworth	10 gals.	Fuel line damage	Left roadway, overturned	No injuries
10/23/87	1650	1981 Mack	45 gals.	Left fuel tank rupture	Struck concrete guardrail	1 injury

DATE OF ACCIDENT	TIME	TRACTOR MAKE	FUEL SPILL	INTEGRITY LOSS	ACCIDENT REPORTED (Police Report)	INJURIES
10/29/87	1000	1975 Int'l	Unknown	Right tank ruptured	Hit cement rail	1 injury
11/17/87	845	1981 Kenworth	30 gals.	Right tank ruptured	Brakes locked, hit bridge	No injuries
11/19/87	550	1977 Auto Car	150 gals.	Left tank ripped open	Hit grass to avoid pick-up	No injuries
11/30/87	1530	1982 PB	60 gals.	Side of fuel tank	Hit recap of another tire	No injuries
12/30/87	1324	1986 Freight	40 gals.	Left tank ruptured	Load shifted	2 fatalities
1/08/88	600	1979 Kenworth	75 gals.	Broken main line	Fuel line came loose	No injuries
2/3/88	700	1979 Ford	200 gals.	Ruptured 2 tanks	Truck failed to yield right of way	1 injury
2/5/88	530	1987 Freight	35 gals.	Left tank ruptured	Truck did not stop at intersection	1 injury
2/5/88	550	1983 Kenworth	10 gals.	Right tank punctured	Rear ended another truck	1 injury
2/11/88	1115	1986 Chevrolet	75 gals.	Left tank ruptured	Brakes locked, truck jackknifed	1 injury
2/17/88	925	1983 Freight	110 gals.	Broken crossover line	Truck ran over piece of steel	No injuries
2/18/88	600	1982 Int'l	100 gals.	Right tank ruptured	Jackknifed on wet pavement	No injuries
4/13/88	730	1987 PB	50-75 gals.	Left tank ripped open	Hit guardrail	No injuries
5/17/88	2020	1979 Kenworth	All	Exploded	Ran into gully & hit concrete bank	1 injury
6/14/88	125	1984 Kenworth	35 gals.	Leaked out of cap	Ran off road, turned over	No injuries
6/14/88	640	1984 Freight	6 inches deep	Right tank ruptured	Swerved to avoid car, rolled over	No injuries
6/20/88	1312	1981 Kenworth	25 gals.	Left tank damaged	Trying to avoid dog crossing road	No injuries
6/27/88	720	1987 Int'l	70 gals.	None	Ran off road, rolled over	1 injury
7/5/88	630	1981 Int'l	25 gals.	Feed line broke	Turned too quickly	1 injury