Sag # R-671

# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

**Date:** August 28, 1997

**In Reply Refer To:** R-97-9 through -21

Honorable Jolene M. Molitoris
Administrator
Federal Railroad Administration
Washington, DC 20590

About 5:39 p.m. on February 16, 1996, Maryland Rail Commuter (MARC) train 286 collided with National Railroad Passenger Corporation (Amtrak) passenger train 29 near Silver Spring, Maryland. En route from Brunswick, Maryland, to Union Station in Washington, DC, MARC train 286 was traveling under CSX Transportation Inc. (CSXT) operation and control on CSXT tracks. MARC train 286 passed an APPROACH signal before making a station stop at Kensington, Maryland; proceeded as if the signal had been CLEAR; and, then, could not stop for the STOP signal at Georgetown Junction, where it collided with Amtrak train 29. All 3 CSXT operating crewmembers and 8 of the 20 passengers on MARC train 286 were killed in the derailment and subsequent fire. Eleven passengers on MARC train 286 and 15 of the 182 crewmembers and passengers on Amtrak train 29 were injured.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the apparent failure of the engineer and the traincrew because of multiple distractions to operate MARC train 286 according to signal indications and the failure of the Federal Railroad Administration (FRA), the Federal Transit Administration (FTA), the Maryland Mass Transit Administration (MTA), and the CSXT to ensure that a comprehensive human factors analysis for the Brunswick Line signal modifications was conducted to identify potential sources of human error and to provide a redundant safety system that could compensate for human error.

Contributing to the accident was the lack of comprehensive safety oversight on the CSXT/MARC system to ensure the safety of the commuting public. Contributing to the severity of the accident and the loss of life was the lack of appropriate regulations to ensure adequate emergency egress features on the railroad passenger cars.

[1]For more detailed information, read Railroad Accident Report--*Collision and Derailment of Maryland Rail Commuter MARC Train 286 and National Railroad Passenger Corporation Amtrak Train 29, near Silver Spring, Maryland, on February 16, 1996* (NTSB/RAR-97/02).

The 35-year experience using cockpit voice recordings (CVRs) to assist in determining the cause of commercial aviation accidents has shown that evidence about the operating communications among crewmembers is frequently important in accident investigations. Initially installed on aircraft carrying 40 or more passengers, CVRs only recorded the last 30 minutes of cockpit and radio conversation before an accident. In the early 1990's a change was made to establish design standards that increase the recording length from 30 minutes to 2 hours. Although required for all newly manufactured transport aircraft registered in Europe after 1995, a 2-hour CVR is not required for any aircraft operating in the United States. However, the Safety Board is of the opinion that a 2-hour CVR should be required on all newly manufactured commercial aircraft registered in the United States.

Over the years the CVR recordings have been a key tool in documenting the circumstances leading up to an accident and a valuable assistance to the Safety Board in determining the probable cause of aviation accidents. The CVR has been most useful in the type of accident that has not been caused by mechanical failure onboard an aircraft. The CVR recording has shown to be an almost necessary tool in documenting the operational decisions or mistakes of the crew that lead up to the accident. The Safety Board had repeatedly recommended to the Federal Aviation Administration (FAA), using this argument, that the FAA require CVRs on smaller commuter aircraft, and the FAA has now required that CVRs be installed on all multi-engine aircraft that carry more than six passengers.

The Safety Board understands that appropriate protections of the privacy of such communications have been established in aviation and could also be adopted by the railroad industry. The communications that occurred from the Garret Park station up to the collision at Georgetown Junction would have been extremely valuable to this investigation. In particular, knowing the signal aspect acknowledged by the MARC train 286 engineer at signal 1124-2 would have facilitated investigative activities. Although Safety Board investigators conducted an exhaustive attempt to reconstruct traincrew activities, they could not document the MARC train 286 engineer's acknowledgment of the Kensington signal or the communications, if any, among crewmembers as the train approached Georgetown Junction.

Current locomotive event recorders have great utility but only provide mechanical response data, which cannot answer some questions asked in an accident investigation about the traincrew's knowledge and actions. The voice recordings maintained by the CSXT operations center included no communications between trains or among MARC train 286 crewmembers. Had a voice recording from MARC train 286 existed, the signal aspect acknowledged and the communications in the last few minutes before the collision would have been available to this investigation. A few years ago the FRA contemplated issuing a rule requiring voice recorders in locomotive compartments but rejected the idea because it did not consider them as a necessary safety measure. The FRA could have included traincrew voice recording requirements in the 1993 regulations for locomotive event recorders as part of the minimum parameters to be recorded. The Safety Board, consequently, concluded that had the FRA required the recording of the train crewmembers' voice communications, the essential details about the circumstances of this accident could have been provided. Therefore, the Safety Board believes that the FRA should amend 49 Code of Federal Regulations (CFR) Part 229 to require the recording of train crewmembers' voice communications for exclusive use in accident investigations and with appropriate limitations on the public release of such recordings.

The CSXT and MARC had operational reasons to modify the Brunswick Line signal system: improve passenger safety and freight train operations by changing the method that CSXT dispatched and monitored trains, upgrade the system capacity to operate more trains with increased peak and midday service, increase the MARC labor and equipment productivity, and reduce the CSXT operating costs.

Identifiable improvements, such as total trains, traincrew use, cost savings, and centralized traffic control (CTC) operations, could be quantified and measured; however, the signal system modifications did not address the overall safety of the signal system for traincrew use. The adequacy of the system safety could only have been addressed with a total system review that included a human factors analysis of such issues as human information processing capabilities.

A total system review examining human capabilities and limitations may have resulted in the installation of a redundant system, such as an automatic train control system or automatic cab signals, which would have produced an audible indication to alert the engineer and a visible reference to identify when the cab signal display changed to a more restrictive aspect. The MTA application for FTA funding for the project indicated that the funding approval for the project would later address advanced train control systems. Yet, when MTA and MARC officials were queried about this subject, they had no current plans.

The Safety Board investigators questioned the removal of signal 100, which, located east of the Kensington station, had been the last signal on track 2 for eastbound trains traveling towards Georgetown Junction. As a result of the modification and respacing of the signals, the last signal on track 2 for trains traveling towards Georgetown Junction was now signal 1124-2, which is west of Kensington station and about 1.25 miles west of the former signal 100 location. The spacing of signals is FRA regulated under 49 CFR Part 236.24, which requires signals to be adequately spaced to provide proper distances for reducing speeds or stopping by use of other than an emergency brake application before reaching the point where reduced speed or stopping is required. The FRA determined during routine signal inspections that the Brunswick Line signal system complied with the regulation for the spacing of roadway signals.

The CSXT signal system modification, however, did not adequately account for the operating characteristics of passenger trains stopping at the Kensington station, as evidenced by this accident. The removal of signal 100 relocated a source of vital information for passenger train engineers stopping at the Kensington station from a position close to where it would be acted upon to a position farther away. In this case, the physical distance the signal was moved was not the critical element; but rather, the relocation created the potential for other information and tasks to intervene and interfere with the retention of the signal indication, thus permitting it to be forgotten before it was required to be used. Of course, the potential for interference to lead to an operational error did not necessarily exist to the same degree for all trains, and the right set of circumstances had to exist. Nevertheless, the potential for an operational error to occur as a result of the relocated signal could have been foreseen. Had the design of the signal system received input from knowledgeable human factors specialists, the potential pitfall of the relocation could have been addressed and redundancy provided for an engineer forgetting a signal. Such redundancy could have been accomplished through a delayed-in-block rule change, as the FRA did with its emergency order (EO) 20 issued following this accident; with a repeater signal; with cab signals; or with a positive train separation (PTS) control system.

The FRA EO 20 contained specific information for all railroads on every push-pull operation without benefit of cab signal, automatic train stop, or automatic train control and whose speed exceeds 30 mph. The new rule required that all trains stopped or delayed in a block immediately preceding interlockings and controlled points must reduce their speed in accordance with applicable operating rules, but, in no case, may speed exceed 40 mph. In addition, EO 20 added another measure that required appropriate signs be installed at each affected signal and at the departure end of stations. The Safety Board concluded that had the FRA and the FTA required the CSXT to perform a total signal system review of the proposed signal changes that included a human factors analysis within a comprehensive failure modes and effects analyses, this accident may have been prevented.

Although Federal funding provided most of the funds for the design and installation of the CTC system on the CSXT Brunswick and Camden Line signal modification, the Federal Government apparently did not perform an in-depth analysis or evaluation of this project from a safety standpoint primarily because the applying agency self-certified that it had the technical capacity to undertake the project. Furthermore, the project justification statement indicated that safety would be enhanced by the installation of this upgraded signal system; however, the available evidence indicates that the project was undertaken for economic reasons and that a total system safety review, including a human factors analysis of the upgraded signal system, was not considered at either the State or Federal Government level. The Safety Board concluded that Federal funds granted for the signal modifications on the CSXT Brunswick Line to accommodate an increase in MARC trains did not ensure that the safety of the public was adequately addressed. Therefore, the Safety Board believes that the FRA should require comprehensive failure modes and effects analyses, including a human factors analysis, for all signal system modifications.

The Safety Board requested the FRA to respond to its concerns about commuter railroad operations within FRA regulatory authority, which included a 5-year reportable accident listing for MARC and the Virginia Railway Express (VRE) and a 5-year accident, inspection, and defect history for commuter railroad operations. The FRA responded that 17 commuter rail operations are under its regulatory authority of which six, including VRE, are operated by Amtrak; two, including MARC operations, are operated by Amtrak and CSXT together; seven are operated by the commuter railroad, itself; two are operated by a freight railroad; and one is operated by a contractor. The FRA reported that it does not have a 5-year accident, inspection, defect, or violation record database for individual commuter railroads and that before 1996, any data regarding accidents/incidents was reported as it related to the railroad operating the commuter service. This data could not be readily separated because it was commingled with the freight and intercity rail reporting data. The FRA advised that it is currently working with those railroads to ensure that commuter rail operations data will be reported separately in the future.

The Safety Board, consequently, concluded that without a separate collection database specific to commuter rail inspections and accident/incidents, it is difficult for the FRA to evaluate its own effectiveness of inspections and to identify problematic trends. Records should include reporting on inspections and accident/incidents to determine the effectiveness of its own as well as that of participating State organizations and to identify, and to take corrective action in, those areas inadequate to public safety. Therefore, the Safety Board believes that the FRA should develop and maintain separate identifiable data records for commuter and intercity rail passenger operations.

The Safety Board has long advocated a PTS control system and since 1970[2] has issued safety recommendations concerning train collision prevention. A PTS control system can prevent trains from colliding by automatically interceding in the operation of a train when an engineer does not comply with the requirements of the signal indication.

Following its investigation of a head-on collision on the Burlington Northern Railroad on July 29, 1993, near Ledger, Montana,[3] the Safety Board issued the following safety recommendation to the FRA:

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[2]Railroad Accident Report--*Head-on Collision between Penn Central Trains N-48 and N-49 at Darien, Connecticut, August 20, 1969* (NTSB/RAR-70/03).

[3]Railroad Accident Report--*Head-on Collision between Burlington Northern Freight Trains 602 and 603 near Ledger, Montana, on August 29, 1991* (NTSB/RAR-93/01).

> In conjunction with the Association of American Railroads [AAR] and the Railway Progress Institute [RPI], establish a firm timetable that includes at a minimum, dates for final development of required advanced train control system hardware, dates for an implementation of a fully developed advanced train control system, and a commitment to a date for having the advanced train control system ready for installation on the general railroad system. (R-93-12)

The Safety Board additionally issued a similar recommendation to the AAR and to the RPI.

The Safety Board classified Safety Recommendation R-93-12 "Open--Acceptable Response" after the FRA took the measure to seek the "final system definition, migration path, and timetable" for a PTS control system by December 1994. The Safety Board had classified the recommendations to the AAR and the RPI, respectively, "Closed--Superseded" and "Closed--Acceptable Alternate Action." Neither the AAR nor the RPI is in a position either to establish timetables or to implement a PTS control system for the railroad industry. The FRA and the railroad industry share the responsibility for the development and implementation of a PTS control system. Under its regulatory authority, the FRA can order a railroad to install a PTS control system, and the FRA can issue emergency orders, as it did following the Silver Spring accident, where an unsafe condition or practice causes an emergency situation involving a hazardous death or injury.

Citing the recent train accidents in Secaucus, New Jersey,[4] and Silver Spring, the FRA stated in EO 20 that it had a particular concern for operations that involve lead cars carrying passengers on track segments that have neither cab signals nor an automatic train stop or automatic train control. EO 20 required that commuter and intercity passenger railroads modify services operating above 30 mph that lack cab signals or automatic train stop or automatic train control protections and that permit passengers to occupy the lead car, either cab control cars in the forward position push-pull mode or self-propelled locomotives with passenger seating (MU [multiple-unit] locomotives). The FRA also exercised its oversight responsibility for operating rules by concluding that certain current conditions and practices on commuter and intercity passenger railroads posed an imminent and unacceptable threat to public and employee safety. The EO 20 specifically addressed the delayed-in-block rule and the exclusion granted to passenger trains under certain conditions. The FRA recognized that unacceptable threats to public and employee safety exist where protection is not provided by cab signal or automatic train stop or automatic train control systems. The FRA addressed several public safety issues that required immediate attention in EO 20; however, it did not address the other critical risks posed by reliance on crew alertness in complying with operating rules.

The Safety Board has investigated numerous train collisions in which the probable cause or contributing cause was the inattention of the traincrew to wayside signals. In its investigation of the head-on collision of two freight trains near Kelso, Washington,[5] the Safety Board attempted to determine again why one traincrew did not comply with the signal indication of an intermediate signal. The Safety Board reported its concerns about a systemic safety issue: the adequacy of passive wayside signals to reliably capture traincrews' attention when competing sources of attention are present, and it urged the railroad industry to recognize that human vigilance has limits and that wayside signals do not ensure safe train operations. The FRA EO 20, notice no. 2, concluded that "certain current conditions and practices on

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[4]Railroad Accident Report--*Near Head-on Collision and Derailment of Two New Jersey Commuter Trains near Secaucus, New Jersey, on February 9, 1996* (NTSB/RAR-97/01).

[5]Railroad Accident Report--*Head-on Collision and Derailment of Burlington Northern Freight Train with Union Pacific Freight Train, Kelso, Washington, on November 11, 1993* (NTSB/RAR-94/02)

commuter and intercity passenger railroads pose an imminent and unacceptable threat to public and employee safety. Of greatest concern are push-pull and MU operations lacking the protection provided by cab signal, automatic train stop, or automatic train control systems." After its investigation of the Thedford, Nebraska,[6] accident, the Safety Board stated that had a PTS control system been in place it could have detected that the engineer was not responding appropriately to the signal indications and could have slowed and stopped the train, thus preventing the collision.

The FRA newly required rule for calling signals has basically the same instructions as the existing CSXT operating rule 34. The signal calling that the FRA requires likely occurred in the Silver Spring accident, and at least one crewmember was in the cab control car with the engineer and is believed also to have seen the signal. The accident still happened because such a rule does not adequately compensate for human capabilities and crew interaction. Therefore, the Safety Board concluded that the FRA reliance on the need for increased vigilance of wayside signals and special actions in operating rules, such as the crew communication rule of EO 20, does not adequately safeguard the public.

The full development of a PTS control system is still underway; however, current technology exists for cab signal, automatic train stop, or automatic train control systems. The Safety Board concurs with the FRA EO 20, notice no. 1, that:

> Since most train collisions on the railroad result from human factors, the most effective preventive measure is a highly effective train control system. Cab signal systems serve an important safety purpose because they provide a constant display of the governing signal indication. This provides a corrective measure should an engineer fail to note, forget, or misread a restrictive wayside signal indication. Even greater security is provided by a train control system capable of intervening should the engineer fail to observe signals and operating rules for whatever reason....Such systems are referred to as automatic train control or automatic train stop.

Although all MARC locomotives and cab control cars have cab signal equipment, the Brunswick Line was not equipped with a train control system to implement those devices. A train control system, which would have been recognized by the MARC cab control car cab signal equipment, could have provided the engineer with a visual reminder of the 1124-2 signal aspect, required him to acknowledge and comply with the APPROACH signal indication, or enforced the requirements of the signal indication by stopping the train. The Safety Board concluded that had a train control system that could utilize the cab signal equipment on the MARC cab control car been a part of the signal system on the Brunswick Line, this accident may not have occurred. Therefore, the Safety Board believes that the FRA should require, in the interim of a PTS control system being available, the installation of cab signals, automatic train stop, automatic train control, or other similar redundant systems for all trains where commuter and intercity passenger railroads operate.

The Silver Spring accident is the latest in a series of collisions that could have been prevented had a PTS control system been in place. A PTS control system could have detected that the MARC train 286 engineer was not responding appropriately to signal indications and then slowed and stopped the train, thus, preventing the collision. The Safety Board concluded that a fully implemented PTS control system would have prevented this accident by recognizing that MARC train 286 was not being operated within allowable parameters, based on other authorized train operations, and would have stopped the train be-

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[6]Railroad Accident Report--*Collision and Derailment Involving Three Burlington Northern Freight Trains near Thedford, Nebraska, on June 8, 1994* (NTSB/RAR-95/03).

fore it could enter into the unauthorized track area. The Safety Board therefore believes that the FRA should require the implementation of PTS control systems for all trains where commuter and intercity passenger railroads operate. In addition, the Safety Board reiterates Safety Recommendation R-93-12 as well as the following Safety Recommendation R-87-16 to the FRA:

> Promulgate Federal standards to require the installation and operation of a train control system on main line tracks that will provide for positive separation of all trains.

During the investigation of the Silver Spring accident, the Safety Board identified problems with emergency egress from the passenger cars that contributed to the number of fatalities and therefore issued the following urgent safety recommendation on March 12, 1996, to the FRA:

> Inspect all commuter rail equipment to determine whether it has: (1) easily accessible interior emergency quick-release mechanisms adjacent to exterior passageway doors; (2) removable windows or kick panels in interior and exterior passageway doors; and, (3) prominently displayed retroreflective signage marking all interior and exterior emergency exits. If any commuter equipment lacks one or more of these features, take appropriate emergency measures to ensure corrective action until these measures are incorporated into minimum passenger car safety standards. (R-96-7)

After reviewing the FRA response of June 6, 1996, the Safety Board classified Safety Recommendation R-96-7 "Open--Acceptable Action" in March 1997. The FRA had stated in that response that it had inspected 1,250 pieces of railroad equipment on 16 commuter organizations, that any variation in the inspection results was indicative of equipment age and of difference by commuter agencies, and that emergency quick-release mechanisms were typically accessible to passengers; although, many were not adjacent to exterior passageway doors. In addition, the FRA had stated that marking emergency exits inside cars with luminescent rather than retroreflective materials may be better. The FRA, however, has taken no immediate action to make corrections. The Safety Board acknowledges the FRA efforts concerning its urgent safety recommendation and recognizes the complexities of developing practical solutions within the requested 1-year period; therefore, the Safety Board classifies Safety Recommendation R-96-7 "Closed--Superseded" and is substituting it with three separate safety recommendations for longer-term action. Consequently, the Safety Board believes that the FRA should:

> Require all passenger cars to have easily accessible interior emergency quick-release mechanisms adjacent to exterior passageway doors and take appropriate emergency measures to ensure corrective action until these measures are incorporated into minimum passenger car safety standards.

> Require all passenger cars to have either removable windows, kick panels, or other suitable means for emergency exiting through the interior and exterior passageway doors where the door could impede passengers exiting in an emergency and take appropriate emergency measures to ensure corrective action until these measures are incorporated into minimum passenger car safety standards.

> Issue interim standards for the use of luminescent or retroreflective material or both to mark all interior and exterior emergency exits in all passenger cars as soon as possible and incorporate into minimum passenger car safety standards.

Current FRA regulations for passenger car safety standards are inadequate. They do not address passenger car safety standards for self-contained emergency lighting; inspection, removal, and maintenance of emergency windows; exterior emergency door releases; interior flammability and smoke standards; and structural crashworthiness. The Safety Board is encouraged by the FRA current position in developing rulemaking on rail passenger equipment safety standards to comply with the Federal Railroad Safety Authorization Act of 1994 and expects that the passenger car safety standards will not only address the safety of passengers in newly built passenger cars but also in existing passenger cars. The FRA indicated that the group working on the development of passenger car safety standards completed their work in December 1996, and a notice of proposed rulemaking (NPRM) is expected by the end of 1997.

During the investigation of the Silver Spring accident, the Safety Board identified several areas of safety deficiencies that should be addressed by passenger car safety standards for improved passenger safety. The identified areas are the power source of emergency lighting, the difficulty in removing emergency windows, the missing or inaccessible exterior emergency door release handles, the failure of interior materials to meet flammability and smoke standards, and the structural crashworthiness of cab control cars.

The two passengers who had been in the MARC coach car 7720 stated that no emergency lighting was available after the accident. One passenger's injuries and the other's loss of eye glasses compounded the reported difficulty in moving in the darkness. Additionally, the tilted position of the car contributed to their disorientation and hindered their mobility. Postaccident inspection of the car revealed that batteries supplying power to the emergency lighting system, located below the floor level, had been damaged in the derailment. The MARC passenger cars are not unique in the location of the battery supplying power to the emergency lighting system being below the car floor, which makes them susceptible in a derailment to damage from contact with the car trucks, the rails, or the ground. The installation of battery pack ballasts or other self-contained independent power sources in the car interior would provide reliable power to emergency lighting in derailments when the batteries under the car are most likely to be damaged. The Safety Board concluded that a need exists for Federal standards requiring passenger cars be equipped with reliable emergency lighting fixtures with a self-contained independent power source when the main power supply has been disrupted to ensure passengers can safely egress. Therefore, the Safety Board believes that the FRA should require all passenger cars to contain reliable emergency lighting fixtures that are each fitted with a self-contained independent power source and incorporate the requirements into minimum passenger car safety standards.

One passenger in coach car 7720 stated that he exerted much effort to open an emergency window in that car. Postaccident inspection of the car emergency windows revealed that much effort was also necessary to open two other emergency windows in the same car because the window lubricant had hardened. The Safety Board determined that no periodic preventive maintenance had been performed on the emergency windows of the MARC passenger equipment and that none had been required. The FRA EO 20 requires all passenger railroads to inspect emergency windows exits for proper operation, marking, and instructions as part of routine equipment maintenance. The FRA informed the Safety Board in October 1996 that changes to the regulatory text of the draft NPRM on Passenger Train Emergency Preparedness were being made because the inspection cycle requirements of EO 20 were vague. The February 24, 1997, FRA-issued NPRM proposes that a railroad test a representative sample of emergency window exits on its cars a least once every 180 days to verify proper operation and that it repair a defective unit before returning the car to service. The Safety Board, however, is concerned that the FRA EO 20, pertaining to the inspection cycle, does not require a prescribed test cycle and that until the proposed rulemaking becomes effective, emergency windows on passenger rail carriers may not be adequately inspected. The Safety Board concluded that prescribed inspection and maintenance test cycles are needed

to ensure reliable operation of emergency windows in all long-distance and commuter rail passenger cars. Therefore, the Safety Board believes, pending the issuance of the final rule on passenger car safety standards, that the FRA should promptly provide a prescribed inspection and maintenance test cycle to ensure the proper operation of all emergency exit windows as well as provide that the 180-day inspection and maintenance test cycle is prescribed in the final rule.

The MARC II passenger cars have provisions for a T-handle, which is used to disconnect the interior release mechanism allowing the exterior side doors to be opened from the outside, at each of the four exterior doors. During postaccident inspection of cab control car 7752, investigators found that the exterior emergency door release T-handles were missing. In addition, when MARC last performed general servicing of cab control car 7752, the T-handles were noted as missing. MARC mechanical officers explained that because of the difficulty, receiving replacements from the original equipment supplier, they needed time to manufacture and install substitute T-handles, but MARC did not restrict the car from being placed back into passenger service.

The postaccident inspection of the passenger coach 7720, immediately behind cab control car 7752, revealed that the exterior emergency door release T-handles on the right side were buried in ballast when the car derailed and were, therefore, inaccessible to emergency responders. The T-handles were designed to be below the floor line of the car and about 3 inches inboard. The original design plans for the MARC II passenger cars showed the emergency door release T-handles above the bottom of the car body and in a glass-covered recessed pocket adjacent to each vestibule door. However, the T-handles had not been installed there because of an approved design change during car building. Emergency responders may have been able to quickly locate the T-handles and gain access to passenger coach interior had the handles been located where planned.

The Safety Board concluded that the exterior emergency door release T-handles for the MARC cars were not either in place or accessible to firefighters because no requirements for their maintenance or accessibility exist. Therefore, the Safety Board believes that the FRA should require that all exterior emergency door release mechanisms on passenger cars be functional before a passenger car is placed in revenue service, that the emergency door release mechanism be placed in a readily accessible position and marked for easy identification in emergencies and derailments, and that these requirements be incorporated into minimum passenger car safety standards.

The analysis of fire debris indicated that diesel fuel from the breached fuel tank of Amtrak unit 255 sprayed into the breached opening of the MARC 286 cab control car. Positive residues were found on some passenger seats and on a sheetmetal panel near the opening. The analysis revealed that the diesel fuel played a significant role in the early fire growth within the car, and within 3 to 5 minutes after the collision based on witness testimony, flashover developed in the cab control car with the fire accelerating over the breached area because of that sprayed diesel fuel. Had diesel fuel not sprayed into the cab control car, the fire likely would not have spread as quickly as it did.

The Maryland Department of Transportation purchase contract for 11 passenger cars, including cab control car 7752, contained the following smoke and flammability specifications:

> All materials used in the interior of the car (that is, all materials inboard of the structural shell and including, but not limited to, liners, floor panels, thermal and acoustic insulation, seats and cushions, floor covering materials, wainscots, carpeting, glazing materials, and light fixture lenses) shall have the highest degree of fire resistance and lowest smoke emission consistent with the other qualities required. As a minimum, all materials used in the interior of the car

shall meet the requirements of the U.S. Department of Transportation's "Proposed Guidelines for Flammability and Smoke Emission Specifications."

To determine the compliance of the MARC car interior materials with the flammability and smoke requirements, tests were conducted on materials from an exemplar MARC passenger car by the University of Maryland Department of Fire Protection Engineering at College Park, Maryland. These tests were governed by the FRA recommendations for testing the flammability and smoke emission characteristics for commuter and intercity rail vehicle materials. The tested materials, consisting of the major combustible items in the car, included the upholstered portion, but not the rigid plastic side-rail and back components, of the seats; the ceiling lining, which was similar, if not identical, to the other wall lining and partition materials; and the window mask material. The pad cushion materials of the seat passed the smoke criterion but failed the flammability criterion. The fabric upholstery seat covering passed the flammability test but failed the smoke test in the flaming mode. The vinyl seat coverings passed the flammability test but failed the smoke test in the nonflaming mode. The ceiling panel passed both the smoke and flammability criteria; however, the window mask material failed both criteria. Floor materials were not included in the tests because the cab control car 7752 floor was not destroyed by the fire.

The Safety Board recognizes that the materials taken from an exemplar MARC car may not have been identical to the materials that were installed on cab control car 7752 and that other factors, such as wear, can affect the performance of the car materials; nevertheless, the materials taken from the exemplar car were significantly similar to the materials in the accident car. Some of the interior materials from the exemplar MARC car failed current flammability and smoke emissions testing criteria, and the materials in the cab control car 7752 also most likely would have failed. Had the materials met current performance criteria, however, the outcome would not have been any different because of the presence of diesel fuel as an ignition source. The fire would have spread quickly whether or not the interior materials of the MARC passenger cars had met current performance criteria regarding flammability and smoke emissions characteristics; still, the Safety Board is concerned that the interior materials in the MARC passenger cars did not meet existing performance criteria for flammability and smoke emissions characteristics.

Performance criteria is based on guidelines developed by the FRA and the FTA, and the passenger commuter industry could reference them with or without modification when ordering new equipment. The Safety Board concluded that because other commuter passenger cars may also have interior materials that may not meet specified performance criteria for flammability and smoke emission characteristics, the safety of passengers in those cars could be at risk. Therefore, the Safety Board believes that the FRA should require that a comprehensive inspection of all commuter passenger cars be performed to independently verify that the interior materials in these cars meet the expected performance requirements for flammability and smoke emissions characteristics.

Federal regulations under 49 CFR Part 228.17 require that each carrier keep records of train movements that are made under the direction and control of a dispatcher who uses a telephone, radio, or any other electrical or mechanical device to dispatch, report, transmit, receive, or deliver orders pertaining to train movements. These records are to contain such important information as the identification of the timetable in effect; the train location and the date; the dispatcher identification and duty time; the weather conditions at 6-hour intervals; the identification of the trains and the traincrews and their duty times; the station names and the office designations; the distances between stations; the direction of train travel and the times of arrival, departing, and passing all reporting stations; and any unusual events affecting the movement of trains and the identity of affected trains. Before the computerization of dispatching offices, these records were recorded manually and retained on file for review by railroad operating officers, Federal regulators, and accident investigators.

The CSXT operates its CTC system with a computed-aided dispatching (CAD) system, as do many major railroads in the country. The CAD generates "computerized train sheets" (a computer file that can print out the requested information), which was designed by the CSXT for the recordkeeping of each train (about 3,000 per month). The Safety Board examined train sheets covering about 90 days, with particular attention given to the accident trains, and found that the train sheets were incomplete in so far as recording the information delineated under 49 CFR Part 228.17. For example, the computer-generated train sheet for MARC train 286 did not show the train activity after its departure from Point of Rocks, Maryland, when it was required to make a reverse movement to crossover and go around a disabled freight train; the weather that day; and the accident occurrence. The Safety Board investigation revealed that the train sheets being maintained by CSXT lacked the information required by FRA regulation and, therefore, were of little value in determining unusual events the day of the accident. The Safety Board concluded that the FRA has not addressed the use of CAD system records to provide information for the identification and evaluation of potential safety-related trends for corrective action. The FRA must consider, when alternative methods of recordkeeping are employed, that the current minimum data requirements are critical to good event recording and that alternative should be comparable or better. Consequently, the Safety Board believes that the FRA should update 49 CFR Part 228.17, Train Dispatcher's Record of Train Movements, to include the same parameters for electronic recordkeeping of the dispatcher's record of train movements.

In 1992 the Safety Board conducted comprehensive Safety Study (NTSB/SS-92/04), *Locomotive Fuel Tank Integrity*, which addressed, among other issues, the potential in railroad accidents for diesel fuel fires to fatally injure the trapped crewmembers. The report primarily covered the risk in freight locomotive operations, although a passenger train collision case study was cited. However, the risk of collision damage is effectively the same for both types of operations because fuel tanks for freight locomotives are configured essentially the same as passenger locomotives, such as the one involved in this accident. Specific safety issues discussed in the study were the adequacy of current fuel tank design, factors that affect fuel tank design, and the sufficiency of research to improve fuel tank integrity or fuel containment. The study findings concluded that the evaluation of the extent of locomotive fuel tank damage and spills on an annual basis is difficult because of the limited data available. Furthermore, although the railroad industry has explored changes in fuel tank design, no evidence was found that the industry has performed a systematic engineering analysis to determine the feasibility of providing better crash protection for fuel tank systems.

As a result of this safety study, the Safety Board issued Safety Recommendation R-92-10 to the FRA:

> *Conduct, in conjunction with the Association of American* Railroads, the General Electric Company [GE], and the Electro-Motive Division [EMD] of General Motors, research to determine if the locomotive fuel tank can be improved to withstand forces encountered in the more severe locomotive derailment accidents or if fuel containment can be improved to reduce the rate of fuel leakage and fuel ignition. Consideration should be given to crash or simulated testing and evaluation of recent and proposed design modifications to the locomotive fuel tank, including increasing the structural strength of end and side wall plates, raising the tank higher above the rail, and using internal tank bladders and foam inserts.

The Safety Board also issued the similar recommendations to the AAR, GE, and the EMD. The Safety Board classified Safety Recommendation R-92-10 "Open--Acceptable Response" after noting the industry efforts to address the issue. However, the crash or simulation testing and evaluation of recent and

proposed design modifications has not yet been addressed. Therefore, the Safety Board reiterates Safety Recommendation R-92-10 to the FRA.

The locomotive in the Silver Spring accident, Amtrak unit ATK 255, was built in 1977 and was under the FRA standard in 49 CFR Part 229.71, stipulating the minimum clearance from the top of the rail. The current FRA regulations do not address the design, size, locations, or performance of locomotive fuel tanks, and do not require a regularly scheduled or periodic inspection of fuel tanks to ensure no safety hazards are present. In this collision, substantial compressive forces bearing on the lead truck of Amtrak unit ATK 255 caused it to be displaced into the front plate of the fuel tank, located immediately behind the lead truck. The front of the fuel tank compressed inward substantially damaging the fuel tank. The left side of the fuel tank subsequently was ruptured catastrophically by the raking action of the body bolster of the MARC cab control car 7752 as both trains continued to move forward. The fuel tank provided little impact resistance to the compressive forces of the lead truck and the shearing action of the projecting body bolster of cab control car 7752. The released fuel sprayed into the exposed interior of cab control car 7752, and with multiple sources of ignition, the fuel quickly ignited and engulfed the car.

The Safety Board has previously expressed its concern to the FRA about locomotives built before September 1, 1995, noting that many of these locomotives will remain in service for several years, and this accident only reinforces that concern about this issue. The Safety Board will continue to address the crashworthiness issue and to monitor the FRA progress for improving locomotive fuel tank crashworthiness.

Therefore, the National Transportation Safety Board recommends that the Federal Railroad Administration:

Amend 49 Code of Federal Regulations Part 229 to require the recording of train crewmembers' voice communications for exclusive use in accident investigations and with appropriate limitations on the public release of such recordings. (R-97-9)

Require comprehensive failure modes and effects analyses, including a human factors analysis, for all signal system modifications. (R-97-10)

Develop and maintain separate identifiable data records for commuter and intercity rail passenger operations. (R-97-11)

Require, in the interim of a positive train separation control system being available, the installation of cab signals, automatic train stop, automatic train control, or other similar redundant systems for all trains where commuter and intercity passenger railroads operate. (R-97-12)

Require the implementation of positive train separation control systems for all trains where commuter and intercity passenger railroads operate. (R-97-13)

Require all passenger cars to have easily accessible interior emergency quick-release mechanisms adjacent to exterior passageway doors and take appropriate emergency measures to ensure corrective action until these measures are incorporated into minimum passenger car safety standards. (R-97-14)

Require all passenger cars to have either removable windows, kick panels, or other suitable means for emergency exiting through the interior and exterior passageway doors where the door could impede passengers exiting in an emergency and take appropriate emergency measures to ensure corrective action until these measures are incorporated into minimum passenger car safety standards. (R-97-15)

Issue interim standards for the use of luminescent or retroreflective material or both to mark all interior and exterior emergency exits in all passenger cars as soon as possible and incorporate the interim standards into minimum passenger car safety standards. (R-97-16)

Require all passenger cars to contain reliable emergency lighting fixtures that are each fitted with a self-contained independent power source and incorporate the requirements into minimum passenger car safety standards. (R-97-17)

Provide promptly a prescribed inspection and maintenance test cycle to ensure the proper operation of all emergency exit windows as well as provide that the 180-day inspection and maintenance test cycle is prescribed in the final rule. (R-97-18)

Require that all exterior emergency door release mechanisms on passenger cars be functional before a passenger car is placed in revenue service, that the emergency door release mechanism be placed in a readily accessible position and marked for easy identification in emergencies and derailments, and that these requirements be incorporated into minimum passenger car safety standards. (R-97-19)

Require that a comprehensive inspection of all commuter passenger cars be performed to independently verify that the interior materials in these cars meet the expected performance requirements for flammability and smoke emissions characteristics. (R-97-20)

Update 49 Code of Federal Regulations Part 228.17, Train Dispatcher's Record of Train Movements, to include the same parameters for electronic recordkeeping of the dispatcher's record of train movements. (R-97-21)

Furthermore, the National Transportation Safety Board reiterates Safety Recommendations R-87-16, R-92-10, and R-93-12 to the Federal Railroad Administration.

Promulgate Federal standards to require the installation and operation of a train control system on main line tracks that will provide for positive separation of all trains. (R-87-16)

Conduct, in conjunction with the Association of American Railroads, the General Electric Company, and the Electro-Motive Division of General Motors, research to determine if the locomotive fuel tank can be improved to withstand forces encountered in the more severe locomotive derailment accidents or if fuel containment can be improved to reduce the rate of fuel leakage and fuel ignition. Consideration should be given to crash or simulated testing and evaluation of recent and proposed design modifications to the locomotive fuel tank, including increasing the structural strength of end and side wall plates, raising the tank higher above the rail, and using internal tank bladders and foam inserts. (R-92-10)

In conjunction with the Association of American Railroads and the Railway Progress Institute, establish a firm timetable that includes at a minimum, dates for final development of required advanced train control system hardware, dates for an implementation of a fully developed advanced train control system, and a commitment to a date for having the advanced train control system ready for installation on the general railroad system. (R-93-12)

Also, the Safety Board issued Safety Recommendations R-97-22 through -25 to the FTA; R-97-26 through -31 to the CSXT; R-97-32 through -35 to the MTA; R-97-36 to the U.S. Department of Transportation; R-97-37 to the Federal Emergency Management Agency; R-97-38 to the Governor and the General Assembly of Maryland; R-97-39 through -42 to the AAR; R-97-43 to the Montgomery County Emergency Management Agency; R-97-44 to the Baltimore County Emergency Management Agency, the Baltimore City Emergency Management Agency, the Metropolitan Washington Council of Governments, the Jefferson County Commissioners, and the Berkeley County Commissioners; and R-97-45 to the American Short Line Railroad Association, the Brotherhood of Locomotive Engineers, the United Transportation Union, the International Brotherhood of Teamsters, and the American Public Transit Association. The Safety Board also reiterated Safety Recommendations R-92-16 to GE and R-92-17 to the EMD. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

Safety Recommendation Reiteration List

| SR Number | Reiteration Number | Report Number | Report Date | Accident Description | Accident City | Accident State | Accident Date |
|---|---|---|---|---|---|---|---|
| R-97-009 | 1 | RAR-01-01 | 5/9/2001 | Collision Involving 3 Consolidated Rail Corporation Freight Trains Operating In Fog On A Double Main Track | Byran | OH | 1/17/1999 |
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Safety Recommendation Reiteration List

| SR Number | Reiteration Number | Report Number | Report Date | Accident Description | Accident City | Accident State | Accident Date |
|---|---|---|---|---|---|---|---|
| R-97-017 | 1 | RAR-98-03 | 8/31/1998 | Derailment Of Amtrak Train 4, Southwest Chief, On The Burlington Northern Santa Fe Railway | Kingman | AZ | 8/9/1997 |
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