Runway Overrun
American Airlines Flight 2253
Boeing 757-200, N668AA
Jackson Hole, Wyoming
December 29, 2010

Incident Report

NTSB/AAR-12/01
PB2012-910401

National
Transportation
Safety Board

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Abstract: This report discusses the December 29, 2010, incident involving American Airlines flight 2253, a Boeing 757-200, N668AA, which ran off the departure end of runway 19 and came to a stop in deep snow after landing at Jackson Hole Airport, Jackson Hole, Wyoming. The occupants were not injured, and the airplane sustained minor damage.

Safety issues identified in this incident include the following: inadequate pilot training for recognition of a situation in which the speedbrakes do not automatically deploy as expected after landing, lack of an alert to warn pilots when speedbrakes have not automatically deployed during the landing roll, lack of guidance for pilots of certain Boeing airplanes to follow when an unintended thrust reverser lockout occurs, lack of pilot training for multiple emergency and abnormal situations, and lack of pilot training emphasizing monitoring skills and workload management. As a result of this investigation, three new safety recommendations are issued and three existing safety recommendations are reiterated to the Federal Aviation Administration.

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Abbreviations and Acronyms

AC	advisory circular
CFR	*Code of Federal Regulations*
CVR	cockpit voice recorder
EICAS	engine indication and crew alerting system
FAA	Federal Aviation Administration
FDR	flight data recorder
JAC	Jackson Hole Airport
MLG	main landing gear
MU	unit used to designate a friction value representing runway surface conditions
NPRM	notice of proposed rulemaking
NTSB	National Transportation Safety Board
ORD	Chicago O'Hare International Airport
SAFO	Safety Alert for Operators
SNPRM	supplemental notice of proposed rulemaking
SOP	standard operating procedure

Executive Summary

This report discusses the December 29, 2010, incident involving American Airlines flight 2253, a Boeing 757-200, N668AA, which ran off the departure end of runway 19 and came to a stop in deep snow after landing at Jackson Hole Airport (JAC), Jackson Hole, Wyoming. The occupants were not injured, and the airplane sustained minor damage.

The National Transportation Safety Board determines that the probable cause of this incident was a manufacturing defect in a clutch mechanism that prevented the speedbrakes from automatically deploying after touchdown and the captain's failure to monitor and extend the speedbrakes manually. Also causal was the failure of the thrust reversers to deploy when initially commanded. Contributing to the incident was the captain's failure to confirm speedbrake extension before announcing their deployment and his distraction caused by the thrust reversers' failure to initially deploy after landing.

This report addresses increased pilot awareness of and focus on speedbrake and thrust reverser deployment during landing. The incident pilots were familiar with winter operations at JAC and thoroughly assessed the pertinent weather, airport, and airplane performance information while en route to JAC. The pilots determined that they could land safely at JAC using normal deceleration procedures (thrust reversers, speedbrakes, and wheel brakes). However, the precise timing of the unloading of the main landing gear just after touchdown that coincided with the deployment of the thrust reversers resulted in a rare mechanical/hydraulic interaction in the thrust reverser system, and the thrust reversers were locked in transit instead of continuing to deploy. Further, an unrelated defect in the automatic speedbrake mechanism prevented the speedbrakes from automatically deploying. Although the pilots could have manually deployed the speedbrakes at any time during the landing roll, neither pilot recognized that the speedbrakes had not automatically deployed (as selected) because they were both distracted by, confused by, and trying to resolve the thrust reverser nondeployment.

Safety issues identified in this incident include the following:

- **Inadequate pilot training for recognition of a situation in which the speedbrakes do not automatically deploy as expected after landing.** As stated above, the incident pilots did not recognize that the speedbrakes had not automatically deployed after touchdown. This report cites three other events in which the pilots were distracted and did not ensure deployment of the speedbrakes. Prompt speedbrake deployment after touchdown and monitoring of the speedbrake system during the landing roll is especially critical for increased braking effectiveness when landing on short and/or contaminated runways.

- **Lack of an alert to warn pilots when speedbrakes have not automatically deployed during the landing roll.** Although American Airlines had a company requirement for a callout confirming automatic speedbrake deployment after touchdown, the pilots still became distracted from ensuring that the speedbrakes deployed properly. A clearly distinguishable and intelligible alarm would help bring the monitoring pilot's attention back to the speedbrakes and enable him to manually deploy them in case they do not automatically deploy.

- **Lack of guidance for pilots of certain Boeing airplanes to follow when an unintended thrust reverser lockout occurs.** Because of the lockout condition that was created in the thrust reverser system during the incident landing, the flight crew needed to stow the reverse thrust lever to unlock the system before attempting to redeploy the thrust reversers. However, postincident interviews with American Airlines pilots indicated that company pilots were not aware of this technique, and moving the reverse thrust levers to the stow position during the landing roll would not be an intuitive action.

- **Lack of pilot training for multiple emergency and abnormal situations.** About the time that the speedbrakes did not deploy, the thrust reverser system also did not deploy. In this incident, the pilots encountered an abnormal situation when both the speedbrake and thrust reverser systems did not deploy as expected. Although the pilots were not aware of the specific solution to the thrust reverser abnormality, the pilots were aware that they could manually deploy the speedbrakes at any time. However, because of the pilots' focus on and efforts to resolve the thrust reverser anomaly, neither pilot noticed the abnormal speedbrake situation until the airplane had come to a stop off the end of the runway. If the incident pilots had received training on the handling of multiple emergency or abnormal situations, they might not have focused exclusively on the thrust reverser nondeployment and may have recognized the speedbrake nondeployment earlier.

- **Lack of pilot training emphasizing monitoring skills and workload management.** After the first officer attempted to deploy the thrust reversers, the captain took command of the reverse thrust levers. By doing this, the captain deviated from normal company procedures regarding the pilot flying/pilot monitoring responsibilities during the landing roll. If the captain had adhered to his monitoring responsibilities during the landing roll, it is more likely that he would have recognized that the speedbrakes had not automatically deployed and corrected the situation by manually deploying them.

As a result of this investigation, three new safety recommendations are issued and three existing safety recommendations are reiterated to the Federal Aviation Administration.

1. The Incident

On December 29, 2010, about 1138 mountain standard time,[1] American Airlines flight 2253, a Boeing 757-200, N668AA, ran off the departure end of runway 19 after landing at Jackson Hole Airport (JAC),[2] Jackson Hole, Wyoming. The airplane came to rest about 730 feet past the departure end of the runway in deep snow. The 179 passengers, 2 pilots, and 4 flight attendants on board were not injured, and the airplane sustained minor damage. The airplane was registered to and operated by American Airlines as a scheduled domestic flight under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121. Instrument meteorological conditions in light snow prevailed at JAC at the time of the landing, and the flight operated on an instrument flight rules flight plan. The flight originated from Chicago O'Hare International Airport (ORD), Chicago, Illinois, about 0941 central standard time.

Pilot statements and cockpit voice recorder (CVR) data[3] indicated that the first officer was the pilot flying and the captain was the pilot monitoring during the flight from ORD to JAC. During postincident interviews, both pilots stated that they were familiar with the challenging landing conditions that could exist at JAC in the winter (for example, slippery runway conditions and relatively high landing weights,[4] which were common during the ski season). As a result, they said they were especially vigilant and began preparing for the approach and landing at JAC early during what they described as an uneventful flight from ORD to JAC.

According to American Airlines' 757/767 Performance Manual, pilots should confirm landing performance limits just before landing, using the actual runway conditions at the time. If the runway braking action is determined to be less than good,[5] pilots are required to use the company-provided landing charts to confirm that the runway length is adequate for the landing.[6] American Airlines' 757/767 Performance Manual further states that pilots "must use the most adverse reliable and appropriate braking action report or the most adverse expected conditions for the runway, or portion of the runway, that will be used for landing when assessing the required landing distance."

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[1] All times in this report are mountain standard time, unless otherwise noted, based on a 24-hour clock.

[2] The airport is located at an elevation of 6,491 feet. Runway 01/19, the only runway surface at JAC, is 6,300 feet long and 150 feet wide, with runway safety areas at both ends that comply with Federal Aviation Administration (FAA) standards. The runway is paved with porous friction course asphalt and has a -0.6 percent downward slope from north to south, with a drop in elevation of 38 feet.

[3] A partial transcript of the CVR recording is appended.

[4] According to American Airlines' 757/767 Operating Manual, the incident airplane's maximum landing weight was 198,000 pounds. The airplane's actual landing weight for the incident landing was 194,055 pounds.

[5] According to American Airlines' 757/767 Performance Manual, if the landing conditions upon arrival indicate dry or wet/good braking action conditions, no further assessment is required because the company's dispatch requirements "are sufficient to assure adequate performance at the time of landing."

[6] American Airlines requires its pilots to ensure that they will not exceed the runway available, interpolating when using the landing distance charts if needed; however, exact calculations are not required.

The captain gathered the most current information about the JAC weather[7] and runway conditions, including wind, MU[8] runway friction values, and pilot braking action reports. Although the pilot of a corporate jet that landed on runway 19 about 1 hour before the incident airplane reported "poor" braking action on the last one-third of the runway, he also reported "good" braking action on the first two-thirds of the runway.[9] The most current MU friction values for the runway were obtained about 18 minutes before the incident airplane's landing and indicated values of 0.43, 0.43, and 0.39 for the first, second, and third sections of the runway, respectively. The incident pilots also reviewed information about potential delays and/or alternate airports for various circumstances. In addition, the pilots specifically discussed the airplane's performance at high density altitude airports.

After reviewing this information and American Airlines' 757 landing charts for JAC, the pilots determined that they were legal and safe to land on runway 19 based on the airplane's landing weight, the existing wind, the weather, and the "good" braking action that was reported on the first two-thirds of the runway, and they continued preparations to land at JAC. A review of the CVR data revealed that the pilots discussed landing within the first 1,000 feet of the runway and then making efforts to slow the airplane using automatic wheel brakes[10] and thrust reversers[11] as promptly as possible to maximize braking effectiveness while on the "good" braking action portion of the runway. To this end, during their preparations for landing, the pilots armed the speedbrakes[12] for automatic deployment after touchdown and selected the automatic wheel brakes "MAX AUTO" setting.

The pilots' statements, CVR data, and National Transportation Safety Board (NTSB) airplane performance study indicated that the approach to the runway was normal and that the airplane's touchdown was "firm" and about 600 feet beyond the approach threshold. The first officer (the pilot flying) reported that he tried to deploy the thrust reversers promptly after

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[7] The most recent JAC automatic terminal information service weather observation received by the captain indicated, in part, the following conditions: a broken layer of clouds at 400 feet above the ground and an overcast layer of clouds at 1,000 feet above ground level; wind out of 190° at 6 knots; and 3/4-mile visibility in light snow.

[8] The FAA *Aeronautical Information Manual* defines MU as a unit "used to designate a friction value representing runway surface conditions." MU friction values range from 0.0 to 1.0, with 0.0 as the lowest friction value and 1.0 as the theoretical best friction value available. Friction testing devices provide MU values for the first, second, and third sections of the runway length.

[9] The CVR recorded the incident pilots discussing this pilot report and the captain describing the corporate jet as a "Challenger thirty, so little light guy...it's a light airplane."

[10] The airplane's wheel brake system is intended to slow and/or stop the airplane after landing and during taxi operations. It consists of brakes installed on each of the main landing gear wheels that are hydraulically-actuated manually (by the pilots' application of pressure to the brake/rudder pedals) or automatically when autobrakes are selected before touchdown.

[11] The airplane's thrust reversers help the airplane decelerate after landing by diverting the flow of the engine thrust and are generally more effective at higher ground speeds. The airplane's thrust reverser system is further discussed in section 2.2.2 of this report.

[12] The airplane's speedbrakes are used to help the airplane decelerate after landing by disrupting the airflow over the wings, maximizing the airplane's weight on its landing gear and increasing the wheel brakes' effectiveness. The speedbrakes are generally more effective at higher ground speeds. The NTSB notes that although the terms "speedbrakes" and "spoilers" are commonly used interchangeably by manufacturers, operators, and pilots, this report uses the term "speedbrakes" because Boeing and American Airlines predominantly use that term when referring to 757 landing procedures. The airplane's speedbrake system is further discussed in section 2.2.3 of this report.

touchdown, but they did not initially deploy. After the first officer made several attempts to deploy the thrust reversers, the captain took over the thrust reverser controls and eventually succeeded in deploying the thrust reversers with about 2,100 feet of runway remaining.[13] Subsequently, the airplane continued off the departure end of the runway, coming to a stop in deep snow off the end of the paved surface. Both pilots stated that they were unaware until after the airplane came to a stop that the speedbrakes, which they had armed for automatic deployment, had not automatically deployed after touchdown as they expected. (The NTSB notes that the pilots could have manually extended the speedbrakes at any time during the landing roll had they recognized the nondeployment.)

When the airplane was stopped in the snow, the captain told the flight attendants not to evacuate immediately; he checked on the condition of the passengers and the airplane and determined that it was safer to remain in the airplane until help arrived. In the meantime, the first officer advised JAC air traffic control and American Airlines operations personnel that they had run off the end of the runway and would need assistance. All occupants remained on board the airplane until JAC ground personnel reached the airplane to assist in the occupants' egress. Postincident examination of the airplane revealed minor damage to the airplane. Figures 1 and 2 show the incident airplane where it came to a stop in the snow off the departure end of runway 19 at JAC.

Figure 1. A photograph of the incident airplane, viewed from behind, where it came to a stop in the snow off the departure end of runway 19 at JAC.

[13] Flight data recorder data indicated that the thrust reversers deployed about 18 seconds after the airplane's initial touchdown and reached full reverse power about 10 seconds later.

Figure 2. A photograph of the front of the incident airplane where it came to a stop in the snow off the departure end of runway 19 at JAC.

2. Investigation and Analysis

2.1 Pilot Performance/Operational Issues

Postincident interviews and American Airlines' records indicated that the incident pilots were certificated in accordance with federal regulations and were current and qualified in the incident airplane in accordance with American Airlines' training requirements. Records also showed that the captain had 19,645 hours of total flight time, including 10,779 hours in the 757, and the first officer had about 11,800 hours of total flight time, including 3,582 hours in the 757. Additionally, company records showed that both pilots had completed American Airlines' JAC special airport training[14] and had recent (and, in the captain's case, extensive) experience flying into JAC.[15]

Company records showed that both pilots had 3 days off before starting duty the day before the incident. During postincident interviews, both pilots described normal activities and sleep patterns: the captain indicated that he received his normal 7 1/2 to 8 hours of sleep per night and needed no special rest breaks, and the first officer described a schedule that included about 8 1/2 to 9 1/2 hours of sleep per night and stated that he was well rested for the incident flight. Neither pilot reported any recent changes in their health, financial, or personal circumstances. The NTSB's review of company records, postincident pilot interviews, and work/sleep/wake and medical histories revealed no evidence of fatigue or any medical or behavioral conditions that might have adversely affected the pilots' performance during the incident flight.

2.1.1 Pilot Actions in Preparation for Landing at Jackson Hole Airport

A National Weather Service winter weather advisory indicating heavy snowfall, gusty wind, and possible blowing snow conditions was in effect for the JAC area the morning of the incident. However, the JAC automated weather observing system reports logged immediately before and after the incident landing indicated relatively benign conditions, with wind out of the southwest at 8 to 10 knots. In addition, other ground observations at JAC around the time of the incident indicated only light snow. The captain obtained numerous updates on JAC weather and runway conditions throughout the flight, including a braking action report from the pilot of the corporate jet that landed on runway 19 at JAC ahead of them. The corporate jet pilot reported "good" braking action on the first two-thirds of the runway, with "poor" braking action on the

[14] American Airlines requires special airport training for its pilots who are operating into airports with challenging landing conditions. The company's JAC-related special airport training required pilots to (1) review the approved photo and Ops Advisory pages in the company flight manual and (2) review the software-based airport familiarization program for JAC. The familiarization program for JAC involved a 5-minute computer animation with narration that showed an instrument approach to a visual landing on runway 19 and instructed pilots to land in the first 1,000 feet of the runway. The video also cautioned that the last 1,500 feet of runway 19 might be "slick" due to frozen snow melt.

[15] The captain estimated that he had flown into JAC 300 to 400 times in his career, and the first officer stated that he had flown into JAC frequently, including 4 times with the captain during the month of the incident.

last one-third of the runway. This runway condition assessment was supported by the most recent reported MU values, which translated to “wet/good” on the first two-thirds of the runway.[16]

The pilots’ before-landing calculations accounted for the weather and reported runway conditions as well as the airplane’s loading and performance capabilities[17] and indicated that, based on the reported “wet/good” runway braking action, the airplane could land and be stopped safely on the runway using normal techniques (including a combination of speedbrakes, wheel brakes, and thrust reversers, as needed, after touchdown). In preparation for this landing, the pilots had moved the speedbrake lever to the “armed” position. Consistent with American Airlines’ before-landing guidance for such a landing, they selected the “MAX AUTO” deceleration option for the main landing gear (MLG) autobrake system.

The NTSB concludes that the pilots had the pertinent weather, airport, and airplane performance information necessary to determine whether a safe landing could be made at JAC, and they had taken all appropriate before-landing actions; based on that information, the pilots appropriately decided that a landing at JAC was in accordance with company and performance guidelines.

2.1.2 Pilot Actions During the Landing at Jackson Hole Airport

According to the NTSB’s airplane performance study, the airplane approached runway 19 at JAC at a standard glidepath of about 3° and touched down about 600 feet beyond the runway’s approach threshold. After the airplane touched down, the pilots had about 5,700 feet of runway surface remaining on which to stop the airplane. According to the pilots’ prelanding calculations and the NTSB’s postincident airplane performance study, this available runway surface should have been sufficient for the airplane to come to a complete stop.

Flight data recorder (FDR) data indicated that the signal from the air/ground sensing system transitioned from “air” mode to “ground” mode at 1137:43.5.[18] FDR data also showed that, about 1 second later, the airplane’s air/ground signal temporarily transitioned back to “air” mode before transitioning back to “ground” mode for the remainder of the landing roll.[19] This brief cycling of the air/ground signal during a landing is not uncommon; however, in this case, it coincided with the first officer’s attempt to deploy the thrust reversers immediately after touchdown. The first officer’s rapid deployment of the thrust reversers was understandable and consistent with his awareness of the runway conditions at JAC and his intention to stop the airplane in the first two-thirds of the runway. However, because of the precise timing of these events, a rare mechanical/hydraulic interaction occurred in the thrust reverser system, and the

[16] About 1051, the pilots sent a message to the dispatcher saying that they would stop in the first two-thirds of the runway, indicating that they were aware that the last one-third of the runway was more slippery than the first two-thirds of the runway.

[17] Among other documents, the pilots reviewed American Airlines’ 757/767 Performance Manual (including the braking action chart) and the company’s 757 Special Landing Analysis chart for JAC.

[18] For the purpose of this report, this time will be considered the time of initial touchdown at JAC. The NTSB normally confirms the time of touchdown by examining the normal acceleration parameter; however, this parameter was not operating properly during the incident landing.

[19] This cycling of the air/ground sensing system is discussed further in section 2.2.1 of this report.

thrust reversers were locked in transit instead of continuing to deploy. Although the pilots reported multiple movements of the reverse thrust levers after the air/ground sensing system returned to "ground" mode, the thrust reversers did not begin to redeploy until about 18 seconds after touchdown.[20]

American Airlines' procedures indicate that the pilot monitoring is to monitor the speedbrake lever and the thrust reverser and autobrake systems during the landing roll. Specifically with regard to the speedbrake lever, the procedures indicate that the pilot monitoring should observe and call out the position of the speedbrake lever after landing and that, if the speedbrakes do not automatically deploy, the captain should manually deploy the speedbrakes (regardless of which pilot had monitoring responsibilities). American Airlines' 757/767 Operating Manual states, "Pilot awareness of the speedbrake lever during the landing phase is important in the prevention of overrun." Further, American Airlines' 757/767 Operating Manual also states, "Without speedbrakes deployed after touchdown, braking effectiveness may be reduced initially by as much as 60 [percent]." Figure 3 shows the throttle console in the incident airplane's cockpit, with the reverse thrust lever and speedbrake levers marked.

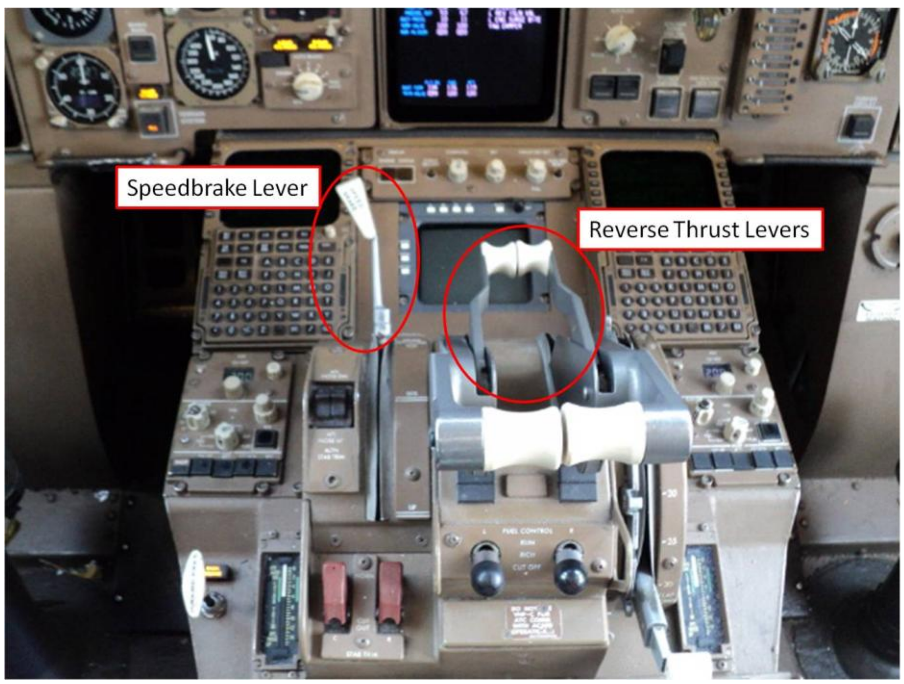

Figure 3. A photograph of the center console in the incident airplane's cockpit, with the reverse thrust lever and speedbrake levers marked.

The incident airplane's CVR transcript showed that, about 2.8 seconds after the airplane's initial touchdown, the captain stated, "deployed," likely referring to deployment of the speedbrakes, and then, about 1.2 seconds later, "two in reverse," likely referring to thrust reversers.[21] According to the CVR, at 1137:48.0 (about 0.5 seconds after the captain called out "two in reverse"), the first officer stated, "no reverse" in a strained voice. About 0.8 second later,

[20] The thrust reversers' operation is discussed further in section 2.2.2 of this report.

[21] The captain's callouts were erroneous, as neither system had deployed.

the CVR recorded the captain stating, “I got it”; then, about 0.6 second later, the captain stated, “get the...reverse.” At 1137:51.1, the CVR simultaneously recorded the captain stating, “I got it you steer” and the first officer stating, “I can’t get it.” About 1.8 seconds later, the CVR recorded the first officer responding, “I’m steerin’.”

According to American Airlines’ 757/767 Operating Manual, the pilot monitoring is to call out “deployed” when speedbrakes deploy or “no spoilers” if the speedbrakes do not deploy. Regarding reverse thrust operation, American Airlines’ 757/767 Operating Manual states that if the green “REV” annunciation light is not illuminated on either engine, the pilot monitoring is to call out “no reverse [pertinent engine]”; the Operating Manual does not specify language for a positive reverse thrust deployment callout. (American Airlines lists the pilot flying’s tasks during landings as moving the thrust reverser levers to reverse “smoothly and without delay” after landing, using brakes as needed, and then stowing the thrust reversers as the airplane decelerates through about 60 knots.)

At the NTSB’s request, Boeing completed a 757-200 landing performance analysis using criteria obtained from the incident airplane’s FDR and assuming a variety of runway braking action and speedbrake and manual thrust reverser deployment conditions consistent with the incident landing. Boeing’s calculations confirmed that, under the landing conditions the pilots anticipated (touchdown about 800 feet from the end of the runway with “wet/good” braking action and with prompt automatic deployment of speedbrakes and manual deployment of thrust reversers after touchdown), the airplane would have stopped about 3,800 feet down the 6,300-foot-long runway. The calculations also showed that, under similar touchdown and runway conditions, with thrust reverser deployment delayed until 21.8 seconds[22] after initial touchdown but prompt speedbrake deployment, the airplane would have stopped about 4,500 feet down the runway, still on the runway surface. Finally, the performance calculations support that the runway surface conditions were consistent with “wet/good” conditions as expected by the flight crew. A stopping distance of about 6,800 feet, about 500 feet beyond the end of the paved runway surface, was calculated for “wet/good” runway conditions, delayed thrust reverser deployment, and no speedbrake deployment. It is apparent that the immediate deployment of the speedbrakes after landing is critical for situations in which stopping distance is a prime concern (as was the case at JAC on the day of the incident). American Airlines recognizes this in its 757/767 Operating Manual, which states that braking effectiveness may be reduced by as much as 60 percent when speedbrakes are not deployed.

The NTSB concludes that if either pilot had observed that the speedbrakes had not automatically deployed and subsequently corrected the situation by manually deploying them, the airplane’s stopping distance would have been greatly decreased.

[22] During the incident landing, the thrust reversers deployed about 18 seconds after landing but did not reach full power until about 10 seconds later. Because Boeing’s analysis tool cannot factor in this gradual engine spool-up after thrust reverser deployment, the analysis has the thrust reversers deploying at full power 21.8 seconds after landing.

2.2 Airplane Systems

This section will further discuss the operation and postincident testing of the airplane's air/ground sensing system, thrust reversers, and automatic speedbrakes. (The pilots' monitoring of these systems during the landing roll is further discussed in section 3 of this report.)

2.2.1 Air/Ground Sensing System

The 757's air/ground sensing system provides air/ground status information to various airplane systems, including the automatic speedbrake and thrust reverser control systems. Two proximity sensors on each of the airplane's two MLG assemblies provide "ground" signals to the air/ground sensing system when both MLG assembly tilt angles reduce from about 9.6° rear-wheels-down when the gear is extended during flight to less than about 5.4° rear-wheels-down during touchdown. When all four proximity sensors sense that this has occurred, "ground" signals are sent to pertinent airplane systems, allowing their activation. The air/ground signal will cycle from "ground" mode to "air" mode and back to "ground" mode again if any one of the four proximity sensors on the MLG assemblies momentarily "unloads" (fails to meet the specified tilt angle) after touchdown.

Postincident inspections and testing of the incident airplane's air/ground sensing system components (including all proximity sensors, switches, and relays) revealed that the system was fully functional. No failures were detected that would have affected the system's operation during the landing at JAC. Although FDR data showed that, about 1 second after initial touchdown, the "ground" signal transitioned back to "air" mode for about 0.5 second before transitioning back to "ground" mode for the remainder of the landing roll, the air/ground sensing system was capable of normal operation; therefore, this brief interruption of the "ground" signal most likely resulted from a momentary unloading of one or both of the MLG assemblies. (The NTSB did not have data to verify that an "unloading event" occurred because the normal acceleration parameter on the FDR was not operating properly during the incident landing.) During its investigation of this incident, the NTSB reviewed the air/ground data from the previous 13 landings performed in the incident airplane and identified 2 additional landings during which intermittent air/ground signals similar to those observed in the JAC incident data occurred. Neither of these events prevented the deployment of the thrust reversers as occurred during the incident landing because the relative timing of the MLG unloadings and the thrust reverser lever movements were different from the incident landing. The operation of these systems during the incident landing is discussed below.

2.2.2 Thrust Reversers

The airplane's thrust reverser system is designed to help the airplane decelerate after landing by diverting the direction of the engine exhaust gas stream. Although use of thrust reversers is not required during landing, when they are deployed early in the landing roll, thrust reversers help reduce the airplane's stopping distance. To initiate thrust reverser extension, the airplane must detect that it is on the ground, and the pilot flying must lift the reverse thrust levers up and rearward to their interlock position. The thrust reversers would begin to deploy,[23] and, after they reach their mid-travel positions, the pilot must move the reverse thrust levers further aft to apply reverse thrust, increasing engine power as required to help stop the airplane.

Each engine has its own thrust reverser control system that hydraulically deploys the thrust reversers based on electrical and mechanical commands it receives from the following sources: pilot inputs; the air/ground sensing system; the thrust reverser auto restow system;[24] and multiple thrust reverser system sensors, relays, and feedback signals. The thrust reverser systems function independently except for the common signal they receive from the air/ground system. Because a thrust reverser extension command is a function of several system inputs, an intermittent loss of any one of these inputs could briefly interrupt continuous deployment.

During the incident landing, a momentary interruption in the "ground" signal from the air/ground sensing system occurred almost immediately after the thrust reversers began to extend.[25] Such interruptions in the "ground" signal are not unusual (commonly occurring during bounced landings, for example). Under normal circumstances, such interruptions are benign and go undetected by pilots because the thrust reversers continue to deploy automatically when the air/ground "ground" signal resumes with no further pilot action required. However, during the incident landing, the thrust reversers locked in transit and did not continue to deploy. The pilots made multiple attempts to deploy the thrust reversers after the air/ground sensing system returned to "ground" mode; however, the thrust reversers did not deploy until about 18 seconds after touchdown.

Postincident testing of the thrust reverser control system verified that each engine's thrust reverser system was fully operational and that each engine's thrust reverser translating sleeve extended and retracted per the specified maintenance requirements. A detailed review of the thrust reverser control system design identified one potential scenario in which the momentary change from "ground" mode to "air" mode could cause each engine's thrust reverser sync-lock[26] mechanism to lock in transit. Such a lockout could only occur if a momentary change from the "ground" mode to the "air" mode occurs in the instant (1) immediately after the thrust reversers begin to extend after touchdown and (2) in the split second before the thrust reverser's auto restow system is activated. This lockout would prevent movement of the thrust reversers until about 5 seconds after a pilot moves the reverse thrust levers back to their stowed position, allowing the thrust reverser system to deactivate and begin deployment again when commanded.

[23] The thrust reverser control system is designed to deploy the thrust reversers when the air/ground sensing system sends a "ground" signal and the thrust reverser levers are in their interlock position. Each reverse thrust lever is restricted to an intermediate or interlock position until its respective thrust reverser reaches its mid-travel position.

[24] This system is activated when sensors detect that the thrust reverser's translating sleeves are no longer in their stowed positions. Its main design purpose is to automatically return the translating sleeves to their stowed positions if they move from the stowed position when the aircraft is airborne.

[25] FDR data showed that the thrust reversers began to deploy about 1 second after the airplane touched down, and, while the reversers were deploying, the air/ground sensing system transitioned back to "air" mode for about 0.5 second before it transitioned back to "ground" mode for the remainder of the landing roll.

[26] The sync-lock mechanism is intended to prevent the thrust reverser translating sleeves from accidentally extending due to failures within the thrust reverser system.

FDR data showed that one of the pilots (likely the captain, based on postincident statements and CVR data) briefly moved the reverse thrust levers to the stowed position and then back to the interlock position about 10 seconds after touchdown. The data further showed that the reverse thrust levers were moved forward of their interlock position allowing the full deployment of the thrust reversers about 18 seconds after touchdown.[27] During postincident interviews, both incident pilots indicated that they were unaware of a circumstance in which the thrust reversers could be locked in transit and were unaware of the actions needed to correct the situation. (Further, American Airlines' personnel in general, including the company's 757/767 fleet manager, were unaware of this rare event or its resolution.) It is likely that, during their postlanding manipulations of the reverse thrust levers, the pilots moved the levers forward enough to deactivate the system because when the levers returned to their interlock position, the system was properly configured, and the thrust reversers deployed normally.

The NTSB concludes that, although the momentary interruption of the air/ground system's "ground" signal after touchdown would not normally adversely affect the deployment of thrust reversers, in this case it coincided almost precisely with the initial deployment of the thrust reversers and resulted in the thrust reversers locking in transit instead of continuing to deploy.

2.2.3 Automatic Speedbrake System

The airplane's automatic speedbrake system consists of six panels on the upper surface of each wing that can be automatically or manually deployed at touchdown to disrupt the airflow over the wings, maximizing the weight on the landing gear and increasing the wheel brakes' effectiveness.[28] Although automatic speedbrakes are not generally required for landings[29] (because pilots can manually deploy the speedbrakes at any time), use of the automatic speedbrakes can ensure prompt deployment of the speedbrakes after touchdown and optimize the airplane's deceleration during the landing roll.[30]

To deploy the speedbrakes automatically, the pilots should move the speedbrake lever to its "armed" detent before touchdown.[31] By design, when the speedbrake lever is "armed," the speedbrake actuator automatically drives the speedbrake lever to its full aft position after the airplane touches down (indicated by the air/ground sensing system signal's transition from "air" mode to "ground" mode). This normally results in the deployment of the speedbrake panels to their fully deployed position. However, if the air/ground sensing system reverts back to

[27] Consistent with the FDR data, a video taken through a left-side window by a passenger during the landing showed that the left thrust reverser began to deploy shortly after touchdown, then stopped moving and remained in a partially deployed position for about 10 seconds. The video then showed the left thrust reverser closing for about 6 seconds before finally fully extending.

[28] These panels are also used when the airplane is in flight to assist the ailerons in lateral control and to increase drag and reduce lift. Boeing refers to these panels as "spoilers" when referring to their lateral control function.

[29] According to American Airlines' 757/767 Minimum Equipment List, the automatic speedbrake function is required to be operable at the time of dispatch for flights into JAC.

[30] As previously noted, an airplane's braking effectiveness may be reduced by as much as 60 percent when speedbrakes are not deployed promptly after landing.

[31] If the pilots do not move the speedbrake lever to its armed detent before touchdown, the system will normally automatically deploy the speedbrakes when the thrust reversers are deployed.

"air" mode after the automatic speedbrake actuator has begun to extend, the speedbrake actuator will retract automatically and retract the speedbrake lever. If the air/ground sensing system signal subsequently transitions back to "ground" mode, the speedbrake system is designed to again automatically drive the speedbrake lever to extend the speedbrakes.

Review of FDR and CVR data confirmed that the pilots positioned the speedbrake lever to its armed detent at 1130:29, about 7 minutes before landing at JAC. FDR data further indicated that, after the airplane touched down, the speedbrake lever initially remained in its armed position, and then briefly moved from, and then returned to, its armed position where it remained for the duration of the landing. This movement of the speedbrake lever coincided with the air/ground sensing system cycling from "ground" mode to "air" mode and then back to "ground" mode. The speedbrake lever's movement from its "armed" position indicated that the automatic speedbrake actuator had partially extended upon initial touchdown.[32] Normally, when the air/ground signal indicated "ground" a second time, the automatic speedbrake system would have driven the speedbrake lever beyond its "armed" position to fully deploy the speedbrakes. The NTSB concludes that, although the pilots had armed the automatic speedbrake system during the approach to JAC, the automatic speedbrakes failed to automatically deploy as designed after touchdown.

Initial examination and testing of the incident airplane's automatic speedbrake system and its components revealed no evidence of a malfunction that would have prevented normal operation during the incident landing.[33] However, the automatic speedbrake mechanism was removed and examined after the incident airplane experienced another automatic speedbrake system nondeployment on March 31, 2011.[34] This examination revealed a latent assembly defect in the no-back clutch mechanism[35] that intermittently prevented the speedbrake actuator from automatically driving the speedbrake lever beyond its armed detent to extend the speedbrakes. Specifically, one of the four speedbrake lever braking pins was improperly secured, which allowed it to intermittently rotate within its assembly and prevented the no-back clutch from transmitting the torque from the automatic speedbrake actuator to the speedbrake lever. Additional testing showed that this condition would only occur when the actuator was attempting to drive the speedbrake lever towards the "up" (speedbrakes extended) position and would not occur when the actuator was retracting the speedbrake lever. Further, it was noted that this defect only affected the speedbrakes' automatic deployment function and would not have prevented the pilots from manually deploying the speedbrakes. Figure 4 contains two diagrams showing the cockpit center console, the speedbrake lever and its linkages, and components of the automatic speedbrake system. The no-back clutch mechanism has been highlighted in the side view

[32] If the automatic speedbrake actuator had not begun to extend the speedbrakes at touchdown, the system's temporary retraction of the speedbrake lever could not have occurred.

[33] During postincident examination, the NTSB discovered that a bushing had not been installed in the automatic speedbrake actuator's aft mounting attachment. This defect would not have prevented the automatic speedbrake actuator from operating.

[34] The NTSB notes that the pilots involved in the March 31, 2011, event noted the automatic speedbrake system's nondeployment and manually extended the speedbrakes; the airplane stopped on the available runway surface.

[35] The no-back clutch mechanism allows the speedbrake lever to be moved freely (independently) from the automatic speedbrake actuator and allows an input (extend/retract) from the automatic speedbrake actuator to drive the speedbrake lever.

diagram on the left. A photograph of the speedbrake actuator and no-back clutch mechanisms has been superimposed on the front view to show those components' relative positions within the center console.

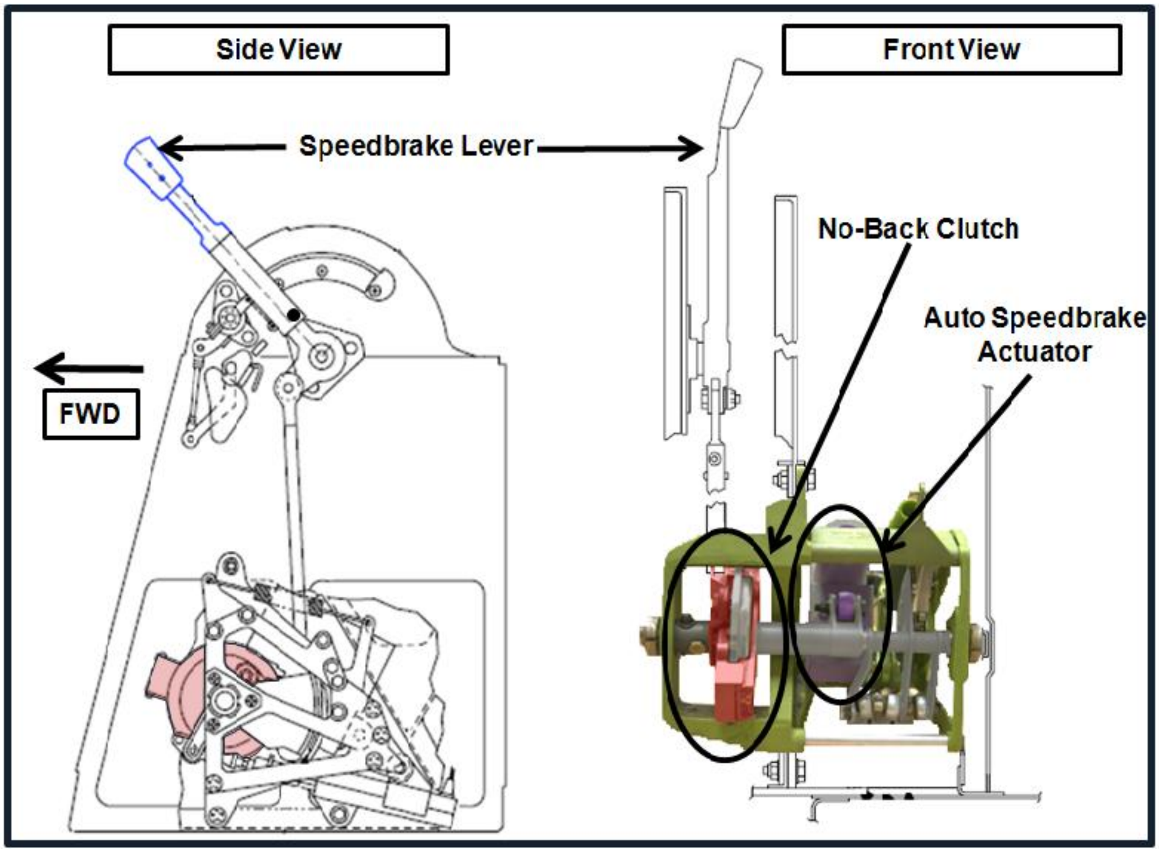

Figure 4. Two diagrams showing the cockpit center console, the speedbrake lever and its linkages, and components of the automatic speedbrake system. The no-back clutch mechanism has been highlighted in the side view diagram on the left. A photograph of the speedbrake actuator and no-back clutch mechanisms has been superimposed on the front view to show those components' relative positions within the center console.

Because the effects of this defect were intermittent and the defect's visual detection would require disassembly of the no-back clutch mechanism (a function usually performed by the manufacturer or another external facility, not the operator), an operator would not likely have detected the defect during normal maintenance testing. When this assembly defect in the no-back clutch was identified, the manufacturer of the no-back clutch told NTSB investigators that the company was not aware of any instances involving similar anomalies in other no-back clutch units.[36] As a result of this investigation, the manufacturer clarified its documentation to ensure proper assembly of the no-back clutch units. In addition, in its March 7, 2012, submission for

[36] Since this anomaly was identified, the company has received 32 no-back clutch assembly units from operators for repair. Although 2 of these units were returned with complaints of "auto speedbrake failed to deploy," disassembly and repair of all 32 units revealed no similar anomalies.

this incident, Boeing indicated that it is "currently writing a *Fleet Team Digest*[37] article that will contain the information concerning the no-back clutch and its possible intermittent anomaly."

The NTSB concludes that a manufacturing defect in the incident airplane's speedbrake no-back clutch mechanism prevented the speedbrakes from automatically deploying during the incident landing.

2.2.4 Airplane System Summary

In summary, the NTSB's postincident examination and testing of the airplane's systems revealed no evidence of any failures of the air/ground sensing system during the incident landing, indicating that the intermittent air/ground signal occurred when the MLG unloaded just after touchdown. The investigation also showed that the thrust reverser system and its components were capable of normal operation during the incident landing. In addition, although an intermittent mechanical defect in the automatic speedbrake system intermittently prevented the speedbrakes from automatically deploying, the defect would not have prevented the pilots from manually deploying the speedbrakes, if they had noted that the speedbrakes did not deploy.

2.3 Flight Data Recorder Maintenance and Documentation

The incident airplane was equipped with an L-3/Fairchild FA2100 FDR, which contained about 44 hours of data, including the incident flight. The FDR was removed from the incident airplane and transported to NTSB headquarters in Washington, D.C., for downloading and data evaluation.[38] The NTSB's readout of the incident airplane's FDR revealed that several of the parameters (including normal acceleration, a mandatory parameter) were not functioning properly.

In addition, during its investigation, the NTSB identified issues with American Airlines' FDR system-related documentation, its FDR-related maintenance program, and the Federal Aviation Administration's (FAA) oversight of that maintenance program. Specifically, although operators are required by federal regulations to maintain accurate documentation of their FDR configurations, American Airlines personnel could not provide appropriate documentation and/or wiring diagrams for the incident airplane's FDR installation. In addition, the investigation showed that American Airlines' improper performance of the two tests intended to ensure that

[37] Boeing's *Fleet Team Digest* is a publication the company uses to provide model-specific maintenance updates and other fleet-specific information that its operators can access through Boeing's customer service website at <http://www.boeing.com/commercial/aviationservices/myboeingfleet/index.htm> (accessed May 3, 2012).

[38] While acting as a party to the investigation and before transporting the FDR to NTSB headquarters, the FDR was flown to Tulsa, Oklahoma, where American Airlines personnel downloaded the FDR data. Because this unauthorized downloading of FDR data was not consistent with its signed commitment to the party system and could have destroyed evidence critical to the investigation, American Airlines was removed as a party to this investigation.

the FDR system is operating properly[39] allowed numerous FDR discrepancies to go undetected, which hampered FDR data collection and evaluation during this investigation.

Since 1972, the NTSB has made numerous recommendations to address problems regarding installation and maintenance of FDR systems, inaccurate or incomplete documentation, and inadequate oversight of the maintenance programs that should have identified these problems.[40] These FDR-related issues, although not factors related to the cause of this incident, did affect the NTSB's ability to evaluate the available data.

[39] A reasonableness check is performed every 4,000 flight hours and involves downloading and evaluating/auditing FDR data. A system functional check is performed by maintenance personnel every 72 months to ensure that all FDR system components and interfaces are working properly.

[40] For additional information, see (a) *Uncontrolled Impact With Terrain, Fine Airlines Flight 101, Douglas DC-8-61, N27UA, Miami, Florida, August 7, 1997*, Aircraft Accident Report NTSB/AAR-98/02 (Washington, D.C.: National Transportation Safety Board, 1998); (b) *Loss of Pitch Control on Takeoff, Emery Worldwide Airlines, Flight 17, McDonnell Douglas DC-8-71F, N8079U, Rancho Cordova, California, February 16, 2000*, Aircraft Accident Report NTSB/AAR-03/02 (Washington, D.C.: National Transportation Safety Board, 2003); and (c) *Crash During Landing, Executive Airlines (doing business as American Eagle) Flight 5401, Avions de Transport Regional 72-212, N438AT, San Juan, Puerto Rico, May 9, 2004*, Aircraft Accident Report NTSB/AAR-05/02 (Washington, D.C.: National Transportation Safety Board, 2005), which are available at <http://www.ntsb.gov>.

3. Safety Issues

3.1 Pilot Performance/Operational Issues

3.1.1 Deployment of the Thrust Reversers and Speedbrakes

The NTSB evaluated possible explanations for the captain's erroneous and premature speedbrake and thrust reverser callouts and his failure to monitor and notice that the speedbrakes had not automatically deployed as expected. The only positive indication available to the captain to verify extension of the speedbrakes would have been the aft position of the handle, which was visible from and within reach of both pilots' seating positions. FDR data showed that the speedbrake handle was in the armed position for landing and began to move within 1 second of landing but did not continue to move to the aft (extended) position as expected. The NTSB concludes that the captain's erroneous speedbrakes "deployed" callout was likely made in anticipation (not in confirmation) of speedbrake deployment after he observed the speedbrake handle's initial movement; after the "deployed" callout was made, both pilots likely presumed that the reliable automatic speedbrakes were functioning normally and focused on the thrust reverser problem.

About the same time that the speedbrake handle started to move, the amber annunciation lights on the engine indication and crew alerting system (EICAS) display would have provided the captain with a cue that the thrust reversers were in transition.[41] Although the captain called out "two in reverse," this callout was not based on the illumination of the green annunciation since the air/ground sensing system cycling to "air" mode prevented the reversers from deploying at that time. (Immediately following the captain's "two in reverse" callout, the CVR recorded the first officer stating, "no reverse" in a voice that sounded strained.) Given the typical reliability of the thrust reverser system,[42] it is likely that the captain made the callout because he expected normal thrust reverser deployment after seeing the amber EICAS annunciation.

The NTSB considered whether operational stress during the approach and landing might have resulted in the captain's erroneous callouts, his failure to monitor, and both pilots' failure to notice that the speedbrakes had not deployed. Under normal circumstances, landing at JAC can be challenging; it is located at an elevation of 6,451 feet, it is surrounded by mountainous terrain, and runway 19 is relatively short (6,300 feet) and has a downward slope of 0.6 percent. On the day of the incident, additional challenges were present; there was snow on the runway, the approach was flown to published minimums, and the airplane was near its maximum landing weight. Although operating into JAC in such conditions can be demanding and requires pilots to maintain a heightened alertness throughout the approach and landing, the operational conditions encountered by the incident pilots were typical for JAC in winter. CVR data showed that the incident pilots had prepared thoroughly for the landing and accurately determined they had sufficient performance to land safely on the runway. Despite the challenges of the approach and

[41] Green annunciations would illuminate when the thrust reversers are fully deployed.

[42] As previously stated, in normal bounced landing circumstances, the thrust reversers would redeploy when the air/ground "ground" signal resumes (as would the automatic speedbrakes) with no further pilot action required.

landing, the pilots seemed alert but not stressed. During postincident interviews, the pilots stated they had no concerns about landing at JAC as they were both experienced flying into the airport, they were familiar with the conditions that existed, and they felt comfortable with the approach. Therefore, the NTSB considers it unlikely that those challenges created operational stress during the incident landing.

However, despite their experience flying into JAC and their adequate preparation for the landing, the flight crew tunneled their attention on deploying the thrust reversers. Although the CVR recorded both pilots commenting that the airplane was not slowing on the runway, the captain did not return to his monitoring duties. Neither pilot was able to broaden his focus enough to look at the big picture and notice that the speedbrakes (the more crucial deceleration tool) had not deployed.

The NTSB notes that the captain's expectation that the speedbrake and thrust reverser systems would function reliably and routinely as the pilots had observed them function during multiple previous landings might have led to less vigilant monitoring of those systems. Research has shown that reliable automated systems can lead pilots to have trust and confidence that the system will function as designed. In some cases, this expectation of proper system functioning can lead to poor system monitoring and failure to detect automation malfunctions.[43]

Further, pilots are often required to divide their attention between multiple tasks in routine flight operations, and the challenges involved in managing multiple tasks is heightened during unexpected or abnormal situations. In this incident, the pilots encountered an abnormal situation when both the speedbrake and thrust reverser systems did not deploy as expected. The NTSB has previously issued safety recommendations addressing issues related to pilots handling multiple emergency and/or abnormal situations. For example, Safety Recommendations A-09-24 and -25[44] asked the FAA to do the following:

> Establish best practices for conducting both single and multiple emergency and abnormal situations training. (A-09-24)
>
> Once the best practices for both single and multiple emergency and abnormal situations training asked for in Safety Recommendation A-09-24 have been established, require that these best practices be incorporated into all operators' approved training programs. (A-09-25)

On August 11, 2009, the FAA indicated that it published a notice of proposed rulemaking (NPRM), titled "Qualifications, Service, and Use of Crewmembers and Aircraft Dispatchers," on January 12, 2009 (74 *Federal Register* 1280). The FAA stated that the NPRM addressed these recommendations by requiring the inclusion of scenario-based training. The FAA indicated its

[43] See (a) J.D. Lee and N. Moray, "Trust and the Allocation of Function in the Control of Automatic Systems," *Ergonomics,* vol. 35 (1992), pp. 1243-1270; (b) J.D. Lee and N. Moray, "Trust, Self-Confidence, and Operators' Adaptation to Automation," *International Journal of Human-Computer Studies,* vol. 40 (1994), pp. 153-184; and (c) R. Parasuraman, R. Molloy, and I.L. Singh, "Performance Consequences of Automation-Induced 'Complacency,'" *The International Journal of Aviation Psychology,* vol. 3(1) (1993), pp. 1-23.

[44] For additional information, see *In-Flight Left Engine Fire, American Airlines Flight 1400, McDonnell Douglas DC-9-82, N454AA, St. Louis, Missouri, September 28, 2007,* Aircraft Accident Report NTSB/AAR-09/03 (Washington, D.C.: National Transportation Safety Board, 2009), which is available at <http://www.ntsb.gov>.

belief that these scenario-based training events constituted the establishment of industry best practices for single and multiple emergency and abnormal situations training. The FAA also planned to revise FAA Order 8900.1 and/or issue a notice to require FAA inspectors to withdraw approval of 14 CFR Part 121 training programs that do not incorporate scenario-based training and practices. The FAA further indicated that training programs conducted under its Advanced Qualification Program[45] were already required to make use of scenario-based line operational evaluations. Finally, the FAA stated that it planned to review the existing and proposed regulatory and policy framework to determine whether additional guidance or requirements were necessary.

On April 2, 2010, the NTSB replied that the use of scenario-based training would address the intent of Safety Recommendations A-09-24 and -25 but asked how the training scenarios will be developed, noting that the collection of best practices related to such scenarios would remain necessary. The NTSB noted that issuance of the final rule proposed in the January 12, 2009, NPRM would give the FAA the regulatory framework to require such training but that, without a guide to best practices, inspectors and operators would have difficulty creating effective programs. The NTSB stated that the FAA's planned review of the regulatory and policy framework to determine whether additional guidance or requirements were necessary might include the collection and dissemination of the recommended best practices. Pending the outcome of that review and issuance of the final rule proposed in the NPRM,[46] Safety Recommendations A-09-24 and-25 were classified "Open—Acceptable Response."

Although pilots are typically trained to handle a single emergency, the reality is that pilots are sometimes faced with situations that include multiple abnormalities or emergencies. Training for multiple emergency and abnormal situations would provide pilots the opportunity to practice the processes and skills needed to handle such events so that the pilots would be better prepared to handle them in flight. Trained pilots would have better situational awareness and would be better equipped to adapt a learned process to the specific circumstances and time constraints of the event they encounter. This increased situational awareness is even more important in time-critical situations when pilots must respond quickly.

The NTSB has investigated a number of accidents and incidents in which pilots have focused their attention on one emergency or abnormal situation at the exclusion of another, which ultimately resulted in an accident.[47] The incident at JAC shows that even experienced

[45] The FAA's Advanced Qualification Program is a voluntary alternative to the traditional regulatory requirements for pilot training and checking that was designed to (1) increase aviation safety through improved training and evaluation and (2) be responsive to changes in aircraft technology, operations, and training methodologies.

[46] A related supplemental notice of proposed rulemaking (SNPRM), published May 20, 2011 (76 *Federal Register* 29336), contained the relevant portions of the NPRM. The SNPRM is further discussed in section 3.1.2 of this report.

[47] Two examples of such accidents are the accidents involving Southwest Airlines flight 1248 at Chicago, Illinois, and Empire Airlines flight 8284 at Lubbock, Texas. For additional information, see *Runway Overrun and Collision, Southwest Airlines Flight 1248, Boeing 737-7H4, N471WN, Chicago Midway International Airport, Chicago, Illinois, December 8, 2005,* Aircraft Accident Report NTSB/AAR-07/06 (Washington, D.C.: National Transportation Safety Board, 2007) and *Crash During Approach to Landing, Empire Airlines Flight 8284, Avions de Transport Regional, Aerospatiale Alenia ATR 42-320, N902FX, Lubbock, Texas, January 27, 2009,* Aircraft Accident Report NTSB/AAR-11/02 (Washington, D.C.: National Transportation Safety Board, 2011), both of which are available at <http://www.ntsb.gov>.

pilots with adequate preparation for a given situation (in this case, landing) can become distracted and narrow their attention when multiple abnormal situations occur. If the incident pilots had received training for multiple emergency or abnormal events, they likely would have evaluated the situation as a whole rather than focusing on the most salient cue, which was the thrust reversers not deploying.

During the landing at JAC, two qualified, experienced pilots encountered simultaneous system abnormalities when neither the thrust reversers nor the automatic speedbrakes deployed as expected. Although the pilots were not aware of the specific solution to the thrust reverser abnormality (which they only resolved through persistent efforts and luck), all pilots know that they could manually deploy the speedbrakes at any time during a landing. However, because of their focus on and efforts to resolve the thrust reverser anomaly, neither pilot noticed the abnormal speedbrake situation until the airplane had come to a stop off the end of the runway. The NTSB concludes that if the incident pilots had received specific pilot training on the handling of multiple emergency or abnormal situations, they might not have focused exclusively on the thrust reverser nondeployment and might have been more likely to recognize and properly resolve the speedbrake nondeployment during the landing. Therefore, the NTSB reiterates Safety Recommendations A-09-24 and -25.

Research has shown that abnormal and emergency situations increase pilot workload, require additional effort to manage effectively, and can result in task fixation and narrowing of attention.[48] In addition, the NTSB's review of accident and incident data shows that unexpected events or anomalies during approach and landing have the potential to distract pilots' attention from routine actions and cues, which, in some cases, has resulted in runway overruns. In one such case (the June 1, 1999, accident involving American Airlines flight 1420 at Little Rock, Arkansas),[49] the NTSB concluded that the pilots were focused on expediting the landing because of impending weather and did not ensure that the automatic speedbrakes were armed before landing, nor did they detect this omission and manually extend the speedbrakes while they were struggling to stop the airplane and maintain directional control during the landing roll. In another such case (the December 8, 2005, accident involving Southwest Airlines flight 1248 at Chicago, Illinois),[50] the NTSB concluded that the pilots' first use of the airplane's autobrake system during a challenging landing distracted them from the otherwise routine task of thrust reverser deployment. In addition, the NTSB is currently investigating the April 26, 2011, runway overrun incident involving Southwest Airlines flight 1919, a 737, at Chicago Midway International Airport, Chicago, Illinois.[51] Postincident interviews indicate that these pilots were distracted by a series of events during the approach, did not arm the automatic speedbrake system before landing, and did not recognize that the speedbrakes had not deployed, as they were focused on braking performance.

[48] R.K. Dismukes, G.E. Young, and R.L. Sumwalt, "Cockpit Interruptions and Distractions: Effective Management Requires a Careful Balancing Act," *ASRS Directline*, vol. 10 (1998) pp 4-9.

[49] For additional information, see *Runway Overrun During Landing, American Airlines Flight 1420, McDonnell Douglas MD-82, N215AA, Little Rock, Arkansas, June 1, 1999,* Aircraft Accident Report NTSB/AAR-01/02 (Washington, D.C.: National Transportation Safety Board, 2001), which is available at <http://www.ntsb.gov>.

[50] For additional information, see NTSB/AAR-07/06.

[51] Preliminary information about this incident, NTSB case number DCA11IA047, can be found online at <http://www.ntsb.gov/aviationquery/index.aspx>.

Prompt speedbrake deployment after touchdown and monitoring of the speedbrake system during the landing roll is especially critical for increased braking effectiveness when landing on short and/or contaminated runways. Although the CVR only recorded the pilots discussing thrust reverser deployment during their preparations for landing at JAC, American Airlines' 757/767 Operating Manual states that braking effectiveness may be reduced by as much as 60 percent when speedbrakes are not deployed; therefore, both pilots were aware that the timely deployment of the speedbrakes was critical in reducing stopping distance after landing. In addition, based on the captain's training and American Airlines' procedures, he should have been aware of his responsibility for monitoring the speedbrake system during the landing roll.

According to CVR data, rather than confirming the speedbrake deployment using the available cues, both pilots were focused on the thrust reversers' nondeployment and became preoccupied with attempting to deploy them. The NTSB concludes that, although American Airlines' manuals and procedures emphasized the importance of prompt speedbrake deployment and monitoring of the speedbrake lever after landing, the pilots did not recognize that the speedbrakes had not automatically deployed because both pilots were distracted by, confused by, and trying to resolve the thrust reversers' nondeployment. Therefore, because timely deployment and monitoring of speedbrakes is so critical to landing safely, the NTSB recommends that the FAA require all operators of existing speedbrake-equipped transport-category airplanes to develop and incorporate training to specifically address recognition of a situation in which the speedbrakes do not deploy as expected after landing.

As a result of the June 1, 1999, American Airlines flight 1420 accident at Little Rock, Arkansas, the NTSB issued Safety Recommendation A-01-50, which asked the FAA to do the following:

> For all 14 [CFR] Part 121 and 135 operators, require a callout if the spoilers [speedbrakes] do not automatically or manually deploy during landing and a callout when the spoilers [speedbrakes] have deployed, and verify that these operators include these procedures in their flight manuals, checklists, and training programs. The procedures should clearly identify which pilot is responsible for making these callouts and which pilot is responsible for deploying the spoilers [speedbrakes] if they do not automatically or manually deploy.

In response, the FAA amended Advisory Circular (AC) 120-71, "Standard Operating Procedures for Flightdeck Crew Members," Appendix 1, to include more explicit language regarding the use of spoiler/speedbrake systems. The AC now contains, as recommended standard operating procedures (SOP), dual pilot confirmation that the automatic speedbrakes have been armed before landing and a callout by the pilot monitoring to verify that the speedbrakes deployed (or failed to deploy) after landing.[52]

American Airlines had incorporated the speedbrake-related SOPs into its operations, manuals, and training, and the incident pilots were aware of them. Further, CVR data and postincident interviews confirmed that both pilots were aware of and focused on the need for

[52] As a result of the FAA's actions, on December 10, 2003, the NTSB classified Safety Recommendation A-01-50 "Closed—Acceptable Action."

rapid deceleration during the incident landing. However, despite the captain's callout confirming that the speedbrakes had deployed, both pilots were too distracted by the thrust reversers' nondeployment to notice that the speedbrakes had not deployed.

This incident shows that, even with a company requirement for a callout confirming automatic speedbrake deployment after touchdown and with pilots who have a heightened awareness of the need for prompt speedbrake deployment during a landing, pilots can still become distracted from ensuring that the speedbrakes deploy properly. In addition, the pilot monitoring in the December 8, 2005, Southwest Airlines flight 1248 accident at Chicago, Illinois, was also required to call out the absence of speedbrake deployment (and manually deploy speedbrakes), and he did not notice the speedbrakes' nondeployment either, as both pilots quickly focused their attention on braking performance after touchdown. The NTSB concludes that a clearly distinguishable and intelligible alert that activates when the speedbrakes do not automatically deploy after landing would have provided the pilots with a salient warning that the speedbrakes did not function as expected and would likely have brought the captain's attention back to the speedbrakes and resulted in manual speedbrake deployment. Although previously type-certificated airplanes may not be equipped for installation of an aural alert system,[53] with more modern technology such a system could easily be designed into newly type-certificated airplanes. Therefore, the NTSB recommends that the FAA require all newly type-certificated 14 CFR Part 25 airplanes to have a clearly distinguishable and intelligible alert that warns pilots when the speedbrakes have not deployed during the landing roll.

Because of the rare mechanical/hydraulic interaction that locked the thrust reversers in transit during the incident landing, the pilots needed to stow the reverse thrust lever to unlock the system before attempting to redeploy the thrust reversers. However, postincident interviews with American Airlines pilots indicated that company pilots were not aware of this technique,[54] and moving the reverse thrust levers to the stowed position during the landing roll would not be an intuitive action. The NTSB concludes that if the incident pilots had known that when the thrust reversers locked in-transit they needed to move the reverse thrust levers to the stowed position before attempting to deploy them again, the deployment of the thrust reversers could have occurred much earlier in the landing roll. Therefore, the NTSB recommends that the FAA require Boeing to establish guidance for pilots of all relevant airplanes to follow when an unintended thrust reverser lockout occurs and to provide that guidance to all operators of those airplanes.

3.1.2 Pilot Responsibilities After Landing

American Airlines' procedures indicate that the pilot monitoring (in this case, the captain) is to monitor the automatic speedbrake and thrust reverser deployment during the landing roll, whereas the pilot flying (in this case, the first officer) is to deploy the thrust reversers, apply manual brakes as required, and stow the thrust reversers as the airplane

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[53] The NTSB notes that the previously issued safety recommendation regarding pilot training to address nondeployment of speedbrakes could address this issue for crews in previously type-certificated airplanes.

[54] The potential for this type of event had not been identified before this incident; as a result, Boeing's 757/767 guidance did not contain related guidance. According to Boeing, its Pratt and Whitney engine-equipped 757/767 airplanes are the only Boeing-manufactured airplanes that have the potential for this type of event.

decelerates. However, in this case, CVR data showed that about 0.8 second after the first officer stated "no reverse," the captain was taking command of the thrust reverser levers. By assuming control of the thrust reversers before the first officer could attempt to resolve the situation, the captain deviated from normal company procedures regarding the pilot flying/pilot monitoring responsibilities during the landing roll. Specifically, if the captain had adhered to his monitoring responsibilities during the landing roll, it is more likely that he would have recognized that the speedbrakes had not automatically deployed and corrected the situation by manually deploying them, increasing the airplane's braking effectiveness significantly.

The NTSB has previously issued safety recommendations related to pilot workload management and monitoring skills, including Safety Recommendation A-07-13,[55] which asked the FAA to do the following:

> Require that all pilot training programs be modified to contain modules that teach and emphasize monitoring skills and workload management and include opportunities to practice and demonstrate proficiency in these areas.

On January 12, 2009, the FAA published an NPRM titled "Qualifications, Service and Use of Crewmembers and Aircraft Dispatchers." Based on comments that the FAA received on this NPRM, on May 20, 2011, the FAA published a supplemental notice of proposed rulemaking (SNPRM) that proposed additional training requirements for flight crewmembers, including the use of flight simulators for training of flight crewmembers.

On July 15, 2011, the NTSB submitted comments to the FAA on the SNPRM and noted its general support for the requirements proposed in the SNPRM. In its comments, the NTSB noted that proposed section 121.1213 partially addressed Safety Recommendation A-07-13 by requiring that pilot training include opportunities to practice and demonstrate proficiency in monitoring skills and workload management. However, the SNPRM did not propose a requirement for modules that teach and emphasize these subjects. The NTSB indicated that the FAA would need to require pilot training programs to include appropriate training modules on these subjects during which crews would be required to practice and demonstrate proficiency.

On November 7, 2011, the FAA published Safety Alert for Operators (SAFO) 11011, "Runway Excursions at Jackson Hole Airport (JAC)," which "emphasizes the importance of implementing and following SOPs and training for flightcrews."[56] The related supplement provided best practices and mitigation strategies that include emphasis on pilot monitoring responsibilities and the manual deployment of speedbrakes if they do not automatically deploy. However, the information in the SAFO is only guidance, and this incident demonstrates the need for the changes proposed in the SNPRM.

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[55] For additional information, see *Crash During Approach to Landing, Circuit City Stores, Inc., Cessna Citation 560, N500AT, Pueblo, Colorado, February 16, 2005,* Aircraft Accident Report NTSB/AAR-07/02 (Washington, D.C.: National Transportation Safety Board, 2007), which is available at <http://www.ntsb.gov>. Also, see *Northwest Airlines, Inc., [Flight 255], McDonnell Douglas DC-9-82, N312RC, Detroit Metropolitan Wayne County Airport, Romulus, Michigan, August 16, 1987,* Aircraft Accident Report NTSB/AAR-88/05 (Washington, D.C.: National Transportation Safety Board, 1988) and *Delta Air Lines, Inc., [Flight 1141], Boeing 727-232, N473DA, Dallas-Fort Worth International Airport, Dallas, Texas, August 31, 1988,* Aircraft Accident Report NTSB/AAR-89/04 (Washington, D.C.: National Transportation Safety Board, 1989).

[56] American Airlines provides its pilots with 757 Special Landing Analysis charts for JAC.

The NTSB concludes that, if the importance of adhering to pilot monitoring responsibilities were included in flight crew training, the incident captain would have been less likely to assume control of the reverse thrust levers (a pilot flying responsibility) during the landing roll and remained focused on his pilot monitoring duties; as a result, he most likely would have observed that the speedbrakes had not automatically deployed. This incident reinforces the need for the FAA to move as quickly as possible to issue a final rule based on the SNPRM. Thus, the NTSB reiterates Safety Recommendation A-07-13.

4. Conclusions

4.1 Findings

1. Postincident interviews and American Airlines' records indicated that the incident pilots were certificated in accordance with federal regulations and were current and qualified in the incident airplane in accordance with American Airlines' training requirements.

2. Company records showed that both pilots had completed American Airlines' Jackson Hole Airport (JAC) special airport training and had recent (and, in the captain's case, extensive) experience flying into JAC.

3. The National Transportation Safety Board's review of company records, postincident pilot interviews, and work/sleep/wake and medical histories revealed no evidence of fatigue or any medical or behavioral conditions that might have adversely affected the pilots' performance during the incident flight.

4. The pilots had the pertinent weather, airport, and airplane performance information necessary to determine whether a safe landing could be made at Jackson Hole Airport (JAC), and they had taken all appropriate before-landing actions; based on that information, the pilots appropriately decided that a landing at JAC was in accordance with company and performance guidelines.

5. Although the pilots had armed the automatic speedbrake system during the approach to Jackson Hole Airport, the automatic speedbrakes failed to automatically deploy as designed after touchdown.

6. A manufacturing defect in the incident airplane's speedbrake no-back clutch mechanism prevented the speedbrakes from automatically deploying during the incident landing.

7. If either pilot had observed that the speedbrakes had not automatically deployed and subsequently corrected the situation by manually deploying them, the airplane's stopping distance would have been greatly decreased.

8. The captain's erroneous speedbrakes "deployed" callout was likely made in anticipation (not in confirmation) of speedbrake deployment after he observed the speedbrake handle's initial movement; after the "deployed" callout was made, both pilots likely presumed that the reliable automatic speedbrakes were functioning normally and focused on the thrust reverser problem.

9. Although the momentary interruption of the air/ground system's "ground" signal after touchdown would not normally adversely affect the deployment of thrust reversers, in this case it coincided almost precisely with the initial deployment of the thrust reversers and resulted in the thrust reversers locking in transit instead of continuing to deploy.

10. If the incident pilots had received specific pilot training on the handling of multiple emergency or abnormal situations, they might not have focused exclusively on the thrust reverser nondeployment and might have been more likely to recognize and properly resolve the speedbrake nondeployment during the landing.

11. Although American Airlines' manuals and procedures emphasized the importance of prompt speedbrake deployment and monitoring of the speedbrake lever after landing, the pilots did not recognize that the speedbrakes had not automatically deployed because both pilots were distracted by, confused by, and trying to resolve the thrust reversers' nondeployment.

12. A clearly distinguishable and intelligible alert that activates when the speedbrakes do not automatically deploy after landing would have provided the pilots with a salient warning that the speedbrakes did not function as expected and would likely have brought the captain's attention back to the speedbrakes and resulted in manual speedbrake deployment.

13. If the incident pilots had known that when the thrust reversers locked in-transit they needed to move the reverse thrust levers to the stowed position before attempting to deploy them again, the deployment of the thrust reversers could have occurred much earlier in the landing roll.

14. If the importance of adhering to pilot monitoring responsibilities were included in flight crew training, the incident captain would have been less likely to assume control of the reverse thrust levers (a pilot flying responsibility) during the landing roll and remained focused on his pilot monitoring duties; as a result, he most likely would have observed that the speedbrakes had not automatically deployed.

4.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this incident was a manufacturing defect in a clutch mechanism that prevented the speedbrakes from automatically deploying after touchdown and the captain's failure to monitor and extend the speedbrakes manually. Also causal was the failure of the thrust reversers to deploy when initially commanded. Contributing to the incident was the captain's failure to confirm speedbrake extension before announcing their deployment and his distraction caused by the thrust reversers' failure to initially deploy after landing.

5. Recommendations

5.1 New Recommendations

The National Transportation Safety Board makes the following recommendations to the Federal Aviation Administration:

> Require all operators of existing speedbrake-equipped transport-category airplanes to develop and incorporate training to specifically address recognition of a situation in which the speedbrakes do not deploy as expected after landing. (A-12-44)

> Require all newly type-certificated 14 *Code of Federal Regulations* Part 25 airplanes to have a clearly distinguishable and intelligible alert that warns pilots when the speedbrakes have not deployed during the landing roll. (A-12-45)

> Require Boeing to establish guidance for pilots of all relevant airplanes to follow when an unintended thrust reverser lockout occurs and to provide that guidance to all operators of those airplanes. (A-12-46)

5.2 Previous Recommendations Reiterated in this Report

In addition, the National Transportation Safety Board reiterates the following recommendations to the Federal Aviation Administration:

> Establish best practices for conducting both single and multiple emergency and abnormal situations training. (A-09-24)

> Once the best practices for both single and multiple emergency and abnormal situations training asked for in Safety Recommendation A-09-24 have been established, require that these best practices be incorporated into all operators' approved training programs. (A-09-25)

> Require that all pilot training programs be modified to contain modules that teach and emphasize monitoring skills and workload management and include opportunities to practice and demonstrate proficiency in these areas. (A-07-13)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

DEBORAH A.P. HERSMAN
Chairman

ROBERT L. SUMWALT
Member

CHRISTOPHER A. HART
Vice Chairman

MARK R. ROSEKIND
Member

Member **Earl F. Weener** did not Participate.

Adopted: June 18, 2012

Board Member Statements

Vice Chairman Christopher A. Hart, concurring:

I concur with the report, including the findings and probable cause, but I am concerned that we are not giving enough attention to an emerging issue – the human factors issues associated with the improving reliability of automation.

Three (of many) challenges with automation are (a) reliability, (b) the ability of operators to know when the automation is not working properly, and (c) the ability of operators to take over in a timely and effective manner when the automation is not working properly. Ironically, as the reliability of automation increases, the other two challenges become ever more difficult because it is human nature to rely on systems that almost always work, which can then lead to automation complacency.

This incident involves the simultaneous failure of two systems that are normally very reliable – the thrust reverser deployment mechanism and the automatic speedbrake deployment mechanism. The likelihood that one would fail is very small, and the likelihood of both failing at the same time, being the product of the two failure probabilities, is yet significantly smaller. In the rush of the moment, in a landing that the pilots knew would be challenging with little margin for error, the captain demonstrated expectation bias – thinking that he saw what he expected to see – with respect to both systems.

I submit that we, along with the entire aviation community, need to focus more attention on the human factors challenges that are brought about by increasing reliability, including but not limited to expectation bias. We conclude the pilots should have monitored more effectively, but we do not, in my view, give adequate attention to the systems issues, such as how to make increasingly reliable automation more responsive to human factors realities such as expectation bias.

In addition, in a distance-challenged landing such as this one, it is very foreseeable that (a) the touchdown might be firm enough to result in at least a partial bounce, and (b) the pilots would commence thrust reverser deployment immediately after touchdown. As revealed by this incident, a very minor bounce that is sufficient to cause a main landing gear truck to de-rotate, along with an immediate thrust reverser command, if timed just wrong, could interrupt the thrust reverser deployment by causing the air-ground sensor to revert to "air," due to the truck de-rotation, just as the thrust reverser deployment began. Apparently the window of opportunity for this sequence to cause problems is very short, measured in microseconds, because operational experience reveals that the specific problem that occurred in this incident is very rare.

Given the rarity of this timing problem, it is not surprising that (a) the pilots had never encountered this situation before in actual operation, and (b) they had never been trained in the simulator that when this problem occurred, they should stow the thrust reversers and begin the sequence anew, rather than trying to continue from where the thrust reverser levers stuck. Thus, while we can say in hindsight that the captain's effort to assist with the thrust reversers was not helpful, and was not consistent with the fact that the most important first task at the time was ensuring maximum brake effectiveness (by ensuring speedbrake deployment), I do not believe that it was unreasonable, under the circumstances and given what he knew at the time, for the captain to try to help the first officer move the thrust reverser levers. Moreover, if the captain had not tried to help, and if our investigation had revealed that additional force on the thrust reverser levers might have resulted in deployment (which we now know, in hindsight, is not the case), query whether we would have criticized the captain for not trying to help.

Improving reliability is obviously good; but until we recognize and respond to the human factors realities of increasingly reliable automation, we are not appropriately aligning the automation with the humans to maximize the reliability of the human-machine system.

Chairman Hersman and Members Sumwalt and Rosekind concurred with this statement.

Member Robert L. Sumwalt, concurring:

I believe this investigation did a nice job of identifying two distinct mechanical conditions faced by this crew upon landing at Jackson Hole (JAC). The speedbrake malfunction was elusive and not readily identifiable on the accident aircraft until it malfunctioned again - three months after the JAC incident.

Although the report does a nice job describing the mechanical aspects of the incident, there are elements of the report regarding pilot training and human performance that I do not totally agree with, or feel are lacking. This concurring statement expounds upon those areas.

As mentioned, the crew faced multiple abnormalities upon touchdown. The report states "If the incident pilots had received specific pilot training on the handling of multiple emergency or abnormal situations, they might not have focused exclusively on the thrust reverser nondeployment and might have been more likely to recognize and properly resolve the speedbrake nondeployment during the landing." We also reiterated two previously issued recommendations (A-09-24 and A-09-25) that called for pilots to receive training on multiple abnormal and emergency situations.

While I supported issuance of those recommendations in 2009, I note they were issued in response to an *inflight* emergency where the crew faced multiple abnormalities and emergency conditions. I believe the key difference between that event and this event is the element of time.

For most emergency and abnormal situations that occur inflight, there is often time for the crew to sort-out the situation and decide the best way to deal with the problem. For those situations, recommendations A-09-24 and A-09-25 are appropriate and relevant. In the JAC incident, however, the crew was under extremely tight time constraints to steer the aircraft and get it stopped under challenging conditions of a relatively short runway that was contaminated with snow and ice, while trying to sort-out why the thrust reversers did not deploy. For this reason, I seriously doubt that even if the crew had undergone training for dealing with multiple abnormal and emergency situations, it would have made a difference in the outcome of this event.

I believe the best way to achieve a specific result is to provide specific training. For example, for a rejected takeoff – another example of time criticality due to trying to get the aircraft stopped quickly from high speed – specific training is provided and procedures clearly delineated regarding crewmember roles and responsibilities. To that point, I am pleased that in this report, the Board issued a recommendation to develop and incorporate training to specifically address recognition of a situation where the speedbrakes do not deploy. I feel this training will provide greater efficacy in improving safety in a similar situation, rather than taking a previous recommendation that was issued for an inflight abnormal situation and trying to force it to fit this incident.

The second point of this concurring statement surrounds what I feel is an incomplete analysis of human performance issues. It is curious to me that the report explained why the captain erroneously called out speedbrake and thrust reverser deployment when they had not deployed, but did not explain why both crewmembers tunneled their attention on the thrust reverser problem.

If there were crew interaction problems, as staff stated in the board meeting (a statement that is not supported by crew interviews), then this would have huge implications for crew resource management training. Content of NTSB reports gets widespread dissemination and that information can provide tremendous learning value. However, if no attempt is made to explain human performance in the report, then we have missed an opportunity to provide that teaching moment.

Alternate explanations for their actions might include the fact that the crew was appropriately aware of how challenging their landing would be, compounded by the surprise factor of suddenly realizing their thrust reversers would not deploy.

Whatever the reason, I am disappointed the report made no attempt to explain this element of human performance.

In sum, NTSB accident reports are to explain not only *what* happened, but they should explain *why* something happened, as well.

I hope future reports will be more descriptive in this respect.

Chairman Hersman, Vice Chairman Hart and Member Rosekind concurred with this statement.

6. Appendix: Cockpit Voice Recorder Transcript

The following is a transcript of the L-3 Communications FA2100-1020 solid-state cockpit voice recorder, serial number 107348, installed on an American Airlines Boeing-757-200 (N668AA), which overran the runway at Jackson Hole Airport, Jackson Hole, Wyoming, on December 29, 2010.

LEGEND

CAM	Cockpit area microphone voice or sound source
HOT	Flight crew audio panel voice or sound source
RDO	Radio transmissions from N668AA
CTR	Radio transmission from Salt Lake center controller
ATIS	Radio transmission from Jackson Hole Automatic Terminal Information Service
OPS	Radio transmission from the Jackson Hole American Airlines operations
PA	Public address system in aircraft
TWR	Radio transmission from the Jackson Hole airport tower controller
EGPWS	Enhanced Ground Proximity Warning System
AC	Delta flight 1331
SAAB	SAAB friction tester vehicle
ARFF	Airport rescue and firefighters
CRASH	Airport crash and rescue
-1	Voice identified as the captain
-2	Voice identified as the first officer
3	Voice identified as the flight attendant
-?	Voice unidentified
*****	Unintelligible word
#	Expletive
@	Non-pertinent word
( )	Questionable insertion
[ ]	Editorial insertion

Note 1: Times are expressed in mountain standard time (MST).

Note 2: Generally, only radio transmissions to and from the accident aircraft were transcribed.

Note 3: Words shown with excess vowels, letters, or drawn out syllables are a phonetic representation of the words as spoken.

Note 4: A non-pertinent word, where noted, refers to a word not directly related to the operation, control or condition of the aircraft.

CVR Quality Rating Scale

The levels of recording quality are characterized by the following traits of the cockpit voice recorder information:

Excellent Quality	Virtually all of the crew conversations could be accurately and easily understood. The transcript that was developed may indicate only one or two words that were not intelligible. Any loss in the transcript is usually attributed to simultaneous cockpit/radio transmissions that obscure each other.
Good Quality	Most of the crew conversations could be accurately and easily understood. The transcript that was developed may indicate several words or phrases that were not intelligible. Any loss in the transcript can be attributed to minor technical deficiencies or momentary dropouts in the recording system or to a large number of simultaneous cockpit/radio transmissions that obscure each other.
Fair Quality	The majority of the crew conversations were intelligible. The transcript that was developed may indicate passages where conversations were unintelligible or fragmented. This type of recording is usually caused by cockpit noise that obscures portions of the voice signals or by a minor electrical or mechanical failure of the CVR system that distorts or obscures the audio information.
Poor Quality	Extraordinary means had to be used to make some of the crew conversations intelligible. The transcript that was developed may indicate fragmented phrases and conversations and may indicate extensive passages where conversations were missing or unintelligible. This type of recording is usually caused by a combination of a high cockpit noise level with a low voice signal (poor signal-to-noise ratio) or by a mechanical or electrical failure of the CVR system that severely distorts or obscures the audio information.
Unusable	Crew conversations may be discerned, but neither ordinary nor extraordinary means made it possible to develop a meaningful transcript of the conversations. This type of recording is usually caused by an almost total mechanical or electrical failure of the CVR system.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
09:40:20.0 **START OF RECORDING**			
10:58:29.7 **START OF TRANSCRIPT (APPROACH BRIEFING PORTION)**			
10:58:29.7 **CAM-1**	are you comfortable with the approach you want to go over it?		
10:58:32.5 **CAM-2**	ah yeh basically just like what we've been doing all month one oh nine one one eighty seven inbound we need three quarters of a mile sixty six fifty one is the M-D-A six fifty one.		
10:58:46.1 **CAM-1**	ah six fifty one I was doin' I was doin' the outbound I have the seventy four fifty for the outbound.		
10:58:51.5 **CAM-2**	yep.		
10:58:51.9 **CAM**	*.		
10:58:52.4 **CAM-2**	uh if we * if we miss and we're prior to that two point eight D-M-E we'll do the left hand turn back around we'll probably hafta' do the whole thing back around.		
10:59:01.9 **CAM-1**	yeah * have to go up to DUNOIR.		
10:59:03.7 **CAM-2**	right.		
10:59:04.0 **CAM-1**	if we're burnin' if were burnin' we'll turn right around and come in if we're have a other maintenance issues if not we're on fire let's go to Salt Lake you know what I mean with this weather.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
10:59:04.1 **CAM-2**	and the weather is.		
10:59:12.8 **CAM-2**	okay.		
10:59:14.0 **CAM-2**	yep.		
10:59:14.9 **CAM-2**	um missed is in the box be straight out there to KICNE at * there is terrain we know about that I'll get slowed down for the turn comin' out of DUNOIR and we will * if we come in below five hundred feet or so and uh and maybe a little bit earlier I'll be droppin' down to about a half a dot maybe a little more and touchdown in the first five hundred feet.		
10:59:36.2 **CAM-1**	kind'a like what I did yesterday and I just closed the throttle and went for it because uh * 'cause this thing'll float you know.		
10:59:37.3 **CAM-2**	yeah.		
10:59:39.8 **CAM-2**	right.		
10:59:42.2 **CAM-2**	correct.		
10:59:44.2 **CAM-2**	speed 'ill be on and everything so I'll make sure all that.		
10:59:48.2 **CAM**	*.		
10:59:49.2 **CAM-2**	if you * don't like what you see tell me to go around.		
10:59:52.2 **CAM-1**	okay one thirty one on the numbers.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
10:59:55.2 **CAM-2**	one thirty one that works for me...left hand turn off...max brakes yeah.		
11:00:02.6 **CAM-1**	* be slippery slippery max auto it'll be slippery at the end there.		
11:00:04.7 **CAM-2**	yeah.		
11:00:06.3 **CAM-2**	right once we get down you know we're slowin' down I'll whenever you either want it or I'll hand it over to ya'.		
11:00:13.3 **CAM-1**	yeah * probably I'll get it just 'cause wanna make sure I'm comfortable with the steering in the turn before I get to the turn...cause it's got that ninety degree turn.		
11:00:13.8 **CAM-2**	*.		
11:00:19.5 **CAM-2**	right okay.		
11:00:23.9 **CAM-2**	right.		
11:00:26.6 **CAM-2**	with those M-Us I almost stop before I turn.		
11:00:30.1 **CAM-1**	yeah well that's it.		

END OF TRANSCRIPT (APPROACH BRIEFING PORTION)
11:00:30.1

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:13:23.2	**START OF TRANSCRIPT (LAST PORTION OF FLIGHT)**		
11:13:37.8 **HOT-1**	...at seventeen ten the guy landed after that called it good first two thirds poor the last one third but he was a uh Challenger thirty so little light guy.		
		11:13:37.9 **CTR**	...thirty two Salt Lake center roger other aircraft say again.
11:13:42.0 **PA-3**	ladies and gentlemen we are very shortly beginning our descent if you would make sure your seat belts is securely fastened once again thank you.		
11:13:48.2 **HOT-2**	skip we'll get her slowed down no matter what.		
11:13:50.0 **HOT-1**	yeh um (ramp's a) light snow base is sixty nine hundred foot no ice in the arrival or turbulence.		
11:14:00.5 **CAM-1**	s'that last one third I'm worried about.		
11:14:02.5 **CAM-2**	okay.		
11:14:03.6 **CAM-1**	but it's a light airplane.		
11:14:05.0 **CAM-2**	right.		
11:14:07.7 **HOT-1**	alright I'm off just a minute.		
11:14:08.7 **HOT-2**	okay.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:14:13.8 **PA-1**	well as you can tell we've started our descent into Jackson Hole. there are a few breaks in the clouds uh not sure all what we're going to see but ah give you an idea cause ah if the clouds do break a little bit its so spectacularly beautiful here uh (id would) be kind'a nice to know what we're gonna look at. we arrive in Jackson Hole from the Northeast ah through ah the (Togwotee Pass). ah if your lookin' off the left hand side uh out there through the clouds you can see the Wind River Range that works its way to the Northwest. we're gonna come up over the ah the south end of the (af sirc) range and the valley between them is the (Togwotee Pass) route twenty six. if you've ever driven that and that's ah the route we kind'a take into the ah valley as we fly due west. once we get in (to) the center of the valley we make a left hand turn start our descent to the south land to the south at the ah Jackson ah Hole airport. as you make that ah left turn to the south ah Jackson Lake will ah be close in on the right hand side it still has a little bit of open water and last we looked at it. and (then) of course the Tetons will be off our right. the highest one will be Grand Teton. Teton Villages will be a little bit south of the airport you won't be able to see them on landing if you’re on the ah left hand side. as we enter the valley ah as we make that turn you'll have a nice view of the Snake River it'll be following us all the way. ah as we make the approach into the airport the ah the (Gros Ventre) Range is ah off to the left hand side. and ah on short final ah very close in it looks like it’s right off the left wing tip you'll see Black Tail Butte if there is a break in the clouds an ah we didn't see it yesterday we saw it a couple days ago ah off the right as we ah just as we make the turn to the South we can look way off the right wing ah about thirty miles up we often get a nice view of ah Yellowstone Lake. we should be on the ground in Jackson Hole in ah about twenty minutes maybe just a little bit more than that.		
11:16:07.3 **HOT-1**	thank you sir.		
11:16:08.2 **HOT-2**	ah you're welcome.		
11:16:21.0 **HOT-2**	[sound of person humming]		
11:16:26.8 **HOT-2**	there goes the traffic we were up-		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:16:28.5 **HOT-1**	yep.		
11:16:29.0 **HOT-2**	-above.		
11:16:32.5 **HOT-1**	I'm back to yah.		
		11:17:03.1 **CTR**	American twenty two fifty three descend and maintain one six thousand Jackson altimeter two niner one five.
		11:17:11.3 **RDO-1**	descend to one six thousand altimeter two niner one five American ah twenty two fifty three.
11:17:17.8 **HOT-2**	two nine one five? holy #.		
11:17:21.8 **HOT-1**	yep two nine one six on theirs.		
11:17:22.4 **HOT-2**	wow.		
11:17:24.3 **HOT-2**	sixteen thousand set.		
11:17:43.1 **PA-1**	and now as we descend into the clouds here at Jackson a fairly strong wind about ah eighty miles an hour across the (Absircs) here could give us a little bump or two so at this time I would like to ask our flight attendants to complete their duties take their seats and remain seated for the rest of the flight thank you.		
11:17:59.7 **CAM-1**	one six is what they give us.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:18:00.6 **PA-3**	in final preparation for our landing please adjust your seat back to the upright position and stow your tray table if you have taken carry on luggage out during the flight it does need to be once again beneath the seat in front of you please turn off and put away all electronic devices flight attendants will be collecting remaining service items we'll be landing soon.		
11:18:01.8 **HOT-2**	sixteen alright that's way down there two niner one six.		
11:18:06.0 **CAM-1**	this has two nine one six yeah.		
11:18:07.9 **HOT-2**	alright that works for me.		
11:18:10.5 **CAM-1**	that's low.		
11:18:11.6 **HOT-2**	it is.		
11:18:22.5 **HOT-1**	did the airplane perform ok?		
11:18:24.3 **HOT-1**	cruise checklist complete.		
11:18:25.8 **HOT-2**	yeah it did.		
11:18:26.2 **HOT-1**	we didn't divert did we?		
11:18:27.3 **HOT-2**	no not yet.		
11:18:28.0 **HOT-1**	alright.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:18:36.8 **HOT-1**	uh-oh last time crew coordination last one for the year.		
11:18:39.7 **HOT-2**	*.		
11:18:41.4 **HOT-1**	close close your eyes touch your nose yeah alright good.		
11:18:43.5 **HOT-2**	good cool.		
11:19:09.5 **HOT-2**	v-ref one thirty one.		
11:19:11.1 **HOT-1**	one thirty one set and cross checked.		
11:19:14.1 **HOT-2**	flight instruments and bugs altimeters.		
11:19:15.9 **HOT-1**	two nine one six.		
11:19:17.3 **HOT-2**	two nine sixteen.		
11:19:19.2 **HOT-2**	brakes.		
11:19:20.8 **HOT-1**	max auto.		
11:19:21.1 **HOT-2**	maximus set.		
11:19:44.9 **HOT-2**	[sound of person humming]		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:19:55.3 **HOT-2**	cloudy down here.		
11:20:37.5 **CAM-1**	I can see ah the reservoir up there.		
		11:20:39.3 **CTR**	American twenty two fifty three information Whiskey is now current.
		11:20:42.5 **RDO-1**	we'll pick it up.
		11:20:43.3 **ATIS**	...* temperature minus five dewpoint minus seven altimeter two niner one four I-L-S approaches landing and departing runway one niner runway one niner M-U's forty three forty three thirty nine at one eight one zero reported by a SAAB friction tester thin loose snow over packed thin packed snow and ice on runway taxiway and ramps runway one niner MALS four hundred foot light bar out of service personnel and equipment on runway for snow removal braking action advisories are in effect hazardous weather information for the Northwest region available from flight watch or flight service PIREP time one seven three seven a Challenger thirty I-L-S runway one niner reported the first and second third of the runway braking action good last third braking action poor advise on initial contact you have information Whiskey. Jackson Hole tower information Whiskey time one eight one five wind one niner zero at six visibility three quarter light snow ceiling four hundred broken one thousand overcast temperature minus five...
11:21:15.4 **CAM-1**	mu's forty three forty three thirty nine.		
11:21:22.4 **CAM-1**	so that's the only difference I can hear.		
11:21:23.7 **HOT-2**	what was it.		
11:21:25.4 **CAM-1**	forty three forty three thirty nine.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:21:27.6 **HOT-2**	okay I like that.		
11:21:29.6 **HOT-2**	ah I heard men and equipment are clearing the runway right now too.		
11:21:31.5 **CAM-1**	what.		
11:21:33.0 **CAM-1**	what.		
11:21:33.2 **HOT-2**	they they're clearing the runway right now is what they are saying on ATIS too right so.		
11:21:35.4 **CAM-1**	yeah.		
11:22:03.4 **CAM-1**	fourteen.		
11:22:08.6 **HOT-2**	fourteen set.		
11:22:10.8 **CAM-1**	I-L-S one niner basically ah one ninety at six on your winds three quarters light snow and still four hundred over.		
11:22:16.8 **CAM-2**	alright.		
		11:22:26.9 **RDO-1**	American twenty two fifty three has Whiskey.
		11:22:30.4 **CTR**	American twenty two fifty three roger.
11:24:00.6 **HOT-2**	heat?		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:24:01.7 **HOT-1**	yep go ahead.		
11:24:06.4 **PA-1**	ah there's also one other thing I would like to mention going to Jackson Hole if you've not been here before relatively short runway up here in the mountains it's been snowing today we don't ah try and make a smooth landing here at Jackson Hole we just ah put the aircraft ah on the runway very quickly and firmly and go into full reverse and then use a heavy amount of braking make sure we stop in the first ah part of the runway so ah just be aware of that that's normal procedure for a mountain airport.		
		11:24:29.5 **CTR**	American twenty two fifty three descend and maintain one five thousand.
		11:24:32.8 **RDO-1**	one five thousand American twenty two fifty three.
11:24:35.6 **HOT-2**	fifteen thousand.		
11:24:36.6 **HOT**	[sound of single chime]		
11:25:21.2 **HOT-2**	sixteen for fifteen.		
11:25:24.1 **HOT-1**	check we're sterile seat and smoking signs on.		
11:25:35.8 **HOT-2**	I see a little ice out there on the window and I got it on my probe my ah windshield wiper out here.		
11:25:43.9 **HOT-1**	I'm not showing anything uh is it?		
11:25:44.0 **HOT-2**	little flake I got a couple little flakes on my eh forward edge of that ole windshield wiper out there.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:25:53.8 **HOT-1**	oh yeah just a little bit on that ah leading edge ju-		
11:25:56.5 **HOT-2**	yeah.		
11:25:57.3 **HOT-1**	little light rime level at fifteen.		
		11:26:14.3 **RDO-1**	Jackson twenty two fifty three.
		11:26:19.2 **OPS**	hey captain @ @ here.
		11:26:21.1 **RDO-1**	how you doin' ah looks like the runway's pretty good we got forty three forty three thirty nine ah little bit light snow eh.
		11:26:27.1 **OPS**	okay did you just get that the SAAB just came off um so yeah its uh a little better maybe than it was in the run out especially.
		11:26:35.8 **RDO-1**	yeah that's what it looks like to us he just came off and they uh quickly changed the ATIS on it so uh it shouldn't be a problem we're just about eight miles out of DUNOIR so ah it should be on the ground in ah about thirty five after the hour.
		11:26:46.4 **OPS**	very good uh we'll see you there.
		11:26:48.6 **RDO-1**	see you then.
		11:26:55.0 **CTR**	American twenty two fifty three cross DUNOIR V-O-R at or above one three thousand cleared I-L-S approach Jackson airport.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:26:56.5 **CAM-1**	look at the ice.		
		11:27:01.5 **RDO-1**	okay cross DUNOIR at or above one three thousand ah cleared for the I-L-S ah runway one niner approach to ah Jackson Hole American ah twenty two fifty three.
		11:27:11.6 **RDO-1**	and f-y-i up here at fifteen thousand American twenty two fifty three's getting light rime ice.
		11:27:19.9 **CTR**	Cactus seventy eight roger and American twenty two fifty three say again.
		11:27:23.7 **RDO-1**	ah we're gettin' light rime ice here at ah one five thousand.
		11:27:27.2 **CTR**	American twenty two fifty three roger.
11:27:31.6 **HOT-1**	you don't see much on this machine so you know you're gettin' it.		
11:27:34.8 **HOT-1**	remind me to hit the tail ah as we get to ah to FAPMO.		
11:27:37.3 **HOT-2**	okay.		
11:27:39.1 **HOT-2**	alright.		
		11:28:00.2 **CTR**	American twenty two fifty three do you have a ah temperature there.
		11:28:05.7 **RDO-1**	standby.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:28:10.8 **HOT-1**	where's my temperature?		
		11:28:12.3 **RDO-1**	minus sixteen degrees ah ah's what we're showin' up here.
		11:28:18.2 **CTR**	American twenty two fifty three roger let me know if you get out'a that ice please.
		11:28:22.2 **RDO-1**	wilco.
11:28:22.9 **HOT-2**	alright inside of DUNOIR if you set eleven for me.		
11:28:26.9 **HOT-1**	inside DUNOIR one one thousand for ah QUIRT.		
11:28:33.2 **HOT-1**	one one thousand.		
11:28:34.9 **HOT-2**	eleven thousand set.		
11:28:35.0 **HOT-1**	I show you on the radial.		
11:28:37.1 **HOT-2**	thank you.		
11:29:03.6 **HOT-2**	below two forty flaps one.		
11:29:06.8 **HOT-1**	below two forty verified.		
11:29:08.1 **CAM**	[sound similar to flap handle movement]		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:29:09.8 **HOT**	[sound of weak ident] (continues for approximately 30 seconds, increasing in volume and clarity)		
11:29:13.6 **HOT-1**	little weak on the ah ident here.		
11:29:31.7 **HOT-2**	below two twenty flaps five.		
11:29:35.7 **HOT-1**	verified flaps five.		
11:29:36.8 **CAM**	[sound similar to flap handle movement]		
11:29:38.9 **HOT-1**	ah I-L-S one niner identifies Jackson Hole.		
11:29:42.7 **HOT-2**	thank you.		
11:29:46.9 **HOT-1**	there's the ground.		
11:29:48.2 **HOT-2**	below two ten flaps fifteen.		
11:29:52.7 **HOT-1**	verified.		
11:29:53.7 **CAM**	[sound of mechanical click]		
		11:30:05.8 **RDO-1**	and Salt Lake American twenty two fifty three we came out of the ice about one three thousand.
11:30:13.4 **HOT-2**	below one ninety five flaps twenty.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
		11:30:14.9 **CTR**	American twenty two fifty three roger contact Jackson tower one one eight point zero seven good day.
11:30:17.8 **CAM-1**	verified.		
11:30:18.5 **CAM**	[sound similar to flap handle movement]		
		11:30:19.3 **RDO-1**	eighteen zero seven talk to you on the way out American twenty two fifty three.
11:30:22.8 **HOT-1**	it's startin' tah come off do you see that.		
11:30:24.7 **HOT-2**	yep.		
11:30:28.0 **CAM**	[sound of mechanical clicks]		
11:30:29.8 **HOT-2**	spoilers are armed.		
11:30:31.1 **HOT-1**	armed.		
11:30:34.5 **HOT-1**	okay eleven ah twelve for eleven thousand.		
11:30:37.1 **HOT-2**	twelve for eleven.		
11:30:37.9 **HOT-1**	there's the dam at Jackson Lake.		
11:31:11.4 **HOT-2**	in the turn.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:31:12.8 **HOT-1**	there's the turn.		
11:31:18.0 **HOT-2**	come'n inside of QUIRT I got the localizer thank you ninety seven hundred feet please.		
11:31:20.4 **HOT-1**	altitude capture.		
11:31:23.9 **HOT-1**	ninety seven.		
11:31:24.8 **HOT-2**	ninety seven.		
11:31:32.0 **HOT-2**	and approach is armed.		
11:31:33.9 **HOT-1**	'kay good.		
		11:31:36.4 **RDO-1**	Jackson ah tower American twenty two fifty three is at QUIRT.
		11:31:42.1 **TWR**	American twenty two fifty three Jackson tower report FAPMO.
		11:31:45.9 **RDO-1**	report FAPMO American twenty two fifty three missed you yesterday what happened?
		11:31:49.5 **TWR**	American twenty two fifty three I thought it was noon that's what I was told I'm real sorry about that we need to try again though.
		11:31:56.6 **RDO-1**	yeah we will ah fortunately I'll talk to you on the ground about it.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
		11:32:00.2 **TWR**	American twenty two fifty three roger.
11:32:03.7 **HOT-2**	alright loc capture glide slope's armed.		
11:32:08.6 **HOT-1**	loc captured glide slope armed that's confirmed.		
11:32:21.3 **HOT-2**	gear down.		
11:32:23.4 **HOT-1**	below two hundred fifty knots gear down.		
		11:32:25.0 **TWR**	American twenty two fifty three at one seven three seven a Challenger landed reporting the first and second half braking action good * last oh sorry the first and second third braking action good the last third braking action poor.
		11:32:38.1 **RDO-1**	ah twenty two fifty three copy that an' uh we got the latest mu on the latest ATIS we got that ah PIREP too thank you very much.
		11:32:45.4 **RDO-1**	you're gonna see us ah brake real hard in the first part of the runway.
		11:32:50.1 **TWR**	American twenty two fifty three roger and request braking action upon arrival.
		11:32:54.6 **RDO-1**	wilco.
11:32:55.9 **HOT-2**	gear's down below one ninety flaps twenty five.		
11:32:57.0 **CAM-1**	verified down.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
		11:32:57.7 **TWR**	American twenty two fifty three if you could take note of bases tops turbulence and icing I'd appreciate that as well .
11:32:59.0 **HOT-1**	verified.		
11:32:59.6 **CAM**	[sound of mechanical click]		
		11:33:03.1 **RDO-1**	wilco the only icing we've had so far we were at about fifteen thousand feet got light rime ice.
		11:33:09.5 **TWR**	roger.
11:33:10.4 **HOT-1**	gear.		
11:33:11.2 **HOT-2**	gear's down.		
11:33:11.9 **HOT-1**	down.		
11:33:13.1 **HOT-1**	cleared the approach.		
11:33:15.0 **HOT-2**	glide slope's captured missed is comin' in.		
11:33:17.3 **HOT-1**	okay glide slope capture fourteen thousand that's set.		
11:33:19.5 **HOT-2**	set.		
		11:33:23.0 **RDO-1**	and American ah twenty two fifty three is FAPMO.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
		11:33:26.0 **TWR**	American twenty two fifty three wind two six zero at five runway one niner cleared to land.
		11:33:31.9 **RDO-1**	cleared to land ah runway one niner American twenty two fifty three.
11:33:34.5 **HOT-1**	two sixty at five now so that's a crosswind okay.		
11:33:38.1 **HOT-2**	yes and ah below one sixty two flaps thirty.		
11:33:41.4 **CAM**	[sound of mechanical double click]		
11:33:42.6 **HOT-1**	verified.		
11:33:43.0 **CAM**	[sound of mechanical click]		
11:33:47.4 **HOT-1**	flaps.		
11:33:48.2 **HOT-2**	I see thirty.		
11:33:49.3 **HOT-1**	thirty checklist complete cleared to land brakes f* everything's good.		
11:33:51.8 **HOT-2**	okay got loc glideslope.		
11:34:08.3 **HOT-2**	radio altimeter's alive.		
11:34:12.6 **HOT-2**	right FAPMO lookin' got that good.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:34:16.9 **EGPWS**	twenty five hundred.		
11:34:30.1 **HOT-1**	ice is breakin' up a little bit.		
11:34:34.7 **HOT-1**	minus six.		
		11:34:40.7 **AC**	American at Jackson Delta thirteen thirty one.
		11:34:45.4 **RDO-1**	go ahead this is American twenty two fifty three.
		11:34:47.5 **AC**	yeh could you give us a PIREP when you br*k *--
		11:34:49.2 **TWR**	broadcasting tower.
		11:34:52.4 **RDO-1**	we're still airborne.
		11:34:53.8 **RDO**	[sound of double microphone click]
11:35:04.5 **HOT-2**	I see the ground.		
11:35:06.3 **HOT-1**	yep.		
11:35:40.2 **HOT-1**	see the ground way out here.		
11:35:41.8 **HOT-2**	yeah.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:35:42.4 **HOT-1**	yeah.		
11:35:43.2 **HOT-2**	forward visibility's not very good.		
11:35:45.0 **HOT-1**	no.		
11:35:47.3 **HOT-1**	should be good because we're fifteen hundred feet above the ground we see down real well.		
11:36:07.4 **HOT-1**	yeah Moose Lodge should be right here somewhere I...		
11:36:13.0 **HOT-1**	there's Black Tail Butte right there...I see it...Moose Lodge is ah twelve o'clock low I see the lodge.		
11:36:17.8 **HOT-2**	yep we got the river a-here I got the river and a bridge.		
11:36:22.0 **HOT-1**	yep.		
11:36:30.1 **HOT-1**	one thousand feet checklist complete cleared to land.		
11:36:30.8 **EGPWS**	one thousand.		
11:37:05.2 **EGPWS**	five hundred.		
11:37:06.7 **HOT-2**	pickin' up the runway.		
11:37:07.3 **HOT-1**	speed's good pickin' up the runway I agree with you.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:37:10.8 **HOT-1**	there's the lights sixty nine fifty.		
11:37:12.3 **HOT-2**	get the lights.		
11:37:13.9 **HOT-2**	autopilot's comin' off.		
11:37:15.3 **HOT-1**	okay.		
11:37:16.3 **HOT-1**	ease er' down there.		
11:37:18.0 **HOT-2**	throttles are off.		
11:37:28.4 **HOT-1**	'bout two knots one knot slow.		
11:37:31.9 **HOT-1**	keep er' comin' down push 'er down.		
11:37:35.9 **EGPWS**	one hundred.		
11:37:39.2 **EGPWS**	fifty.		
11:37:40.3 **EGPWS**	forty.		
11:37:40.7 **HOT-1**	get 'er on.		
11:37:41.4 **EGPWS**	thirty.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:37:42.3 **EGPWS**	twenty.		
11:37:43.1 **EGPWS**	ten.		
11:37:44.5 **HOT-1**	very good.		
11:37:44.8 **CAM**	[sound of multiple mechanical clicks and thumps]		
11:37:46.3 **HOT-1**	deployed.		
11:37:47.0 **CAM**	[sound of multiple mechanical clicks and thumps]		
11:37:47.5 **HOT-1**	two in reverse.		
11:37:48.0 **HOT-2**	no reverse [voice sounds strained].		
11:37:48.8 **HOT-1**	I got it.		
11:37:49.4 **HOT-1**	get the (rers) get the reverse.		
11:37:51.1 **HOT-1**	I got it you steer.		
11:37:51.1 **HOT-2**	I can't get it.		
11:37:52.9 **HOT-2**	I'm steerin'.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:37:53.6 **HOT-1**	auto brakes.		
11:37:54.5 **CAM**	[sound of physical exertion] [sound of multiple mechanical clicks and thumps]		
11:37:58.9 **HOT-1**	heh.		
11:37:59.6 **HOT-1**	alright I got max brake.		
11:38:03.6 **HOT-2**	#.		
11:38:05.4 **HOT**	there we go.		
11:38:06.4 **HOT-2**	I don't know what the # is wrong.		
11:38:08.3 **HOT-2**	son of a #.		
11:38:11.1 **HOT-2**	we're screwed.		
		11:38:13.9 **RDO-2**	and American ah twenty two fifty three is goin' off the end of the runway.
11:38:17.3 **CAM**	[sound of rumbling]		
		11:38:19.4 **TWR**	American twenty two fifty three roger.
11:38:24.3 **HOT-1**	shut that.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:38:26.5 **HOT-2**	mother #.		
		11:38:32.4 **RDO-1**	call the ground crew.
11:38:35.0 **PA-1**	flight attendants stay in the airplane passengers stay in the airplane.		
11:38:40.0 **HOT-1**	what happened?		
11:38:41.3 **CAM-2**	I didn't get * - auto * - I couldn't pull-		
		11:38:42.0 **TWR**	American twenty two fifty three the...American twenty two fifty three trucks are rollin'.
11:38:49.4 **HOT-1**	thank-		
		11:38:50.7 **RDO-1**	thank you we're gonna stay in the airplane.
		11:38:53.0 **TWR**	American twenty two fifty three roger.
		11:38:56.1 **SAAB**	Jackson gr- ah Jackson tower airport SAAB can you close the runway please.
11:38:58.0 **CAM-2**	they would not come up.		
11:38:59.2 **CAM-1**	I know it.		
		11:39:00.8 **TWR**	airport SAAB copy wilco.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:39:00.9 **CAM-1**	brakes di- they did not release.		
		11:39:03.9 **SAAB**	and uh myself and the ARFF equipment will be on the runway.
11:39:05.1 **CAM-1**	well...end of our career.		
11:39:06.9 **HOT-2**	# @...it's not the end we did everything right we didn't get the thrust reversers.		
11:39:12.2 **HOT-1**	yeah.		
11:39:15.6 **HOT-2**	son of a #.		
11:39:18.1 **HOT-2**	ape- you got the A-P-U goin'.		
11:39:19.4 **PA-1**	ah ladies and gentlemen ah our ah thrust reversers didn't come on and we're gonna roll the ah ground crew. went off the edge of the runway here and uh ground crews are gonna come here and they're gonna assist us off the airplane. I've been here nineteen years and ah we got virtually no assist on the braking.		
		11:39:34.9 **ARFF**	and American this is airport ARFF ah do you need any more assistance as far as injuries er' ah you have any-
		11:39:41.3 **RDO-2**	ah we're checkin' in the back right now for American twenty two fifty three.
		11:39:44.7 **TWR**	American twenty two fifty three you're checkin' for injuries right now is that what you said?

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:39:44.8 **HOT-1**	any injuries?...yeah that's the engines...right.		
		11:39:48.5 **RDO-2**	yeah captains on the horn ah ah talkin' to the ah flight attendants here right now.
11:39:52.9 **HOT-1**	shut the engines.		
11:39:54.9 **HOT-2**	A-P-U up?		
11:39:55.7 **HOT-1**	nobody no injuries yeah A-P-U's up.		
11:40:03.8 **HOT-2**	son of a #.		
11:40:07.4 **HOT-1**	well.		
11:40:08.8 **PA-3**	ah ladies and gentlemen just please remain seated with your seat belts fastened until further advised thank you.		
11:40:14.7 **PA-1**	ah ladies and gentlemen captain @. they're gonna ah ah send out a ah trucks and ah check out the airplane first and then ah get us off to ah to the terminal here. ah we'll find out a way in just a minute. we're not sure what ah happened we're not sure if the braking didn't work. looked like it was but our reversers did not work so ah we're not sure what happened here. ah we'll talk to you as soon as I get more information. please remain please remain seated until you hear instructions from myself or the flight attendants.		
11:40:41.8 **HOT-2**	did * the flight attendants everybody okay in the back and everything? they're wantin' to know on the ground.		

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:40:44.8 **HOT-1**	yeah...yeah they're okay.		
		11:40:47.7 **RDO-1**	Jackson ops uh we off the runway did you copy that.
11:40:49.9 **HOT-2**	(we) told fire fire department that.		
11:40:52.0 **HOT-1**	hm.		
11:40:53.0 **HOT-2**	we tell the fire department that everybody's ok no injuries.		
11:40:55.0 **HOT-1**	yeah yeah.		
		11:40:56.7 **RDO-2**	and uh fire department and ground American twenty two fifty three there are no injuries uh everybody's fine ah we'll just need to have ah ah * may as well come out and check the airplane out and we'll go from there.
		11:41:01.0 **RDO-1**	Jackson ops copy.
11:41:10.2 **HOT-1**	we got no braking action.		
11:41:12.8 **HOT-2**	we didn't get thrust reversers out .		
		11:41:12.8 **ARFF**	ah this is the airport ARFF ah we copy all that ah we'll get some maintenance techs out here and we'll start ah doin' snow removal to get you out.
		11:41:22.4 **RDO-2**	okay thank you.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:41:23.7 **HOT-1**	alright I'm gonna walk the airplane you stay on the radios.		
11:41:25.5 **HOT-2**	okay to park the brakes?		
11:41:26.9 **HOT-1**	yeah.		
11:41:29.5 **HOT-2**	'kay brakes are parked.		
11:41:30.7 **CAM-1**	there was no way to go around by the time we saw it either.		
11:41:33.3 **HOT-2**	no we were sliding and uh uh I couldn't get the thrust reverser would not come out they were stuck.		
11:41:39.7 **CAM-1**	that's why I tried * gimme the thrust reversers you wouldn't give 'em to me yeah.		
11:41:41.3 **HOT-2**	and I went back and um pulled again and we would not could not get thrust reversers.		
11:41:56.8 **HOT-2**	I'm a run a ah after landing checklist here.		
11:41:58.4 **CAM-1**	yeah go ahead.		
11:42:02.8 **HOT-2**	flight directors are off autothrottle arm switch is off.		
		11:42:06.8 **TWR**	crash commander all vehicles have ah access to runway one niner.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
11:42:07.1 **CAM-2**	flaps * spoilers stab trim.		
		11:42:11.8 **ARFF**	roger copy that thank you.
11:42:14.4 **PA-1**	I apologize for that I'm not sure why the brakes didn't ah they didn't take and the thrust reversers didn't come on. there's no use ah getting off the airplane. is everybody okay uh alright we're going to uh bring up and they're gonna bring a uh a crew up here to remove the snow uh so that we can uh get a truck so uh may have to walk back to the terminal but uh we're just a little bit off the edge of the runway into the overrun and uh we don't want anybody to get hurt jumpin' into this heavy snow down here so we stay with the airplane as long as everything is runnin' good and uh should be just about fifteen twenty minutes we'll have more information. sorry about that.		
		11:42:47.1 **RDO-2**	and ah fire rescue American ah twenty two fifty three.
11:43:01.9 **CAM-1**	did we hit the uh *.		
11:43:03.1 **HOT-2**	no that's I don't that's what I'm askin' about there's one back here that's why I kicked it to the right.		
		11:43:17.5 **RDO-2**	and tower American twenty two fifty three.
		11:43:20.1 **TWR**	American twenty two fifty three Jackson tower.
		11:43:22.9 **RDO-2**	yeah is there any ah vehicles out there that can look I just want to confirm that we missed the ah the ah the ah lighting ah the departure end light er approach end lighting here ah we steered just to the right of it I just want to make sure we didn't clip that.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
		11:43:36.7 **TWR**	American twenty two fifty three copy break airport SAAB did you copy that request?
		11:43:47.8 **TWR**	Airport SAAB Jackson tower.
		11:43:57.3 **TWR**	Crash Jackson tower.
11:43:58.1 **CAM-1**	all right.		
11:44:01.1 **HOT-2**	I asked 'em they're checking with a uh a uh truck out here to make sure we missed that other stanchion there's one just like that right behind us that's why I kicked it I kicked us right to make sure we're gonna' clear that.		
11:44:01.2 **CAM-1**	where ya at?		
11:44:09.2 **CAM-1**	yeah I can't see it.		
		11:44:09.5 **AC**	Jackson hole tower Delta thirteen thirty one.
		11:44:13.0 **TWR**	Delta thirteen thirty one standby.
11:44:16.2 **HOT-2**	should we pull the uh circuit breaker?		
11:44:17.8 **CAM-1**	yeah find it.		
		11:44:19.6 **CRASH**	Jackson tower Crash two.

TIME and SOURCE	INTRA-AIRCRAFT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
		11:44:22.9 **TWR**	Crash two Jackson tower American twenty two fifty three-
11:44:26.6 **END OF TRANSCRIPT (LAST PORTION OF FLIGHT)** **END OF RECORDING**			