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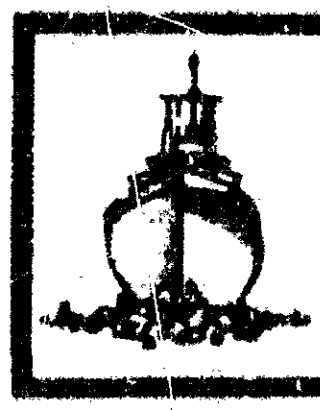

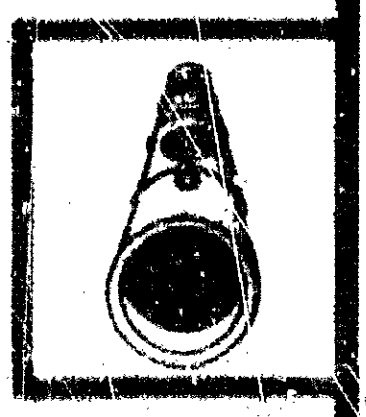

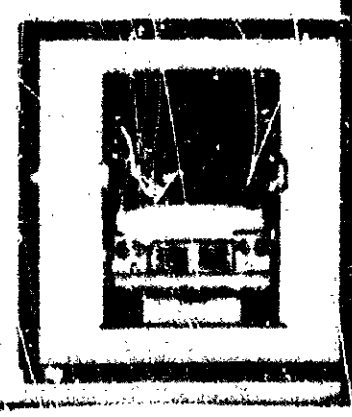

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SPECIAL INVESTIGATION

UMTA PROTOTYPE BUS FIRE NEAR PHOENIX, ARIZONA MAY 13, 1975

REPORT NUMBER: NTSB-HAR-75-8

UNITED STATES GOVERNMENT

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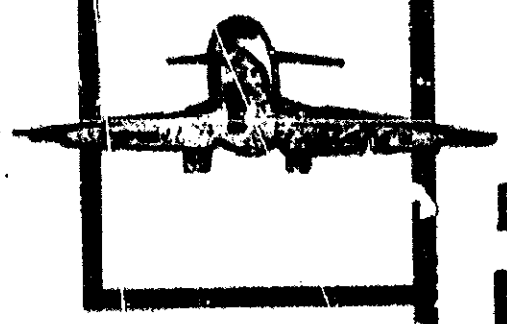

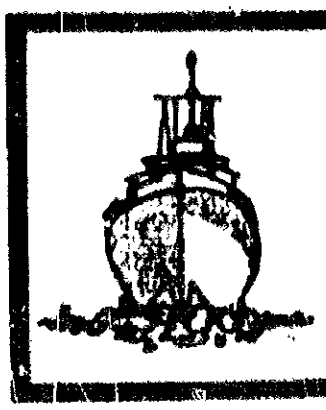

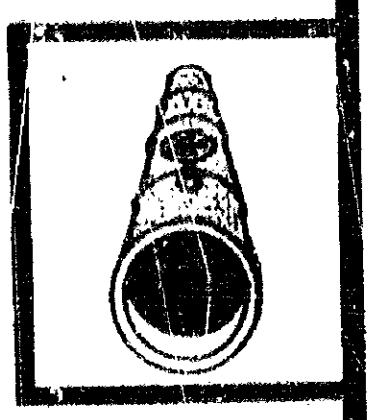

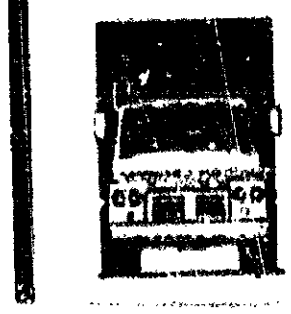

ERRATA

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SPECIAL INVESTIGATION REPORT - NTSB-HAR-75-8.
UMTA Prototype Bus Fire,
Near Phoenix, Arizona, May 13, 1975

Please make the following changes to the subject report:

Technical Report Standard Title Page (Abstract):
Paragraph 1, line 1 change: 1974 to 1975.
Paragraph 3, line 2 change: Transit to Transportation.
Page iii:
Paragraph 1, line 1 change: Transit to Transportation.
Page 19:
Paragraph 2, line 3 change: Transit to Transportation.

January 13, 1976

UNITED STATES GOVERNMENT

TECHNICAL REPORT STANDARD TITLE PAGE

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4. Title and Subtitle	5. Report Date
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	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Surface Transportation Safety Washington, D. C. 20594	10. Work Unit No. 1710
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594	13. Type of Report and Period Covered Special Investigation May 13, 1975
	14. Sponsoring Agency Code

On May 13, 1974, a Rohr Industries' prototype bus was being road-tested on Interstate 17, 35 miles north of Phoenix, Arizona. At 12:13 p.m., the driver and a technical observer heard a noise originating in the engine compartment, felt a loss of engine power, and saw smoke coming from the rear engine compartment. When they stopped to examine the bus, they saw a fire in the upper right area of the engine compartment. They attempted to raise the hydraulically powered engine hood, but it would not open. The driver tried to extinguish the fire through the hood access door, but it did not provide adequate access to extinguish the fire. The fire spread to the passenger compartment and destroyed the entire bus.

The National Transportation Safety Board determines that the probable cause of the fire was the ignition of oil which leaked from the accessory drive manifold when it came in contact with a hot engine exhaust system component. The fire spread because of (1) the failure of the hood-opening mechanism to operate and permit fire extinguisher access, and (2) the presence of fire-consumable materials in the fire wall of the bus.

As a result of its investigation, the National Transportation Safety Board made recommendations to the Urban Mass Transit Administration, the National Highway Traffic Safety Administration, the Bureau of Motor Carrier Safety, the National Association of Motor Bus Owners, and the American Trucking Associations, Inc.

17. Key Words	18. Distribution Statement
Prototype bus; bus fire; autoignition of oil; firefighting; firefighting accessibility; fire wall; extinguishers; combustible materials.	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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FOREWORD

In the early 1970's, the Urban Mass Transit Administration (UMTA) of the Department of Transportation contracted with Booz-Allen Applied Research to design a prototype transit bus which would attract commuters away from private vehicles. Three vehicle manufacturers designed prototype buses to Booz-Allen's specifications. On May 13, 1975, while it was being tested near Phoenix, Arizona, a prototype bus built by Rohr Industries burned.

At the request of the Administrator of UMTA, the National Transportation Safety Board conducted a special investigation of the incident described in this report.

The report is based on facts obtained from an investigation conducted by the Safety Board. Information was also obtained from Booz-Allen, Rohr Industries, the Cummins Engine Company, and the Arizona Department of Public Safety.

The conclusions, the determination of probable cause, and the recommendations are those of the Safety Board.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

SPECIAL INVESTIGATION

Adopted: December 5, 1975

UMTA Prototype Bus Fire
Near Phoenix, Arizona, May 13, 1975

SYNOPSIS

On May 13, 1975, a prototype bus manufactured by Rohr Industries was being road-tested on Interstate 17, 35 miles north of Phoenix, Arizona. At 12:13 p.m., the driver and a technical observer heard a noise originating in the engine compartment, felt a loss of engine power, and saw smoke coming from the rear engine compartment. When they stopped to examine the bus, they saw a fire in the upper right area of the engine compartment. They attempted to raise the hydraulically powered engine hood, but it would not open. The driver tried to extinguish the fire through the hood access door, but it did not provide adequate access to extinguish the fire. The fire spread to the passenger compartment and destroyed the entire bus.

The National Transportation Safety Board determines that the probable cause of the fire was the ignition of oil which leaked from the accessory drive manifold when it came in contact with a hot engine exhaust system component. The fire spread because of (1) the failure of the hood-opening mechanism to operate and permit fire extinguisher access, and (2) the presence of fire-consumable materials in the fire wall of the bus.

FACTS

Sequence of Events

On May 13, 1975, a driver and a technical observer prepared to test a prototype bus to evaluate transmission noise levels and operating temperatures. (See Figure 1.) The bus was designed by Rohr Industries and was one of nine prototypes developed under an Urban Mass Transportation Administration (UMTA) program.

A 6-percent upgrade on northbound Interstate 17 (I-17), about 35 miles north of Phoenix, Arizona, was chosen for the test. At 11:30 a.m., the bus departed for the testing area. During the trip, the driver turned on the air conditioning; he shut it down when he realized that it was not operating properly.

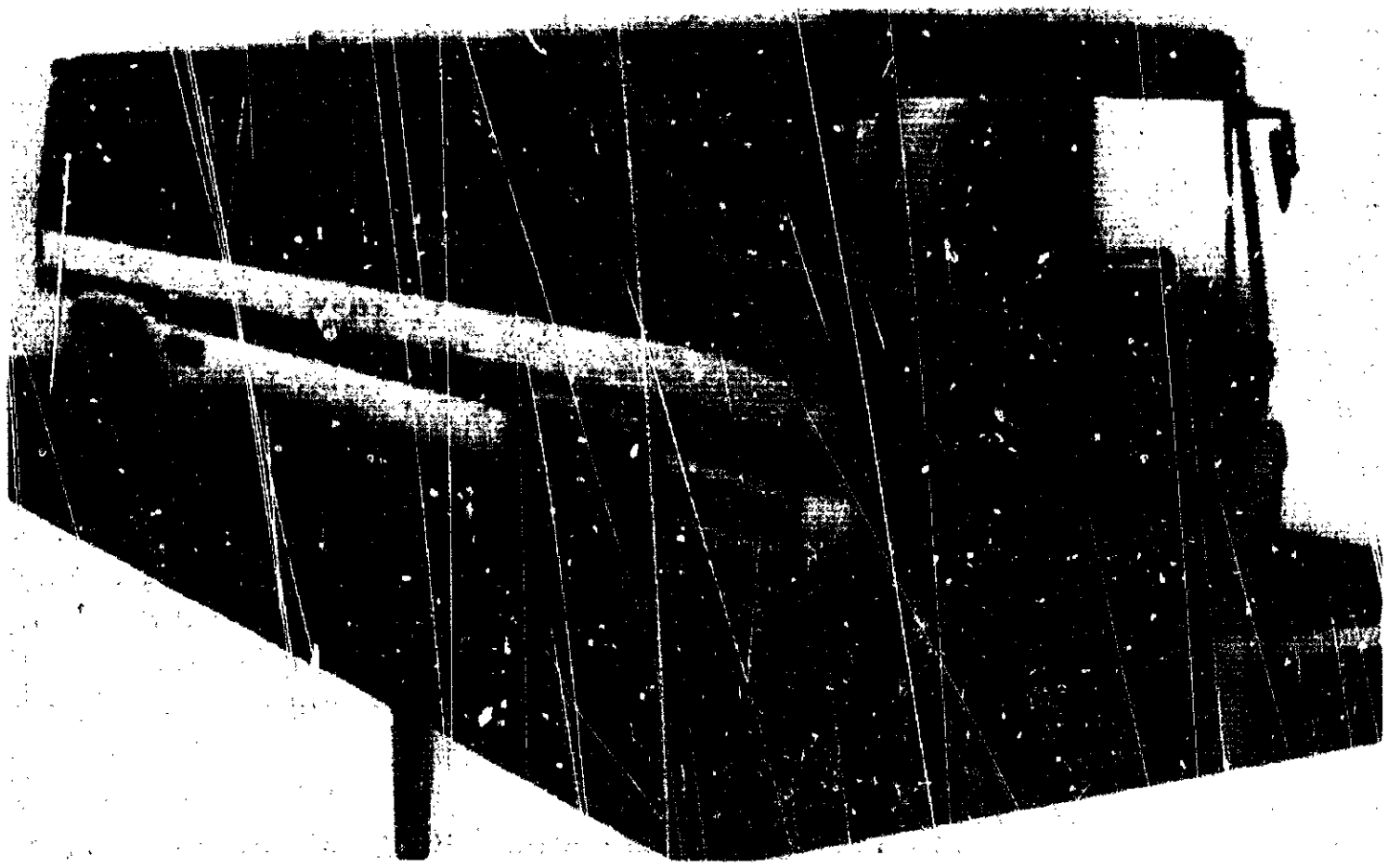

Figure No. 1. Scale Model of Rohr Prototype Transbus.

After the bus passed over the summit of a hill about 12:13 p.m., both the driver and the technical observer heard a noise, described as a thump or a thud, which appeared to originate in the engine compartment. (See Figure 2.) Simultaneously, they felt the engine lose power and the bus decelerate. The driver looked in his rearview mirror and saw smoke coming from the engine compartment. He pulled over to the shoulder of the highway, stopped the bus, shut off the master switch, removed a 2 1/2-pound dry chemical fire extinguisher from its compartment, and ran to the rear of the bus.

The driver attempted to open the engine compartment's hood without success. (See Figure 3.) Since the hood would not open, he opened the hood's access door, which provides a small opening into the engine compartment. (See Figures 3, 4, and 5.) In addition to the first extinguisher, the driver used three other 10-pound dry chemical extinguishers. The fire flashed back after every application of the extinguishers and continued to burn.

Figure No. 2. Engine Compartment.

A - Muffler
B - Air Cleaner
C - Engine Radiator
D - Air Conditioning Compressor
E - Air Conditioning Compressor Mounting Plate
F - Electrical Control Box
G - Engine
H - Oil Cooler/ A-C Condensor
I - Hydraulic Reservior (Accessory Drive System)

Figure No. 3. Engine Compartment Hood in Raised Position.

A - Engine Access Door
B - Engine Compartment Hood

Figure No. 4. Fire Extinguisher Accessibility To Initial Fire.

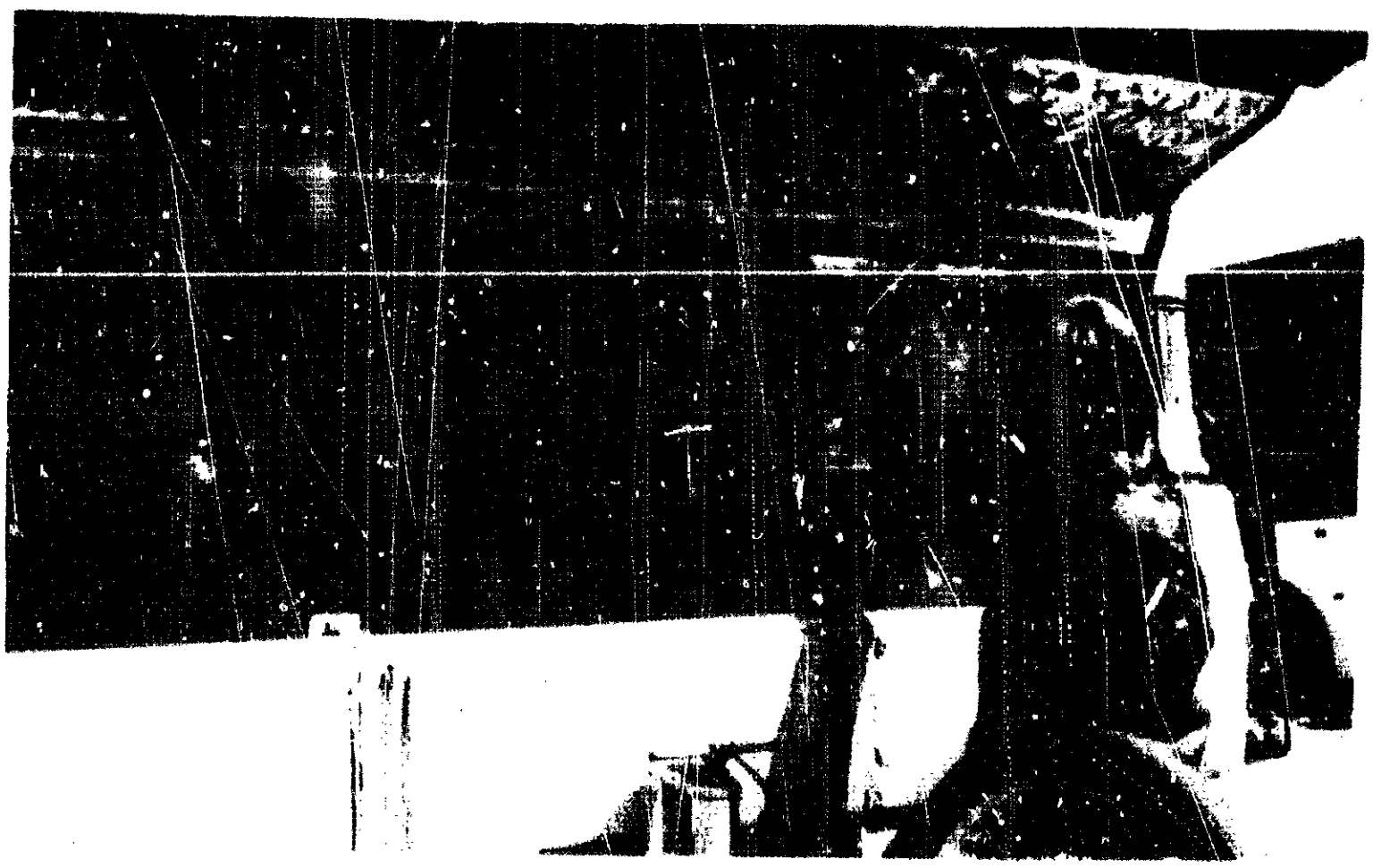

Figure No. 5. Driver Pointing To Location Of Initial Fire.
A - Engine Compartment Access Door
B - Engine
C - Exhaust Manifold (Left Bank)
D - Exhaust Pipe (Left Bank)

While the driver was attempting to extinguish the fire, the technical observer was removing the transmission instrumentation from the passenger compartment. Nine minutes after the fire was detected, the engine compartment was engulfed completely and the fire spread to the passenger compartment. (See Figure 6.)

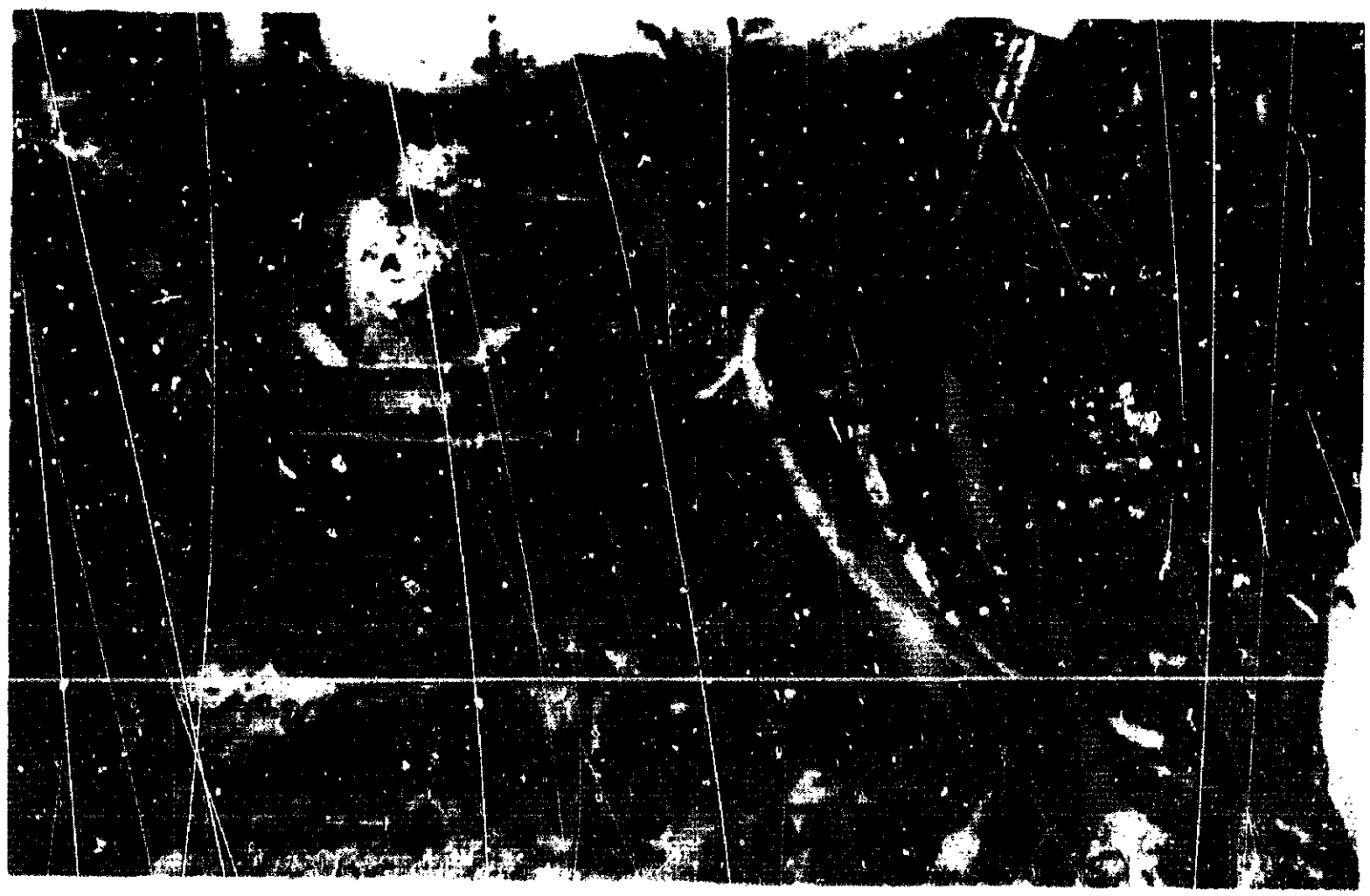

Figure No. 6. Postfire Condition of Engine Compartment.
A - Air Conditioning Compressor
B - Turbocharger
C - Engine - Initial Fire Area

Light breezes caused the flames to travel around the fire wall. The flames ignited the sides, windows, and roof of the bus. (See Figure 7.) Fire also traveled through the air conditioning vents in the fire wall and into the passenger compartment.

While the fire burned, an Arizona Highway Patrol car arrived on the scene. At 12:25, the patrolmen indicated by radio that the two occupants were out of the bus. About 12:28, they reported that the environment inside the bus would not support life. At 12:40, they reported that the bus was engulfed in flames. By 1:55, the bus was destroyed.

The Vehicle

The bus (No. R-45-WTA-102) was manufactured by Rohr Industries. The 43-passenger bus had accumulated 25,000 miles before the incident. On the day of the fire, it was loaded with 6,200 pounds of sandbags to simulate a load of passengers. The tare weight of the bus was 26,000 pounds.

The bus was powered by a 350 HP-VT 903, V-8 turbocharged Cummins diesel engine and an Allison 730, 3-speed transmission plus torque converter. The diesel engine was equipped with an aneroid, which controlled fuel flow to reduce exhaust smoke emissions. The aneroid had three lines. The first was a fuel line to the aneroid from the fuel tank, the second was from the aneroid to the fuel pump, and the third was from the aneroid to the engine's intake manifold. The line to the intake manifold was used to sense manifold air pressure. The aneroid regulated engine fuel on the basis of the engine's ability to burn efficiently. When the intake manifold pressure was high, the fuel flow was high. When manifold pressure was low, the fuel flow was restricted.

The location of the air conditioning equipment in this bus was different from that in most buses. Most buses have the air conditioning equipment under the bus floor. To provide a lower center of gravity, thereby improving vehicle ride and reducing the probability of overturn, the floor in this bus was low. Because there was no room to install the air conditioning equipment under the floor, the air conditioning equipment was installed in the rear engine compartment.

Figure No. 7. Initial Passenger Compartment Fire Involvement.

Engine Compartment Hood

The rear engine compartment is illustrated in Figures 2, 3, 4, and 8. Figures 2 and 3 show the fiberglass hood in the raised position. Figure 5 shows the engine hood in the down position, with the access hatch open and the driver pointing to the area where the fire began. The hood-raising mechanism consisted of an electric motor which drove a hydraulic pump. Hydraulic pressure forced two rams (one on each side) outward and upward; this lifted the hood. The switch which activated the hood-raising mechanism was located on the left side, near the engine's radiator.

Accessory Drive System

The two hydraulic pumps, driven by an engine gear case, developed pressure to drive the hydraulic motors which drove the air conditioning compressor and two air conditioning evaporator fans; they also controlled the engine radiator and oil cooler fans.

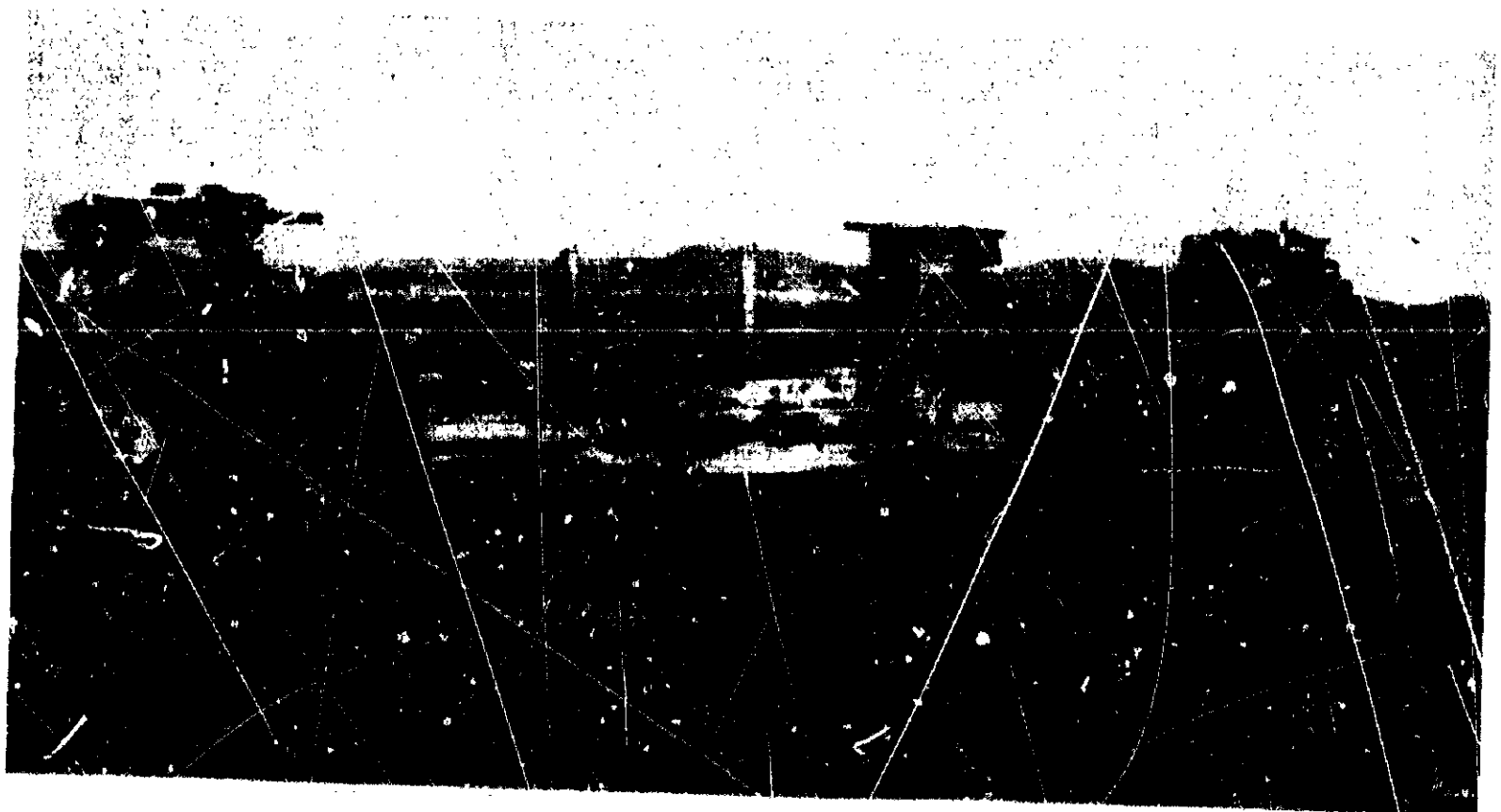

Figure No. 8. Postfire Condition of the Bus.

Four and one-half gallons of SAE-10W-20W-30 oil, a type of engine lubricant, were used as the hydraulic fluid for the accessory drive system. The two hydraulic pumps delivered the oil at 2,400 pounds per square inch to the accessory drive manifold. The manifold regulated and controlled hydraulic oil flow to the above accessories. Oil passed through a separate return manifold, through the accessory drive's hydraulic manifold, into the oil cooler, and finally to the oil reservoir as it returned from the accessories.

Figure 9 shows the hydraulic manifold. Figure No. 10 shows the manifold after the fire. Figure No. 11 shows the assembly of the accessory drive's oil reservoir.

Fire Wall

The engine fire wall was a steel plate which separated the engine compartment from the passenger compartment. There were four openings in the fire wall. (See Figure 12.) Two small openings at the top corners were vents for the air conditioning. Rubber ducts connected the fire wall vents to the two evaporator fan housings. (See Figure 13.) The large opening in the top center was a return duct for the heater and air conditioning. The hole at the bottom was for engine accessibility. This hole was closed by a steel hatch before and during the fire.

Tests and Research

After the accident, a Rohr Industries bus of similar design and construction was tested to determine:

(1) If an electrical failure of the fuel line's shutoff valve could have caused the loss of engine power and the deceleration;

(2) If the exhaust system's components were hot enough to have caused the autoignition of the hydraulic oil.

TEST No. 1

The electrical circuit of the solonoid-operated fuel shutoff valve was modified so that the current could be interrupted from the passenger compartment.

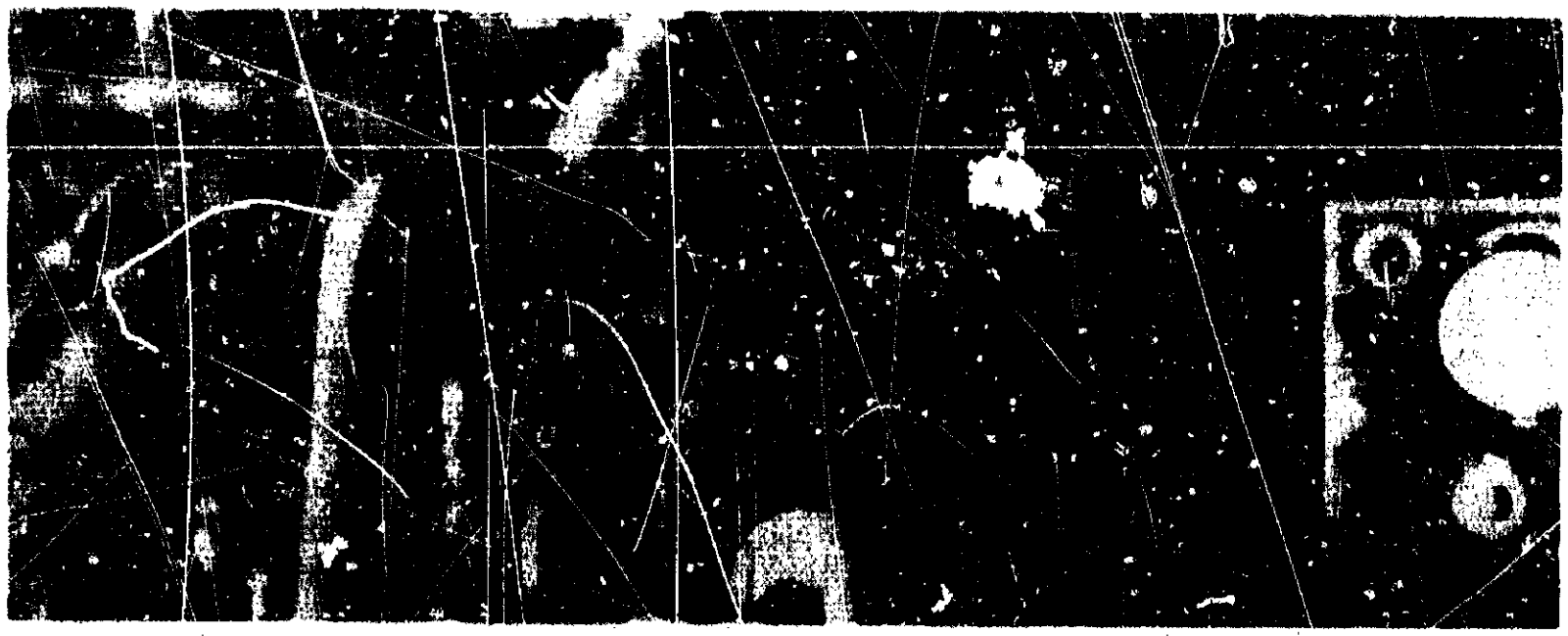

Figure No. 9. Engine Compartment, Upper Right Side.
A - A-C Compressor
B - Accessory Drive Manifold
C - Manifold Mounting Stilt
D - A-C Condensor/Oil Cooler Fan Drive

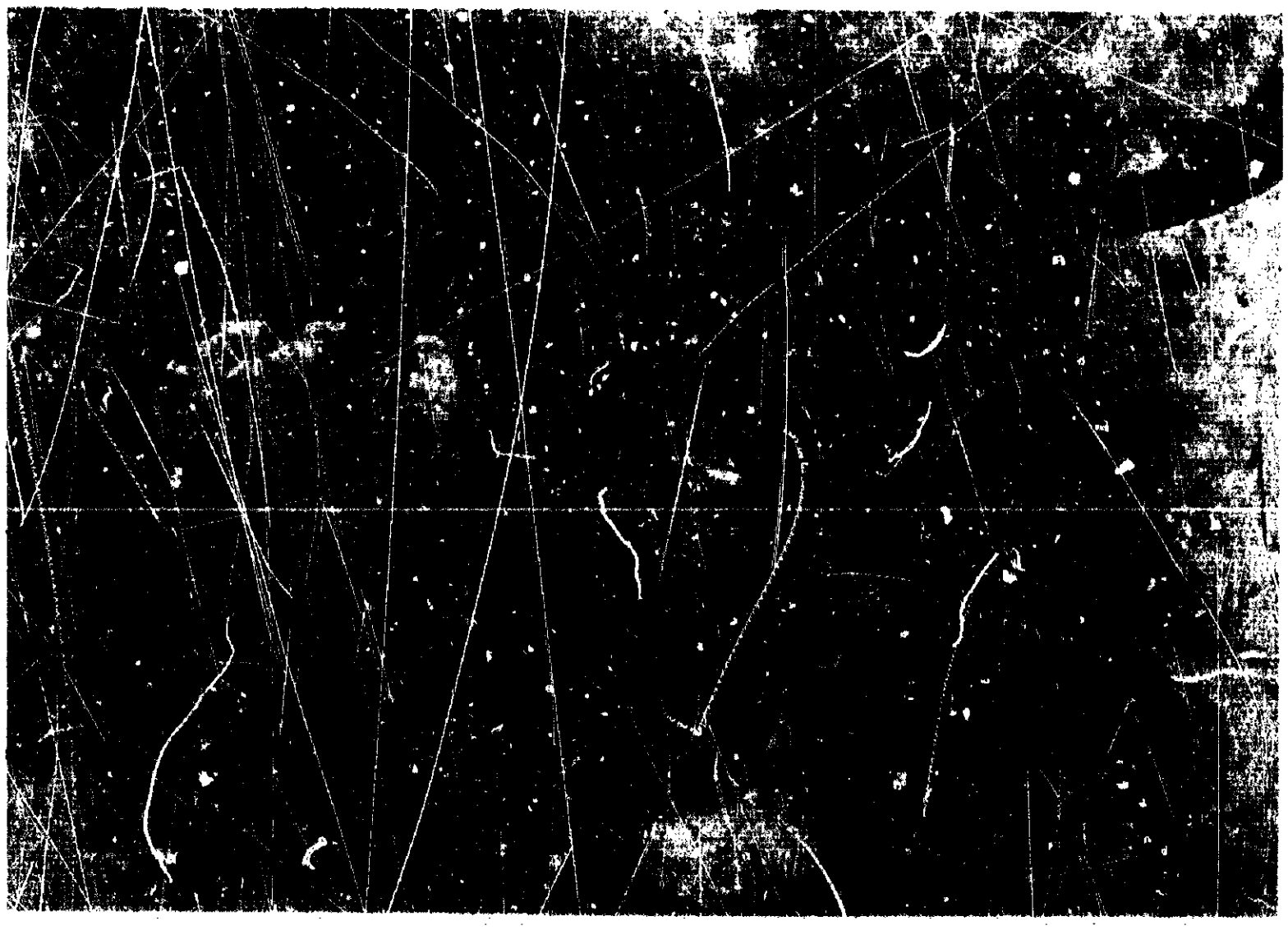

Figure No. 10. Postfire Condition of Accessory Drive Manifold.

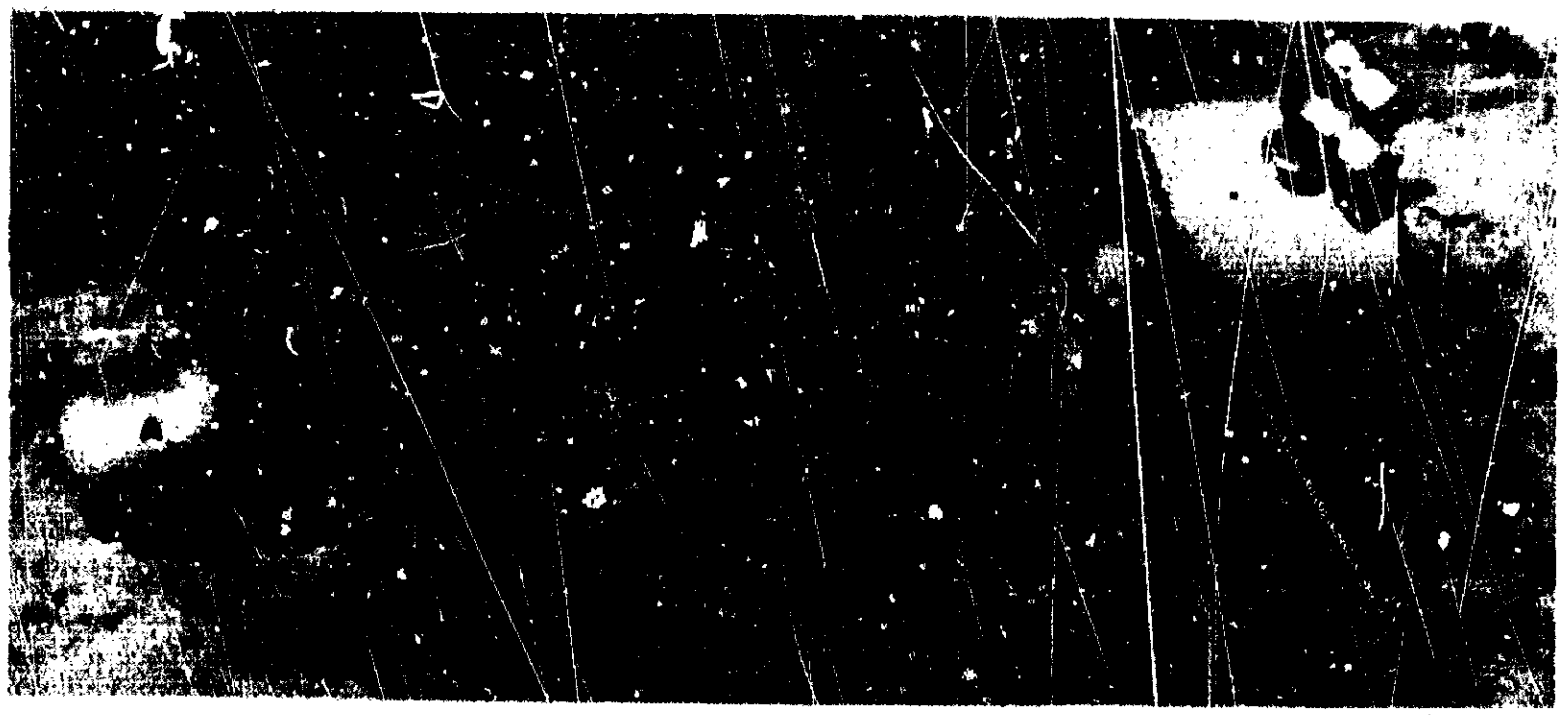

Figure No. 11. Accessory Drive Hydraulic Reservoir.
A - Air Chamber
B - Diaphragm
C - Shaft "O" Ring

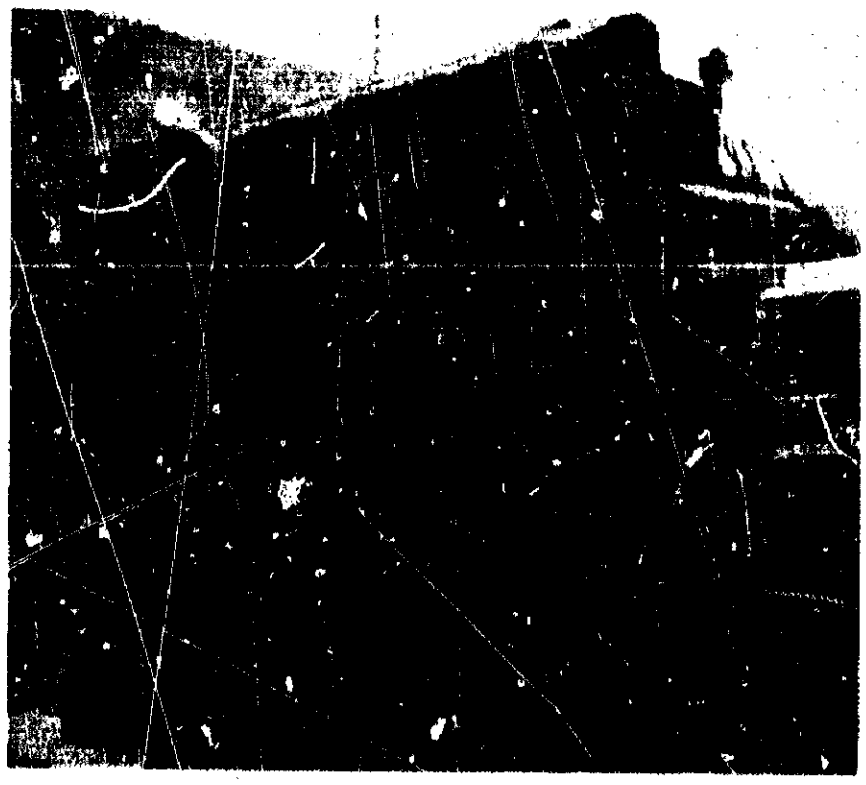

Figure No. 12. Fire Wall, Postfire Condition.
A - A-C Vent Passages
B - Heater
C - Engine Access Opening

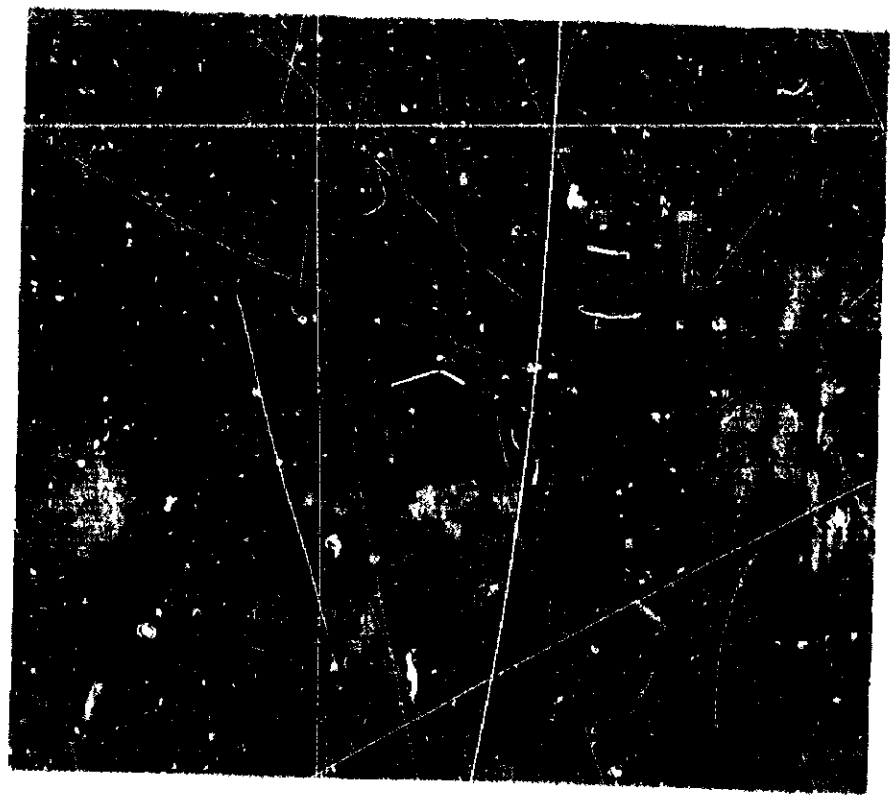

Figure No. 13. A-C Vent Passage.
A - Evaporator Fan
B - Fan Housing
C - Fire Wall (Front Surface)

The test vehicle was operated at 50 mph on a test track. The shutoff valve's electric circuit was opened, and the bus stopped without an application of brakes. The test was repeated. As the bus decelerated, the electric circuit was returned to normal, but the bus continued its deceleration. The engine was not operating after the vehicle stopped. The driver reported that the engine was still operating after the bus stopped on the day of the fire. This test was repeated several times, with identical results.

TEST No. 2

Five thermocouples were mounted in the engine compartment to determine various operating temperatures. The thermocouples were located as follows:

(1) On the left exhaust manifold.
(2) On the left exhaust pipe, about 4 inches from thermocouple No. 1.
(3) On the left exhaust pipe, halfway between the exhaust manifold and the turbocharger.

(4) On top of the turbocharger.
(5) On the top of the air conditioning compressor's mounting plate, under the compressor's hydraulic motor.

The test bus was operated without simulated passenger load, and over the same route as the burned bus. Results were as follows:

Time From Start of Trip	Thermocouples' Temperatures (Degrees F)				
Minutes	No. 1	No. 2	No. 3	No. 4	No. 5
15	418	490	574	397	166
30	365	465	506	364	166
40 (on hill)	517	620	693	483	173
43 (on hill)	550	602	741	445	180
-- hill summit	430	556	628	360	177
47 (fire site)	330	422	580	325	173
57 (after 10 minute stop at site)	220	325	386	338	145
During return trip	448	574	566	417	159

TEST No. 3

Based on the high temperatures recorded in this test, the need to determine the autoignition temperature of the accessory drive hydraulic oil was apparent. Consequently, Booz-Allen Applied Research arranged for tests to determine the autoignition temperature of the hydraulic oil. The tests 1/ established that the autoignition temperature of the hydraulic oil was 600° F.

1/ Tests were run in accordance with American Society of Testing and Materials' (ASTM) 1966 Edition, "Tentative Method of Testing Auto-Ignition Temperatures of Liquid Petroleum Products," pp. 735-738. ASTM defines autoignition temperature as the temperature at which a product will ignite in the absence of flame or spark.

During the preparation for Test No. 2, a leak developed in the accessory drive system at the top of the hydraulic oil reservoir. Oil in sufficient quantities to cause ignition came out of the air vent at the top of the air chamber (See Figure No. 11), dropped down into the air stream from the oil cooler fan, and was sprayed throughout the engine compartment.

ANALYSIS

Fuel Source

Engine fuel oil, engine lubricating oil, transmission fluid, and the accessory drive's hydraulic oil were in the engine compartment; each had the potential of being the fuel source. All, with the exception of the hydraulic oil, were discounted because (1) there was no indication that diesel fuel or transmission oil had leaked, and (2) the other fuels were not close enough to the initial fire.

There are two ways the hydraulic oil could have become the fuel source: It could have leaked from the hydraulic manifold, or it could have leaked from the hydraulic oil reservoir and then been sprayed over the engine compartment by the oil cooler fan.

Hydraulic Manifold -- The driver observed that the fire began near the accessory drive's hydraulic manifold. In this area, aluminum (1,200° F melting point) and brazing material (1,800° F) had melted. This area was the hottest part of the fire.

During the tests, when the test bus' engine was running and when the hydraulic system was cycling, the hydraulic system's manifold vibrated excessively. The intensity of the hydraulic manifold vibrations could be attributed to vibrations of the compressor's mounting plate; the vibrations were being transmitted and intensified through the manifold's mounting stilts. This action, coupled with hydraulic pulses resulting from changes in demand on the hydraulic system, created vibrations of such frequency and magnitude that a hydraulic oil leak could result, and possibly did.

These vibrations were not measured on the test bus; however, one of the hydraulic manifold's flexible lines on the test bus was found to have worn through its outer surface where it was in contact with another component. The worn area resulted from constant rubbing by manifold vibrations.

During other tests, a leak developed in the hydraulic manifold. The test personnel indicated that hydraulic oil came in contact with the engine's exhaust system.

Hydraulic Oil Reservoir -- The fuel for the initial fire could have been hydraulic oil which was released through the air vent on top of the hydraulic oil reservoir. Such an oil release occurred during Test No. 2. Oil apparently passed through, or around, either the reservoir's diaphragm or the shaft's "O" ring, and entered the reservoir's air chamber. Oil in the air chamber then passed through the air vent and flowed downward into the air stream from the oil cooler fan. Oil was sprayed throughout the engine compartment.

The possibility that hydraulic oil was released through the reservoir's air vent cannot be discounted. However, it is more likely that the fuel for the initial fire came through a leak in the hydraulic manifold.

Ignition Source

Potential ignition sources of the hydraulic oil were an electrical short circuit, a turbocharger failure, and a component of the engine's exhaust system.

Electrical Short -- An electrical short circuit could have caused the fuel to ignite at its flash point temperature of 426° F. However, examination of the electrical system did not reveal any short circuits.

Turbocharger Failure -- Engine exhaust through an opening in the system could have caused ignition of the hydraulic oil at 426° F. Postaccident investigation showed that the air intake side of the turbocharger had separated from its housing, and it appeared possible that hot exhaust gases (1,000° F or higher) could have been released into the engine compartment and could have caused ignition. Several blades of the turbocharger appeared to have failed from mechanical stress. The mechanical failure of the blades, coupled with the driver and observer reports that they heard a noise and experienced a loss of engine power, supported the theory that the turbocharger failed before the fire, but this possibility was discounted after discussions with the engine manufacturer and the Safety Board's metallurgical personnel. The air intake housing was aluminum and the fire was hot enough to melt aluminum. Accordingly, steel turbine vanes would have been

weakened severely and could have failed mechanically from minor load applications either during the fire or after the fire was extinguished.

Hot Exhaust System Component -- During the second vehicle test, many of the recorded surface temperatures were higher than the 600° F autoignition temperature of the hydraulic oil. Technicians from two oil companies were questioned relative to the accuracy of the 600° F autoignition temperature test value. They indicated this was a realistic value and that the autoignition temperature could be even lower if the oil were in mist form. The highest temperature recorded in Test No. 2 was 741° F. It is possible that exhaust components which were not instrumented, specifically those of the right bank, were even hotter, as the right bank did not receive as much air circulation as the left bank.

Since the temperatures of many of the exhaust system's components were in excess of the hydraulic oil's autoignition temperature, the most likely ignition source appears to be one of those hot components.

One of the most important lessons to be learned in this accident is the potential hazard of using a pressurized hydraulic oil with an autoignition temperature lower than temperatures of the exhaust system, in the engine compartment. Fuels and lubricants with low ignition temperatures, located in the engine compartment, should be limited to those which are absolutely essential to vehicle propulsion. When circumstances dictate that other hydraulic systems must also be in the engine compartment, either an oil with ignition temperatures higher than predictable temperatures in the engine compartment should be used, or hydraulic components should be located in such a manner that leaks cannot contact hot surfaces within the compartment.

Fire Propagation

Although the smoke was detected at 12:13 p.m., there are several factors which suggest that the fire was burning before that time:

(1) Failure of the electric circuit to operate the hood-raising mechanism. If this failure resulted from fire, it had been burning for a long time before the driver tried to raise the hood. Fire had to destroy the electric wire's insulating material of the hood-raising mechanism before an electric failure could occur.

(2) Both the driver and the observer felt a loss of engine power and vehicle deceleration at 12:13 p.m. The best explanation for the loss of engine power is that the fire destroyed the intake manifold's aneroid line. The line ceased to sense high manifold pressure and reduced the fuel flow to the engine. Accordingly, the engine power was reduced significantly. This would cause the loss of engine power and the vehicle deceleration. Accordingly, the fire must have been burning before the bus decelerated.

(3) The temperatures of the engine components exceeded the autoignition temperature of the hydraulic oil from the time the bus left the test center at 11:30. Ignition could have occurred any time after the oil began to leak.

The probable sequence of the fire in the engine compartment follows:

Oil was released under pressure from a leak at the hydraulic manifold and was sprayed about the engine compartment. When the oil contacted a hot exhaust system component, the oil ignited. For an unknown period of time, the fire spread about the engine compartment, consumed the intake manifold's aneroid line, and caused the failure of the hood-raising mechanism's electric circuit. As the fire consumed the 4 1/2 gallons of hydraulic oil, it increased in intensity. The fire consumed the combustible materials in the engine compartment such as the rubber hoses, belts, wire insulation, flexible line fabrics, fiberglass, etc. Aluminum parts and brazing material melted, which suggests temperatures approaching 1,800° F. The fire completely engulfed the engine compartment 9 minutes after the driver detected smoke.

Fire Extinguishment

If the engine compartment had been equipped with a fire alarm system, the driver would have known about the fire earlier, and the sequence of events might have been significantly changed. Early detection would have permitted the driver to open the hood, and he could have extinguished the fire with the portable extinguishers on the bus.

This incident illustrates the importance both of vehicle design and of driver awareness of firefighting techniques in vehicle fire situations. The busdriver's understanding of the vehicle and of

firefighting techniques was good. He probably would have been able to put out the fire if the hood-raising mechanism had worked.

CONCLUSIONS

1. The fire began when hydraulic oil ignited after it leaked from the accessory drive manifold and contacted a hot component of the engine's exhaust system.

2. The fire burned in the engine compartment an undetermined length of time before it was detected.

3. The bus' power loss and deceleration resulted when fire destroyed the engine's intake manifold aneroid line.

4. The driver was knowledgeable both about firefighting procedures and about the vehicle. He could have put out the fire if the hood-opening mechanism had operated properly.

5. The 2 1/2-pound dry chemical fire extinguisher failed to put out the initial fire because the driver was unable to spray the chemical directly on the fire.

6. The burning of combustible materials in the engine compartment contributed to the intensity of the fire.

7. The fire was confined to the engine compartment by the fire wall long enough for a full load of occupants to have escaped.

8. The ability of the fire wall to confine the fire was affected adversely by the combustible rubber ducts between the air conditioning fan housings and the vents in the fire wall.

9. Fire spread into the passenger compartment through the vents in the fire wall.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the fire was the ignition of oil which leaked from the accessory drive manifold when it came in contact with a hot

engine exhaust system component. The fire spread because of (1) the failure of the hood-opening mechanism to operate and permit fire extinguisher access, and (2) the presence of fire-consumable materials in the fire wall of the bus.

RECOMMENDATIONS

As a result of its investigation of this incident, the National Transportation Safety Board made recommendations to the Urban Mass Transit Administration, the National Highway Traffic Safety Administration, the Bureau of Motor Carrier Safety, the National Association of Motor Bus Owners, and the American Trucking Associations, Inc.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

December 5, 1975

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX A

ISSUED: December 23, 1975

Forwarded to:

Honorable Robert E. Patricilli
Administrator
Urban Mass Transportation Administration
Washington, D. C. 20590

SAFETY RECOMMENDATION(S)
H-75-39

On May 13, 1975, a Rohr Industries' prototype bus was being road-tested near Phoenix, Arizona. The two occupants heard a noise from the engine compartment, felt a loss of engine power, and saw smoke coming from the rear engine compartment. They attempted to raise the hydraulically powered engine hood, but it would not open. The driver tried to extinguish the fire through the hood's access door, but he was not successful. The fire spread to the passenger compartment and destroyed the bus.

The Safety Board is concerned with the problem of occupant evacuation from burning mass transportation vehicles. Successful evacuation depends in a large measure on how long the environment in the passenger compartment can continue to support life. Experimental work in the aircraft industry suggests that poisonous gases, smoke, and oxygen depletion may cause incapacitation more quickly than does total flame involvement.

It is the Safety Board's understanding that, following the planned vehicle testing of the prototypes, they will not be sold or otherwise used. Therefore, the National Transportation Safety Board recommends that the Urban Mass Transportation Administration:

> Burn one or more of the prototype buses to establish the rate at which nonlife-supporting environments develop in the bus' passenger compartment. The recommended fire test should simulate actual traffic accident involvement. All combustible materials should be pretested to determine their ability to

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meet Federal Motor Vehicle Safety Standard 302, "Flammability of Interior Materials." (Recommendation H-75-39) (Class II, Priority Followup)

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation.

By: John H. Reed
Chairman

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX B

ISSUED: December 23, 1975

Forwarded to:

Honorable James B. Gregory
Administrator
National Highway Traffic Safety
Administration
Washington, D. C. 20590

SAFETY RECOMMENDATION(S)

H-75-40 through H-75-44

On May 13, 1975, a Rohr Industries' prototype bus was being road-tested near Phoenix, Arizona. The two occupants heard a noise from the engine compartment, felt a loss of engine power, and saw smoke coming from the rear engine compartment. They attempted to raise the hydraulically powered engine hood, but it would not open. The driver tried to extinguish the fire through the hood's access door, but he was not successful. The fire spread to the passenger compartment and destroyed the bus.

The circumstances which not only caused, but also contributed to the severity of, this incident suggest that at least five Federal Motor Vehicle Safety Standards are in order. Even though the vehicle involved was a limited-production prototype, the following basic issues are applicable to all vehicle types.

Firefighting Accessibility

The prototype had a massive engine compartment hood. The size and weight of the hood necessitated the use of a power mechanism to open it. After the engine compartment fire was detected, the hood-opening mechanism would not operate. The fire probably could have been extinguished if the hood could have been opened.

Current cab-over-engine trucks incorporate mechanical as well as hand-operated power-assist mechanisms to tilt the cab forward, thereby providing engine compartment access. Designers of future bus and other motor vehicle types should be aware of engine hood configurations which may interfere with quick access to the engine and related components.

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Autoignition Temperature of Fluids in the Engine Compartment

This incident illustrates the potential hazards of using a fluid with an autoignition temperature lower than the operating temperatures of engine components. Fluids essential to vehicle propulsion systems must be located in engine compartments, regardless of ignition characteristics. Those not essential, which, if they leaked would ignite under the engine compartment environment, should not be permitted in the engine compartment.

Fire Alarm System

This incident illustrates the importance of the earliest possible warning of an engine compartment fire. Delayed fire detection resulted in the failure of components which ultimately caused the complete loss of the bus. The fire was not detected early because the driver's seat was about 30 feet from the engine compartment and there was no fire alarm system.

Fire Wall

The fire wall protected the passenger compartment from the fire for 9 minutes after it was detected. The fire wall would have been more effective had it not been for the consumption of the combustible rubber ducts between the air conditioning fan housings and the fire wall vents. Regardless of vehicle type, the primary objective of a fire wall is to protect the passenger compartment from fire encroachment. Most existing vehicle types use combustible materials through and adjacent to their fire walls, which reduces their effectiveness. Examples of the use of combustible materials include heating and air conditioning ducting; rubber and plastic grommets; rubber boots for the transmission, clutch, brake, and accelerator pedal linkages; and boots for steering columns. Although it may be necessary to use some combustible materials in the accessory and control cutouts in the fire wall, a restriction should be placed on such use.

Use of Combustible Material in the Engine Compartment

The fire increased in intensity as the many combustible materials in the engine compartment were consumed. Rubber hoses, insulation material, fiberglass reinforced plastic fan shrouds, and fan belts contributed to the fire's intensity.

Certain parts made of combustible materials are essential to engine operation, others are not.

Because of the above-mentioned safety issues, the National Transportation Safety Board recommends that the National Highway

APPENDIX B

Traffic Safety Administration develop Federal Motor Vehicle Safety Standards:

1. To require that all trucks and buses are designed so that one person could gain access to the engine and related components within 1 minute without the assistance of power-assist mechanisms. (Recommendation H-75-40) (Class III, Longer Term Followup)

2. To prohibit the use in the engine compartment of rear-engine buses of any fluid, except for those essential to propulsion, with an autoignition temperature less than the surface temperatures of the operating engine components. (Recommendation H-75-41) (Class III, Longer Term Followup)

3. To require that all buses with propulsion engines mounted to the rear of the driver's seat be equipped with a fire alarm or automatic fire suppression system in the engine compartment. (Recommendation H-75-42) (Class III, Longer Term Followup)

4. To require that all buses be equipped with a fire wall of noncombustible material between the passenger and the engine compartments which will provide sufficient fire protection for occupants to assure their successful evacuation. (Recommendation H-75-43) (Class II, Priority Followup)

5. To limit the quantity of combustible materials permitted in engine compartments of rear engine buses. (Recommendation H-75-44) (Class III, Longer Term Followup)

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendations.

By: John H. Reed
Chairman

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX C

ISSUED: December 23, 1975

Forwarded to:

Dr. Robert A. Kaye
Director
Bureau of Motor Carrier Safety
Federal Highway Administration
Washington, D. C. 20590

SAFETY RECOMMENDATION(S)

H-75-45

On May 13, 1975, a Rohr Industries' prototype bus was being road-tested near Phoenix, Arizona. The two occupants heard a noise from the engine compartment, felt a loss of engine power, and saw smoke coming from the rear engine compartment. They attempted to raise the hydraulically powered engine hood, but it would not open. The driver tried to extinguish the fire through the hood's access door, but he was not successful. The fire spread to the passenger compartment and destroyed the bus.

The engine fire extinguishment effort was frustrated by a basic design feature which is common to most, but not all, small fire extinguishers. The 2 1/2-pound dry chemical extinguisher used in the incident had a nozzle which was an integral part of the extinguisher. To direct the extinguishing medium at the flames, the entire extinguisher had to be manipulated.

The space available to manipulate the extinguisher and the location of the initial fire made it impossible to direct the dry chemical at the fire. Had the extinguisher been equipped with a hose between the container and the nozzle, the nozzle could have been manipulated into a position which would have permitted direct application of the dry chemical on the fire.

Therefore, the National Transportation Safety Board recommends that the Bureau of Motor Carrier Safety:

> Amend 49 CFR 393.95, "Emergency Equipment on All Power Units," to require that all extinguishers be equipped with a flexible hose between the

extinguishing medium's container and the outlet nozzle, of sufficient length to improve efficiency in fighting fires that are not directly accessible. (Recommendation H-75-45) (Class II, Priority Followup)

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation.

By: John H. Reed
Chairman

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX D

ISSUED: December 23, 1975

Forwarded to:

Mr. Charles A. Webb
President
National Association of Motor Bus Owners
Suite 308 Blake Building
1025 Connecticut Avenue, N. W.
Washington, D. C. 20036

and

Mr. William A. Bresnahan
President
American Trucking Associations, Inc.
1616 P Street, N. W.
Washington, D. C. 20036

SAFETY RECOMMENDATION(S)

H-75-46

On May 13, 1975, a Rohr Industries' prototype bus was being road-tested near Phoenix, Arizona. The two occupants heard a noise from the engine compartment, felt a loss of engine power, and saw smoke coming from the rear engine compartment. They attempted to raise the hydraulically powered engine hood, but it would not open. The driver tried to extinguish the fire through the hood's access door, but he was not successful. The fire spread to the passenger compartment and destroyed the bus.

Of particular interest to commercial motor vehicle operators was the driver's effort to extinguish the fire. Unfortunately, circumstances were such that the driver's fire extinguishing efforts were frustrated and the entire vehicle was lost.

This incident illustrates how important it is that each driver know the proper firefighting procedures for his particular vehicle. Motor vehicle fires can involve engine fuel, tires, brakes, cargo, hazardous cargo, and electrical systems, etc. The procedures to put out fires involving each of these are varied. Also, each vehicle varies in configuration.

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Therefore, the National Transportation Safety Board recommends that the National Association of Motor Bus Owners and the American Trucking Associations:

> Encourage member companies to train their drivers to fight actual motor vehicle fires using vehicles which have been scrapped or have been classified as obsolete. (Recommendation H-75-46) (Class III, Longer Term Followup)

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members concurred in the above recommendation.

By: John H. Reed
Chairman