



# National Transportation Safety Board

Washington, D. C. 20594

## Safety Recommendation

**Date:** April 29, 1991

**In Reply Refer To:** H-91-3 through -6

Honorable Wallace E. Stickney  
 Director  
 Federal Emergency Management Agency  
 500 C Street S.W.  
 Washington, D.C. 20472

On May 10, 1990, a 1974 Hahn custom pumper fire engine operated by the Waterbury Fire Department (WFD), while responding to an emergency call in Waterbury, Connecticut, ran off the road and hit a large tree when the driver lost control on a steep downgrade. The fire engine carried five paid firefighters and 500 gallons of water. Two firefighters were fatally injured, one firefighter sustained moderate injuries, and the driver and remaining firefighter sustained only minor injuries. The pavement was wet from previous rain.<sup>1</sup>

This accident and several others involving emergency fire apparatus<sup>2</sup> responding to alarms prompted the Safety Board to conduct a special investigation to determine the adequacy of fire apparatus maintenance and inspection, fire department operating procedures, and occupant seatbelt use. National Fire Protection Association (NFPA)<sup>3</sup> data indicate that between 1980 and 1989, 15 percent<sup>4</sup> of all firefighters who died in the line of duty died as a result of accidents involving fire apparatus that were en route to alarms. As part of this special investigation, the Safety Board examined 8 separate fire apparatus accidents and conducted an informal survey of the 50 States and the District of Columbia to determine their requirements for inspecting fire apparatus.

<sup>1</sup>For more detailed information, read Special Investigation Report--"Emergency Fire Apparatus," (NTSB/SIR-91/01).

<sup>2</sup>For the purposes of this report, "fire apparatus" refers to the heavy fire vehicles, such as pumpers/engines, ladder trucks, heavy squad units, 10,000 pounds and over, that transport people, and specialized equipment, such as foam/crash units used at airports.

<sup>3</sup>The National Fire Protection Association (NFPA), organized in 1896, is an independent, voluntary membership, nonprofit organization that develops voluntary standards and codes which serve as guidelines for the fire services in all phases of operations.

<sup>4</sup>One hundred and seventy-nine firefighters.

## Maintenance

All the Waterbury Fire Department (WFD) fire apparatus had hour meters that recorded engine running time and were used to determine when vehicle service was needed. Under the WFD preventive maintenance program, a vehicle was to be serviced after 150 hours of operation. The 150-hour service check included changing the engine oil and filter, lubricating the chassis, checking all fluids, and inspecting all belts, hoses, batteries, tires, exhaust system, fuel system, steering, suspension, and brakes. The service manual for the 1974 Hahn pumper, which was the accident vehicle, recommends service every 50 hours.

The fire engine was equipped with an automatic transmission and air-mechanical service brakes. A mechanical examination of the vehicle following the accident indicated that the front axle brakes had no defects and that the push-rod adjustments were within operating limits. An accumulation of rust was observed in both the left and right rear axle brakes. Three of the four rear axle brakeshoes were not making contact with the drum upon application. The lower left and both the upper and lower right brakeshoes were frozen at the anchor pins. The rear axle brake chamber push-rod adjustments were within operating limits on the right side and at the maximum operating limit on the left side. The air chambers were misaligned, and the push rods had severe wear markings on the sides.

If only one brakeshoe out of four makes contact with one of the two drums, the rear axle receives only 25 percent of the brake retarding force that it should. According to Safety Board calculations, which took into account the size of the air chamber (24 square inches on the front axle and 30 square inches on the rear axle) and which assumed an air pressure application of 100 psi, the rear axle brakes were in such poor condition that the apparatus had only 58 percent of its original braking capability. The driver indicated that the wet/dry switch<sup>5</sup> was in the wet position, thus providing only 50 percent of the braking capability of the front axle. The condition of the rear axle brakes, coupled with the use of the wet/dry switch in the wet position, reduced the original braking capability of the vehicle to about 36 percent.

The accumulated rust around the anchor pins of the WFD apparatus rear axle brakes indicated that they were in need of lubrication. According to the manufacturer's service manual, the brakeshoe pins should be cleaned and lubricated after every 500 hours of use. Based on the hour-meter recorded measurements, the accident vehicle's brakeshoe pins should have been serviced in November 1989. The rust and the frozen condition of the pins indicate that the service was not performed. The Safety Board concludes that the BAR did not adequately maintain the accident vehicle's brakes and did not follow the manufacturer's recommended service guidelines.

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<sup>5</sup>Many vehicles use a manual limiting valve (commonly called a dry road/slippy road valve or wet/dry switch) that is controlled by a pneumatic switch in the cab. In the "dry road" position, the valve is a 1:1 valve. In the "slippy road" position, it reduces front brake pressure to 50 percent of control line pressure at all control line pressure levels.

The WFD BAR policy was that fire apparatus should receive preventive maintenance after every 150 hours of operation, as measured by the engine hour-meters. A review of the service records for the accident vehicle shows that in September 1988 it received a 150-hour service check although it had been in service for 267 hours since its last check. In November 1989, 468 hours of service later, it received its next check. The Safety Board concludes that the BAR did not adhere to its own policy of servicing a vehicle after every 150 hours of service. The manufacturer's service intervals are intended to insure that a vehicle performs as designed. Service intervals of 50 hours were recommended by the manufacturer's maintenance manual for the WFD accident vehicle. Most vehicle manufacturers recommend service based on either the amount of use or elapsed time, whichever comes first, because a vehicle can deteriorate even while it is idle. Lubricants can dry out, and rust and corrosion can develop, especially in the case of spare vehicles that may be used infrequently.

About 2:34 p.m., on October 24, 1990, a Spillway Volunteer Fire Department (SVFD) firefighter was dispatched in a tanker truck to transport 1,000 gallons of water to other firefighters at the scene of a house fire in rural Tarrant County, Texas. Before departing on the fire call, she had been babysitting the fire chief's 2-year-old daughter. She was unable to find another babysitter and took the infant with her. The 1963 International Loadstar 1600 firetruck was not equipped with seatbelts, and the infant was not restrained in a child safety seat.

The firetruck was eastbound on Farm-to-Market Road 1886 at a witness-estimated speed of 45 mph when the driver began negotiating a shallow left curve on a 6-percent downgrade. The right side tires of the firetruck dropped 5 inches off the right pavement edge, and the driver steered to the left and lost control of the vehicle. The firetruck eventually travelled off the pavement on the south side of the road, dropped 10 feet, and crashed head-on into a dirt embankment. The firetruck exploded into flames at impact, and both occupants were killed.

The Tarrant County, Texas, SVFD had 6 vehicles (a tanker, two engines, a rescue vehicle, and two grass trucks). The SVFD did not have a formal maintenance program or record system. It did change the oil in its vehicles every 3 or 4 months and did take the vehicles to an outside shop for repair when they were not functioning properly.

The postcrash examination of the firetruck disclosed numerous deficiencies: The left front tire was underinflated; its rated inflation pressure was 95 psi; however, it was only inflated to 50 psi. The right rear dual tires were inflated to 45/44 psi; their rated inflation pressure was 85 psi. Further, the firetruck's steering components were excessively worn. The splined shaft attaching the pitman arm to the steering gear box was worn, and the ball socket joint where the steering arm attached to the drag link was excessively worn.

The firetruck's hydraulic brakes also had several deficiencies. SVFD personnel indicated that before the accident the firetruck would pull to the left during brake applications. An examination of the brakes revealed that the right front drum was rusted and the bottom shoe did not make contact with the drum.

As illustrated by the Waterbury, Connecticut, accident, some fire department maintenance programs do not ensure that fire apparatus are properly maintained. Further, as illustrated by the Tarrant County, Texas, accident some fire departments have no maintenance program. Because fire apparatus often stop suddenly,

because they are frequently operated at higher speeds than are conventional vehicles, and because they are operated under hazardous conditions, it is essential that they be properly maintained. Therefore, the Safety Board believes that the U.S. Fire Administration (USFA) of the Federal Emergency Management Agency and the International Association of Fire Chiefs (IAFC) should urge fire departments to establish vehicle maintenance programs that follow all of the manufacturers service requirements and schedules.

### Engine Retarders

About 6:50 p.m., on June 9, 1990, engine 381, a 1979 Oren pumper-tanker of the Long Green Volunteer Fire Company (LGVFC) in Baltimore County, Maryland, was traveling north on Manor Road responding to an emergency call when the driver lost control of the vehicle while turning at an intersection. The fire apparatus rotated 180 degrees and overturned in a ditch. The driver and four firefighters received minor to no injuries. All of the firefighters were restrained by seatbelts. The pavement was wet from a previous rain. The driver stated that as he entered the curve, he was traveling 25 to 30 miles per hour. He took his foot off the gas to slow the truck, and he "counted on the engaged engine retarder<sup>6</sup> to slow him down." He also stated that "the rear end went very fast, slipped around 180 degrees till I hit a ditch and flopped over." He indicated that the engine retarder was always left on and that none of the drivers turned it off.

The driver indicated that he had been driving fire apparatus for 26 years. He had participated in obstacle course driver training sponsored by the Baltimore County Fire Department. The LGVFC Chief indicated that the company periodically received driver training from the Baltimore County Fire Department in which participants were taught to leave engine retarders on all the time. It was the LGVFC practice to have engine retarders on at all times. Additionally, the training officer of the Baltimore County Fire Department indicated that its drivers were taught to leave engine retarders on all the time.

The Jacobs Manufacturing Company, one of several manufacturers of engine retarders, warns drivers in its "Professional Driver Techniques and Owner's Manual" about the dangers of using retarders when they are driving on slippery or wet roads. The manual states that the driver should not use the retarder until he is sure that his truck is maintaining traction without its use. Then he can use the lower power settings on the retarder. Progressively higher power settings should not be used until it is established that the vehicle is maintaining traction in the lower settings. "If the tractor drive wheels lock or if there is a fishtail motion, immediately turn off the master switch and don't turn the Jake Brake [engine retarder] on until road conditions improve."

In the NHTSA booklet entitled "A Professional Truck Driver's Guide on the Use of Retarders,"<sup>7</sup> truck drivers are warned to turn engine retarders off when they are driving empty trucks or pulling empty trailers on wet pavement or when they are driving tractors without trailers.

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<sup>6</sup>An engine retarder uses the engine itself to aid in slowing and controlling the vehicle. When activated, the engine retarder alters the operation of the engine's exhaust so that the engine works as a power-absorbing air compressor; however, this provides a retarding action only to the drive axle.

<sup>7</sup>DOT HS 806 675, January 1985.

The "Model Driver's Manual for Commercial Vehicle Driver Licensing"<sup>8</sup> also addresses engine retarders and states:

Some vehicles have "retarders." Retarders help slow a vehicle, reducing the need for using your brakes. They reduce brake wear and give you another way to slow down. There are many types of retarders (exhaust, engine, hydraulic, electric). All retarders can be turned on or off by the driver. On some the retarding power can be adjusted. When turned "on" retarders apply their braking power (to the drive wheels only) whenever you let up on the accelerator pedal all the way.

Caution: When your drive wheels have poor traction, the retarder may cause them to skid. Therefore you should turn the retarder off whenever the road is wet, icy or snow covered.

In 1982 and 1983, the NHTSA sponsored research that was done by the Transportation Research Institute of the University of Michigan.<sup>9</sup> The research explored the influence of retarder torque on directional control on slippery pavements. In summary, the study indicates that drivers of retarder-equipped vehicles should be informed that they may avoid potential control problems by turning off their retarders when they are operating either empty or lightly loaded vehicles on roads that are either icy or slippery. The experimental portion of the research was performed by a test driver who had experience in heavy-truck braking experiments on slippery surfaces. In the experiment, this driver could not recover from the rapid jackknives that occurred on slippery surfaces when he was turning an empty vehicle while decelerating with the engine retarder.

In 1985 and 1986, the Safety Board investigated accidents in Texas and Colorado<sup>10</sup> in which heavy trucks lost directional control due to the misuse of engine retarders. The drivers of the trucks did not have manufacturers' operating manuals, and the motor carriers had not established operating procedures that were consistent with the manufacturers' warnings about the proper use of engine retarders.

As a result of these investigations, the Safety Board recommended that the National Highway Traffic Safety Administration (NHTSA):

H-89-38

Require the installation of a permanently affixed placard in the interior of new truck tractors equipped with an engine retarder to warn against using the retarder on slippery/wet surfaces when the

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<sup>8</sup>U.S. DOT, Federal Highway Administration Publication No. FHWA-MC-89-051, dated January 31, 1989.

<sup>9</sup>"Retarders for Heavy Vehicles: Phase III Experimentation and Analysis; Performance, Brake Savings, and Vehicle Stability" (DOT HS 8006 672).

<sup>10</sup>Highway Field Report--"1981 GMC Astro Jackknife and Loss of Control, near Decatur, Texas," August 13, 1985 (NTSB-FTW-85-H-TR38), and Highway Field Report--"1981 Freightliner Jackknife and Overturn, near Mineral Wells, Texas," April 3, 1986 (NTSB-FTW-86-H-TR09).

vehicle is empty or lightly loaded. The placard should also warn against using the engine retarder to shift gears in these conditions.

The NHTSA responded that the warnings in the booklet "A Professional Truck Driver's Guide on the Use of Retarders" and in the commercial drivers license (CDL) "Model Driver's Manual" should reach the truck driving population and eliminate the need for placarding. The NHTSA was concerned about "driver-compartment clutter and information overload from an excessive number of lights, buzzers, and warnings." The NHTSA is investigating the "driver overload issue." Safety Recommendation (H-89-38) has been classified as "Open--Acceptable Action."

Also as a result of the Texas and Colorado accidents, the Safety Board issued recommendations to the Professional Truck Drivers Institute of America, Inc., the International Brotherhood of Teamsters, the American Trucking Associations, Inc., the manufacturers of engine retarders, and the Federal Highway Administration, recommending that they inform their members of the potential hazards of misusing engine retarders and develop training on the proper use of engine retarders. However, no recommendations were issued to the fire service community.

Some of the newer fire apparatus are equipped with engine retarders and these vehicles have operating characteristics that are similar to those of heavy commercial trucks. The use of engine retarders on wet pavement can lead to loss of control. As the Baltimore County, Maryland, accident shows, some fire departments have policies that directly conflict with the written warnings issued by the manufacturers of engine retarders. Therefore, the Safety Board believes that the USFA and the IAFC should inform fire departments nationwide of the potential hazards of misusing engine retarders and encourage fire departments to establish operating procedures that are consistent with manufacturers warnings about the proper use of engine retarders.

### **Manual Brake Limiting Valves**

Following the Waterbury, Connecticut, accident, the front axle limiting valve was found in the "wet or "slippery-road" position. The driver stated that it had been raining on and off on the morning of the accident and that the streets were wet. He had set the valve to the "wet" position earlier that morning before driving the apparatus. It was WFD practice that when the roads were wet, the brake limiting valve was to be switched to the slippery road position.

Hahn "Maintenance-Operating Manual" states that "Putting the lever in the 'slippery road' position reduces pressure on the front brakes to half of that on the rear brakes. The front wheels will have less tendency to slide and steering control is maintained. Keep the lever in the 'dry road' position under all normal operating conditions." The "Model Driver's Manual for Commercial Vehicle Driver Licensing" states:

Some older vehicles (made before 1975) have a front brake limiting valve and control in the cab. The control is usually marked "normal" and "slippery." When you put the control in the "slippery" position, the limiting valve cuts "normal" air pressure to the front brakes by half. Limiting valves were used to reduce the chance of the front wheels skidding on slippery surfaces. However, they actually reduce the stopping power of the vehicle. Front wheel braking is good under all conditions. Tests have shown front wheel

skids from braking are not likely even on ice. Make sure the control is in the "normal" position to have normal stopping power.

According to a published NHTSA report,<sup>11</sup> a two-axle vehicle that weighs 27,300 pounds consistently performs better with the front axle limiting valve in the "dry road" position, even on a wet road surface. "Use of a limiting valve on this [type of] vehicle appears unwise; it degrades performance." This research program was completed in 1985.

Currently, the Safety Board is conducting a nationwide study of heavy-vehicle brake performance that evaluates nationwide data on inspections and accidents involving commercial vehicles. The results of the study will be used as a basis for making more definitive recommendations concerning the use of brake limiting valves on other types of highway vehicles. Many of the older fire service apparatus are equipped with a dry road/slippery road brake limiting valve. Because fire apparatus often stop suddenly, because they are frequently operated at higher speeds than are conventional vehicles, and because they are operated under hazardous conditions, the Safety Board concludes that the use of manual brake limiting valves can diminish the apparatus stopping capability and, therefore, their use should be discontinued.

### Seatbelt Use

About 7:38 p.m. on September 28, 1989, wagon 7 of the Catlett Volunteer Fire Company was struck on its left side by a southbound National Railroad Passenger Corporation (AMTRAK) train. The accident occurred at a private-driveway grade crossing off Virginia Route 28 about 1 mile south of Catlett, Virginia.<sup>12</sup> The cab and chassis of the apparatus rotated counterclockwise 450 degrees during the collision and came to rest facing north about 80 feet southeast of the crossing. Most of the apparatus was destroyed; however, the passenger compartment of the canopy cab remained intact. The unrestrained driver and the other firefighter seated in the cab were ejected and fatally injured, and two unrestrained firefighters riding in the rear-facing canopied jumpseat behind the cab were ejected and sustained moderate to severe injuries. A fifth firefighter riding in the rear-facing jumpseat remained within the apparatus following the collision. He received serious injuries.

About 6:09 a.m., on January 30, 1990, a Crow Valley Fire Protection District 1989 Pierce pumper fire engine responding to a house fire overturned while traversing a residential driveway which collapsed. The engine-pumper overturned 1.5 times down a 20-foot incline and came to rest on its roof. The apparatus was occupied by three firefighters, who were restrained by seatbelts. All of the firefighters remained within the apparatus during the overturn. Following the accident all of the firefighters were treated for minor injuries and released from the hospital.

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<sup>11</sup>U.S. DOT, NHTSA DOT HS 806 738, Interim Report "NHTSA Heavy Duty Brake Research Program, Report No. 1--Stopping Capability of Air Brake Vehicles. Volume I: Technical Report."

<sup>12</sup>See docket HY-514-89 for further information concerning this accident.

On March 1, 1990, engine 91, a Seagrave firetruck of the Los Angeles City Fire Department, left the station house on a nonemergency run (no lights or siren) and was struck broadside at the intersection of Borden Avenue and Polk Street in the Sylmar section of Los Angeles by an automobile that failed to stop for a red light.

The fire apparatus was hit on the right side behind the rear axle. The police estimated that the automobile's speed was "well in excess of 55 mph." As a result of the collision, the apparatus rotated approximately 90 degrees and overturned onto its roof. The driver and an officer were seated in the forward cab section, and the two firefighters were seated facing rearward in the jumpseat in the enclosed rear cab section. The firetruck cab remained intact during the crash, and all of the firefighters were wearing their seatbelts. The firefighters received only minor injuries. The driver of the automobile was fatally injured.

About 2:45 p.m., on May 17, 1990, the Cresson Volunteer Fire Company responded to an emergency call about a motor vehicle accident. As the 1968 Chevrolet firetruck was traveling northbound downhill on State Route 53, the driver lost control of the vehicle. The rear of the vehicle struck and rode up on a guardrail, and the vehicle overturned more than 360 degrees. The vehicle then struck a bridge abutment, traveled over the side of the bridge, and came to rest on its left side in a creek bed. Both occupants were ejected onto the roadway and were fatally injured.

The police report indicated that the occupants were not wearing seatbelts. Following the crash, the State Police Motor Carrier Inspection Division officer inspected the accident vehicle. The only problem noted was that the "female ends of both seatbelts were found tucked under the seat, rendering them unusable." The cab was intact after the accident.

About 1:54 p.m., on August 5, 1990, Dallas Fire Department engine 9, a 1990 Quality firetruck with four occupants, was responding to a medical emergency and was traveling south on South Beltline Road. The driver released the accelerator while he was traveling down a hill that curved to the left; the rear of the apparatus began to skid to the right. The apparatus skidded sideways down the road until the right front tires hit the soft dirt shoulder on the left side of the road and the apparatus rolled over and came to rest 30 feet from the road facing north. It was drizzling rain, and the pavement was wet. The driver and officer in the cab and the two firefighters in the jumpseat were wearing their seatbelts. Although the damage to the apparatus was extensive, there were no injuries.

The NFPA is an independent, voluntary-membership, nonprofit organization. More than 200 NFPA committees develop voluntary standards and codes that serve as guidelines for the fire services in all phases of operations. These standards are updated every 3 to 5 years; however, they are not mandatory.

The 1987 NFPA Standard 1500, "Fire Department Occupational Safety and Health Program," Chapter 4, "Vehicles and Equipment," Section 3, "Persons Riding on Fire Apparatus," states:

4-3.1 All persons riding on fire apparatus shall be seated and secured to the vehicle by seat belts or safety harnesses at any time the vehicle is in motion. Riding on tailsteps or in any other exposed positions shall be specifically prohibited. Standing while riding shall be specifically prohibited.



In the Catlett, Virginia, accident four unrestrained firefighters were ejected from the apparatus, and two of these firefighters were fatally injured. Even though the fire apparatus was heavily damaged, the cab section remained intact. In the Gallitzin Township, Pennsylvania, accident, both unrestrained occupants were ejected. However, the apparatus passenger compartment remained intact. The NHTSA Fatal Accident Reporting System (FARS) 1988 data concerning fatal accidents indicate that 17.4 percent of the unrestrained passenger-car occupants were ejected from the vehicle; of those ejected, 73.5 percent were fatally injured. Although there is no similar data concerning occupant ejection as a result of accidents involving fire apparatus, it is clear that ejection from a vehicle during a collision is likely to cause a serious or fatal injury.

In contrast, several accidents in which fire apparatus overturned and the restrained occupants remained within the apparatus and were not injured illustrate the benefits of using seatbelts. In the Los Angeles, California, accident and in the Eugene, Oregon, accident, the vehicles overturned, yet the firefighters, who had used their seatbelts, received only minor injuries. In the Dallas, Texas, accident the fire apparatus rolled over and came to rest 30 feet from the road; however, the four firefighters were uninjured. Accordingly, it is likely that had the occupants of the Catlett, Virginia, and Gallitzin Township, Pennsylvania, accident vehicles been restrained, they might not have been ejected and might have been less severely injured.

NFPA voluntary standard 1500 clearly states that all persons shall be seated and restrained while riding on fire apparatus, and most departments have policies requiring the use of seatbelts. Yet, firefighters continue to be injured and killed because they are not restrained. Fire apparatus are frequently operated at higher speeds than conventional vehicles are and, therefore, are prone to overturn and high-speed accidents. It is essential for firefighters to wear available seatbelts to prevent ejection and injury. Although there are voluntary standards that encourage seatbelt use, there is no nationwide program to educate the firefighting community concerning the benefits of seatbelts. Thus, the Safety Board believes that the USFA, in cooperation with the IAFC and the NFPA, should encourage fire departments to establish and enforce mandatory seatbelt policies and to develop programs that promote the use of seatbelts in fire apparatus.

Therefore, the National Transportation Safety Board recommends that the U.S. Fire Administration of the Federal Emergency Management Agency:

Urge fire departments to establish vehicle maintenance programs that follow all of the manufacturers service requirements and schedules. (Class II, Priority Action) (H-91-3)

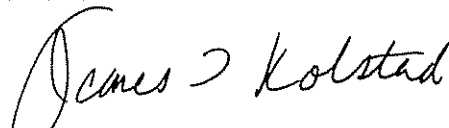
Inform fire departments nationwide of the potential hazards of misusing engine retarders, and encourage fire departments to establish operating procedures that are consistent with manufacturers warnings about the proper use of engine retarders. (Class II, Priority Action) (H-91-4)

Notify fire departments of the hazards of using fire apparatus manual brake limiting valves, and urge them to discontinue the use of these devices. (Class II, Priority Action) (H-91-5)

In cooperation with the National Fire Protection Association and the International Association of Fire Chiefs, encourage fire departments to establish and enforce mandatory seatbelt policies and to develop programs that promote the use of seatbelts in fire apparatus. (Class II, Priority Action) (H-91-6)

Also, as a result of its investigation, the Safety Board issued Safety Recommendations H-91-7 through -10 to the International Association of Fire Chiefs, Safety Recommendation H-91-11 to the National Fire Protection Association, and Safety Recommendation H-91-12 to the Governors and legislative bodies of those States without fire-apparatus inspection programs.

KOLSTAD, Chairman, COUGHLIN, Vice Chairman, and BURNETT, LAUBER, and HART, Members, concurred in these recommendations.

A handwritten signature in cursive script that reads "James L. Kolstad". The signature is written in dark ink and is positioned above the typed name.

By: James L. Kolstad  
Chairman