Ltr H-343

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

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Forwarded to:

Honorable Leo J. Trombatore
Director
Department of Transportation
Sacramento, California 95814

SAFETY RECOMMENDATION(S)

H-83-10 through -15

About 12:12 a.m. P.s.t., on April 7, 1982, several vehicles on westbound California State Route 24 entered the north, No. 3 Bore of the Caldecott Tunnel near Oakland, California. A Honda car driven by an intoxicated driver struck the raised curbs inside the tunnel and came to rest at the left edge of the roadway about one-third of the way through the tunnel. It was struck soon afterward by a following gasoline tank truck and tank trailer and then by an Alameda/Contra Costa (AC) Transit bus which subsequently struck the tank trailer. The busdriver was ejected, and the empty bus continued west, exited the tunnel, and struck a concrete road support pier. The tank trailer overturned, and gasoline was spilled inside the tunnel. A fire erupted and heavy black smoke quickly filled the tunnel. The tank truck and tank trailer, the Honda car, and four other vehicles that had entered the tunnel were completely destroyed by the fire. Seven persons were killed, and two persons were treated for minor smoke inhalation. The tunnel incurred major damage. 1/

The driver of a Ford pickup truck, who had stopped his vehicle when he witnessed the collision between the bus and the tank trailer, noticed a small fire at the tank truck and backed his vehicle to the nearest emergency station phone. While his mother, who was a passenger in the pickup, went to the phone to advise tunnel personnel of the accident, he started walking to the east toward the stopped and approaching traffic to advise them they could not get through the tunnel and they should back out. A beer truck, occupied by its driver and a passenger, had stopped close behind the Ford pickup. There were approximately 8 or 9 passenger cars immediately to the rear of the beer truck. These motorists later stated that at this time they were not aware of any hazards from the fire, and their main concern was the possibility of being struck from behind by following vehicles. The fire near the tank truck was reported as "about the size of a barbeque fire" at this time.

Shortly thereafter, as the motorists to the rear of the beer truck awaited their turn to back out, they observed that " thick black smoke appeared to be coming up from the road and moving rapidly toward them." Before all of the motorists had backed out of the tunnel, a second heavy concentration of black, hot smoke overtook them and they had difficulty seeing and breathing. The thick smoke overtook the Ford pickup driver as he was walking eastward, and he was unable to get back to his mother who was using the phone. Another driver, who had backed his Toyota pickup truck until it was stopped by a

1/ For more detailed information, read Highway Accident Report—"Multiple Vehicle Collision and Fire, Caldecott Tunnel, Near Oakland, California, April 7, 1982 (NTSB/HAR-83/1).

Pontiac car that was turned around in the roadway, found it necessary to abandon his vehicle, grope through the smoke to the wall, and feel his way out of the tunnel. The two occupants of the Pontiac stayed in their car. Motorists reported that the intense heat and smoke prevented any of the onlookers at the east portal from returning inside and rescuing any of the trapped motorists. Meanwhile, the tank truck driver had run from his truck out of the west end of the tunnel.

There are 14 emergency stations at 250-foot intervals along the north wall of the tunnel. Each recessed emergency station contains a box for fire extinguishers, a water valve, a fire alarm, and a telephone to the control room. The fire alarm system was designed so that, when activated, it would alert the Oakland and Orinda fire departments. At present, however, the alarm rings only in the tunnel control room. A public address speaker was originally installed at each emergency station, but these speakers were later removed. There are 13 additional recessed openings, also located on the north wall of the tunnel, which contain fire extinguishers and miscellaneous maintenance equipment.

Video camera monitors were installed at each bore portal to allow tunnel operators to monitor traffic on the approaches and exits to the bores. Although provisions had been made when the tunnel was built to install television cameras inside the tunnel for more thorough observation, the cameras were never installed.

Based on emergency response and monitoring capabilities, tunnels can be classified as follows:

Active.--Traffic over the full length of the tunnel is closely monitored using guards within the tunnel, video monitors, loop detectors, combinations or all of these to survey developing situations, permitting immediate action. Immediate action could include use of signals and signs to stop movement of traffic or keep vehicles from entering the tunnel and verbal directions or guidance from trained guards, public address systems, or through vehicle radios. These systems also have emergency response capabilities to fight fire or assist inoperable vehicles. The Baltimore Harbor Tunnel, the Hampton Road Tunnel, and the Port Authority of New York and New Jersey Tunnels are examples of active tunnels.

Reactive.--A reactive tunnel is a tunnel that is manned but does not have traffic monitoring capability. With this type of system, assistance is delayed especially if motorists are incapacitated; it will take longer to physically close lanes of traffic, and the public has to assess the situation and develop its own guidance. These tunnels have a limited capability to respond to an emergency. The Caldecott Tunnel is an example of a reactive tunnel.

Passive.--A passive tunnel is a tunnel that is unmanned, unmonitored, with limited or nonexistent communication for emergency response personnel. In this type of tunnel, motorists are completely dependent on their own resources and on the response of emergency services that may not be immediately adjacent to the tunnel. The motorist may not even be provided with firefighting capabilities in the tunnel. The District of Columbia's Center - Leg Tunnel as reviewed was an example of a passive tunnel.

The driver of the third vehicle that observed the stopped Honda before the vehicle collisions stated that after he exited the tunnel and before he exited the freeway (one-fourth mile away) he heard a "rumbling sound that reminded him of an earthquake." Assuming the noise he heard was from the collision, a time and distance calculation determined that the Honda was stopped in the tunnel at least 24, but less than 38 seconds before being struck by the truck and the bus. Prior to stopping, the vehicle was slowing for 2 to 15 seconds.

Had the tunnel been equipped with internal television monitors and traffic signals, the tunnel operator could have responded to the initial Honda accident by reducing vehicle speed limits and switching signals to red within the first 10 seconds. The truck and bus would probably still have been outside the tunnel, and the drivers could have observed red signals at the portal entrance or signals within the tunnel and stopped before colliding with the Honda. The following vehicles also could have been warned of the emergency situation and probably could have stopped before entering the tunnel. After the initial impact involving the gasoline truck, it was at least 3 minutes before the tunnel was engulfed in fire.

The Ford pickup driver's mother, two occupants immediately behind her in the beer truck, and two elderly people 120 feet from the end of the tunnel did not escape the smoke and fire and died. All the fatalities other than the busdriver were found in or near their vehicles, suggesting that they had decided to remain with their vehicles and wait for help or had panicked. In a tunnel emergency, rescue personnel may be hampered in reaching stranded victims. Motorists need to be informed about life-threatening situations and about possible exits in order to evacuate the tunnel in such instances.

The Caldecott Tunnel has three adits which connect the bores of the tunnel and which provide egress from the tunnel. In addition, a stairwell from the California Transportation Department (CalTrans) control booth to the tunnel is located approximately 40 feet east of the west portal. None of the exits were identified or marked and none were used. The survivors stated that they were not aware of the existence of these exits. Location of the victims following the accident indicated that all were close enough to an unmarked adit door to have walked to safety in less than 1 minute. The Safety Board believes that these adit doors should be clearly marked as exits to afford motorists the opportunity to escape. Signs indicating direction and distance to emergency exits may also be warranted. In addition, had the tunnel been equipped with television monitors and/or guards, a public address system and/or a motorist's radio station override system, the motorists could have been given an early warning of the situation, been told to evacuate the tunnel and not wait for emergency response personnel, and been informed of the location of the adit doors. The Safety Board believes that had the tunnel been equipped with suitable monitoring and communciation systems, the five victims who were not involved in the collisions could have survived. While the pickup driver provided some warning, communication from a person of more authority might have mitigated the circumstances.

The Caldecott Tunnel fire demonstrates the need for active monitoring of vehicular tunnels and immediate notification of fire to the predesignated responding jurisdictions. Notification was not received by the Oakland Fire Department until 9 minutes after the accident. The console operator did not follow the CalTrans procedures which require fire department notification by calling first the Berkeley Area 911 emergency assistance operator who would then contact the Orinda and Oakland Fire Departments. To avoid delays in responding to emergency situations, fire alarm systems in tunnels should be designed to provide immediate notification to the responding jurisdictions.

On April 28, and 29, 1982, CalTrans conducted traffic volume counts on State Route 24 to determine the average daily traffic (ADT) immediately east of the tunnel. The count indicated that 63,700 vehicles traveled the westbound route daily; of the 1,126 trucks, 26, including 8 flammable materials tankers, carried hazardous materials.

The Safety Board reviewed accident records to determine the number of accidents that have occurred in the limits of the three bores of the Caldecott Tunnel. According to these data, 39 accidents occurred in a 3-year period ending December 31, 1981, resulting in 18 injuries and no fatalities; 16 of these accidents involved westbound motorists. Twenty accidents were rear-end collisions; 9 involved a stopped vehicle; 8 involved a slowing vehicle; and 3 involved a vehicle changing lanes. Eight accidents were sideswipe accidents, seven of which involved a vehicle changing lanes. Eight were hit-object accidents, of which three involved vehicles changing lanes. Two were broadside accidents, and one was an overturn accident.

Changing lanes and passing both are permitted in the Caldecott Tunnel. The Safety Board literature review and survey of tunnel authorities indicated that changing lanes and passing is prohibited by most tunnel authorities, while other authorities encourage trucks to remain in one lane. The accident data of the Caldecott Tunnel indicate that 13 of 39 accidents which have occurred in the three bores involved vehicles changing lanes. The Safety Board believes that CalTrans should consider prohibiting passing and lane changes in the Caldecott Tunnel as well as other tunnels in the State.

CalTrans procedures require that the console operator turn the fans on high as soon as a fire alarm is tripped or a report of a fire is received. The CalTrans console operator did not turn on the ventilation fans when he received a fire report at 12:15 a.m., nor did the carbon monoxide (CO) detection system automatically activate the fans during the fire. However, based on the estimates of natural air movement produced by circumstances similar to the "Stack Effect" 2/ in Bore No. 3 during the fire, the transverse lateral ventilation system in the west end of Bore No. 3 would have had little, if any, effect in reducing the intense and rapid smoke buildup during the first 3 minutes. This was verified shortly after 3:00 a.m. when the ventilation fans were turned on and CalTrans reported that the fans were ineffective in reducing any of the smoke.

In rear-end car collisions where fuel tanks rupture, and fires of less intensity occur, smoke and heat would be generated more slowly than was the case in this accident. In such instances, the ventilation system would be useful in reducing smoke and/or fire in a life-threatening environment. CalTrans should insure that all tunnel operating personnel are trained in and comply with the emergency procedures regarding fan operation and should assure that all such emergency equipment is operational through periodic tests and maintenance.

The Safety Board reviewed the tank truck driver's planned route of travel (east on Route 4 to I-680, south to State Route 24, west on Route 24 to State Route 17, and then southwest on Fruitvale Avenue to 24th Street) and determined that alternate routes either to the north or the south of the planned route would have avoided the tunnel.

2/ The Stack Effect is the natural air movement in buildings during a fire and is characterized by a strong draft from the ground floor to the roof of tall buildings. The Stack Effect is often responsible for the wide distribution of smoke and toxic gases in high rise buildings. The magnitude of this effect is a function of the building height, the air tightness of exterior walls, air leakage between floors of the building, and the temperature difference between the inside and outside. Fire Protection Handbook, Fourteenth Edition, National Fire Protection Association, Chapter No. 5, "Smoke Movement in Buildings."

The "Explosions Routes and Stopping Places" map issued by the California Highway Patrol (CHP) in 1973 specifies alternate routes north and south of the Caldecott Tunnel for explosives transportation and does not permit the use of Highway 24 through the tunnel.

A further consideration in route selections is that east of State Route 13, the Bay Area Rapid Transit (BART) system runs in the median of State Route 24 for about 7 miles, with two stations between the east and westbound roadways. At certain locations, the westbound roadway is elevated 10 to 15 feet above the BART system, separated only by a concrete median barrier and a chain link fence. The Safety Board has investigated a previous accident 3/ in which a tank trailer rolled over median barriers, ruptured, and as a result gasoline was spilled and ignited. An accident of this type would endanger BART passengers, and, according to the Oakland fire officials, firefighting efforts would be difficult because of the lack of hydrants.

The 49 CFR Section 397.9(a) states that:

> (a) Unless there is no practicable alternative, a motor vehicle which contains hazardous materials must be operated over routes which do not go through or near heavily populated areas, places where crowds are assembled, tunnels, narrow streets, or alleys. Operating convenience is not a basis for determining whether it is practicable to operate a motor vehicle in accordance with this paragraph. This paragraph does not apply to radioactive materials.

The Armour Oil Company management acknowledged its responsibility under 49 CFR Parts 386-399 for safe route selection for the shipment of hazardous materials. It did survey the area for feasible, alternate routes. Also, the company involved the responsible drivers in its decisionmaking and decided that Route 24 through the Caldecott Tunnel was the safest and most convenient route and that there was no feasible alternate route.

In retrospect, considering the inadequacy of motorist protection and the consequences of the fire within the tunnel, it is easy to find fault with the Company's decision. It is difficult to envision an area along an alternate route where a similar accident would result in losses of similar magnitude. Consequently, the Safety Board feels that additional evaluation of hazardous materials delivery routes should be made by both the carriers and agencies of the State of California to provide guidance and regulations that are compatible with Federal regulations. The carriers and agencies should make use of the recently published Federal Highway Administration's (FHWA) Implementation Package, "Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials" (FHWA-IP-80-15) to provide hazardous materials cargo truck drivers with the most recent information available, so that they will be able to make the safest route selection.

After the Caldecott Tunnel fire, CalTrans and the CHP jointly established a task force composed of representatives from State government and industry. The findings and recommendations presented by the task force generally appear sound and viable. The Safety Board believes that applicability of 49 CFR Section 397.9 to a great number of the

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3/ For more information read, Highway Accident Report--"Multiple Vehicle Collision and Fire, U.S. Route 101, Los Angeles, California, March 3, 1980.

hazardous materials cargo movements appears to have been overlooked by the task force and should be reviewed by CalTrans as a step in dealing with the problem. Determination of alternative routes should include an assessment of compatibility with other transportation systems, especially rapid transit systems. A hazardous materials tank truck with its high center of gravity (and some van type trucks) can override barriers such as exist along Route 24 and block the path of an oncoming high-speed train.

The Safety Board notes that the task force limited its recommendation regarding restriction of movements in tunnels to flammable materials cargoes. The Board believes that restricting the movements of other types of hazardous materials cargoes regardless of vehicle type should also be considered. The State of California has begun to act on the findings of the task force, and the governor recently signed into law A.B. 2457, a bill requiring the California Department of Transportation (CDOT) to adopt regulations governing the transport of flammable materials through tunnels in tank trucks. He also signed S.B. 2066, prohibiting hazardous materials cargoes from traveling through the Caldecott Tunnel near Oakland, California, except between the hours of 0300 and 0500. The ban on hazardous materials cargoes traffic in the tunnel will remain in effect until CDOT promulgates its new regulations. A CDOT spokesman noted that, since repairs on the tunnel are not yet complete, traffic through the tunnel is still generally limited. A.B. 2457 requires CDOT to seek assistance from the CHP in developing the regulations; CDOT hopes to issue draft rules in early 1983.

Though progress is being made, other items also need attention. Therefore, the National Transportation Safety Board recommends that the Secretary of the California Department of Transportation:

> Evaluate and revise, where necessary, equipment requirements and emergency procedures at the Caldecott Tunnel to provide early warning of an emergency to motorists in the event of a life-threatening emergency. (Class II, Priority Action) (H-83-10)
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> Develop a state-wide emergency response plan and train tunnel employees in all phases of emergency operations, including smoke and toxic fumes management and immediate emergency response notification, and periodically conduct drills to determine employees' ability to perform the above operations under stress. (Class II, Priority Action) (H-83-11)
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> Provide easily identifiable exit markings for adits in the Caldecott Tunnel. (Class II, Priority Action) (H-83-12)
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> Prohibit passing and lane changes in vehicular tunnels in California. (Class II, Priority Action) (H-83-13)
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> In cooperation with appropriate local authorities, survey all vehicular tunnels, and upgrade, where necessary, tunnel traffic controls, communication systems, firefighting equipment, and towing capabilities. (Class II, Priority Action) (H-83-14)
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> Ban the movement of hazardous materials through vehicular tunnels where the relative risks of the tunnel route are higher than alternate routes. (Class II, Priority Action) (H-83-15)

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "...to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations." (P.L. 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendation(s). Therefore, we would appreciate a response from you regarding action taken or contemplated with respect to the recommendation(s) in this letter.

BURNETT, Chairman, GOLDMAN, Vice Chairman, McADAMS, BURSLEY, and ENGEN, Members, concurred in these recommendations.

By: Jim Burnett
Chairman