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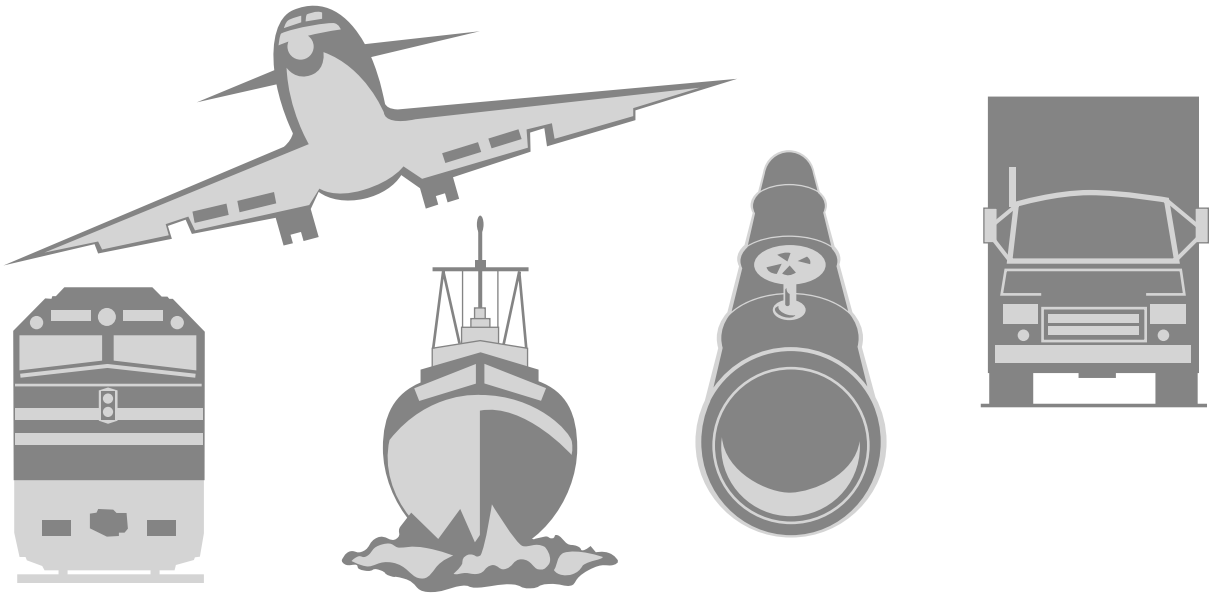
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SAFETY RECOMMENDATIONS

ADOPTED FEBRUARY 2002



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 8, 2002

In reply refer to: A-02-01 and -02

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

This safety recommendation letter addresses an industry-wide safety issue involving omissions in pilot training on transport-category airplanes. Specifically, the National Transportation Safety Board has learned that many pilot training programs do not include information about the structural certification requirements for the rudder and vertical stabilizer on transport-category airplanes. Further, the Safety Board has learned that sequential full opposite rudder inputs (sometimes colloquially referred to as "rudder reversals")—even at speeds below the design maneuvering speed[1]—may result in structural loads that exceed those addressed by the requirements. In fact, pilots may have the impression that the rudder limiter systems installed on most transport-category airplanes, which limit rudder travel as airspeed increases to prevent a single full rudder input from overloading the structure, also prevent sequential full opposite rudder deflections from damaging the structure. However, the structural certification requirements for transport-category airplanes do not take such maneuvers into account; therefore, such sequential opposite rudder inputs, even when a rudder limiter is in effect, can produce loads higher than those required for certification and that may exceed the structural capabilities of the aircraft.

This safety issue was identified in connection with the Safety Board's ongoing investigation of the November 12, 2001, accident involving American Airlines flight 587, an Airbus Industrie A300-600.[2] Flight 587 was destroyed when it crashed into a residential area of Belle Harbor, New York, shortly after takeoff from John F. Kennedy International Airport (JFK), Jamaica, New York. Before impact, the vertical stabilizer and rudder separated from the fuselage.[3] The 2 pilots, 7 flight attendants, 251 passengers, and 5 persons on the ground were

[1] The design maneuvering airspeed is the maximum speed at which the structural design's limit load can be imposed (either by gusts or full deflection of the control surfaces) without causing structural damage.

[2] Under the provisions of Annex 13 to the Convention on International Civil Aviation, the Bureau Enquêtes-Accidents and Airbus Industrie are participating in the Safety Board's investigation of this accident as the Accredited Representative and technical Advisor, respectively, of the State of Design and Manufacture.

[3] The vertical stabilizer and rudder assemblies were found floating in the water about 0.7 mile from the main impact crater. The vertical stabilizer was largely intact with no significant damage, although some localized areas of

killed. Visual meteorological conditions prevailed and an instrument flight rules flight plan had been filed for the flight destined for Santo Domingo, Dominican Republic. The scheduled passenger flight was conducted under 14 *Code of Federal Regulations* (CFR) Part 121.

The investigation is still examining many issues, including the adequacy of the certification standards for transport-category airplanes, the structural requirements and integrity of the vertical stabilizer and rudder, the operational status of the rudder system at the time of the accident, the adequacy of pilot training, and the role of pilot actions in the accident. It must be emphasized that, at this time, the Board has not yet determined the probable cause of the accident. Further, the Board is not aware of any prior events in which rudder movements have resulted in separation of a vertical stabilizer or rudder. Nonetheless, the investigation has revealed this safety issue, which should be immediately addressed.

Before the separation of the vertical stabilizer and rudder, flight 587 twice experienced turbulence consistent with encountering wake vortices from a Boeing 747 that departed JFK ahead of the accident aircraft. The two airplanes were separated by about 5 (statute) miles and 90 seconds at the time of the vortex encounters. During and shortly after the second encounter, the flight data recorder (FDR) on the accident aircraft recorded several large rudder movements (and corresponding pedal movements) to full or nearly full available rudder deflection in one direction followed by full or nearly full available rudder deflection in the opposite direction.[4] The subsequent loss of reliable rudder position data is consistent with the vertical stabilizer separating from the airplane. The cause of the rudder movements is still under investigation. Among the potential causes being examined are rudder system malfunction, as well as flight crew action.

Preliminary calculations by Safety Board and Airbus engineers show that large sideloads were likely present on the vertical stabilizer and rudder at the time they separated from the airplane. Calculations and simulations show that, at the time of the separation, the airplane was in an 8° to 10° airplane nose-left sideslip while the rudder was deflected 9.5° to the right. Airbus engineers have determined that this combination of local nose-left sideslip on the vertical stabilizer and right rudder deflection produced air loads on the vertical stabilizer that could exceed the airplane's design loads. The Board notes that, at the time the vertical stabilizer and rudder separated from the airplane, the airplane was flying at 255 knots indicated airspeed (KIAS), which is significantly below the airplane's design maneuvering speed of 273 KIAS.

Transport-category airplanes certified by the Federal Aviation Administration (FAA) must meet the airworthiness standards in 14 CFR Part 25. Subpart C, pertaining to the airplane structure, includes Section 25.351, titled "Yaw maneuver conditions," which requires that the

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damage were evident around the stabilizer-to-fuselage interface. At the lower end of the stabilizer, all of the attachment fittings were either fractured through the attachment hole or the stabilizer structure was fractured around the fittings. Portions of the closure rib and skin attach angle and front spar were also fractured from the stabilizer. Most of the rudder was separated from the vertical stabilizer except for portions of the rudder spar, which remained attached to the actuators and the upper hinge (no. 5 and 7).

[4] Preliminary information based on FDR data and an analysis of the manner in which rudder position data is filtered by the airplane's systems indicates that within about 7 seconds, the rudder traveled 11° right for 0.5 second, 10.5° left for 0.3 second, between 11° and 10.5° right for about 2 seconds, 10° left for about 1 second, and, finally, 9.5° right before the data became unreliable.

airplane be designed for loads resulting from the following series of maneuvers in unaccelerated flight, beginning at zero yaw: (1) full rudder input resulting in full rudder deflection (or as limited by the rudder limiter system); (2) holding this full deflection input throughout the resulting over-swing[5] and steady-state sideslip angles; and (3) while the airplane is at the steady-state sideslip angle, a release of this rudder input and the return of the rudder to neutral. The A300 was certified as having met this regulatory standard. In other words, the airplane must be designed to withstand the results of a full rudder input in one direction followed by (after the airplane reaches equilibrium) a release of that rudder input.

It is noteworthy that these certification requirements do not consider a return of the rudder to neutral from the over-swing sideslip angle, nor do they consider a full rudder movement in one direction followed by a movement in the opposite direction. Although, as previously mentioned, most transport-category airplanes are equipped with rudder limiter systems that limit rudder deflection at higher airspeeds, which prevents single rudder inputs from causing structural overload, the Safety Board is concerned that pilots have not been made aware that, a full or nearly full rudder deflection in one direction followed by a full or nearly full rudder deflection in the other direction, even at speeds below the design maneuvering speed, can dramatically increase the risk of structural failure of the vertical stabilizer or the rudder.

The Safety Board is also concerned that pilots may not be aware that, on some airplane types, full available rudder deflections can be achieved with small pedal movements and comparatively light pedal forces. In these airplanes, at low speeds (for example, on the runway during the early takeoff run or during flight control checks on the ground or simulator training) the rudder pedal forces required to obtain full available rudder may be two times greater and the rudder pedal movements required may be three times greater than those required to obtain full available rudder at higher airspeeds.

On the A300-600, for example, at airspeeds lower than 165 knots (when rudder travel is unrestricted by the airplane's rudder limiter system) the rudder can travel +/-30°, requiring a pilot force of about 65 pounds to move the rudder pedals about 4.0 inches. However, at 250 knots, when the limiter restricts rudder travel to about +/-9.3°, a pilot force of about 32 pounds is required to move the rudder pedals about 1.3 inches. The rudder system on the A300-600 uses a breakout force[6] of about 22 pounds. Thus, at 250 knots, the rudder can reach full available travel (9.3°) with a pedal force of only 10 pounds over the breakout force. There are several other types of rudder limiter systems that operate differently. For example, on some airplanes, full pedal travel (and corresponding pedal force) is required to obtain full available rudder, regardless of airspeed, even though the maximum available rudder deflection is reduced with airspeed by mechanical means. Lacking an awareness of these differences in necessary pedal force and movement, some pilots, when sensing the need for a rudder input at high speeds, may use rudder pedal movements and pressures similar to those used during operations at lower airspeeds, potentially resulting in full available rudder deflection.

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[5] Over-swing refers to the maximum sideslip angle resulting from the airplane's momentum as it yaws in response to the rudder's movement; the over-swing sideslip angle will always be greater than the subsequent steady-state sideslip angle.

[6] Breakout force is the force required to start moving a flight control such as the rudder pedal or control column.

The Safety Board notes that there is a potential for pilots to make large and/or sequential rudder inputs in response to unusual or emergency situations, such as an unusual attitude or upset, turbulence, or a hijacking or terrorist situation. In fact, unusual attitude training already exists[7] that encourages pilots to use full flight control authority (including rudder), if necessary, in response to an airplane upset. Further, the Board is aware that, since the terrorist attacks of September 11, 2001, operators and pilots have been discussing ways to disable or incapacitate would-be hijackers in cockpits or in cabins during flight. Although the Board understands the need to formulate effective maneuvers for addressing such unusual or emergency situations, the Board is also concerned that, without specific and appropriate training in such maneuvers, pilots could inadvertently create an even more dangerous situation if those maneuvers result in loads that approach or exceed the structural limits of the airplane.

Finally, notwithstanding the concerns noted above about the potential danger of large and/or sequential rudder inputs in flight, it should be emphasized that pilots should not become reluctant to command full rudder when required and when appropriate, such as during an engine failure shortly after takeoff or during strong or gusty crosswind takeoffs or landings. The instruction of proper rudder use in such conditions should remain intact but should also emphasize the differences between aircraft motion resulting from a single, large rudder input and that resulting from a series of full or nearly full opposite rudder inputs.

As previously noted, the Safety Board's examination of the adequacy of the certification standards is ongoing and no conclusions have yet been reached in that regard. However, on the basis of the investigative findings to date, the Board believes that the FAA should require the manufacturers and operators of transport-category airplanes to establish and implement pilot training programs that: (1) explain the structural certification requirements for the rudder and vertical stabilizer on transport-category airplanes; (2) explain that a full or nearly full rudder deflection in one direction followed by a full or nearly full rudder deflection in the opposite direction, or certain combinations of sideslip angle and opposite rudder deflection can result in potentially dangerous loads on the vertical stabilizer, even at speeds below the design maneuvering speed; and (3) explain that, on some aircraft, as speed increases, the maximum available rudder deflection can be obtained with comparatively light pedal forces and small pedal deflections. The FAA should also require revisions to airplane and pilot operating manuals that reflect and reinforce this information. In addition, the FAA should ensure that this training does not compromise the substance or effectiveness of existing training regarding proper rudder use, such as during engine failure shortly after takeoff or during strong or gusty crosswind takeoffs or landings. The Safety Board also believes that the FAA should carefully review all existing and proposed guidance and training provided to pilots of transport-category airplanes concerning special maneuvers intended to address unusual or emergency situations and, if necessary, require modifications to ensure that flight crews are not trained to use the rudder in a way that could result in dangerous combinations of sideslip angle and rudder position or other flight parameters.

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[7] The widely used *Airplane Upset Recovery Training Aid*, which was created by Airbus Industrie, the Boeing Company, many major domestic and international airlines, and major pilot organizations, states that, "pilots must be prepared to use full control authority, when necessary. The tendency is for pilots not to use full control authority because they rarely are required to do this. This habit must be overcome when recovering from severe upsets."

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

> Require the manufacturers and operators of transport-category airplanes to establish and implement pilot training programs that: (1) explain the structural certification requirements for the rudder and vertical stabilizer on transport-category airplanes; (2) explain that a full or nearly full rudder deflection in one direction followed by a full or nearly full rudder deflection in the opposite direction, or certain combinations of sideslip angle and opposite rudder deflection can result in potentially dangerous loads on the vertical stabilizer, even at speeds below the design maneuvering speed; and (3) explain that, on some aircraft, as speed increases, the maximum available rudder deflection can be obtained with comparatively light pedal forces and small pedal deflections. The FAA should also require revisions to airplane and pilot operating manuals that reflect and reinforce this information. In addition, the FAA should ensure that this training does not compromise the substance or effectiveness of existing training regarding proper rudder use, such as during engine failure shortly after takeoff or during strong or gusty crosswind takeoffs or landings. (A-02-01)
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> Carefully review all existing and proposed guidance and training provided to pilots of transport-category airplanes concerning special maneuvers intended to address unusual or emergency situations and, if necessary, require modifications to ensure that flight crews are not trained to use the rudder in a way that could result in dangerous combinations of sideslip angle and rudder position or other flight parameters. (A-02-02)

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these safety recommendations.

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 12, 2002
In reply refer to: A-02-03 and -04

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On January 12, 2002, a model 568F propeller blade, manufactured by Hamilton Sundstrand,[1] separated adjacent to the propeller hub on the No. 2 (right) engine of an Avions de Transport Regional (ATR) ATR42-500 airplane, operated by ACES Colombia and registered in Bermuda as VP-BVE, shortly after takeoff from Cartagena, Colombia.[2] The domestic flight was destined for Bucaramanga, Colombia. The pilots reported that about 5 minutes after takeoff, they felt high vibrations in the airplane, and the No. 2 engine's low oil pressure warning light illuminated. When the pilots attempted to shut down the No. 2 engine with the fuel lever, the lever jammed. They then shut down the engine by pulling the fire handle. The airplane returned to Cartagena for an emergency landing. The 2 pilots, 2 flight attendants, and 37 passengers on board were uninjured. The airplane sustained minor damage to the No. 2 engine's cowling.

The blades of the model 568F propeller assembly have metallic bases made from low alloy steel forgings. The base, also referred to as a "tulip" because of its shape, incorporates the pitch change mechanism, a flange for attaching blade counterweights, and a flared portion for attaching the airfoil. A composite airfoil that is made with a graphite fiber-reinforced epoxy spar surrounded by structural foam and covered by a Kevlar®[3]-reinforced epoxy outer shell is attached to the tulip. The graphite spar and Kevlar shell are adhesively bonded to the outside of the tulip immediately outboard of the counterweight flange fillet radius and are further secured by a circumferential fiberglass composite "compression" wrap. The entire area of the fillet radius is concealed from external view by the compression wrap and additional sealant material.

The initial examination by Colombian Aeronautica Civil investigators of the No. 2 engine's propeller assembly revealed one of the six blades had separated through the metal base just outboard of the propeller hub. An adjacent blade was fractured through the composite airfoil

[1] Although the propeller is certificated by Hamilton Sundstrand in the United States, the blades are manufactured by Ratier Figeac, a Hamilton Sundstrand subsidiary in France.
[2] The National Transportation Safety Board is assisting the Colombian Aeronautica Civil's investigation under the provisions of Annex 13 to the Convention on International Civil Aviation.
[3] Kevlar is the trademarked name of a family of polymers first produced by DuPont in 1971.

at about the midspan area. The examination of the engine revealed that both of the forward engine mounts had broken, and the engine sagged to the bottom of the engine cowling.

The inboard portion of the fractured propeller blade,[4] serial number FR341, containing the majority of the tulip was examined in the National Transportation Safety Board's materials laboratory at the request of the Colombian Aeronautica Civil. Examination of the fractured blade end revealed that blade separation resulted from a fatigue fracture of the tulip originating in an area of widespread corrosion.[5] The fatigue had initiated at multiple corrosion pits on the outer surface of the tulip in the radius immediately outboard of the counterweight flange. The fracture surface bisected corrosion pits that ranged from 0.006- to 0.010-inch deep. The fatigue crack grew through and around about 75 percent of the tulip before tensile overstress separation occurred. Red rust and other evidence of corrosion were visible on the outer diameter surface of the tulip adjacent to the fracture and on the counterweight flange. The examination and metallurgical analysis revealed that the fractured tulip's dimensions and material properties conformed to the manufacturer's specifications. Records for the fractured propeller blade indicate that it was produced on December 12, 1995; had been in service about 6 years; and had accumulated about 11,700 service hours since new.

The tulips from the five other propeller blades installed in the accident airplane's right propeller assembly were examined at the Safety Board's materials laboratory and at Hamilton Sundstrand's Windsor Locks, Connecticut, facility. The examinations revealed that four of the blade tulips (all produced in 1996) had varying degrees of rust and corrosion pitting in the fillet radius but no visual cracking. The remaining blade tulip (produced in 1997) had no rust or corrosion pitting in the fillet radius.

In accordance with Hamilton Sundstrand's Federal Aviation Administration (FAA)-accepted maintenance program, the 568F propeller blades must undergo a major inspection every 8,000 flight hours. This inspection involves a detailed visual examination of the blade but does not involve removal of the compression wrap or nondestructive inspections (NDI) to detect corrosion or cracks in the fillet radius. The fractured blade underwent a major inspection on February 22, 1999, about 5,939 hours before the blade separated, with no corrosion noted. However, the area of the tulip under the compression wrap (including the fillet radius) was not exposed, nor was it required to be, during this inspection.

In a January 23, 2002, presentation to Safety Board staff, Hamilton Sundstrand reported finding rust and corrosion pitting in the tulip fillet radius under the compression wrap of several high service-time blades that had undergone analytical inspections in conjunction with the major inspections[6] beginning in 1998. Hamilton Sundstrand indicated that, in 2000, it inspected 40 additional high service-time blades and reported finding random and isolated corrosion pits up to 0.014-inch deep, but no cracks, on the tulip fillet radius on 34 of the blades inspected (about 85 percent). Hamilton Sundstrand stated that the rust and corrosion pitting uncovered by

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[4] The outboard portion of the blade was not recovered.

[5] The area of the fatigue crack would not be visible during a visual inspection.

[6] As part of a continuing airworthiness program, Hamilton Sundstrand performed additional in-depth inspections on selected blades during major inspections. These inspections included removal of the compression wrap, which is not normally performed during major inspections, and inspections of the fillet radius.

the analytical inspections had likely been occurring since the blades were new and were unrelated to operational or environmental conditions.

Hamilton Sundstrand indicated that as a result of the early findings of rust and corrosion pitting, it modified the design of the 568F propeller blade in 1998 so that the adhesive layer applied to the tulip extended farther inboard past the end of the compression wrap, fully covering the fillet radius. The tightly adherent adhesive layer was intended to act as a barrier to deter corrosion; thus, the modification would protect the fillet radius. All 568F propeller blades with serial numbers 1,699 and greater are manufactured with this modified design.

According to Hamilton Sundstrand, about 2,500 568F propeller blades are currently in service, 1,353 of which are blades with serial numbers 1 through 1,698. The blades are installed in a six-bladed propeller assembly that is used on ATR42-410 and -500 and ATR72-500 airplanes. According to ATR, about 151 ATR42-410 and -500 and ATR72-500 airplanes are in service with 35 operators worldwide. Twelve ATR72-500 airplanes with this propeller assembly, all operated by Simmons Airlines as American Eagle,[7] are registered in the United States.

The Safety Board is concerned that all 568F propeller blades without the modified design are susceptible to, and some may already have, corrosion pitting and fatigue cracks, particularly those that have been in service the longest. The Board notes that the visual examination of the blades that occurs every 8,000 hours as part of the major inspection is not sufficient to detect corrosion and cracking in the fillet radius because it does not involve exposing the tulip fillet radius area where the corrosion pitting and cracks have occurred.

On February 1, 2002, Hamilton Sundstrand issued Alert Service Bulletin 568F-61-A33, "Propellers—Blades—Removal of 568F Propeller Blades from Service," for remedial action on 568F propeller blades with serial numbers 1 through 1,698 to require the removal of the oldest blades from service for inspection and repair[8] according to the following schedule: serial numbers 1 through 182 within 150 flight hours or February 15, 2002, whichever occurs first; serial numbers 183 through 265 within 300 flight hours or February 28, 2002, whichever occurs first; serial numbers 266 through 341 within 450 flight hours or March 15, 2002, whichever occurs first; and serial numbers 342 through 428 within 600 flight hours or March 31, 2002, whichever occurs first. The service bulletin contains no information about repetitive inspections or a terminating action for this safety issue. Further, Hamilton Sundstrand is in the process of developing an ultrasonic inspection to detect cracking in the fillet radius without removing the compression wrap.

The Safety Board is extremely concerned that Hamilton Sundstrand's proposed removal and repair schedule is not aggressive enough and is inadequate to prevent another fatigue fracture because of the uncertainties in the failure mechanism. Specifically, it is unknown when the

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[7] It is unknown which propeller blades (modified or unmodified) are installed on these airplanes.

[8] Hamilton Sundstrand indicated that the intended repair procedure would include removal of the compression wrap, removal of corrosion, an NDI for cracks, shot peening of the radius, and installation of corrosion protection and adhesive coating (as was installed on propeller blades with serial numbers 1,699 and greater). (Shot peening is a metallurgical surface treatment to improve resistance to cracking.)

corrosion pits originate, what the growth rate for the corrosion pits is, what effect the distribution and density of the corrosion pits have on fatigue crack initiation, what the critical spacing is for microcracks initiating at two adjacent pits to join and form a fatigue crack, and what the overall fatigue crack propagation rate is. The Board is concerned that Hamilton Sundstrand's proposed removal and repair plan would have permitted the failed blade, serial number 341, on the accident airplane to remain in service for 450 flight hours or until March 15, 2002, before requiring its removal and repair.

The Safety Board notes that, when failure mechanisms are known and clearly defined, standard industry practice is to use a safety margin that allows two complete inspection cycles before the observed failure time. However, when uncertainties exist in the failure mechanism, such as in this case, standard industry practice is to use a greater safety margin to conservatively determine an appropriate inspection and repair threshold or schedule.

Although the accident flight crew in this case was able to perform a safe emergency landing after the blade separated, propeller blade separations can quickly cause the flight crew to lose control of the airplane, which could result in injuries or death and damage to the airplane.[9] Because the sample population of blades examined suggests that a large percentage of blades with serial numbers 1 through 1,698 have rust and corrosion pitting on the tulip fillet radius, immediate action is warranted to prevent another blade separation. Therefore, the Safety Board believes that the FAA should, for all Hamilton Sundstrand 568F propeller blades with serial numbers 1 through 1,698, (1) require the immediate inspection and repair (including removal of the compression wrap and any existing corrosion, an NDI for cracks, shot peening of the radius, and installation of an appropriate corrosion protection system) of all blades that have been in service more than 6 years or 11,700 hours; (2) immediately determine a conservative threshold for the inspection and repair of the remaining blades that is appropriately less than 6 years or 11,700 hours in service, taking into account the uncertainties in the failure mechanism (including the initiation and growth rate for the pitting and fatigue cracking); (3) require the immediate inspection and repair of those propeller blades that have already reached or exceeded the threshold determined as a result of (2), above; and (4) for those propeller blades that are not immediately inspected and repaired in accordance with (1) and (3), above, require that they be inspected and repaired as soon as possible, but no later than the threshold determined as a result of (2), above.

The Safety Board notes that although Hamilton Sundstrand modified the model 568F propeller blade design such that blades with serial numbers 1,699 and greater include an adhesive layer that extends over the fillet radius on the tulip, Hamilton Sundstrand indicates that it has not yet examined any of these modified propeller blades to determine if the new design does, in fact, prevent corrosion in the fillet radius. Therefore, the Safety Board believes that the

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[9] The Safety Board notes that a propeller blade separation caused the August 21, 1995, crash of Atlantic Southeast Airlines flight 529 in Carrollton, Georgia. A blade from the left propeller separated, causing loss of control of the airplane and a forced landing. The captain and 7 passengers were killed; the first officer, the flight attendant, and 11 passengers sustained serious injuries; and 8 passengers sustained minor injuries. The airplane was destroyed by impact forces and a postcrash fire. For more information, see National Transportation Safety Board. 1996. *In-flight Loss of Propeller Blade, Forced Landing, and Collision with Terrain, Atlantic Southeast Airlines, Inc., Flight 529, Embraer EMB-120RT, N256AS, Carrollton, Georgia, August 21, 1995.* Aircraft Accident Report NTSB/AAR-96/06. Washington, DC.

FAA should require Hamilton Sundstrand to perform additional analytical examinations and testing, including removal of the compression wrap so that the tulip can be fully examined, of a sample of high service-time 568F propeller blades with serial numbers 1,699 or greater to determine if rust and corrosion pitting are occurring in the fillet radius, and, on the basis of the results of those examinations, require additional inspections, modifications, or repairs as appropriate.

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

> For all Hamilton Sundstrand 568F propeller blades with serial numbers 1 through 1,698:
> (1) Require the immediate inspection and repair (including removal of the compression wrap and any existing corrosion, a nondestructive inspection for cracks, shot peening of the radius, and installation of an appropriate corrosion protection system) of all blades that have been in service more than 6 years or 11,700 hours;
> (2) Immediately determine a conservative threshold for the inspection and repair of the remaining blades that is appropriately less than 6 years or 11,700 hours in service, taking into account the uncertainties in the failure mechanism (including the initiation and growth rate for the pitting and fatigue cracking);
> (3) Require the immediate inspection and repair of those propeller blades that have already reached or exceeded the threshold determined as a result of (2), above; and
> (4) For those propeller blades that are not immediately inspected and repaired in accordance with (1) and (3), above, require that they be inspected and repaired as soon as possible, but no later than the threshold determined as a result of (2), above. (A-02-03) (Urgent)
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> Require Hamilton Sundstrand to perform additional analytical examinations and testing, including removal of the compression wrap so that the tulip can be fully examined, of a sample of high service-time 568F propeller blades with serial numbers 1,699 or greater to determine if rust and corrosion pitting are occurring in the fillet radius, and, on the basis of the results of those examinations, require additional inspections, modifications, or repairs as appropriate. (A-02-04)

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 15, 2002

In reply refer to: H-02-1

Honorable Norman Y. Mineta
Secretary of Transportation
400 Seventh Street, S.W.
Washington, D.C. 20590

About 9:47 p.m. on March 15, 1999, National Railroad Passenger Corporation (Amtrak) train 59, with 207 passengers and 21 Amtrak or other railroad employees on board and operating on Illinois Central Railroad (IC) main line tracks, struck and destroyed the loaded trailer of a tractor-semitrailer combination that was traversing the McKnight Road grade crossing in Bourbonnais, Illinois. Both locomotives and 11 of the 14 cars in the Amtrak consist derailed. The derailed Amtrak cars struck 2 of 10 freight cars that were standing on an adjacent siding. The accident resulted in 11 deaths and 122 people being transported to local hospitals. Total Amtrak equipment damages were estimated at $14 million, and damages to track and associated structures were estimated to be about $295,000.[1]

The National Transportation Safety Board determined that the probable cause of the collision between Amtrak train 59 and a truck tractor-semitrailer combination vehicle at the McKnight Road grade crossing in Bourbonnais, Illinois, was the truckdriver's inappropriate response to the grade crossing warning devices and his judgment, likely impaired by fatigue, that he could cross the tracks before the arrival of the train. Contributing to the accident was Melco Tranfer, Inc.'s failure to provide driver oversight sufficient to detect or prevent driver fatigue as a result of excessive driving or on-duty periods.

Following the collision at McKnight Road, the Canadian National/Illinois Central railroad installed video cameras and recording equipment at McKnight Road and several nearby crossings. Several events at these crossings have since been called to the attention of the Safety Board. In one, occurring in August 2000, a truck queued in traffic at St. George Road, the crossing immediately to the north of McKnight Road, stopped on the tracks. While the truck was stopped on the tracks, a train approached, activating the signals; the gate lowered behind the truck cab. The truckdriver succeeded in backing off the tracks but damaged the signal gate. In other instances at McKnight Road, local police received reports that the signal provided inadequate warning time. Review of the video tapes has shown that only one of these reported incidents was truly a delayed activation, which was caused by a broken bond wire in a switch

[1] For more information, see National Transportation Safety Board, *Collision of National Railroad Passenger Corporation (Amtrak) Train 59 With a Loaded Truck-Semitrailer Combination at a Highway/Rail Grade Crossing in Bourbonnais, Illinois, March 15, 1999*, Railroad Accident Report RAR/NTSB-02/01 (Washington, D.C.; NTSB, 2002).

south of the crossing. In the other instances, review of the tapes shows either warning times in excess of the Federally required minimum time, or truckdrivers entering the crossing in violation of the already activated signals.

The Safety Board is pleased to note the steps that have been taken in Illinois and nationwide to improve grade crossing safety through better enforcement of traffic laws at grade crossings. For example, not only do new Federal regulations promulgated in 1999 prevent States from granting a provisional, probationary, or other temporary license to a commercial driver's license (CDL) holder whose CDL has been suspended,[2] the new regulations require CDL suspension for a driver convicted of a grade crossing violation. Further, current Illinois State law provides that motorists convicted of grade crossing violations may be fined up to $500. In the case of CDL holders, both the fine and the potential loss of income (by CDL suspension) should provide an incentive for CDL holders to exercise greater caution at grade crossings.

But while greater penalties for grade crossing violations are welcomed, their deterrent effect can be undermined if motorists perceive that they face little threat of detection or apprehension. To address this problem, some States, localities, and other entities have developed innovative ways of approaching grade crossing enforcement. For example, Operation Lifesaver[3] organizations in several States have conducted programs to place law officers on trains and at stationary locations along the trains' routes. The officers at the stationary locations stop and ticket those motorists identified by on-board officers as having violated traffic control devices at crossings. While programs such as this can increase law enforcement awareness of grade crossing violations, in some States they are conducted only sporadically. As noted above, motorists who encounter what is, at best, limited and intermittent enforcement of traffic laws at grade crossings may conclude that it is possible to violate those traffic laws with some impunity.

To increase the likelihood that grade crossing violations will not go undetected, some States, municipalities, and railroads have turned to the use of photo enforcement at grade crossings. In use throughout the world for more than 40 years,[4] photo enforcement technology such as that used for identifying and citing those who run red lights has recently been adapted for use at grade crossings. In 1995, for example, the Los Angeles Metropolitan Transportation Authority (MTA) began a photo enforcement program that has been credited with reducing by almost 50 percent the number of grade crossing violations detected at 17 gated crossings along the Metro Blue Line route.[5] Encouraged by the program's success, the MTA is planning to expand its use of photo enforcement by installing six more crossing video systems during the first half of 2002.

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[2] The accident truckdriver was operating the vehicle under a 60-day probationary license that had been issued in January 1999 after his CDL was suspended for 90 days because of three traffic citations within a 1-year period.

[3] Operation Lifesaver is a not-for-profit organization that provides information about grade crossing safety to motor vehicle operators, as well as to law enforcement agencies, through safety education programs.

[4] <http://www.photocop.com> is a non-commercial web site providing research and technical information about photo enforcement.

[5] Metropolitan Transportation Authority, *New Signs, Cameras Reducing Accidents, Illegal Crossings on Metro Blue Line*, MTA News <http://www.mta.net/press/stakeholders/scoop_stories/leftturn_trains.htm>.

A grade crossing photo enforcement pilot program has also recently been established in Illinois. The Illinois General Assembly in 1996 required the Illinois Commerce Commission to conduct a study of the effectiveness of photo enforcement at grade crossings. According to the commission, it selected three grade crossings in DuPage County, Illinois, for the test. Because of difficulties in establishing contracts, as well as construction problems, the three sites were completed at different times. Fully functional in January 2000, photo enforcement at the grade crossing in the city of Wood Dale achieved a 47-percent decrease in the number of violations between January and September 2000. This crossing, which had formerly experienced three to four collisions per year had only one collision in the pilot program's first 13 months of operation. Photo enforcement at the grade crossing in the city of Naperville was functional in July 2000, and the crossing has seen a 51-percent reduction in the number of violations.

According to the Federal Railroad Administration, the State of North Carolina has established, with Federal assistance, a program to eliminate grade crossing hazards as part of an attempt to develop a high-speed rail corridor within its borders.[6] Known as the Sealed Corridor Initiative, the program calls for the improvement or closure of every crossing along the proposed corridor. The plans include installation of four-quadrant gates, longer gate arms, and median barriers as well as video enforcement of grade crossing traffic laws. The testing of the video enforcement project has recently begun.

In the Safety Board's 1998 grade crossing safety study,[7] the Safety Board noted the sporadic nature of traffic law enforcement at passive crossings (those without train-activated warning devices). In order to promote better law enforcement at passive crossings, the Safety Board issued the following safety recommendation to the Secretary of Transportation:

> H-98-29
> Provide Federal highway safety incentive grants to States to advance innovative pilot programs designed to increase enforcement of passive grade crossing traffic laws.

After the Department of Transportation indicated that it had made inquiries to State and local law enforcement for suggestions regarding enforcement programs, the Safety Board classified Safety Recommendation H-98-29 "Open—Acceptable Response."

Whereas this recommendation was directed to enforcement at passive grade crossings, this accident, as well as subsequent violations recorded at the McKnight Road and St. George Road grade crossings, indicates that grade crossings equipped with train-activated warning devices could also benefit from innovative enforcement programs such as the photo enforcement programs employed in several locations. The Safety Board therefore makes the following safety recommendation to the Department of Transportation:

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[6] <http://www.fra.dot.gov/o/hsgt/states/NC2.htm> on January 16, 2002.

[7] National Transportation Safety Board, *Safety at Passive Grade Crossings, Volumes I and II*, NTSB Safety Study Nos. NTSB/SS-98/02 (Vol. I: Analysis) and NTSB/SS-98/03 (Vol. II: Case Summaries) (Washington, D.C.: NTSB, 1998).

Provide Federal highway safety incentive grants to States to advance innovative pilot programs designed to increase enforcement of grade crossing traffic laws at both active and passive crossings. (H-02-1)

This recommendation replaces Safety Recommendation H-98-29, which has been reclassified "Closed—Superseded."

The Safety Board also issued safety recommendations to the Federal Railroad Administration, all class I and regional railroads, Amtrak, the International Association of Fire Fighters, and the International Association of Fire Chiefs.

Please refer to Safety Recommendation H-02-1 in your reply. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 15, 2002

In reply refer to: R-02-1

Mr. Allan Rutter
Administrator
Federal Railroad Administration
1120 Vermont Avenue, N.W.
Washington, D.C. 20590

About 9:47 p.m. on March 15, 1999, National Railroad Passenger Corporation (Amtrak) train 59, with 207 passengers and 21 Amtrak or other railroad employees on board and operating on Illinois Central Railroad (IC) main line tracks, struck and destroyed the loaded trailer of a tractor-semitrailer combination that was traversing the McKnight Road grade crossing in Bourbonnais, Illinois. Both locomotives and 11 of the 14 cars in the Amtrak consist derailed. The derailed Amtrak cars struck 2 of 10 freight cars that were standing on an adjacent siding. The accident resulted in 11 deaths and 122 people being transported to local hospitals. Total Amtrak equipment damages were estimated at $14 million, and damages to track and associated structures were estimated to be about $295,000.[1]

The National Transportation Safety Board determined that the probable cause of the collision between Amtrak train 59 and a truck tractor-semitrailer combination vehicle at the McKnight Road grade crossing in Bourbonnais, Illinois, was the truckdriver's inappropriate response to the grade crossing warning devices and his judgment, likely impaired by fatigue, that he could cross the tracks before the arrival of the train. Contributing to the accident was Melco Tranfer, Inc.'s failure to provide driver oversight sufficient to detect or prevent driver fatigue as a result of excessive driving or on-duty periods.

The truckdriver stated that as he approached the grade crossing on the night of the accident, he saw the crossing signal lights illuminate. He said that because of his proximity to the crossing when the lights activated, his best course of action was to accelerate across the tracks before the train arrived.

The only scenario under which the time from activation of the warning signals until the arrival of the train would not have allowed the truckdriver to either stop his truck short of the crossing or accelerate safely across would involve some malfunction of the signal warning system. However, postaccident testing of the lights found no evidence that they were not

[1] For more information, see National Transportation Safety Board, *Collision of National Railroad Passenger Corporation (Amtrak) Train 59 With a Loaded Truck-Semitrailer Combination at a Highway/Rail Grade Crossing in Bourbonnais, Illinois, March 15, 1999*, Railroad Accident Report RAR/NTSB-02/01 (Washington, D.C.; NTSB, 2002).

operating as designed, and the Safety Board concluded that the grade crossing signal lights began flashing at least 26 seconds before the train's arrival at the McKnight Road grade crossing.

Witness statements offered conflicting information about the position of the crossing gates in the moments before the accident. Crossing gates typically begin to lower within 4 to 5 seconds after the warning lights activate. Although data downloaded from the signal system event recorder for the accident crossing showed that a lowering of the gates was initiated, the information captured by the event recorder did not include the actual position of the gates.

Where highway/railroad grade crossing signal systems are equipped with event recorders, it is often possible to put in place a method to detect whether the gate has descended fully. The method of detection is sometimes as simple as an electrical contact made when the gate reaches the horizontal. Such a system may aid signal maintainers and inspectors, enabling them to see clear recorded evidence of signal malfunctions before accidents occur. As noted above, however, the accident crossing in Bourbonnais was not equipped with a gate position detection system.

The Safety Board notes that all modern electronic warning signal systems may be equipped easily with signal event recorders and that almost all the warning systems installed as new or as upgrades by class I railroads are equipped with such devices. These recorders may or may not, however, capture the actual deployed gate position for those systems that are equipped with gates. For example, while all the warning systems installed or upgraded by the Canadian National/Illinois Central (CNIC) Railroad since 1995 have been equipped with signal event recorders, only after the Bourbonnais accident did the company specify that its newly purchased systems be required to capture gate position (horizontal or other than horizontal). According to CNIC officials, about 60 to 75 of the company's crossing signal event recorders now record this data. Some other class I railroads, notably the Burlington Northern/Santa Fe, also use event recorders that capture gate position information.[2]

In the view of the Safety Board, determination of actual crossing gate position is important not only because it facilitates accident reconstruction but also because it can help railroads detect and correct warning system defects or anomalies before they become a hazard to the public. While, as noted above, some railroads already recognize the benefits of gate position information and are installing event recorders that capture such data, other railroads are less aggressive in pursuing this option as they install new or upgraded systems. The Federal Railroad Administration, while not requiring that grade crossing warning systems be equipped with signal event recorders, can nonetheless play a role in ensuring that those systems that are in place provide gate position information.

The National Transportation Safety Board therefore makes the following safety recommendation to the Federal Railroad Administration:

> For all railroads that install new or upgraded grade crossing warning systems that include crossing gates and that are equipped with event recorders, require that the information captured by those event recorders include the position of the deployed gates. (R-02-1)

[2] The Burlington Northern/Santa Fe Railroad event recorders that capture gate position indicate whether the gate is vertical (between 83 and 90 degrees) or horizontal (between 0 and 5 degrees).

The Safety Board also issued safety recommendations to the Department of Transportation, all class I and regional railroads, Amtrak, the International Association of Fire Fighters, and the International Association of Fire Chiefs.

Please refer to Safety Recommendation R-02-1 in your reply. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 15, 2002

In reply refer to: R-02-2

To all Class I and Regional Railroads (See attached list)

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendation in this letter. The Safety Board is vitally interested in this recommendation because it is designed to prevent accidents and save lives.

This recommendation addresses the issue of grade crossing warning signal performance and is derived from the Safety Board's investigation of the March 15, 1999, grade crossing accident in Bourbonnais, Illinois, and is consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued five safety recommendations, one of which is addressed to all class I and regional railroads. Information supporting this recommendation is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

About 9:47 p.m. on March 15, 1999, National Railroad Passenger Corporation (Amtrak) train 59, with 207 passengers and 21 Amtrak or other railroad employees on board and operating on Illinois Central Railroad (IC) main line tracks, struck and destroyed the loaded trailer of a tractor-semitrailer combination that was traversing the McKnight Road grade crossing in Bourbonnais, Illinois. Both locomotives and 11 of the 14 cars in the Amtrak consist derailed. The derailed Amtrak cars struck 2 of 10 freight cars that were standing on an adjacent siding. The accident resulted in 11 deaths and 122 people being transported to local hospitals. Total Amtrak equipment damages were estimated at $14 million, and damages to track and associated structures were estimated to be about $295,000.[1]

The National Transportation Safety Board determined that the probable cause of the collision between Amtrak train 59 and a truck tractor-semitrailer combination vehicle at the McKnight Road grade crossing in Bourbonnais, Illinois, was the truckdriver's inappropriate response to the grade crossing warning devices and his judgment, likely impaired by fatigue, that he could cross the tracks before the arrival of the train. Contributing to the accident was Melco

[1] For more information, see National Transportation Safety Board, *Collision of National Railroad Passenger Corporation (Amtrak) Train 59 With a Loaded Truck-Semitrailer Combination at a Highway/Rail Grade Crossing in Bourbonnais, Illinois, March 15, 1999*, Railroad Accident Report RAR/NTSB-02/01 (Washington, D.C.; NTSB, 2002).

Tranfer, Inc.'s failure to provide driver oversight sufficient to detect or prevent driver fatigue as a result of excessive driving or on-duty periods.

The truckdriver stated that as he approached the grade crossing on the night of the accident, he saw the crossing signal lights illuminate. He said that because of his proximity to the crossing when the lights activated, his best course of action was to accelerate across the tracks before the train arrived.

The only scenario under which the time from activation of the warning signals until the arrival of the train would not have allowed the truckdriver to either stop his truck short of the crossing or accelerate safely across would involve some malfunction of the signal warning system. However, postaccident testing of the lights found no evidence that they were not operating as designed, and the Safety Board concluded that the grade crossing signal lights began flashing at least 26 seconds before the train's arrival at the McKnight Road grade crossing.

Witness statements offered conflicting information about the position of the crossing gates in the moments before the accident. Crossing gates typically begin to lower within 4 to 5 seconds after the warning lights activate. Although data downloaded from the signal system event recorder for the accident crossing showed that a lowering of the gates was initiated, the information captured by the event recorder did not include the actual position of the gates.

Where highway/railroad grade crossing signal systems are equipped with event recorders, it is often possible to put in place a method to detect whether the gate has descended fully. The method of detection is sometimes as simple as an electrical contact made when the gate reaches the horizontal. Such a system may aid signal maintainers and inspectors, enabling them to see clear recorded evidence of signal malfunctions before accidents occur. As noted above, however, the accident crossing in Bourbonnais was not equipped with a gate position detection system.

The Safety Board notes that all modern electronic warning signal systems may be equipped easily with signal event recorders and that almost all the warning systems installed as new or as upgrades by class I railroads are equipped with such devices. These recorders may or may not, however, capture the actual deployed gate position for those systems that are equipped with gates. For example, while all the warning systems installed or upgraded by the Canadian National/Illinois Central (CNIC) Railroad since 1995 have been equipped with signal event recorders, only after the Bourbonnais accident did the company specify that its newly purchased systems be required to capture gate position (horizontal or other than horizontal). According to CNIC officials, about 60 to 75 of the company's crossing signal event recorders now record this data. Some other class I railroads, notably the Burlington Northern/Santa Fe, also use event recorders that capture gate position information.[2]

In the view of the Safety Board, determination of actual crossing gate position is important not only because it facilitates accident reconstruction but also because it can help railroads detect and correct warning system defects or anomalies before they become a hazard to the public. While, as noted above, some railroads already recognize the benefits of gate position information and are installing event recorders that capture such data, other railroads are less

[2] The Burlington Northern/Santa Fe Railroad event recorders that capture gate position indicate whether the gate is vertical (between 83 and 90 degrees) or horizontal (between 0 and 5 degrees).

aggressive in pursuing this option as they install new or upgraded systems. The Safety Board believes that the Federal Railroad Administration, while not requiring that grade crossing warning systems be equipped with signal event recorders, can nonetheless play a role in ensuring that those systems that are in place provide gate position information. The National Transportation Safety Board therefore has made the following safety recommendation to the Federal Railroad Administration:

> For all railroads that install new or upgraded grade crossing warning systems that include crossing gates and that are equipped with event recorders, require that the information captured by those event recorders include the position of the deployed gates. (R-02-1)

In the interim, nothing prevents railroads that have not done so from following the lead of other carriers in regard to obtaining gate position information for those crossings equipped with new or upgraded warning systems that have both gates and event recorders.

The Safety Board therefore makes the following safety recommendation to all class I and regional railroads:

> For all your new and upgraded grade crossing warning systems that include crossing gates and that are equipped with event recorders, ensure that the information captured by those event recorders includes the position of the deployed gates. (R-02-2)

The Safety Board also issued safety recommendations to the Department of Transportation, Amtrak, the International Association of Fire Fighters, and the International Association of Fire Chiefs. In your response to the recommendation in this letter, please refer to Safety Recommendation R-02-2. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Marion C. Blakey
Chairman

Class I Railroads Distribution List

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Mr. Robert D. Krebs
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PO Box 961052
Fort Worth, Texas 76161-0052

Mr. Paul Tellier
President and Chief Executive Officer
Canadian National Railway
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Mr. A. R. Carpenter
President and Chief Executive Officer
CSX Transportation, Inc.
500 Water Street, J-100
Jacksonville, Florida 32202

Mr. Robert J. Ritchie
President and Chief Executive Officer
Canadian Pacific Railway
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Mr. Landon H. Rowland
President and Chief Executive Officer
The Kansas City Southern Railway Co.
Stilwell Financial, Inc.
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Mr. Richard K. Davidson
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Union Pacific Corporation
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Regional Railroads Distribution List

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Mr. David L. Smoot
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Mr. William H. Brodsky
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Mr. Anthony V. Reck
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Mr. John E. West, III
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Utah Railway Company
340 Hardscrabble Road
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Mr. Larry Parsons
Chairman and Chief Executive Officer
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100 East First Street
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Mr. J. Reilly McCarren
President and Chief Executive Officer
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P.O. Box 5062
Rosemont, Illinois 60017-5062

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 15, 2002

In reply refer to: R-02-3

Mr. George Warrington
President and Chief Executive Officer
National Railroad Passenger Corporation
60 Massachusetts Avenue, N.E.
Washington, D.C. 20002

About 9:47 p.m. on March 15, 1999, National Railroad Passenger Corporation (Amtrak) train 59, with 207 passengers and 21 Amtrak or other railroad employees on board and operating on Illinois Central Railroad (IC) main line tracks, struck and destroyed the loaded trailer of a tractor-semitrailer combination that was traversing the McKnight Road grade crossing in Bourbonnais, Illinois. Both locomotives and 11 of the 14 cars in the Amtrak consist derailed. The derailed Amtrak cars struck 2 of 10 freight cars that were standing on an adjacent siding. The accident resulted in 11 deaths and 122 people being transported to local hospitals. Total Amtrak equipment damages were estimated at $14 million, and damages to track and associated structures were estimated to be about $295,000.[1]

About 9:51 p.m., an officer of the Bourbonnais Police Department, who had overheard the initial radio notification of the accident while on routine patrol, arrived at the accident scene. At about the same time, a Bradley Police Department officer arrived on the east side of the tracks. The Bourbonnais police officer reported that a locomotive was on fire and that a number of Amtrak passenger cars had derailed. He observed that the fire was growing, and that it was working its way toward the rear of the locomotive, where a sleeper car (No. 32035) had come to rest. He radioed for additional emergency response support, and he and the Bradley police officer began helping to evacuate the passenger cars. Within a short time, more police units responded, and officers began evacuating passengers wherever they could.

The chief of the Bourbonnais Fire Protection District received the call to dispatch while on scene at a previous response call. While en route to the accident scene, he overheard radio transmissions from responders already at the scene. As incident commander, he radioed a “box alarm” to summon emergency equipment and personnel. He arrived at the accident scene at about 9:52 p.m. Upon arrival, he conducted an initial assessment of the situation and identified the locomotive fire and the necessity for passenger evacuation. About 10:05 p.m., he placed a

[1] For more information, see National Transportation Safety Board, *Collision of National Railroad Passenger Corporation (Amtrak) Train 59 With A Loaded Truck-Semitrailer combination at a Highway/Rail Grade Crossing in Bourbonnais, Illinois, March 15, 1999*, Railroad Accident Report RAR/NTSB-02/01 (Washington, D.C.; NTSB, 2002).

radio call for additional mutual aid emergency response support. The chief then established a fire department field command post at the initial staging area.[2]

About 9:53 p.m., the first ambulances arrived at the scene. About 9:59 p.m., Bourbonnais Fire Protection District Squad 62 arrived at the scene. The squad 62 truck had a water capacity of 500 gallons dispersed through 1 3/4-inch hose lines. The truck was also equipped with 5-gallon fire suppression foam containers.[3] Firefighters then began hand-line water and foam application on the burning locomotive, but they were unable to put out the fire before exhausting their water supply.

About 10:00 p.m., Bourbonnais Fire Protection District Engine 61, a pumper truck carrying about 2,000 feet of 5-inch hose line, arrived at a water hydrant about 2,600 feet from the site of the fire. Firefighters laid out the full length of the hose on their truck, then went to the accident scene. A second pumper truck connected the additional hose line needed to reach the fire scene.

About 10:22 p.m., incident command issued a radio request to responding agencies seeking fire suppression foam. Several units responded, but each carried a small number of 5-gallon containers of foam and eductor systems designed to mix the foam with water for application to a fire.

About 10:24 p.m., the 5-inch hose supply line that was laid along the unpaved road was fully charged and supplying water at the west side of the site. Fire suppression on the burning locomotive recommenced shortly thereafter.

A responding Braidwood Fire Department officer, who was also the emergency response administrator of a petrochemical operation in Elwood, Illinois, said that shortly after he arrived on scene about 10:40 p.m., he recognized that the fire suppression foam at the scene was almost exhausted. He said he also realized that the fire suppression effort had not been effective in extinguishing the locomotive fire. The fire, as he observed it, was “3-dimensional” and petroleum-based, and it remained entrenched within the upper confines of the locomotive carbody wreckage, which made suppression access particularly difficult. He stated that he believed the strategy being used up to that point was having only limited success, because the fire would be extinguished in one location, only to re-ignite in an adjacent location and flash back to the original location. Further, the fire was directly impinging upon and passing beneath the still-occupied sleeper car 32035.

From this, the Braidwood officer concluded that the application of a large volume of fire suppression foam might be an effective attack strategy and that, therefore, a heavy foam tanker truck from the nearest available facility should be used. The Braidwood officer discussed with the incident commander the possibility of organizing a mutual aid heavy foam tanker truck response to the scene.

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[2] Although there is no record of a radio transmission to this effect, incident command participants reported to the Safety Board that the establishment of the command post was understood.

[3] Refers to 5-gallon containers of aqueous film-forming foam or similar foam concentrate.

The incident commander concurred with this proposed strategy, and the Braidwood officer immediately placed a cellular telephone call asking that a heavy foam tanker truck and personnel from the Stepan Chemical Company near Joliet, Illinois, be dispatched to the accident site. The officer arranged for a similar request to be made to a Mobil Oil refinery. Both facilities are about 35 miles away from the accident scene, and the officer anticipated that the trucks might require about 45 minutes to arrive.

About 10:47 p.m., the Braidwood Fire Department heavy rescue truck arrived at the west side staging area. It was then used as a fire suppression field command post.

About 10:55 p.m., incident command issued a request to all responding agencies for all available water tanker truck support.

About 11:19 p.m., incident command radioed that the main body of the fire on the east side of the scene appeared to have been "knocked down," which suggested that the fire was somewhat in control, although not extinguished, in that area.

About 11:30 p.m., a heavy foam tanker truck from Stepan Chemical Company arrived and was directed to the west side staging area. About 11:45 p.m., the foam tanker truck reached the west side staging area and set up near the wreckage pileup. The Braidwood Fire Department officer who organized the Stepan response directed that water supply connections be made to one of the pumper trucks stationed at that location and that fire suppression by hand-line commence immediately. Fire suppression water/foam solution was applied to the main body of the fire in the proximity of the locomotive and the sleeper car until the fire was extinguished; the fire was out within a few minutes. Water/foam solution application continued periodically thereafter, because firefighters were concerned that hot metal in the wreckage might re-ignite the fire.

Several minor rekindle events occurred in the wreckage at times throughout the night; the fires were quickly extinguished by firefighting crews that remained on the scene. The fire was completely extinguished by dawn on March 16.

According to the requirements of 49 *Code of Federal Regulations* 239.101(a)(5), every passenger railroad and every railroad hosting passenger train service must jointly adopt a single emergency preparedness plan describing the procedures to be followed in an emergency. The regulation requires that each railroad organize a liaison with emergency responders in order to familiarize these emergency responders with the passenger railroad equipment, facilities, and communications interfaces.

In order to implement the emergency response liaison element of its emergency preparedness plan, Amtrak provides, upon request, an instructional information/training program for those local agencies most likely to respond to an Amtrak emergency. This training program includes training materials such as manuals and an instructional videotape. In addition, Amtrak offers on-site instruction sessions during which a representative of the railroad gives a training course directly to the local emergency response agencies. This training course is provided whenever possible. Amtrak, however, notes that it operates through regions that encompass about 15,000 emergency response agencies and that, because of limited resources, on-site training is not provided for all agencies that may be called upon to respond to an Amtrak emergency. For example, before the accident, Amtrak had not provided any on-site instruction or

training to the Bourbonnais Fire Protection District or to other Kankakee County emergency responders. Amtrak did conduct passenger train emergency response training in Kankakee County, Illinois, after the accident, on November 12 and 13, 1999.

The effectiveness of emergency response is affected by the preparations made by local jurisdiction responders and by the railroads involved. Because Amtrak is not able to provide on-site training to every emergency response agency within the territories through which it operates, these agencies often face the prospect of responding to a passenger train emergency without any real knowledge about the particular hazards passenger trains may present. In other words, local emergency responders may not know how to gain access to an overturned locomotive or passenger car, may not know where in cars to search for trapped occupants, and may not be aware of the quantities of diesel fuel available to fuel a fire. As noted above, before this accident, neither the Bourbonnais Fire Protection District nor other Kankakee County emergency responders had been provided on-site instruction or training in responding to such emergencies.

The Braidwood Fire Department officer, who arrived about 50 minutes after the first emergency responder, was familiar with petrochemical fires and recognized almost immediately that a large amount of foam was necessary to combat the blaze. He called for heavy foam tanker trucks to come from a local chemical plant, and a foam tanker arrived and was set up about 1 hour later. Within a few minutes of this equipment beginning to apply foam, the fire was extinguished. Before the arrival of the Braidwood officer, on the other hand, the incident commander had directed firefighting operations that had proved ineffective at either extinguishing the flames or at keeping the fire away from the sleeper car in which occupants were entrapped. The Safety Board concluded that because of insufficient training in responding to railroad emergencies or inadequate/inappropriate resources, or both, the Bourbonnais Fire Protection District was not prepared to respond effectively to a train accident involving a significant diesel fuel fire.

Even though modern locomotives, such as the ones involved in this accident, are designed with improved protection for fuel tanks, the possibility of a fuel leak and fire is present anywhere a major railroad accident occurs.

The National Transportation Safety Board therefore makes the following safety recommendation to the National Railroad Passenger Corporation:

> In fulfilling your Federal mandate to help prepare emergency responders to respond to an accident involving Amtrak equipment, emphasize to those responders the possibility that such an accident could result in large quantities of burning diesel fuel and urge them to be prepared to respond to this specific hazard. (R-02-3)

The Safety Board also issued safety recommendations to the Department of Transportation, the Federal Railroad Administration, all class I and regional railroads, the International Association of Fire Fighters, and the International Association of Fire Chiefs.

Please refer to Safety Recommendation R-02-3 in your reply. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 15, 2002

In reply refer to: R-02-4

Mr. Garry L. Briese
Executive Director
International Association of Fire Chiefs
4025 Fair Ridge Drive
Fairfax, Virginia 22033-2868

Mr. Harold A. Schaitberger
General President
International Association of Fire Fighters
1750 New York Avenue, N.W.
Washington, D.C. 20006

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendation in this letter. The Safety Board is vitally interested in this recommendation because it is designed to prevent accidents and save lives.

This recommendation addresses the issue of emergency response and is derived from the Safety Board's investigation of the March 15, 1999, grade crossing accident in Bourbonnais, Illinois, and is consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued five safety recommendations, one of which is addressed to the International Association of Fire Chiefs and the International Association of Fire Fighters. Information supporting this recommendation is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

About 9:47 p.m. on March 15, 1999, National Railroad Passenger Corporation (Amtrak) train 59, with 207 passengers and 21 Amtrak or other railroad employees on board and operating on Illinois Central Railroad (IC) main line tracks, struck and destroyed the loaded trailer of a tractor-semitrailer combination that was traversing the McKnight Road grade crossing in Bourbonnais, Illinois. Both locomotives and 11 of the 14 cars in the Amtrak consist derailed. The derailed Amtrak cars struck 2 of 10 freight cars that were standing on an adjacent siding. The accident resulted in 11 deaths and 122 people being transported to local hospitals. Total Amtrak equipment damages were estimated at $14 million, and damages to track and associated structures were estimated to be about $295,000.[1]

[1] For more information, see National Transportation Safety Board, *Collision of National Railroad Passenger Corporation (Amtrak) Train 59 With A Loaded Truck-Semitrailer combination at a Highway/Rail Grade Crossing in Bourbonnais, Illinois, March 15, 1999*, Railroad Accident Report RAR/NTSB-02/01 (Washington, D.C.; NTSB, 2002).

About 9:51 p.m., an officer of the Bourbonnais Police Department, who had overheard the initial radio notification of the accident while on routine patrol, arrived at the accident scene. At about the same time, a Bradley Police Department officer arrived on the east side of the tracks. The Bourbonnais police officer reported that a locomotive was on fire and that a number of Amtrak passenger cars had derailed. He observed that the fire was growing, and that it was working its way toward the rear of the locomotive, where a sleeper car (No. 32035) had come to rest. He radioed for additional emergency response support, and he and the Bradley police officer began helping to evacuate the passenger cars. Within a short time, more police units responded, and officers began evacuating passengers wherever they could.

The chief of the Bourbonnais Fire Protection District received the call to dispatch while on scene at a previous response call. While en route to the accident scene, he overheard radio transmissions from responders already at the scene. As incident commander, he radioed a "box alarm" to summon emergency equipment and personnel. He arrived at the accident scene at about 9:52 p.m. Upon arrival, he conducted an initial assessment of the situation and identified the locomotive fire and the necessity for passenger evacuation. About 10:05 p.m., he placed a radio call for additional mutual aid emergency response support. The chief then established a fire department field command post at the initial staging area.[2]

About 9:53 p.m., the first ambulances arrived at the scene. About 9:59 p.m., Bourbonnais Fire Protection District Squad 62 arrived at the scene. The squad 62 truck had a water capacity of 500 gallons dispersed through 1 3/4-inch hose lines. The truck was also equipped with 5-gallon fire suppression foam containers.[3] Firefighters then began hand-line water and foam application on the burning locomotive, but they were unable to put out the fire before exhausting their water supply.

About 10:00 p.m., Bourbonnais Fire Protection District Engine 61, a pumper truck carrying about 2,000 feet of 5-inch hose line, arrived at a water hydrant about 2,600 feet from the site of the fire. Firefighters laid out the full length of the hose on their truck, then went to the accident scene. A second pumper truck connected the additional hose line needed to reach the fire scene.

About 10:22 p.m., incident command issued a radio request to responding agencies seeking fire suppression foam. Several units responded, but each carried a small number of 5-gallon containers of foam and eductor systems designed to mix the foam with water for application to a fire.

About 10:24 p.m., the 5-inch hose supply line that was laid along the unpaved road was fully charged and supplying water at the west side of the site. Fire suppression on the burning locomotive recommenced shortly thereafter.

A responding Braidwood Fire Department officer, who was also the emergency response administrator of a petrochemical operation in Elwood, Illinois, said that shortly after he arrived on scene about 10:40 p.m., he recognized that the fire suppression foam at the scene was almost

[2] Although there is no record of a radio transmission to this effect, incident command participants reported to the Safety Board that the establishment of the command post was understood.

[3] Refers to 5-gallon containers of aqueous film-forming foam or similar foam concentrate.

exhausted. He said he also realized that the fire suppression effort had not been effective in extinguishing the locomotive fire. The fire, as he observed it, was "3-dimensional" and petroleum-based, and it remained entrenched within the upper confines of the locomotive carbody wreckage, which made suppression access particularly difficult. He stated that he believed the strategy being used up to that point was having only limited success, because the fire would be extinguished in one location, only to re-ignite in an adjacent location and flash back to the original location. Further, the fire was directly impinging upon and passing beneath the still-occupied sleeper car 32035.

From this, the Braidwood officer concluded that the application of a large volume of fire suppression foam might be an effective attack strategy and that, therefore, a heavy foam tanker truck from the nearest available facility should be used. The Braidwood officer discussed with the incident commander the possibility of organizing a mutual aid heavy foam tanker truck response to the scene.

The incident commander concurred with this proposed strategy, and the Braidwood officer immediately placed a cellular telephone call asking that a heavy foam tanker truck and personnel from the Stepan Chemical Company near Joliet, Illinois, be dispatched to the accident site. The officer arranged for a similar request to be made to a Mobil Oil refinery. Both facilities are about 35 miles away from the accident scene, and the officer anticipated that the trucks might require about 45 minutes to arrive.

About 10:47 p.m., the Braidwood Fire Department heavy rescue truck arrived at the west side staging area. It was then used as a fire suppression field command post.

About 10:55 p.m., incident command issued a request to all responding agencies for all available water tanker truck support.

About 11:19 p.m., incident command radioed that the main body of the fire on the east side of the scene appeared to have been "knocked down," which suggested that the fire was somewhat in control, although not extinguished, in that area.

About 11:30 p.m., a heavy foam tanker truck from Stepan Chemical Company arrived and was directed to the west side staging area. About 11:45 p.m., the foam tanker truck reached the west side staging area and set up near the wreckage pileup. The Braidwood Fire Department officer who organized the Stepan response directed that water supply connections be made to one of the pumper trucks stationed at that location and that fire suppression by hand-line commence immediately. Fire suppression water/foam solution was applied to the main body of the fire in the proximity of the locomotive and the sleeper car until the fire was extinguished; the fire was out within a few minutes. Water/foam solution application continued periodically thereafter, because firefighters were concerned that hot metal in the wreckage might re-ignite the fire.

Several minor rekindle events occurred in the wreckage at times throughout the night; the fires were quickly extinguished by firefighting crews that remained on the scene. The fire was completely extinguished by dawn on March 16.

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emergency preparedness plan describing the procedures to be followed in an emergency. The regulation requires that each railroad organize a liaison with emergency responders in order to familiarize these emergency responders with the passenger railroad equipment, facilities, and communications interfaces.

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Even though modern locomotives, such as the ones involved in this accident, are designed with improved protection for fuel tanks, the possibility of a fuel leak and fire is present anywhere a major railroad accident occurs. The National Transportation Safety Board therefore has made the following safety recommendation to Amtrak:

> In fulfilling your Federal mandate to help prepare emergency responders to respond to an accident involving Amtrak equipment, emphasize to those responders the possibility that such an accident could result in large quantities of burning diesel fuel and urge them to be prepared to respond to this specific hazard. (R-02-3)

The Safety Board also believes that your organizations can play a role in helping to ensure that emergency responders are better prepared for the hazards that may be associated with a railroad accident. The National Transportation Safety Board therefore makes the following safety recommendation to the International Association of Fire Chiefs and the International Association of Fire Fighters:

> Inform your membership of the circumstances surrounding this accident and of the need for responders to prepare for train accidents that may result in significant diesel fuel fires. (R-02-4)

The Safety Board also issued safety recommendations to the Department of Transportation, the Federal Railroad Administration, and all class I and regional railroads. In your response to the recommendation in this letter, please refer to Safety Recommendation R-02-4. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Marion C. Blakey
Chairman