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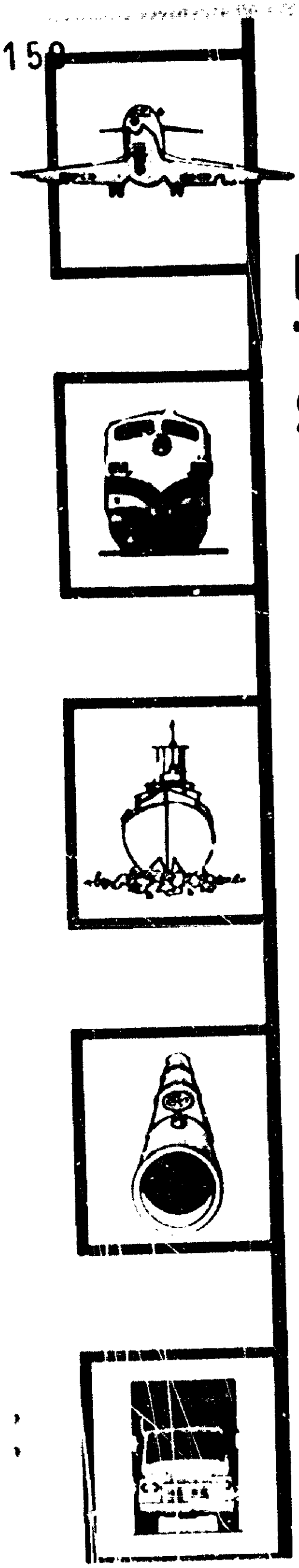

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

HIGHWAY ACCIDENT REPORT

UNION OIL COMPANY OF CALIFORNIA,
TANK TRUCK AND FULL TRAILER
OVERTURN AND FIRE
SEATTLE, WASHINGTON

DECEMBER 4, 1975

REPORT NUMBER: NTSB-HAR-76-7

UNITED STATES GOVERNMENT

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16. Abstract About 1 a.m. on December 4, 1975, a 1975 Peterbilt tank truck and a 1970 Peerless full trailer (tank), owned by Union Oil Company of California, went out of control on the Alaskan Way Viaduct in Seattle, Washington, as the driver attempted to negotiate a curve on the traffic-polished concrete roadway at 52 mph and during a rainstorm. The combination vehicle jackknifed and the trailer struck a viaduct support column. The trailer's tank ruptured and its cargo of gasoline spilled. Fire ensued, spread along the viaduct, and spilled to the ground below, where it ignited 4 railroad freight cars, 30 motor vehicles, and adjacent buildings. The accident caused property damage estimated at $750,000. Two firemen were injured while fighting the fire.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the driver to reduce the speed of the combination vehicle to permit safe negotiation of the curve under existing road and weather conditions. Contributing to the loss of vehicle control was the marginal traction capability of the pavement for the posted speed limit.

As a result of its investigation of this accident, the National Transportation Safety Board made recommendations to the National Highway Traffic Safety Administration, and to the State of Washington.

17. Key Words Combination vehicle; truck-full trailer; aluminum-alloy cargo tank; gasoline; viaduct; adverse weather; speed; FMVSS-121 antilock brakes; brake system incompatibility; mixed brake systems; coefficient of friction; tire-to-road interface; trailer dolly; trailer dolly side support; tow-bar; trailer tow-bar; cargo spill; fire.		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.	
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PRICES SUBJECT TO CHANGE

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

HIGHWAY ACCIDENT REPORT

Adopted: July 28, 1976

UNION OIL COMPANY OF CALIFORNIA
TANK TRUCK AND FULL TRAILER (TANK) OVERTURN AND FIRE
ALASKAN WAY VIADUCT, SEATTLE, WASHINGTON
DECEMBER 4, 1975

SYNOPSIS

About 1 a.m. on December 4, 1975, a 1975 Peterbilt tank truck and a 1970 Peerless full trailer (tank), owned by Union Oil Company of California, went out of control on the Alaskan Way Viaduct in Seattle, Washington, as the driver attempted to negotiate a curve on the traffic-polished concrete roadway at 52 mph and during a rainstorm. The combination vehicle jackknifed and the trailer struck a viaduct support column. The trailer's tank ruptured and its cargo of gasoline spilled. Fire ensued, spread along the viaduct, and spilled to the ground below, where it ignited 4 railroad freight cars, 30 motor vehicles, and adjacent buildings. The accident caused property damage estimated at $750,000. Two firemen were injured while fighting the fire.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the driver to reduce the speed of the combination vehicle to permit safe negotiation of the curve under existing road and weather conditions. Contributing to the loss of vehicle control was the marginal traction capability of the pavement for the posted speed limit.

INVESTIGATION

The Accident

About 1 a.m. on December 4, 1975, a 1975 Peterbilt tank truck and a 1970 Peerless full trailer (tank), owned by the Union Oil Company of California, were southbound on the Alaskan Way Viaduct, State Route 99, in Seattle Washington, at 52 mph. (See Figures 1 and 2.) The truck and the full trailer were loaded with 3,700 gallons and 4,800 gallons of gasoline respectively. It was raining hard and a strong wind was blowing from the west.

Figure 1. Face of tachograph chart from truck. Ⓐ indicates segment in enlargement below.

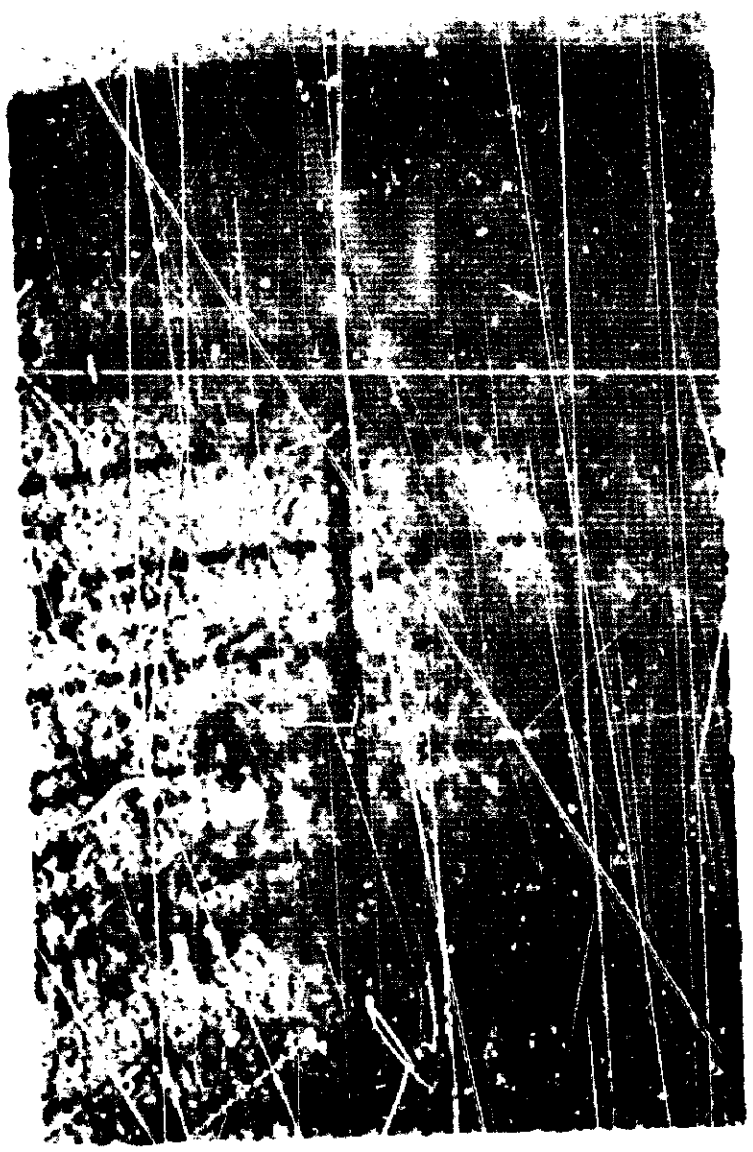

Figure 2. Enlargement of segment Ⓐ of tachograph chart. The accident trip began at approximately 12:54 a.m. and ended at approximately 12:58 a.m., registering a top speed of 52 mph.

As the truckdriver negotiated a right curve, he lost control of the combination vehicle. He later stated that he was traveling in the right lane at 45 mph when suddenly the vehicle pulled hard left into the middle lane; he tried to control it by turning to the right, but the combination vehicle continued to pull to the left, tending to go straight ahead. The truckdriver did not remember applying the brakes.

The combination vehicle jackknifed and the trailer struck the right viaduct curb and viaduct support column No. 107. At impact, the trailer tow-bar and the right safety cable failed, and the trailer dolly axle and wheels separated from the dolly springs. Consequently, the truck was disconnected. The trailer's tank ruptured, gasoline spilled, and fire engulfed a 240-foot section of roadway. The burning gasoline flowed along the roadway, through 3-inch-diameter deck drains and 1-inch-wide expansion joints, and down to railroad tracks which were beneath the viaduct, where the gasoline ignited four freight cars. The truck continued on, struck the left viaduct traffic rail, and rotated counterclockwise. The left safety cable broke and the dolly axle and wheels were propelled through the left traffic rail. The truck came to rest on the roadway headed south. The truck and its cargo were not involved in the trailer fire.

The Alaskan Way Viaduct is a north-south, elevated highway which skirts the west side of downtown Seattle. It consists of two three-lane roadways, one above the other; southbound traffic is routed on the lower deck and northbound traffic on the upper deck.

The viaduct structure is constructed of reinforced concrete and is supported by 4-foot-square columns. The concrete roadway is 40 feet wide and is bounded by raised, 10-inch curbs surmounted by 26-inch-high traffic railings and posts. The right and left lanes are 14 feet wide and the center lane is 12 feet wide. The lanes are delineated by raised, ceramic, 4-inch-diameter pavement markers. The southbound approach to the accident scene is level and contains a right curve, the radius of which is 800 feet and the superelevation of which is 0.056 ft/ft. (See Figure 3.) The Washington State Highway Commission, Department of Highways, tested the viaduct in July 1975 to determine the roadway's skid resistance value. It used the American Society of Testing Materials (ASTM) test to perform two skid tests per mile on one lane of the roadway. The tests indicated that the skid number ranged from 26 to 46 for a test speed of 40 mph. No postaccident skid tests were performed; however, the Safety Board calculated the coefficient of friction between the truck tires and the road to have been .23 at the time of the accident.

The posted speed limit was 50 mph; since the accident, signs which limit the speed to 35 mph through the curve have been posted. No signs were posted to indicate that the pavement was slippery when wet.

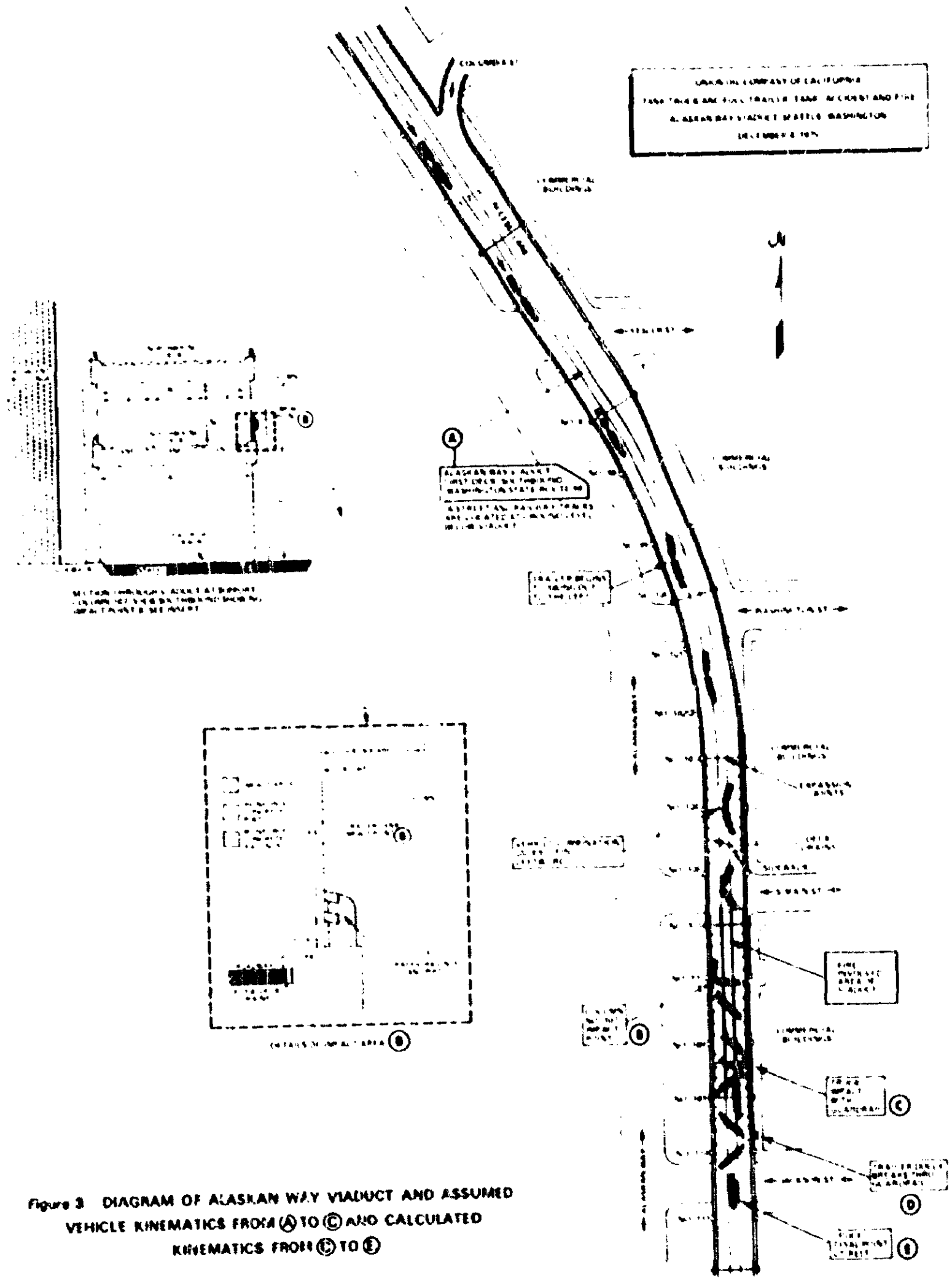

Figure 3 DIAGRAM OF ALASKAN WAY VIADUCT AND ASSUMED VEHICLE KINEMATICS FROM Ⓐ TO Ⓒ AND CALCULATED KINEMATICS FROM Ⓒ TO Ⓔ

Vehicle Damage

The truck was damaged extensively when it ran into the left traffic rail after the trailer had separated. The truck's brakes were undamaged and there was no evidence that they did not operate in accordance with Federal Motor Vehicle Safety Standard No. 121 requirements.

The trailer tow-bar did not fail, but became disconnected from the trailer where it was attached to the trailer dolly. The trailer tow-bar's pintle hook eye component was bent slightly to the left. The left rail of the tow-bar yoke was bowed inward. (See Figure 4.) The right safety cable which attached the truck to the trailer had been sheared or pinched off at the rear cable retention sleeve. Tension had caused the left cable to pull apart and to unravel.

About 90 percent of the aluminum-alloy cargo tank was consumed in the fire. The remaining tank material was in two pieces: (1) The head, the forward left side and bottom, and a smaller portion of the right side, and (2) a section of the right side and lower quadrant. The forward end of the second section of the tank material showed evidence of impact with the viaduct column. Beginning about 4 feet aft of the tank head, the right-side tank shell material was deformed rearward 7 feet in accordion fashion. (See Figure 5.)

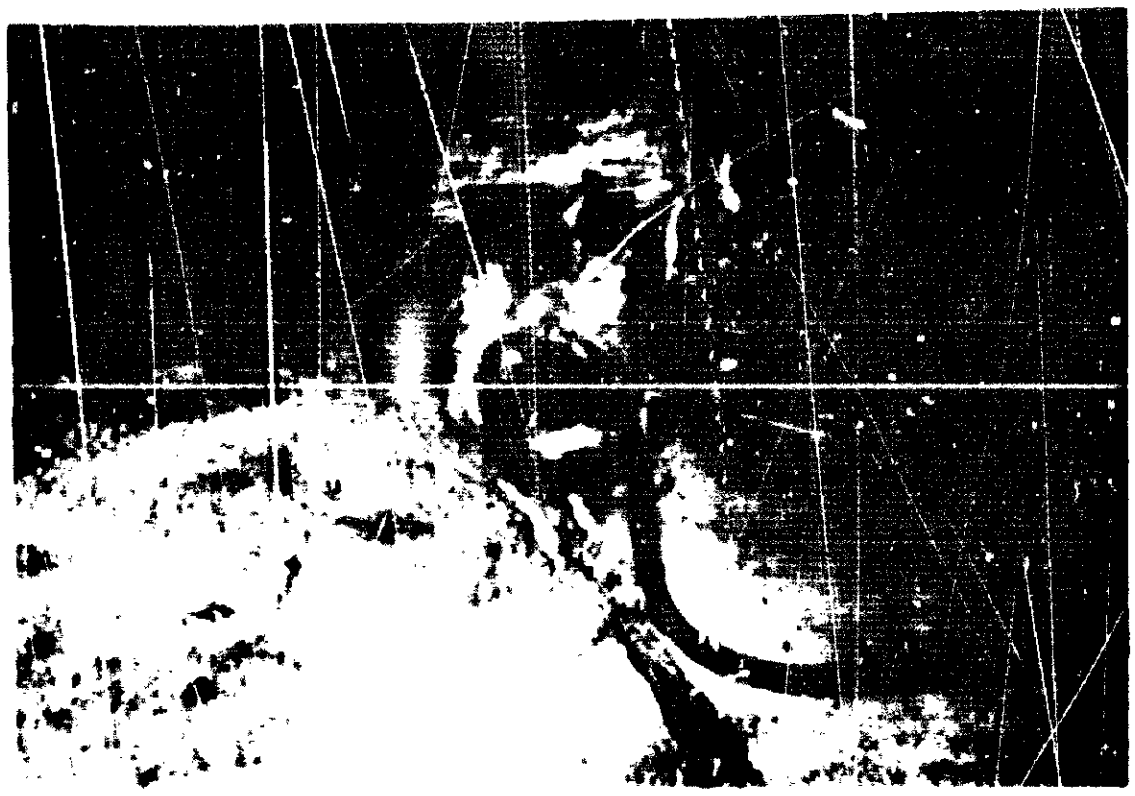

Figure 4. Tow-bar eye Ⓐ and left rail Ⓑ deformation. Safety cable retention sleeves Ⓒ .

Figure 5. Interior of right side of trailer cargo tank. Impact area Ⓐ shows accordion effect.

The trailer dolly's right and left side supports had failed where they were attached to the tow-bar. The left side of the dolly axle was bent. A 7-inch section of the right outside wheel rim flange was broken out and the flange edge was gouged and bent inward along a 140-degree segment of the flange. (See Figure 6.) The flange of the left outside wheel rim was gouged slightly. The dolly side supports, axle, and wheels had not been damaged by the fire. The upper section of the dolly and transverse springs were still attached to the trailer. The left ends of the main and secondary leaves of the springs were bent downward and away from the spring pack and the left rebound clip was broken.

Gouges on the flange of the outside right wheel rim of the rear trailer suspension suggested that the trailer was sliding, without wheel rotation, when the gouges were made. The left wheel showed extensive fire damage. The main spring leaf of the left rear spring had failed about 3/8 inch under the rear edge of the spring clip plate.

Other Damage

Fire destroyed 4 railroad freight cars and their cargos and damaged 30 motor vehicles which were parked adjacent to or beneath the viaduct. It also destroyed high-voltage electrical transmission lines which were underneath the southbound roadway; this interrupted electrical service to a

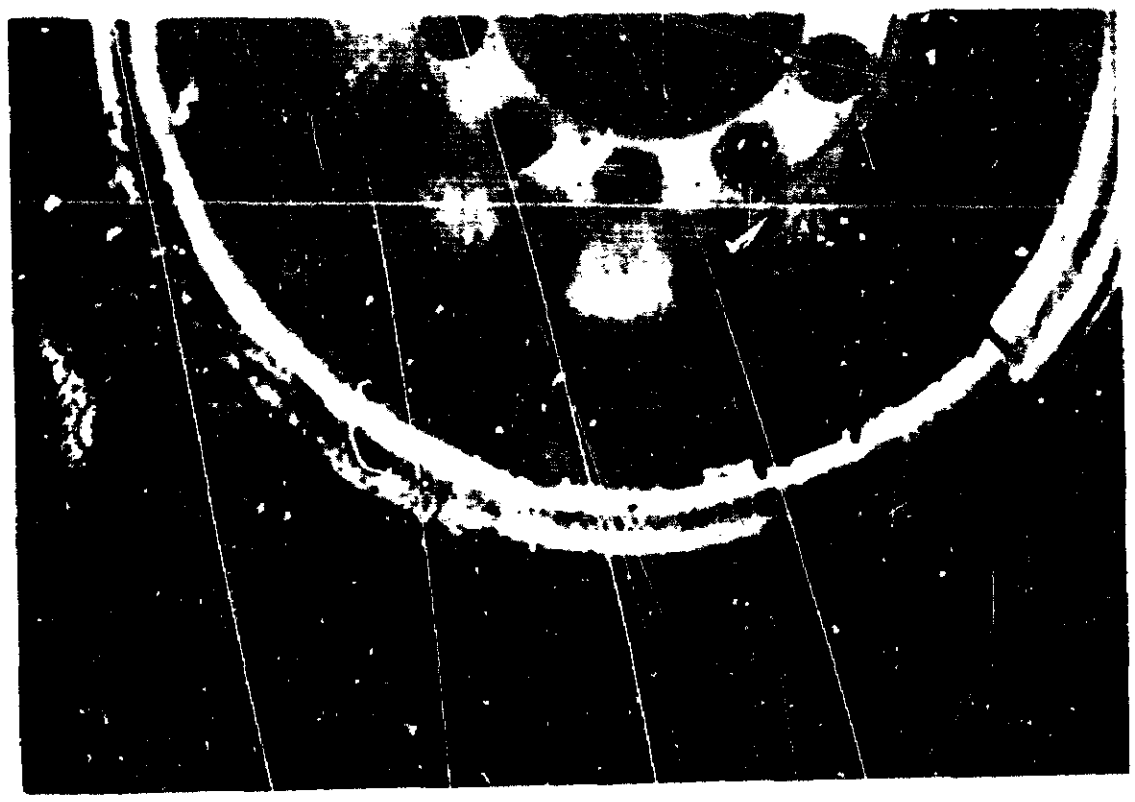

Figure 6. Trailer's right-outside dolly wheel with 7-inch segment broken out of wheel rim and deformation along the edge of the rim. The nature of the brake and deformation indicates that the wheel was not rotating when the damage was inflicted.

portion of downtown Seattle and caused the section to operate on reduced power for 3 days. Buildings east of the viaduct were damaged moderately by fire, smoke, and water. The concrete on the underside of the viaduct's decks, on the columns, and on the traffic railings within the fire-affected area of the southbound deck was spalled. Property damage was estimated to be $750,000.

Driver Information

The 40-year-old truckdriver had been employed by Union Oil Company of California for 11 1/2 years. He had 14 years of experience as a commercial driver and held a valid Washington commercial driver's license. He was certified as medically qualified to drive in interstate or intrastate (hazardous materials) commerce as required by Federal Motor Carrier Safety Regulations. His driving log was current and reflected compliance with regulations regarding hours of service. His traffic record noted no violations or previous accidents. However, Union Oil Company records did note two minor property damage accidents, which involved company vehicles, and a vehicle overturn, which occurred before he was hired.

The truckdriver had driven the truck on four 10-hour work shifts before the accident. He had been briefed on the truck's FMVSS-121 brake system, taken on a demonstration run, and checked out on the equipment by Union Oil personnel after the truck was purchased. The demonstration and checkout consisted of normal operation of the combination vehicle, as well as panic or emergency stops, so that the driver would be familiar with FMVSS-121 brake performance.

On December 3, 1975, the truckdriver started his shift about 10 p.m., after 7 hours of sleep. He arrived at the Union Oil terminal and checked the combination vehicle visually before his first delivery. The delivery took him across the viaduct. He returned to the terminal, reloaded the vehicle, and started the second delivery trip about 12:50 a.m., December 4, 1975. The accident occurred less than 2 miles from the terminal and within 5 minutes from the start of the trip.

Vehicle Information

The vehicle combination consisted of a tank truck and a full trailer, which were connected by a tow-bar. (See Figure 7.) The combined unit and cargo weight was about 79,815 pounds.

The truck was a 3-axle, 1975 Peterbilt, Model 359A13F, chassis No. 79120P, with a 1970 Peerless MC306AL, 4,560-gallon aluminum-alloy cargo tank, serial No. 2330. The truck was equipped with a diesel engine, a manual transmission, air-mechanical brakes which incorporated the FMVSS-121 brake requirements, a tachograph, and an antislack pintle hook. The odometer read 1,068 miles. The tare weight of the truck was 14,780 pounds. The truck had begun operation in November 1975.

The full trailer was a 2-axle, 1970 Peerless, Model 702326, with a MC306AL, 5,399-gallon aluminum-alloy cargo tank. The permanent-front trailer dolly was a 1970 Silver Eagle, Model G67180000, serial No. 9298. The trailer had a conventional air-mechanical brake system. The tare weight of the trailer was 13,120 pounds.

The truck and full trailer were connected by a Silver Eagle tow-bar, the required safety cables, and necessary airbrake and electrical connections.

Tests and Research

The fractured right hand trailer dolly support was examined at the National Transportation Safety Board's metallurgical laboratory. (See the Appendix.)

Visual examination of the fracture under a bench binocular microscope disclosed no evidence of fatigue progression on the fracture. The fracture features appeared typical of a single load application in an overload condition.

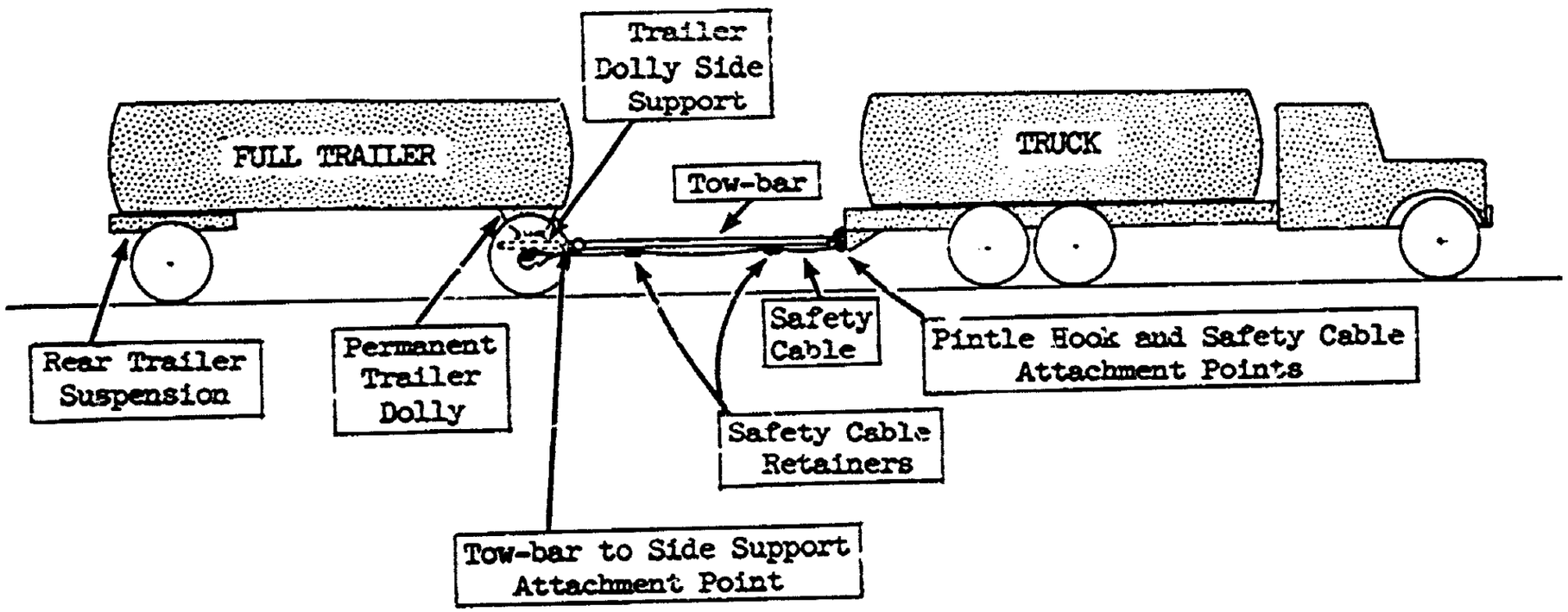

Figure 7. Diagram of truck and full trailer with tow-bar. Safety cable retained along lower left and right sides of tow-bar by short metal sleeves which are welded to the tow-bar rails.

The fracture was slightly discolored around the middle rib of the support and in other areas randomly located on the fracture surface. One area of discoloration was removed from the fracture and examined under a scanning electron microscope. Examination disclosed that the discoloration was caused, in part, by a substance deposited on the fracture. X-ray energy dispersive analysis of a microsection through the dolly support indicated that the material was an aluminum-alloy casting, with silicon as its major alloying element and with small additions of magnesium, iron, and copper. Analysis of the deposit which produced the discoloration gave energy peaks of the alloying elements as well as peaks of sodium, sulfur, chlorine, potassium, calcium, and titaninum.

Examination of the fracture surface and a microsection through the fracture surface also disclosed areas of microshrinkage porosity, which is not uncommon in aluminum-alloy castings. The porosity appeared to have contributed to the discoloration on the fracture surface.

Hardness and electrical conductivity measurements of the dolly support yielded values which ranged from 67 to 79 Rockwell "K" and 35 to 36 percent International Annealed Copper Standard (IACS), respectively. These data, however, could not be correlated to any specific aluminum casting alloy as shown in the American Society for Metals Handbook, Volume No. 1. These data, as well as the chemistry suggested by the X-ray energy analysis, indicate that the material could be a 300-series-type aluminum alloy casting with an exceptionally high hardness value.

ANALYSIS

The Accident

Although the driver stated that his vehicle was traversing the curve at 45 mph, the tachograph showed that the actual speed was 52 mph. Of prime importance to the highway safety program is the necessity for all motor vehicle drivers to comply with current speed control laws and regulations. It is the responsibility of each driver, under the basic speed rule, not to drive a vehicle faster than is reasonable and prudent under existing conditions. In this accident, it was the responsibility of the truckdriver to drive the combination vehicle at a safe and appropriate speed as he approached and negotiated the curve. The hazardous nature of the cargo which the vehicle was transporting and the adverse weather and road conditions increased the need to drive safely.

When the truckdriver felt the truck pull to the left, he steered to the right to correct the truck's course. He noticed that the trailer had rotated toward the left, and he braked in an attempt to reduce the speed of the combination vehicle. The truck's FMVSS-121 brakes were more effective than the trailer's conventional air-mechanical brakes. The dissimilarity of truck and trailer brake equipment caused the truck to decelerate faster

than the trailer. Also, the truck's wheels did not lock and the trailer's wheels did. The difference in trailer and truck deceleration rates caused the trailer, which was out of alignment, to push the truck; thus, the rear of the truck rotated counterclockwise. After the truck and trailer jackknifed to the left, the combination vehicle slid in a yawed attitude toward the right curb and viaduct column no. 107.

Based the following facts, the Safety Board concludes that the driver applied the combination vehicle's brakes:

First, the combination vehicle's attitude at impact. The fact that the tank struck the column 4 feet aft of the front head confirms that the trailer yawed into the viaduct column. Damage to the tank trailer shell also indicates that the trailer yawed. Had the trailer been rolling freely toward the column, the front of the trailer tank head would have been damaged.

Second, the absence of damage to the right side of the truck indicates that the truck was not in front of the trailer before the cargo tank struck the column. Therefore, the truck and trailer were not aligned; both the truck and the trailer were jackknifed toward the left at impact with the column.

Third, the damage to the trailer's right-front wheel rim indicates that the wheel was not rotating when it struck the curb. The forces developed at impact were such that a 7-inch section of the rim was broken out.

The driver reported that the combination vehicle was pulling toward the left. Given the 0.056-ft/ft superelevation and the 52-mph speed, the Safety Board calculated the centrifugal force which was pushing the combination vehicle toward the left, or the outside of the curve, to be 8,846 pounds on the truck and 9,811 pounds on the trailer -- 18,297 pounds of combined force. The lateral force on the heavier trailer caused it to slide toward the left on the rain-drenched, traffic-polished road surface. Logic would dictate that the combination vehicle should have slid toward the outside of the curve and struck the viaduct components on the left. Since there was no damage to the viaduct structure, truck, or trailer to indicate that this occurred, and since the vehicle eventually struck the right side of the viaduct, some sort of loading caused the vehicle to change its course. There is no physical evidence to suggest how, or from what source, the loading was initiated. However, the loading probably was caused by the driver's continued steering toward the right to resist the pull toward the left, combined with the service-brake application to reduce speed.

The FMVSS-121 brakes should, according to the National Highway Traffic Safety Administration and to industry technical authorities, provide a tire-to-road frictional coefficient which is greater than which results from a locked wheel. Assuming a 0.30 frictional coefficient during truck

braking and given the calculated 0.23 frictional coefficient for the trailer, the truck was decelerating faster than the trailer. In other words, the truck, at 52 mph, possessed 306 ft-lbs of energy per pound of braking force available, whereas the trailer had 401 ft-lbs of energy per pound of braking force. Therefore, the trailer was pushing the truck. This action compounded the leftward jackknifing and caused the combination vehicle to yaw toward the right.

The factor which initiated the accident sequence was the speed of the combination vehicle, followed by loss of alignment by the trailer, which skidded laterally outward to the left on a curve while the wheels were rolling freely. This loss of alignment was caused by the interaction of vehicle speed and the road surface, not by braking.

Had the truck and trailer been equipped with FMVSS-121 antilock brake systems, a brake application should not have locked the lateral sliding trailer wheels. This, together with the steering control present in the FMVSS-121 equipped truck, may have permitted the driver to regain control of the combination vehicle. However, it is not certain that the out-of-alignment combination vehicle could have been returned to a safe path even if both truck and trailer had been equipped with antilock brakes. Therefore, although the trajectory taken by the accident vehicle after the brakes were applied was affected by the dissimilar braking systems, it cannot be said that a different trajectory would have been less hazardous had both the tractor and the trailer been equipped with similar brake systems.

The trailer was not aligned with the truck as the combination vehicle came out of the curve, and the trailer was pushing the rear of the truck toward the right. This action caused the front of the truck to rotate toward the left, or counterclockwise. The jackknifed combination vehicle slid to the right and struck the curb and column.

The trailer's brake-locked, sliding, right-front wheel was the first part of the combination vehicle to strike the right curb. The magnitude of the impact caused the trailer dolly axle to be tripped downward at the front. This placed an upward load on the trailer dolly's right side support where it was attached to the tow-bar, and caused the side support to fail at the attachment point. When the side support failed, the right end of the axle rotated rearward and caused the right-side safety cable to fail. The right side of the trailer's cargo tank struck the column and stopped the forward motion of the trailer. The impact force caused the left side support to fail and the left-side safety cable to pull the lower half of the trailer's dolly free of the upper half, separating the truck from the trailer.

The impact with the viaduct column was sufficient to rupture the cargo tank's aluminum-alloy shell. The gasoline which spilled from the tank could have been ignited by sparks from electrical wiring, from contact between ferrous metals, or from contact between ferrous metal and concrete.

The failure surfaces of the trailer's left-rear suspension spring were well-polished from relative motion after failure. The 3/8-inch section of the spring which had been under the spring clip plate was clean and did not appear to have been exposed directly to fire. Both front and rear rebound clips were in place and had not failed, which suggests that the left-rear suspension spring leaf had broken some time before the accident.

Frictional Coefficient

Given a skid number of 26, which was the lowest value obtained with the ASTM test on the roadway surface, the combination vehicle theoretically should not have lost traction or lateral stability. The difference between the skid number range which was obtained in the test and the frictional coefficient which was calculated by the Safety Board probably resulted from the specific conditions required by the ASTM test method. The conditions under which the test was conducted would not have been the same as those in the accident. The ASTM test uses a special tire, manufactured of the rubber composition and with the tread design which are specified in the ASTM procedure. Other variables could have been speed, temperature, depth of surface water, etc. It is generally accepted that skid test values cannot be converted into frictional coefficient values. Although the test results are valuable to compare and evaluate pavement surfaces, they do not necessarily relate to the skid number value which would be obtained with tires purchased on the open market. Therefore, the skid numbers which are obtained with ASTM tires and with commercially available tires will differ. 1/

The Federal Highway Administration recommends that road surfaces have a minimum skid number of 37 for a mean traffic speed of 50 mph and 31 for a mean traffic speed of 30 mph. The tests performed by the Washington State Highway Commission and the analysis of this accident suggest that further testing and analysis should be performed to determine the safe speed for the roadway and to determine what improvements to the road surface are necessary.

FMVSS-121 Testing

The Safety Board is aware that the National Highway Traffic Safety Administration, vehicle and component manufacturers, and motor carriers have been testing the FMVSS-121 brake system. Safety Board representatives witnessed the tests conducted in December 1971 at Marshall, Michigan, by the Department of Transportation and have reviewed films of the tests conducted in Aberdeen, Maryland, by the National Highway Traffic Safety Administration. Based on this limited exposure to FMVSS-121 testing, the

1/ The relationship of skid numbers obtained with ASTM test tires and those obtained with commercially available tires is discussed in Safety Board report concerning a bus accident which occurred in Bethesda, Maryland, on October 11, 1975. (NTSB-HAR-76-6.)

Safety Board did not detect any problems with brake incompatibility on combination vehicles. However, the tests observed did not examine truck-full trailer incompatibility. It is possible that other tests have included the combination vehicle and brake configuration involved in this accident.

Regardless of previous tests, this accident strongly suggests that at high speed and on wet pavement, the combination of conventional brakes on a full trailer and FMVSS-121 brakes on the towing truck can adversely affect vehicle control when the brakes are applied hard enough to lock the trailer wheels.

Role of Tachograph in Analysis

This accident emphasizes the importance of recording vehicle speeds as a part of overall highway safety management. The driver alleged that his speed had been 45 mph, whereas the tachograph record indicated that the speed had been 52 mph. In this case, the driver's speed of 52 mph was not substantially above the posted speed limit of 50 mph. The tachograph record thus demonstrated that the posted speed was too high for the marginal traction capability of the pavement to permit safe negotiation of the curve by this vehicle at 2 mph above the posted speed.

In a recent action, the Federal Highway Administration declined to require the routine use of tachographs on motor vehicles in interstate commerce on the ground that they had not been shown to be sufficiently effective in reducing accidents. The role of tachographs in reducing speed limits is difficult to trace in normal accident investigations. However, in this accident, the tachograph showed that the driver's speed, although higher than the speed which was safe to negotiate the curve, was not significantly higher than the posted speed limit. This information has value both to the vehicle driver, to his company, and to highway management.

It would appear that the routine use of tachographs, although not required by regulations, can be valuable both to the private and to the public sectors in highway safety.

CONCLUSIONS

1. The truckdriver was driving too fast for the existing road and weather conditions, and he lost control of the combination vehicle as he negotiated a right curve.

2. The traction capability of the pavement was marginal and not sufficient to prevent the trailer from sliding outward on the curve at 52 mph, 2 mph faster than the posted speed limit of 50 mph.

3. When the rear end of the trailer slid to the left and out of alignment with the truck, the driver steered to the right to correct the vehicle's direction and he braked to slow the vehicle.

4. The trailer, which was not decelerating as rapidly as the truck, pushed the rear of the truck to the right and caused the front of the truck to rotate toward the left.

5. The forces which caused the jackknifing combination vehicle to slide to the right and strike the viaduct curb and column instead of continuing outward to the left in the curve could not be definitely identified.

6. The sudden dynamic loading, which was imposed on the trailer dolly's right side support when the right-front trailer wheel struck the right curb, caused the side support to fail at its attachment point with the tow-bar. This allowed the trailer to separate from the truck.

7. When the trailer's aluminum-alloy cargo tank struck the viaduct column, the tank ruptured and gasoline spilled and ignited.

8. The truck separated completely from the trailer when the support column snagged the trailer's damaged cargo tank, and the truck continued to travel to the southeast.

9. The tachograph with which the truck was equipped was vital in determining the precrash speed of the combination vehicle and in substantiating the necessity for the speed limit reduction at the curve in question.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the driver to reduce the speed of the combination vehicle to permit safe negotiation of the curve under existing road and weather conditions. Contributing to the loss of vehicle control was the marginal traction capability of the pavement for the posted speed limit.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board submitted the following recommendation to the National Highway Traffic Safety Administration:

> "Test and resolve the apparent problem of operating any vehicle combination over the full-speed range and road and weather conditions encountered in normal operations if one of the units is equipped with a Federal Motor Vehicle Safety Standard No. 121 (FMVSS-121) antilock brake system and the other is not. (H-76-28) (Class II, Priority Followup)"

The National Transportation Safety Board submitted the following recommendations to the State of Washington, Department of Highways:

"Conduct skid tests on the viaduct roadway to determine if there is a problem relative to the road surface and, if such is the case, improve the road surface. (H-76-29) (Class II, Priority Followup)

"Post warning signs on the viaduct to advise drivers that the viaduct roadway is slippery when wet. (H-76-30) (Class II, Priority Followup)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ KAY BAILEY
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ WILLIAM R. HALEY
Member

July 28, 1976

APPENDIX

NATIONAL TRANSPORTATION SAFETY BOARD
Bureau of Aviation Safety
Washington, D. C.

April 5, 1976

Metallurgical Laboratory
Report No. 76-92

METALLURGIST'S FACTUAL REPORT

A. ACCIDENT

Place : Seattle, Washington
Date : December 4, 1975
Vehicle : Tank Trailer
NTSB No. : BSTS 76H-46
Investigator: Charles P. Hoffman, BSTS-10

B. COMPONENT EXAMINED

Fractured Silver Eagle right hand trailer dolly support.

C. DETAILS OF EXAMINATION

Figure A1 shows the condition of the trailer dolly support as received by the NTSB laboratory. The portion of the support shown on the left side of Figure A1 appeared to have been examined by another laboratory. The right hand portion of the dolly support shown in Figure A1 appeared to contain the original fracture half intact. This fracture is shown in a closer view in Figure A2.

Visual examination of the fracture shown in Figure A2 with the aid of a bench binocular microscope disclosed no evidence of fatigue progression on the fracture. The fracture features appeared typical of a single load application in an overload condition.

Some discoloration of the fracture occurred around the middle rib of the support and in other areas randomly located on the fracture surface. One of the areas containing this discoloration was removed from the fracture and examined with the aid of a scanning electron microscope (SEM).

SEM examination disclosed that the discoloration was due in the most part by a substance deposited on the fracture. X-ray energy dispersive analysis of a microsection through the dolly support indicated the material was an aluminum alloy casting having silicon as the major alloying element with small additions of magnesium, iron and copper being present. Analysis of the deposit which produced the discoloration gave energy peaks of the alloying elements as well as peaks of sodium, sulfur, clorine, potassium, calicum and titanium.

APPENDIX

Figure A1. Overall view of parts, as received.

Figure A2. Fracture surface of right-hand trailer dolly support. Approximately X1/2.

C. DETAILS OF EXAMINATION (Cont'd)

Examination of the fracture surface and a microsection through the fracture surface also disclosed areas of microshrinkage porosity which is not uncommon in aluminum alloy castings. The porosity appeared to have contributed in some degree to the discoloration on the fracture surface.

Hardness and electrical conductivity measurements of the dolly support gave values ranging from 67 to 79 Rockwell "K" and 35 to 36% IACS, respectively. This data, however, could not be correlated to any specific aluminum casting alloy as shown in the American Society for Metals Handbook, Volume No.1. This data as well as the chemistry suggested by the X-ray energy analysis indicated the material could be a 300 series type aluminum alloy casting having an exceptionally high hardness value.

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Attachment