Runway Overrun and Collision
Southwest Airlines Flight 1248
Boeing 737-7H4, N471WN
Chicago Midway International Airport
Chicago, Illinois
December 8, 2005

ACCIDENT REPORT

NTSB/AAR-07/06
PB2007-910407

National Transportation Safety Board

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Adopted October 2, 2007

Aircraft Accident Report

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National Transportation Safety Board

490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. Year. ***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, DC.**

Abstract: This report explains the accident involving a Boeing 737-7H4, N471WN, operated by Southwest Airlines (SWA), which departed the end of runway 31C after landing at Chicago Midway International Airport. The safety issues discussed in this report include the flight crew's decisions and actions, the clarity of assumptions used in on board performance computers, SWA policies, guidance, and training, arrival landing distance assessments and safety margins, runway surface condition assessments and braking action reports, airplane-based friction measurements, and runway safety areas. Safety recommendations concerning these issues are addressed to the Federal Aviation Administration.

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Abbreviations and Acronyms

AC	advisory circular
ACM	airport certification manual
agl	above ground level
ARFF	aircraft rescue and firefighting
ASOS	automated surface observing system
ASRS	aviation safety reporting system
ATC	air traffic control
ATCT	air traffic control tower
ATIS	automatic terminal information service
ATP	airline transport pilot
BWI	Baltimore/Washington Thurgood Marshall International Airport
C	Celsius
CFME	continuous friction measurement equipment
CFR	Code of Federal Regulations
CRFI	Canadian Runway Friction Index
CVR	cockpit voice recorder
DEC	decelerometer
DOA	Department of Aviation
DOT	Department of Transportation
EASA	European Aviation Safety Agency

EFB	electronic flight bag
EMAS	engineering materials arresting system
F	Fahrenheit
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FDR	flight data recorder
FOM	flight operations manual
FRM	flight reference manual
Hg	inch of Mercury
ICAO	International Civil Aviation Organization
ILS	instrument landing system
IRFI	International Runway Friction Index
JAA	Joint Aviation Authorities
JWRFMP	Joint Winter Runway Friction Measurement Program
MDW	Chicago Midway Airport
mm	millimeter
msl	mean sea level
MU	coefficient of friction
N1	engine fan speed
NASA	National Aeronautics and Space Administration
NWS	National Weather Service
OPC	on board performance computer

OpSpec	operations specification
POI	principal operations inspector
psi	pounds per square inch
RBF	read-before-flight
RSA	runway safety area
RVR	runway visual range
S/N	serial number
SAFO	safety alert for operators
sm	statute mile
SWA	Southwest Airlines
SWAPA	Southwest Airlines Pilots Association

Executive Summary

On December 8, 2005, about 1914 central standard time, Southwest Airlines (SWA) flight 1248, a Boeing 737-7H4, N471WN, ran off the departure end of runway 31C after landing at Chicago Midway International Airport, Chicago, Illinois. The airplane rolled through a blast fence, an airport perimeter fence, and onto an adjacent roadway, where it struck an automobile before coming to a stop. A child in the automobile was killed, one automobile occupant received serious injuries, and three other automobile occupants received minor injuries. Eighteen of the 103 airplane occupants (98 passengers, 3 flight attendants, and 2 pilots) received minor injuries, and the airplane was substantially damaged. The airplane was being operated under the provisions of 14 *Code of Federal Regulations* Part 121 and had departed from Baltimore/Washington International Thurgood Marshall Airport, Baltimore, Maryland, about 1758 eastern standard time. Instrument meteorological conditions prevailed at the time of the accident flight, which operated on an instrument flight rules flight plan.

The National Transportation Safety Board determined that the probable cause of this accident was the pilots' failure to use available reverse thrust in a timely manner to safely slow or stop the airplane after landing, which resulted in a runway overrun. This failure occurred because the pilots' first experience and lack of familiarity with the airplane's autobrake system distracted them from thrust reverser usage during the challenging landing.

Contributing to the accident were Southwest Airlines' 1) failure to provide its pilots with clear and consistent guidance and training regarding company policies and procedures related to arrival landing distance calculations; 2) programming and design of its on board performance computer, which did not present inherent assumptions in the program critical to pilot decision-making; 3) plan to implement new autobrake procedures without a familiarization period; and 4) failure to include a margin of safety in the arrival assessment to account for operational uncertainties. Also contributing to the accident was the pilots' failure to divert to another airport given reports that included poor braking action and a tailwind component greater than 5 knots. Contributing to the severity of the accident was the absence of an engineering materials arresting system, which was needed because of the limited runway safety area beyond the departure end of runway 31C.

The safety issues discussed in this report include the flight crew's decisions and actions, the clarity of assumptions used in on board performance computers, SWA policies, guidance, and training, arrival landing distance assessments and safety margins, runway surface condition assessments and braking action reports, airplane-based friction measurements, and runway safety areas.

1. Factual Information

1.1 History of Flight

On December 8, 2005, about 1914 central standard time,[1] Southwest Airlines (SWA) flight 1248, a Boeing 737-7H4, N471WN, ran off the departure end of runway 31 center (31C) after landing at Chicago Midway International Airport (MDW), Chicago, Illinois. The airplane rolled through a blast fence, an airport perimeter fence, and onto an adjacent roadway, where it struck an automobile before coming to a stop. A child in the automobile was killed, one automobile occupant received serious injuries, and three other automobile occupants received minor injuries. Eighteen of the 103 airplane occupants (98 passengers, 3 flight attendants, and 2 pilots) received minor injuries, and the airplane was substantially damaged. The airplane was being operated under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 and had departed from Baltimore/Washington International Thurgood Marshall Airport (BWI), Baltimore, Maryland, about 1758 eastern standard time. Instrument meteorological conditions prevailed at the time of the accident flight, which operated on an instrument flight rules flight plan.

The accident occurred on the first flight of the first day of a scheduled 3-day trip. The flight departed BWI about 2 hours late because of deteriorated weather conditions in the Chicago area. The captain was the flying pilot for the accident flight, and the first officer performed the duties of the monitoring pilot.

The pilots reported that they had thoroughly reviewed the two weather information and dispatch documents they received from dispatch before they left BWI. A third document authorizing the release of the accident flight was prepared but was not delivered to the pilots before departure. This document revised the expected landing winds (from "calm" to "090° at 11 knots"), runway braking action (from "wet-good" to "wet-fair"), and landing runway (from 04R to 31C) based on the changing weather. The pilots stated that they subsequently received updated MDW weather information and runway condition/braking action reports[2] for runway 31C, which was the runway in use at MDW at the time. Postaccident interviews with the pilots and evidence from cockpit voice recorder (CVR)[3] data and air traffic control (ATC) communications indicated that the runway 31C braking action reports were mixed, reporting good or fair braking action for the first half of the runway and poor braking action for the second half.

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[1] Unless otherwise indicated, all times are central standard time, based on a 24-hour clock.

[2] Braking action reports are generated by pilots who have used the runway and provided to other arriving pilots by air traffic control. According to Federal Aviation Administration Order 7110.65, "Air Traffic Control," braking action reports provided by controllers are to include a description of the braking action, using the terms "good," "fair," "poor," or "nil," and the type of airplane or vehicle from which the report was received.

[3] For a complete transcript of the CVR recording, see appendix B.

The pilots also stated (and CVR evidence confirmed) that they reviewed and discussed the company's new autobrake system procedures while en route from BWI to MDW; the accident landing was the first time either pilot landed using autobrakes.[4]

About 1833:17, as the airplane was nearing MDW at an assigned altitude of 10,000 feet,[5] ATC issued the pilots instructions to enter a holding pattern. (ATC indicated that the hold was because of runway-clearing snowplow operations at MDW.) About 1844:04, the pilots advised ATC that they were entering the holding pattern at 10,000 feet. The first officer stated that, while in the holding pattern, he entered the updated weather and runway conditions and wind information (090° at 11 knots) in the on board performance computer (OPC)[6] to determine the landing distance required for runway 31C. The reported wind conditions resulted in a computed tailwind component of 8 knots.[7] All SWA 737s are limited to landing with a 10-knot or less tailwind component under all runway surface conditions. Additionally, SWA policies and flight operations manuals indicate that the company does not authorize landings on runways with more than a 5-knot tailwind component with poor braking action. Postaccident statements and CVR evidence indicated that the accident pilots were aware of these limitations and believed that they would be unable to land at MDW if the braking action was reported poor for the full length of the runway.

The first officer entered multiple scenarios into the OPC, entering fair and poor pilot braking action reports separately because the OPC was not designed to accept mixed braking action report inputs. Based on the first officer's inputs, the OPC estimated that the airplane would stop about 560 feet before the departure end of the runway with fair braking action and about 40 feet before the departure end of the runway with poor braking action.[8] The pilots stated that they decided that, consistent with SWA policies, they

[4] According to an SWA bulletin issued the day of the accident, pilots were to begin using the company's autobrake system procedures beginning December 12, 2005. During postaccident interviews, the pilots told investigators that they believed the autobrake policy was implemented the day of the accident. A review of recent SWA bulletins revealed that the autobrake implementation date had changed several times. For additional information regarding the 737 autobrake system and SWA's autobrake procedures and implementation details, see section 1.17.2.2.

[5] Unless otherwise indicated, all altitudes in this report are reported as height above mean sea level.

[6] The OPC is a laptop computer with which every SWA airplane cockpit is equipped and that SWA pilots use in performing takeoff and landing performance calculations. For additional information, see sections 1.6.2 and 1.17.2.3.

[7] According to flight data recorder information, the actual crosswind component at touchdown was between 8 and 9 knots.

[8] During postaccident interviews (and consistent with CVR evidence), the pilots recalled a 30-foot stopping margin for calculations with poor braking action. They noted that they were allowed to land with any positive margin; however, CVR evidence and postaccident interviews indicated that the pilots were concerned about the small stopping margin shown for poor runway braking action. The captain stated that he was glad the 5-knot tailwind component limit for poor runway conditions would prevent them from making the landing under those conditions.

would divert to one of their alternate destinations (Kansas City or St. Louis, Missouri)[9] if the tailwind component increased to above 10 knots or if pilot braking action reports indicated poor braking action for the full length of the runway. The automatic terminal information service (ATIS) reported a runway visual range (RVR)[10] for runway 31C of about 5,000 feet.

About 1854:10, ATC began providing the pilots with radar vectors and descent instructions as they departed the holding pattern for the final approach course for the instrument landing system (ILS) approach to runway 31C. At that time, the RVR was reported as 4,500 feet variable to 5,000 feet,[11] and the ATIS was reporting winds from 100° at 11 knots. About 1903:44, ATC cleared the pilots to intercept the runway 31C localizer. Less than a minute later, ATC cleared them for the approach and advised that the braking action reported for runway 31C was "fair except at the end [it's]…poor."

According to the CVR transcript, when the pilots contacted the MDW Air Traffic Control Tower (ATCT) at 1909:53.7, controllers advised them to "continue for [runway] 31C the winds zero nine zero at nine, brakin' action reported good for the first half, poor for the second half." About 1912:28, the first officer received a landing clearance from the ATCT. Flight data recorder (FDR) data indicated that the airplane was aligned on the runway centerline as it touched down at an airspeed of about 124 knots. The speed brakes deployed and brake pressure increased within about 1 second. Both pilots described the touchdown as "firm."

The captain stated that he tried to deploy the thrust reversers immediately after touchdown but had difficulty moving the thrust reverser levers to the reverse thrust position. He further stated that he felt the antiskid system cycle after the airplane touched down but then felt it stop cycling and that the airplane seemed to accelerate. He said that he subsequently applied the wheel brakes manually but made no further effort to activate the thrust reversers. He told investigators that he believed that the use of the autobrake system distracted his attention from the thrust reversers after his initial attempt to deploy them.

The first officer said that, when he sensed a decrease in the airplane's deceleration during the landing sequence, he exclaimed, "brakes, brakes, brakes," and manually applied the brakes. He stated that he then looked at the throttle console and saw that the thrust reverser levers were still in the stowed position. The first officer moved the captain's hand away from the thrust reverser levers and, about 15 seconds after touchdown, initiated deployment of the thrust reversers to the maximum reverse setting. FDR evidence

[9] Both pilots indicated that SWA fosters an environment in which pilots can make decisions about whether they should divert to an alternate airport without pressure or concern for repercussions. This is consistent with statements made by all other SWA pilots interviewed. Also, another SWA flight, arriving at MDW minutes before the accident flight, diverted to St. Louis because of landing weight considerations. The captain of that flight stated that he had "diverted several times as a captain for SWA and has never gotten any grief" from the company.

[10] RVR is an instrumentally derived value that represents the horizontal distance a pilot will see down the runway from the approach end by observing runway lights or markings.

[11] During postaccident interviews, both pilots stated that the airplane was clear of the clouds from about 1,400 feet to touchdown and that they estimated that the landing RVR was about 5,000 feet.

confirmed the systems functions described by the pilots and indicated that full thrust reverser deployment occurred about 18 seconds after touchdown.

However, the airplane ran off the departure end of runway 31C and continued through the runway safety area (RSA),[12] a blast fence, a navigational aid antenna, across an airport road, through an airport perimeter fence, and onto an adjacent public roadway. The airplane struck a northbound automobile on that roadway before it came to rest near an intersection located on the northwest corner of the airport. (Figures 1 and 2 show the airplane's position off the end of runway 31C.)

The first officer stated that, after the airplane came to a rest, he performed the emergency evacuation checklist while the captain checked on the passengers in the cabin. The passengers evacuated through the forward left and the right rear cabin doors.

Figure 1. Photograph of the accident airplane in the roadway intersection. (Looking southeast, towards the departure end of runway 31C.)

[12] An RSA is a designated area abutting the edge of runways that is intended to reduce the risk of damage to an airplane that runs off those surfaces. For additional information regarding MDW RSAs, see section 1.10.3.

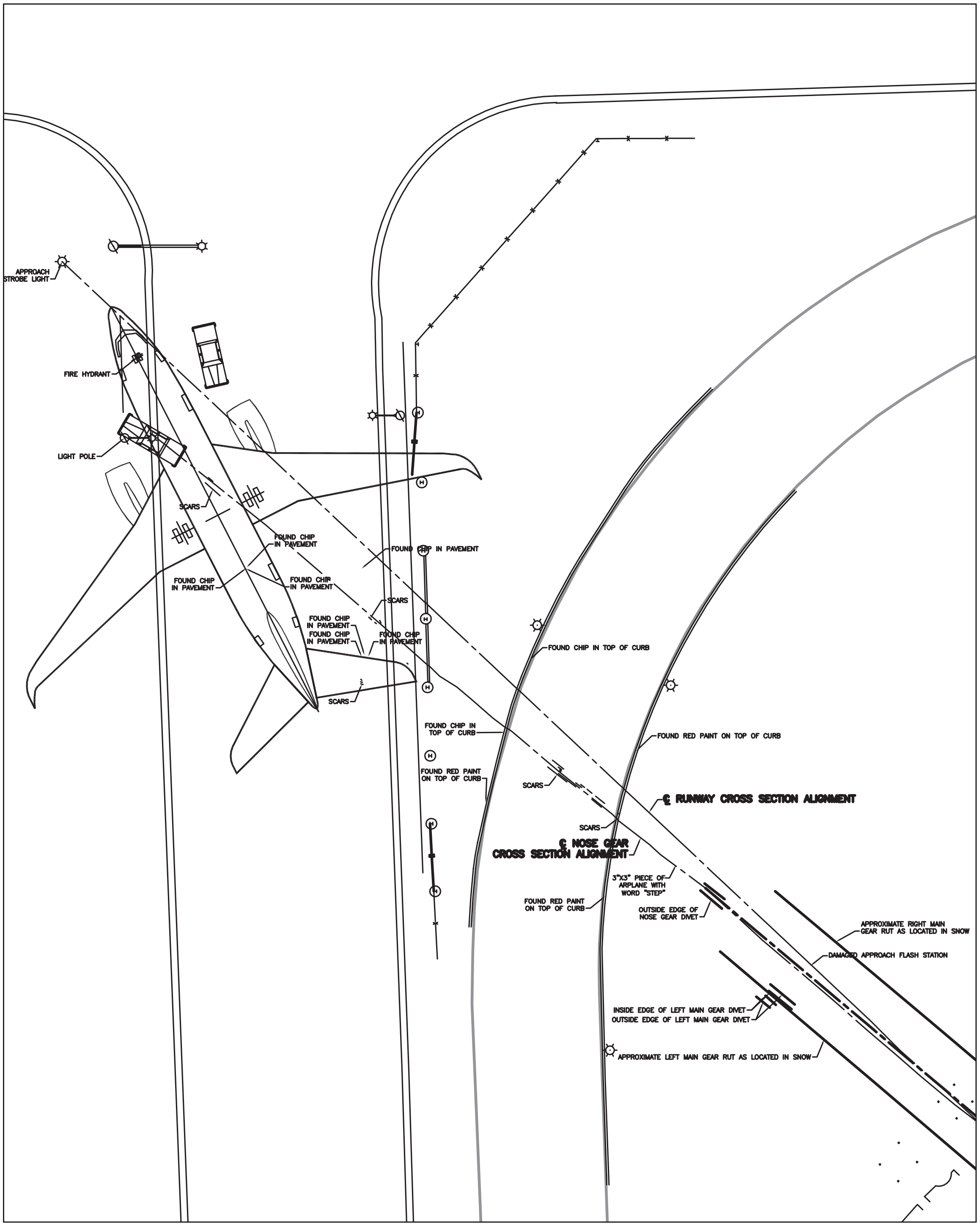

Figure 2. Diagram showing the accident airplane where it came to rest (on a heading of 340°) in the intersection off the end of runway 31C.

1.2 Injuries to Persons

Table 1. Injury chart.

Injuries	Flight Crew	Cabin Crew	Passengers	Other	Total
Fatal	0	0	0	1	1
Serious	0	0	0	1	1
Minor	0	1	17	3	21
None	2	2	81	5	90
Total	2	3	98	10	113

Note: Title 14 CFR 830.2 defines a serious injury as any injury that (1) requires hospitalization for more than 48 hours, starting within 7 days from the date that the injury was received; (2) results in a fracture of any bone, except simple fractures of fingers, toes, or the nose; (3) causes severe hemorrhages or nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns or any burns affecting more than 5 percent of the body surface. A minor injury is any injury that does not qualify as a fatal or serious injury.

1.3 Damage to Aircraft

The airplane had substantial, repairable damage.

1.4 Other Damage

The airplane rolled through an airport blast fence, an ILS array, a frangible airport perimeter fence, and onto a roadway, where it struck an automobile and a fire hydrant. Damage to the wing leading edges and engine nacelles of the airplane aligned with vertical posts from the airport perimeter fence; there was no damage observed in the airplane cockpit or cabin.

1.5 Personnel Information

1.5.1 The Captain

The captain, age 59, was a pilot in the U.S. Air Force for 26 years before he was hired by SWA on August 3, 1995. He was hired as a first officer and was upgraded to captain in July 2000. The captain held a multiengine airline transport pilot (ATP) certificate with a type rating in the Boeing 737. The captain held a first-class Federal Aviation Administration (FAA) airman medical certificate, dated September 21, 2005, with the limitation that he "must wear corrective lenses."[13]

According to the captain's SWA employment and flight records, he had flown about 15,000 hours total flight time, including 9,500 hours as pilot-in-command, about

[13] During postaccident interviews, the captain stated that he was wearing glasses at the time of the accident.

4,500 hours of which were in 737 airplanes. He had flown about 198, 137, 58, 14, and 2 hours in the 90, 60, 30, and 7 days and 24 hours, respectively, before the accident. Company records showed that the captain obtained his initial 737 type rating in May 1995 and that his most recent line check, proficiency check, and recurrent training occurred in June and July 2005. A search of FAA records revealed no accident or incident history, enforcement action, or pilot certificates and ratings failure or retest history. A search of the National Driver Register found no record of driver's license suspension or revocation.

The captain had not flown for the 4 days before the accident flight. He told investigators that he slept well the night before the accident and commuted to BWI from his home in Buffalo, New York, arriving at BWI about 1235. The accident airplane was pushed back from the gate about 1650 for its departure to MDW.

During postaccident interviews, the captain stated that the weather on the accident night was the worst he had experienced but that he expected to be able to land safely and uneventfully. He estimated that he had landed when the runway conditions were poor because of winter weather about 12 to 15 times during his tenure with SWA. However, he indicated that there was never a time previously when he thought he would not be able to stop before the end of the runway. The captain further told investigators that he had not previously used the autobrake system during a simulator or airplane landing.

1.5.2 The First Officer

The first officer, age 34, was a Saab 340 pilot for Mesaba Airlines for 6 years (2 years as first officer, 4 years as captain) before he was hired by SWA as a 737 first officer on February 17, 2003. He held a multiengine ATP certificate with a type rating in the 737. The first officer held a first-class FAA airman medical certificate, dated October 18, 2005, with the limitation that he "must wear corrective lenses."[14]

According to the first officer's SWA employment and flight records, he had flown about 8,500 hours total flight time, including 4,000 hours as pilot-in-command and about 2,000 hours as second-in-command in 737 airplanes. He had flown about 243, 151, 83, 8, and 2 hours in the 90, 60, 30, and 7 days and 24 hours, respectively, before the accident. Company records showed that the first officer obtained his initial 737 type rating in November 2001 and his most recent 737 proficiency check and recurrent training occurred in February 2005. A search of FAA records revealed no accident or incident history, enforcement action, or pilot certificate or rating failure or retest history. A search of the National Driver Register found no record of driver's license suspension or revocation.

The first officer was assigned to a reserve line of flying at the time of the accident, and checked in for reserve duty at BWI about 1040 on December 8. He told investigators that he had about 8 hours of sleep the night before and took a nap the day of the accident flight.

[14] During postaccident interviews, the first officer stated that he was wearing glasses at the time of the accident.

During postaccident interviews, the first officer stated that he had extensive experience with weather conditions similar to those they encountered on the night of the accident, although most of that experience was before he was hired by SWA. He stated that he had only landed in snow a few times since he was hired by SWA, and, in those instances, "nothing unusual occurred." The first officer further told investigators that he had not previously used the autobrake system during a simulator or airplane landing.

1.6 Aircraft Information

1.6.1 General

The accident airplane, serial number 32471, was manufactured by Boeing and received its FAA airworthiness certificate on July 13, 2004. At the time of the accident, the airplane had accumulated about 5,273 total flight hours and 2,901 cycles.[15] The airplane was equipped with two CFM International[16] CFM56-7B24 turbofan engines, both of which were new when the airplane was delivered to SWA.

According to flight dispatch information, the airplane's actual takeoff weight for the accident flight was 129,000 pounds; the FDR recorded an actual MDW landing weight of 118,280 pounds. (The pilots used an estimated landing weight of 119,700 pounds in their OPC stopping margin calculations.) Airplane documentation indicates that the maximum structural takeoff and landing weights are 154,500 and 128,000 pounds, respectively.

Each of the airplane engines is equipped with a hydraulically actuated thrust reverser system, which is used to slow the airplane after landing. When the thrust reversers are deployed, blocker doors change the direction of the engine fan air exhaust, moving it outward and forward to create reverse thrust. The thrust reversers are operated by levers located on the forward side of the thrust levers on the throttle quadrant. Postaccident examination of the thrust reverser components from the accident airplane revealed no evidence of preimpact anomaly.

The 737-700 autobrake system is designed to automatically apply brakes upon main landing gear strut compression and wheel spinup after touchdown. The system senses deceleration during the landing roll and automatically modulates brake pressure accordingly. Postaccident examination of the autobrake system components from the accident airplane revealed no evidence of preimpact anomaly.

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[15] An airplane cycle is one complete takeoff and landing sequence.

[16] CFM International is jointly owned by General Electric Aircraft Engines of the United States and Societe Nationale d'Etude et de Construction de Moteurs d'Aviation of France.

1.6.2 Southwest Airlines On Board Performance Computer

SWA equips each airplane cockpit in its fleet with an OPC,[17] which is stowed behind the captain's seat and is accessible by either pilot. The OPC is used by flight crews for numerous performance calculations, including weight and balance, takeoff performance, en route performance, and expected landing performance and stopping margins. With regard to landing performance and stopping margins, SWA pilots enter current data regarding the landing runway, wind speed and direction, airplane gross weight at touchdown, temperature, altimeter setting, and reported runway braking action into the OPC, and the OPC calculates the airplane's landing performance. The OPC alerts pilots if it calculates that the airplane will not stop on the available runway length under the conditions entered by displaying negative stopping margin numbers in white digits inside of a bracketed red block instead of the standard black digits against a white background.[18]

SWA policies do not authorize landings on runways with good or fair braking action with more than a 10-knot tailwind component or with more than a 5-knot tailwind component on runways with poor braking action. If the computed tailwind component exceeds these tailwind component limits, the OPC displays the stopping margin associated with the maximum tailwind limit rather than the actual tailwind component because of the OPC calculation assumptions that were established by SWA. The reported wind conditions for the accident landing resulted in a tailwind component of 8 knots, which was presented on the OPC display for calculations with both fair and poor runway braking action conditions. However, when the pilots input poor braking action, the stopping margins that were displayed by the OPC were based on the unit's maximum 5-knot tailwind limit. (For additional OPC-related information, see section 1.17.2.3.)

1.7 Meteorological Information

1.7.1 Chicago Midway International Airport Weather Information

About 0620 on the day of the accident, the National Weather Service (NWS) Chicago Regional Forecast Office began issuing snow advisories for northern Illinois. The advisories indicated that snow would begin in northeastern Illinois and the Chicago metropolitan area by mid-morning and continue into the evening hours, with snowfall rates increasing by mid-afternoon. About 1819 (less than 1 hour before the accident), the NWS forecast office issued a winter weather advisory that indicated that a heavy snow warning was in affect for the Chicago area until midnight and estimated a total snow accumulation of between 6 and 9 inches. Snow was reported at MDW beginning about

[17] Although OPCs are generally assigned to a specific airplane, each OPC database contains information for all airplanes in the SWA fleet; thus, OPCs can be exchanged between airplanes. If an OPC is unavailable, pilots may obtain required performance parameters from dispatch personnel.

[18] In addition, when the wind limits are exceeded, the OPC displays a description of the limits on the bottom of the screen in white letters with black background. For an example, see the OPC display in figure 5 in section 1.17.2.3 ("Wind limits: 5T/10X").

1347 on December 8 and ending about 0126 on December 9, 2005, with about 10 inches of total snow accumulation.

An official weather observation recorded at MDW about 1853 indicated winds from 100° at 11 knots; visibility 1/2 statute mile (sm) in moderate snow and freezing fog; ceiling broken at 400 feet above ground level (agl) and overcast at 1,400 feet agl; temperature minus 3° Celsius (C) (28° Fahrenheit [F]); dew point temperature minus 4° C (23° F); altimeter setting 30.06 inches of Mercury (Hg). Remarks: automated observation system, runway 31C 10-minute-averaged RVR 4,500 feet, snow increment 1 inch new snow last hour, 10 inches total, hourly liquid precipitation less than 0.01 inch (trace). As previously noted, according to postaccident interviews with ATC personnel, the ILS to runway 31C was the only approach available to commercial flights landing at MDW on the night of the accident because of approach visibility requirements.

A special weather observation recorded at MDW after the accident (at 1937) indicated winds from 160° at 5 knots; visibility 1/4 sm in heavy snow and freezing fog; sky condition obscured vertical visibility 200 feet; temperature minus 3° C (28° F); dew point temperature minus 4° C (23° F); altimeter setting 30.05 inches Hg. Remarks: automated observ[ing] system, runway 31C 10-minute-averaged RVR 3,000 feet.

Weather observations at MDW are made by an automated surface observing system (ASOS). The 5-minute observations surrounding the time of the accident indicated the following conditions:[19]

- Weather observation at 1910: winds from 110° at 8 knots, visibility 1/2 mile in moderate snow and freezing fog, ceiling broken at 400 feet agl, overcast at 1,400 feet agl, temperature minus 4° C, dew point temperature minus 5° C, altimeter 30.06 inches Hg. Remarks: runway 31C visual range 4,500 feet variable 5,000 feet, hourly precipitation less than 0.01 inches.
- Weather observation at 1915: winds from 110° at 7 knots, visibility 1/2 mile in moderate snow and freezing fog, sky obscured vertical visibility 300 feet, temperature minus 4° C, dewpoint temperature minus 5° C, altimeter 30.06 inches Hg. Remarks: runway 31C visual range 4,500 feet variable 5,000 feet, hourly precipitation less than 0.01 inches.

1.7.2 Flight Crew Dispatch and In-Flight Weather Information

SWA records indicated that the airplane's original dispatch release was revised three times before the accident flight. Examination of these documents indicated that the revisions resulted from changes in alternate airport destinations, the contingency fuel load, and the planned landing runway at MDW. The accident flight's release calculations were based on the use of runway 31C. The release included two alternate airport destinations and enough fuel for the most distant alternate plus 90 minutes of contingency fuel.

[19] The ASOS equipment is located at the center of the airport with additional sensors at the approach end of runway 31C. The ASOS system is augmented as needed by FAA-contracted, NWS-certified weather observers located in the ATCT.

The MDW forecast information in the dispatch paperwork was issued by the NWS about 1515 on December 8 and was considered valid from 1500 that day to 1200 on December 9. This forecast indicated the following conditions after 1500: winds from 080° at 11 knots, visibility 1/2 sm in moderate snow and freezing fog, overcast ceiling at 400 feet agl; temporarily between 1500 and 1600, visibility 1/4 sm in moderate snow and freezing fog, sky obscured vertical visibility 200 feet. After 1600, winds from 070° at 8 knots, visibility 1 sm in light snow and mist, ceiling overcast at 500 feet agl; temporarily between 1600 and 1900 visibility 1/2 sm in moderate snow and freezing fog, sky obscured vertical visibility 400 feet. After 1900, winds from 050° at 7 knots, visibility 2 sm in light snow, ceiling overcast at 700 feet agl. After 2100, winds from 340° at 12 knots, visibility better than 6 sm in light snow, ceiling overcast at 2,500 feet agl, temporarily between 2100 and 0000, visibility 3 sm in light snow showers. Related NWS forecast information indicated that the arrival of the snow system could be slightly delayed but predicted a significant snow event for the area the afternoon and evening of the accident.

A subsequent terminal forecast issued about 1738 predicted the snow ending and higher ceilings and improved visibilities in the early morning of December 9, as the system moved out of the area.

1.8 Aids to Navigation

No problems with any navigational aids were reported.

1.9 Communications

No communications problems between the pilots and any of the air traffic controllers who handled the accident flight were reported.

1.10 Airport Information

MDW is located about 10 miles southwest of downtown Chicago at an elevation of about 620 feet in an area that includes residential, commercial, and industrial land uses. (Figure 3 shows the MDW airport layout plan with surrounding streets and properties. Runway 31C is highlighted in yellow.)

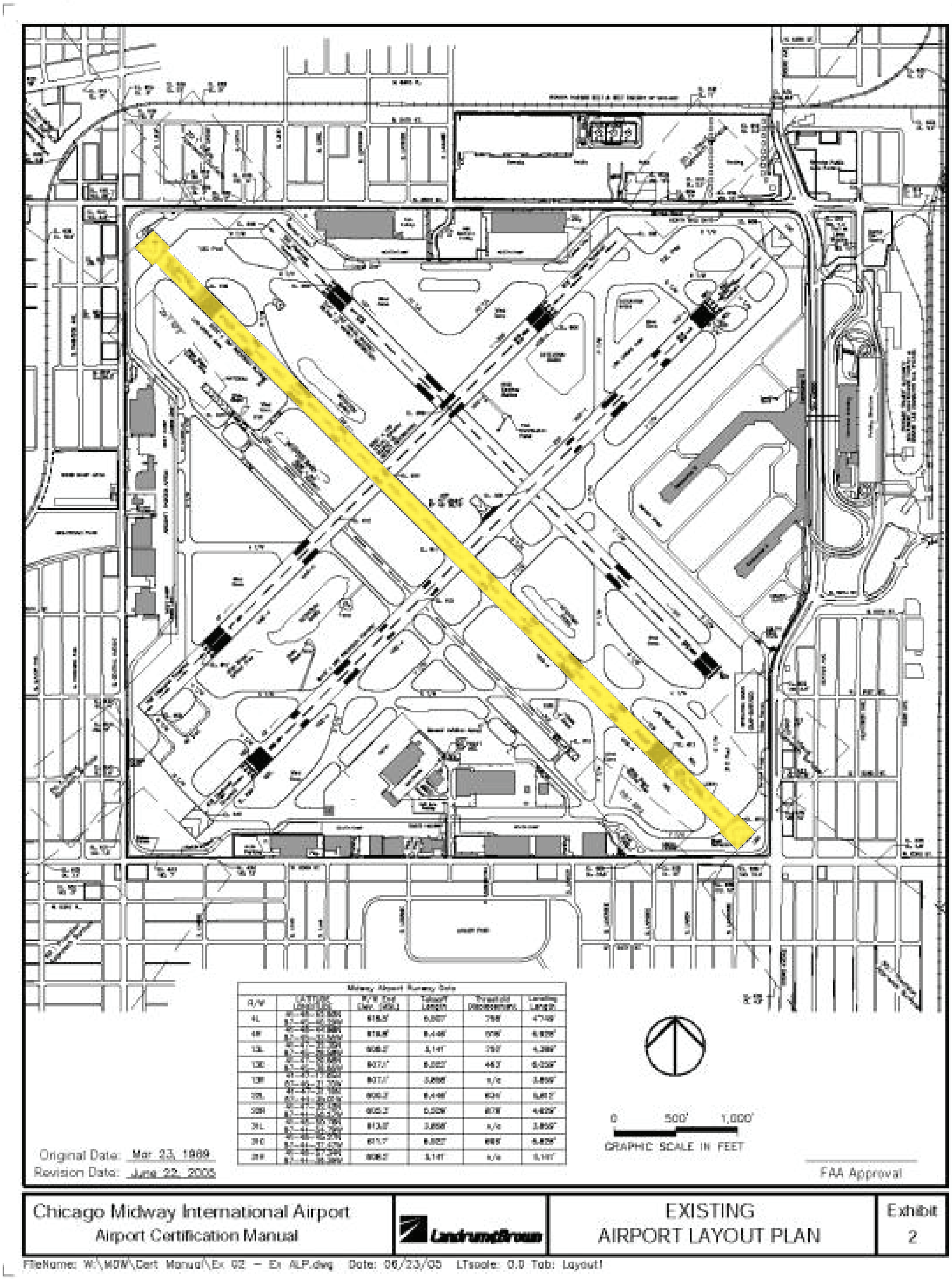

Figure 3. The MDW airport layout plan with surrounding streets and properties. Runway 31C is highlighted in yellow.

The airport is owned by the City of Chicago and operated by the Chicago Department of Aviation (DOA). MDW has five runways, including one set of two parallel runways (4R/22L and 4L/22R) and one set of three parallel runways (13L/31R, 13C/31C, and 13R/31L). Runway 31C is 6,522 feet long by 150 feet wide and is made of grooved concrete. The usable landing distance for runway 31C is 5,826 feet.[20] Runway 31C is equipped with an ILS approach, a visual approach slope indicator system, and runway end identifier lights.

According to postaccident interviews with ATC personnel, the ILS approach to runway 31C was the only approach available to commercial flights landing at MDW on the night of the accident because of approach visibility requirements. When the accident pilots departed the holding pattern for the final approach to runway 31C, the RVR was reported as 4,500 variable to 5,000 feet. The approach visibility requirement for runway 13C was 1 sm, whereas the requirement for the ILS approach to runway 31C was 5/8 sm visibility or 3,000 feet RVR.

The FAA certificated MDW as a 14 CFR Part 139 airport with Index D aircraft rescue and firefighting (ARFF) capabilities. Examination of FAA Airport Certification/Safety Inspection records for MDW from the years 2003, 2004, and 2005 revealed no deficiencies.

1.10.1 Chicago Midway International Airport Winter Operations—General

The MDW 2005-2006 Snow Removal Manual provides an overview of the procedures used by the Chicago DOA for snow removal operations at MDW. According to this manual and MDW personnel, snow removal and anti-icing operations are conducted from runway end to runway end. During snow removal operations, an MDW airport operations supervisor is positioned in the ATCT to act as a liaison between air traffic controllers in the tower and snow removal teams on the field. This coordination effort is intended to optimize use of the runways and minimize delays. The operations supervisor receives pilot reports regarding field conditions and/or runway braking action from ATC and relays them to snow removal teams as necessary. The operations supervisor also maintains a handwritten "snow log" that documents the snow removal and runway friction test activities.

The FAA-approved *Airport Certification Manual* (ACM) for MDW states that the airport is responsible, in part, for monitoring runway conditions and pilot reports, snow and ice removal as necessary, and coordination with ATC, air carriers, and other airport users during snow and ice events. The ACM also specifies that the airport will conduct

[20] Displaced thresholds located at each end of runway 31C reduced the usable landing distance from 6,522 to 5,826 feet. A displaced threshold is a runway threshold located at a point other than the physical beginning or end of the runway. The portion of the runway so displaced may be used for takeoff but not for landing. Landing airplanes may use the displaced area on the opposite end for rollout. Most often the offset threshold is in place to give arriving aircraft clearance over an obstruction while still allowing departing aircraft the maximum amount of runway available.

friction tests on the active runway, or any other runway available for aircraft use, on a "frequent" basis during events involving freezing precipitation or snow.

1.10.2 Chicago Midway International Airport Winter Operations on the Day of the Accident

According to MDW officials, early on the day of the accident, the Chicago DOA had received adverse weather reports and initiated the notification and mobilization phases of the snow operations plan. Snow began falling at the airport about 1347, at which time snow removal operations commenced. Snow removal operations involved the use of runway brooms, snow plows, a snow blower, deice machines, and runway friction testing equipment.

According to postaccident interviews and documentation, runway 13C/31C had been cleared five times during the 5 1/2 hours of snowfall before the accident, most recently about 1845. Friction test logs indicated that runway 31C was friction-tested before this clearing about 1839, with resultant coefficient of friction (MU) readings[21] of .59/.45/.37 (average .47).[22] A friction test conducted about 1847 produced results of .72/.59/.68 (average .67). The most recent field conditions reported on the MDW Web site (which were updated about 1850) indicated that runway 31C had a trace to 1/16 inch of wet snow over 90 percent of its surface, with 10 percent of its surface clear and wet. A friction test conducted after the accident (about 1922) produced results of .41/.40/.38 (average .40).

1.10.3 Chicago Midway International Airport Runway Safety Areas

According to Advisory Circular (AC) 150/5300-13, change 7, "Airport Design," the RSA for runway 13C/31C at MDW should have extended 1,000 feet beyond the runway ends and been 500 feet wide.[23] FAA documentation indicates that, at the time of the accident, the runway 31C RSA extended 82 feet beyond the end of the runway and was 500 feet wide. The FAA's RSA determination for this runway, dated September 20, 2000, stated, "it does not appear practicable to achieve the RSA standards" because the runway could not be realigned on site, and the acquisition of land for an RSA would require relocation of Central Avenue, 55th Street, and many businesses and homes in the area. However, the FAA instructed the Chicago DOA to "explore all options to bring the RSAs into full conformance with FAA standards."

[21] For additional information regarding evaluation of contaminated runways and friction measurements, see section 1.18.2.

[22] MU friction values range from 0.0 to 1.0, where 0.0 is the lowest friction value, and 1.0 is the theoretical best friction value available. Friction testing devices provide MU values for the first, second, and third sections of the runway length. These values are then averaged for an overall friction value representing the entire runway surface.

[23] According to the National Transportation Safety Board's postaccident simulation study, using routine procedures under the accident conditions, the accident airplane would have required an additional 750 feet of runway to come to a complete, unobstructed stop.

In 2003, the FAA asked the Chicago DOA to assess enhancement measures for improving the RSAs at MDW. In May 2004, the city stated in a response letter that there were no alternatives for achieving a standard RSA at MDW. The letter also stated the following:

- The runway could not be shortened and still meet the aircraft operational requirements.
- Extending the RSA would require acquisition and major impact to surrounding commercial properties and residential neighborhoods, public roadways, and public utility infrastructure.
- [The use of an] EMAS [engineering materials arresting system] was assessed, but insufficient spacing existed for installation of EMAS without shortening the runway, thus reducing the operational capacity of the airport.

The letter concluded that RSA enhancement at MDW could be obtained incrementally by improvements such as relocation of light poles and service road signs within the RSA. According to MDW officials, the FAA made no further requests to the city for improvements to MDW RSAs, including the installation of shorter, nonstandard EMAS beds,[24] before the accident.

After the accident, in April 2006, the Chicago DOA sent a letter and an EMAS study to the FAA. The letter summarized options for improving the MDW RSAs and concluded that a nonstandard EMAS bed with a 35-foot setback could be installed at the end of runway 31C. Engineering calculations showed that the nonstandard arrestor bed would be capable of stopping a Boeing 737-700 weighing 102,400 pounds and rolling at a ground speed of up to 57 knots on a wet runway without the use of thrust reversers.

After the accident, the National Transportation Safety Board asked the EMAS system manufacturer to model the accident scenario[25] and estimate the effect a nonstandard EMAS installation off the end of runway 31C would have had on the accident sequence. The EMAS manufacturer estimated that an arrestor bed 229 feet long would fit in the overrun area off the end of runway 31C. The manufacturer’s simulations predicted that, based on the accident airplane’s estimated runway exit speed of 53 knots, a 737 landing under conditions similar to the accident airplane would continue 206 feet into the EMAS bed before stopping. The simulations indicated that the airplane could have been traveling as fast as 58 knots when it ran off the end of the runway and still stop within a 229-foot-long EMAS bed. The simulations indicated that a nonstandard EMAS installation would have stopped the accident airplane before it departed airport property.

[24] Although the FAA was aware of the feasibility of nonstandard EMAS installations and had approved such installations at several airports (for example: John F. Kennedy International Airport, New York, New York; Bob Hope Airport, Burbank, California; Baton Rouge Metropolitan Airport, Ryan Field, Baton Rouge, Louisiana; and Barnstable Municipal Airport-Boardman/Polando Field, Hyannis, Massachusetts), it did not publish guidance related to this option until 2005. In September 2005, the FAA issued AC 150/5220-22A, “Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns.”

[25] Safety Board investigators provided the manufacturer with data regarding the accident scenario, including airplane weight, airport and weather conditions, and likely runway exit speed for the modeling simulations.

After the accident, the FAA approved the installation of nonstandard EMAS beds at MDW, and MDW and City of Chicago officials began to work toward installation of nonstandard EMAS beds at the ends of runways 31C, 13C, 4R, and 22L. By early December 2006, the first portion (170 feet long and 170 feet wide) of an EMAS bed had been installed off the departure end of runway 31C, with an additional 40-foot-long portion planned. Airport and city officials indicated that the installation of EMAS beds at the ends of affected MDW runways would be completed before winter 2007, pending relocation of localizer antennas at the ends of runways 13C, 4R, and 22L.

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

The accident airplane was equipped with a Honeywell model 6022 CVR, serial number (S/N) CVR120-05823. The CVR showed no signs of damage and was sent to the Safety Board's laboratory in Washington, DC, for readout and evaluation. The CVR was played back normally and without difficulty and contained six separate channels of good quality[26] audio information. The recording started at 1712:58.2 and continued uninterrupted until 1914:01.3. A transcript was prepared of the entire 2-hour, 44.7-second recording (see appendix B).

1.11.2 Flight Data Recorder

The accident airplane was equipped with a Honeywell model solid state FDR, S/N 10452, that recorded airplane flight information (including altitude, airspeed, heading, wind direction and speed, control wheel and column position, elevator/aileron/rudder position, engine fan speed, thrust reverser status and position, thrust reverser interlock, brake pressure, and autobrake status) in a digital format using solid-state memory devices. The FDR showed no evidence of damage or excessive wear and was sent to the Safety Board's laboratory for readout and evaluation. The following information was obtained from the accident airplane's FDR data and physical evidence:

- The main landing gear touched down about 1,250 feet beyond the runway's approach threshold.[27] At the time, the airplane's ground speed was about 131 knots, its airspeed was 124 knots, its heading was 316°, and its vertical acceleration reached about 1.4 Gs.

[26] The Safety Board uses the following categories to classify the levels of CVR recording quality: excellent, good, fair, poor, and unusable. A good quality recording is one in which most of the flight crew conversations could be accurately and easily understood.

[27] The airplane touched down within the Boeing-recommended touchdown zone of 1,000 to 2,000 feet beyond the runway threshold. The OPC calculated the landing/stopping distance based on a touchdown point of 1,500 feet beyond the runway threshold.

- The ground spoilers were fully deployed, autobrakes were applied, and vertical acceleration increased to a peak value of about 1.7 Gs within about 1.2 seconds of touchdown.
- About 10 seconds after touchdown, engine fan speed (N_1) decreased from about 32 percent at touchdown to about 20 percent, where it remained for about 8 seconds.
- Autobrakes were deactivated about 12 seconds after touchdown, and pilot-commanded brake pressure increased to 3,000 pounds per square inch (psi).
- The first indication of thrust reverser activity was recorded about 15 seconds after touchdown, with full deployment about 18 seconds after touchdown. N_1 reached 80 percent about 9 seconds later (about 27 seconds after touchdown) at a ground speed of about 62 knots.
- The thrust reversers were fully deployed and the brake pressure was 3,000 psi when the nose landing gear departed the runway overrun at a speed of about 53 knots.
- The airplane came to a stop about 500 feet beyond the end of the runway on a heading of about 340° with a collapsed nose landing gear about 8 seconds after it departed the runway overrun.

1.11.3 Flight Data Recorder Information From Other Landing Airplanes

FDRs from five air carrier airplanes that landed in the 25 minutes before the accident were evaluated. Table 2 provides a comparison of selected parametric data for those five air carrier airplanes and the accident flight.

Table 2. Comparison of selected parametric data for five air carrier airplanes and the accident flight.

Airline and flight number	Airplane type	Time	Touchdown ground speed in knots	Vertical load (G)	Gross weight (lbs)	Seconds to brake use	Seconds to full thrust reverser deployment	Seconds to 40 knots
United Airlines 1446	A320	1849	128	1.33	113,830	3.5*	6	18
SWA 2920	737	1852	140	N/A**	114,560	0.5	4	21
SWA 321	737	1901	121	1.5	103,320	6.0	4	25
SWA 2947	737	1902	132	1.95	110,320	8.0	4	26
SWA 1830	737	1904	126	1.35	105,520	2.0	4	24
Accident flight	737	1913	131	1.41	118,280	3.3*	18	33

*Note: The autobrake system initially applied the brakes for United Airlines flight 1446 and the accident flight.

**N/A in this table indicates not available.

1.12 Wreckage and Impact Information

The airplane came to rest on a magnetic heading of about 340° at the south side of an intersection located on the northwest corner of MDW. The airplane was resting on the engines, both main landing gear, and the nose of the fuselage, with the nose landing gear collapsed and folded aft. The damage to the airplane was largely limited to the forward lower fuselage, engine cowlings and components, forward portions of the wings, and other wing components,[28] with limited damage farther aft. The rear part of an automobile was found damaged beneath the forward portion of the airplane's left fuselage. Postaccident interviews and physical evidence indicate that the automobile was northbound on the roadway and was struck from behind by the airplane.

Postaccident examination and testing of components in the airplane's throttle, antiskid,[29] ground spoiler, and wheel brake systems revealed no evidence of preimpact anomalies. In addition, investigators examined the engine controls and the throttle quadrant (including the thrust levers) in the flight deck area and associated linkages below the cockpit floor level; no evidence of preimpact anomalies was found.

1.13 Medical and Pathological Information

In accordance with Federal regulations, postaccident drug testing was conducted on urine specimens obtained from the captain and first officer;[30] test results were negative. In addition, both pilots volunteered blood samples for analysis within 24 hours of the accident. These test results were negative for alcohol and a wide range of drugs, including drugs of abuse.[31]

The Cook County Medical Examiner's Office reported the cause of death of the automobile passenger as "compressional asphyxia." Other postaccident medical information indicated that another automobile occupant received serious injuries, including multiple fractures, head injuries, and right shoulder pain, and 21 people (1 flight attendant, 17 airplane passengers, and 3 automobile occupants/pedestrians) received minor injuries, including multiple aches and pains, sprains/strains, contusions and abrasions, and a whiplash-type injury, as a result of the accident.

[28] Damage along the wings aligned with observed damage to the airport blast fence and perimeter fence.

[29] The accident airplane's antiskid system is designed to modulate wheel brake pressure to ensure a fixed slip ratio between the tire and ground during braking.

[30] These tests were to include alcohol, amphetamines, cocaine, marijuana, opiates, and phencyclidine.

[31] The drugs tested in the postaccident analysis include (but are not limited to) marijuana, cocaine, opiates, phencyclidine, amphetamines, benzodiazapines, barbiturates, antidepressants, antihistamines, meprobamate, and methaqualone.

1.14 Fire

No evidence of an in-flight or a postcrash fire was found.

1.15 Survival Aspects

According to postaccident interviews and airport documentation, the first ARFF units arrived at the airplane about 2 minutes after the accident and assisted with the evacuation. The captain instructed a flight attendant to open the left front door and told the first officer to help passengers at the bottom of that door's evacuation slide.[32] He used a megaphone to advise passengers that they should evacuate through the front of the airplane. According to City of Chicago records, about 14 minutes after the accident, ARFF personnel positioned mobile stairs at the right rear door and assisted passengers in exiting through that door as well.

The first officer and about half of the airplane passengers evacuated through the left front cabin door. The captain, three flight attendants, and about half of the passengers evacuated through the right rear door using the mobile stairs provided by ARFF personnel. During postaccident interviews, flight attendants described the evacuation as "orderly" and stated that passengers deplaned calmly. The right front, left rear, and right and left overwing exits were not opened during the evacuation.

1.16 Tests and Research

1.16.1 Airplane Simulation and Performance Studies

A postaccident engineering study was conducted to examine the deceleration times and distances required for the accident flight and the four other SWA 737-700 airplanes that landed before it. The Safety Board's airplane performance study identified an airplane braking ability (braking coefficient)[33] that would replicate the accident airplane's ground speed and runway deceleration performance and quantified the effects that different winds, ground spoiler deployment schedules, and reverse thrust throttle settings and stowage schedules would have had on the airplane's stopping performance.

[32] The captain chose to initiate the evacuation through the front of the airplane because the nose of the airplane was closer to the ground after the nosewheel collapsed. The first officer described the evacuation slide at the left front exit as "almost flat to the ground."

[33] Airplane braking coefficient is defined as the ratio of the retarding force due to braking relative to the normal force (that is, weight minus lift) acting on the airplane. The estimated airplane braking coefficient incorporates effects due to the runway surface, contaminants, and airplane braking system (antiskid efficiency, tire pressure, brake wear, etc.).

Simulations that replicated the accident airplane configuration, use of deceleration devices, and weather[34] and runway conditions (see case #31 in table 3) showed that, under these conditions, the airplane would have required about another 753 feet beyond the end of the runway to come to a stop. A simulation case performed under the same conditions but with an equivalent headwind instead of tailwind component (see case #33 in table 3) showed that the airplane could have stopped about 584 feet before the departure end of the runway. A simulation case performed under identical airplane configuration, weather, and runway conditions, but using SWA routine/planned deceleration procedures to decelerate,[35] showed that the airplane would likely have stopped about 1,351 feet beyond the end of the runway (see case #53 in table 3). Under the same conditions and if the pilots had used Boeing's reverse thrust procedures[36] (see case #54 in table 3), simulations showed that the airplane would likely have stopped about 531 feet beyond the end of the runway. However, simulations in which maximum reverse thrust was selected 2 seconds after touchdown and maintained until the airplane came to a complete stop (see case #60 in table 3) showed that the airplane could have stopped about 271 feet before the departure end of the runway.

Table 3. Stopping distances and runway exit speeds for various deceleration scenarios calculated during postaccident airplane performance simulations.

Simulation Case #	Simulation ground speed at runway exit	Calculated runway 31C distance remaining
#31 (accident event conditions)	50 knots	-753 feet
#33 (accident event conditions, but with a headwind)	not applicable	584 feet
#53 (SWA reverse thrust)	46 knots	-1,351 feet
#54 (Boeing reverse thrust)	30 knots	-531 feet
#60 (Maximum reverse thrust stop)	not applicable	271 feet

The previous four SWA 737-700 airplanes landed on runway 31C about 1853, 1901, 1902, and 1904; one of these airplanes exited the runway at taxiway B (the last taxiway before the runway end), the other three airplanes exited at the runway-end taxiway. FDR data indicated that the flight crews on these four airplanes deployed reverse thrust (three out of the four flight crews commanded maximum reverse thrust) early in the landing roll. The Safety Board's study showed that timely and sustained application of reverse

[34] FDR data indicated that the actual tailwind component at touchdown was between 8 and 9 knots. The Safety Board's simulations were based on a 9-knot tailwind component.

[35] SWA planned deceleration procedures specified that reverse thrust be selected within 2 seconds of touchdown and maintained until the airplane decelerated through 80 knots, followed by smooth throttle movement to forward idle thrust as the airplane decelerated from 80 to 60 knots.

[36] Boeing's published reverse thrust procedures were similar to SWA's except that thrust reversers were to be maintained until the airplane decelerated through 60 knots, followed by smooth throttle movement to reverse idle thrust as the airplane decelerated from 60 to 30 knots.

thrust (including maximum reverse thrust as needed)[37] could have been used to stop the accident airplane on the runway.

The study showed that the accident airplane landed in generally deteriorating runway surface conditions; the flight's braking ability was about five times worse than would be expected on a bare and dry runway. The study also stated that the calculated ground roll distances were most sensitive to the airplane braking coefficient magnitude, winds, and time delay to commanded reverse thrust under the landing conditions. However, the study noted that the landing distances would have been less sensitive to similar wind and time delay variations if the landings were conducted on a dry or wet runway.

1.17 Organizational and Management Information

1.17.1 Southwest Airlines Information

SWA began service on June 18, 1971, and is based in Dallas, Texas. At the time of the accident, SWA operated about 3,000 scheduled daily domestic departures to 62 destinations and had more than 31,000 employees. The company's all-737 fleet consisted of 194 737-300s, 25 737-500s, and 222 737-700s.

Five other runway-related accidents or incidents involving SWA have occurred since 1983,[38] including three lateral runway excursions and two runway overruns, one of which involved a contaminated runway surface (heavy rain).

1.17.2 Southwest Operations Guidance Information

1.17.2.1 Thrust Reverser Procedures and Information

SWA policies and procedures specified the use of thrust reversers for all landings, regardless of runway length or condition. At the time of the accident, SWA's FAA-approved flight operations manual (FOM) stated, in part, that after the airplane touches down on the runway, the pilots should do the following:

> Initiate reverse thrust: Raise the reverse thrust levers to the reverse idle interlocks. After the interlocks release, modulate reverse thrust, as required. Avoid exceeding engine limits. Minimum reverse thrust is 65 percent N_1 [engine fan speed]. When required, reverse thrust to engine limits may be used. Initiating reverse thrust at touchdown is an important factor in

[37] SWA procedures indicate that maximum reverse thrust is available for routine use at the pilots' discretion, and, as noted, was also used by three of the four SWA 737s that landed at MDW before the accident airplane. See section 1.17.2.1 for related SWA flight operations manual text.

[38] More information on these five events, FTW03MA160, LAX01IA109, DCA00MA030, FTW96IA210, and FTW85FA202, is available on the Safety Board's Web site at <http://www.ntsb.gov/ntsb/query.asp>.

minimizing brake temperatures, minimizing brake and tire wear, and reducing stopping distances.

The SWA FOM also stated the following:

Under braking advisories less than 'GOOD' use Normal Landing Procedures except for the following:

[Manual] Brakes and thrust reversers should be applied together.[39]

Use thrust reversers as soon as possible during landing roll.

In addition, the SWA FOM stated the following:

Both pilots will monitor systems for warning flags, lights, or out of tolerance conditions.

The [first officer] will advise the captain of deviations from established policies, procedures, and/or regulations.

SWA pilots are trained to move the thrust reverser levers aft smoothly and promptly after touchdown and to keep their forearms on the throttle knobs to keep the throttles at idle during thrust reverser deployment. If the throttle levers are forward of the idle detent by about 1/4 inch,[40] the reverse thrust levers cannot be operated. A postaccident survey of SWA personnel and pilots, a review of SWA maintenance records, and a review of aviation safety reporting system (ASRS) data revealed no evidence of systemic thrust reverser difficulties. Several SWA pilots did report difficulties deploying the thrust reversers when they tried to move the reverse thrust levers past the interlock position too rapidly; those pilots reported that the levers moved readily when they tried to deploy the thrust reversers again after the interlocks released. Postaccident interviews with the previous 10 flight crews for the accident airplane revealed that they reported no difficulty deploying the thrust reversers.

According to SWA personnel, there was no policy allowing pilots to apply a credit for the use of reverse thrust during their landing distance assessments (which would increase the calculated stopping margin for a landing) until 1998, when a reverse thrust credit was incorporated into landing distance calculations for the 737-700 model only. SWA pilots received instruction regarding the reverse thrust credit during differences training when qualifying for the 737-700 model. However, until 1 week before the accident, the information in two out of three FOM locations incorrectly indicated that reverse thrust was not included in 737-700 OPC landing distance calculations. At the time of the accident, the information was correct in two of the three FOM locations. Most SWA

[39] For additional information regarding activities that have been grouped together in an automatic task sequence, such as manual brakes and thrust reversers, see section 2.2.3.

[40] The thrust lever interlock latch prevents movement of the reverse thrust levers (and thus prevents thrust reverser actuation) when the forward thrust lever is forward of the idle stop.

pilots interviewed after the accident were aware of the OPC reverse thrust credit for the 737-700; however, some were not.

1.17.2.2 Autobrake Procedures and Information

At the time of the accident, SWA planned to implement a policy requiring the use of autobrakes under certain landing conditions on December 12, 2005 (4 days after the accident). Previously, SWA's policy did not permit the use of autobrakes because the company's fleet was not then fully equipped with autobrakes. As the fleet became fully equipped, the company took steps to implement autobrake use. In preparation, SWA provided its pilots with a self-study training module on the autobrake system and related SWA procedures (which both accident pilots had completed). SWA pilots were also provided with a series of bulletins regarding the repeatedly delayed start-date for autobrake usage. The most recent of these bulletins was issued December 8, 2005, and noted that the company's autobrake procedures and policies were to be used by SWA pilots beginning December 12, 2005, and therefore were not in effect (or authorized) on the day of the accident.[41]

During postaccident interviews, the pilots told Safety Board investigators that they had read the daily read-before-flight (RBF) letters before the accident flight but that they failed to notice the new delay in autobrake procedure implementation.[42] CVR evidence and postaccident statements indicated that they both believed that the autobrake policy was in effect for the accident flight. A previous autobrake-related RBF letter indicated that the autobrake policy would be in effect as soon as materials were available in the cockpit. On the day of the accident, "flow" cards and checklists with information regarding autobrake procedures had been placed in SWA airplanes.

When using autobrakes, pilots can select from several autobrake system settings, including the following:

- Maximum (MAX): Should be used when minimum stopping distance is required.[43]
- Medium (MED): Should be used for wet or slippery runways or when landing rollout distance is limited.
- Minimum (MIN): These settings provide a moderate deceleration effect suitable for all routine operations.

1.17.2.3 On Board Performance Computer-Related Guidance and Information

Pilots may use a variety of aids when performing airplane performance and landing distance calculations. Options include tabular performance charts and on board electronic

[41] For additional information regarding the increased effort and cognitive resource-use required by new procedures, see section 2.2.3.

[42] The Safety Board's review of SWA RBF letters revealed that there had been several delays in the autobrake implementation dates associated with the autobrake procedure implementation.

[43] The accident flight crew selected MAX autobrakes for the landing and transitioned to maximum manual braking about 12 seconds after touchdown.

computing devices (also known as OPCs at SWA). The FAA evaluates and approves operators' procedures for the use of electronic computing devices with an interactive interface, and advisory guidance regarding the certification and operational approval process for these devices is provided in AC 120-76A.[44] AC 120-76A addresses human factors design issues and contains references to other sources for detailed human factors guidance, including a series of reports developed by the Department of Transportation (DOT) in conjunction with the FAA regarding human factors in the design and evaluation of OPC-type devices.[45] The advisory material states that the results of calculations should be displayed in a manner that is understood easily and accurately and that users should be aware of any assumptions upon which the flight performance calculations are based.

Tabular charts preceded on board electronic computing devices and are still used by many airlines today. These charts present critical information and assumptions through notations directly on the applicable chart or on an introductory performance page. To calculate landing distance using a chart, pilots survey rows and columns of values, select the most appropriate value for conditions, and adjust for inputs accordingly. Use of charts sometimes requires mathematical adjustments or interpolations to account for values that are not exactly listed. OPC-like devices help reduce the pilots' workload by eliminating the need for pilot adjustments and interpolations; however, research shows that it is important for pilots to be aware of the critical underlying performance calculation assumptions.[46]

As previously stated, SWA provides its pilots with an OPC, and the company's FOM provides guidance regarding the use of that OPC. The SWA FOM identifies, in part, the following runway conditions with regard to OPC use:

WET-FAIR—to be used when braking action is reported as fair; and

WET-POOR—to be used when braking action is reported as poor.

The SWA FOM further states the following:

> The [OPC-calculated] landing distance information is provided to give an indication of the braking effort necessary to stop the airplane within the available landing length….Individual pilot braking technique and

[44] Although there is no requirement for the manufacturers of Class 1, Type B electronic computing devices (like SWA's OPCs) and/or operators using such to adhere to the guidance contained in AC 120-76A, FAA evaluators and principal operations inspectors are encouraged to reference the advisory materials during the approval process.

[45] (a) <http://www.volpe.dot.gov/opsad/efb/vreppub.html>; (b) AS 25-11, FAA Policy Statement ANM-99-2, FAA Policy Statement ANM-01-03, DOT-VNTSC-FAA-00-22; RTCA/DO-257; (c) U.S. Department of Transportation, *Human Factors Considerations in the Design and Evaluation of Electronic Flight Bags (EFBs), Version 2*, Report Number DOT-VNTSC-FAA-03-07 (Washington, DC: DOT, 2003); and (d) U.S. Department of Transportation, *A Tool Kit for Evaluating Electronic Flight Bags*, Report Number DOT-VNTSC-FAA-06-21 (Washington, DC: DOT, 2006).

[46] (a) K. Mosier and L. Skitka, "Human Decision Makers and Automated Decision Aids: Made for Each Other?," *Automation and Human Performance: Theory and Applications*, R. Parasuraman and M. Mouloua (Eds.), Mahwah, New Jersey: Lawrence Erlbaum Associates, 1996; and (b) U.S. Department of Transportation, *Human Factors Considerations in the Design and Evaluation of Electronic Flight Bags (EFBs), Version 1: Basic Functions*, Report Number DOT-VNTSC-FAA-00-22 (Washington, DC: DOT, 2000).

> experience will provide equivalent braking efforts that can then be related to the OPC output. The MAX distance is based on maximum manual braking (without the use of thrust reversers) at touchdown.
>
> The approximate stop margins calculated by the OPC are based on three different levels of deceleration as defined by the autobrake system and are based on touching down 1,500 feet from the [runway approach] threshold. The MIN, MED, and MAX values are calculated using the deceleration rates for [associated autobrake settings]. The stop margins include the effects of reverse thrust (-300/-500: stop margins do not include the effects of reverse thrust).[47]

Additionally, according to SWA's FOM, company procedures authorize pilots to land using a MAX autobrake setting, "provided a positive stopping margin is computed" by the OPC.

Specific OPC-related training was provided to SWA pilots during 1 day of dispatch training and two additional classroom training periods. During training, one scenario addressed use of the OPC from takeoff to landing during a normal flight, whereas another addressed use of the OPC from takeoff to landing during an abnormal flight.[48] Additionally, upon completion of the specific OPC training, pilots spent 3 classroom days with a check airman instructor who covered additional FOM topics, including use of the OPC.

Most SWA pilots, instructors, and check airmen who were interviewed told investigators that the company's pilots had adapted well to the use of the OPC and had a good understanding of and trusted the system. There were no procedures in place for pilots to verify or check the numbers calculated by the OPC with another independent source.

Postaccident examination of the data stored on the accident OPC confirmed that the pilots had entered the expected airplane touchdown weight and updated weather data. As previously noted, evidence indicated that the pilots selected WET-FAIR and WET-POOR as possible runway conditions and that the OPC estimated 560 and 40 feet, respectively, of runway remaining under those conditions. (As previously noted, SWA procedures permit company pilots to land with any positive calculated stopping margin.) Based on its assumptions, the OPC display would reflect the landing distance associated with a maximum tailwind component of 5 knots for poor braking action even if the

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47 SWA pilots were type-rated in all three 737 models owned by SWA (-300/-500/-700) and switched between these models on a day-by-day or flight-by-flight basis. Pilots were taught that stopping margins assumed reverse thrust credit (85 percent to MAX) for the -700 model only and not for the other two models (-300/-500). This method of calculation resulted in a more favorable stopping margin for the -700. As noted, until 1 week before the accident, OPC-related information in the SWA FOM stated that reverse thrust was not included in the landing distance calculations in two of three locations; the incorrect information remained in one location when the accident occurred but has since been corrected.

48 Beginning in July 2005, SWA recurrent training included a scenario involving a potential conflict between runway condition reports from two different sources; however, the accident pilots had completed their 2005 recurrent training before that date, and the training still did not include interpretation of mixed-condition runway braking action reports.

computed tailwind component exceeded 5 knots. Figures 4 and 5 show OPC-displayed results of OPC calculations based on the accident conditions with fair and poor braking action, respectively. Note that in both figures the OPC display shows the tailwind value of 8 knots even though the displayed landing distance is based on the OPC tailwind limit of 5 knots. In figure 5, the white "8T" with a red background and the "Wind limits: 5T/10X" remark in white with a black background near the bottom of the display indicate that the tailwind limits for poor braking action were exceeded.

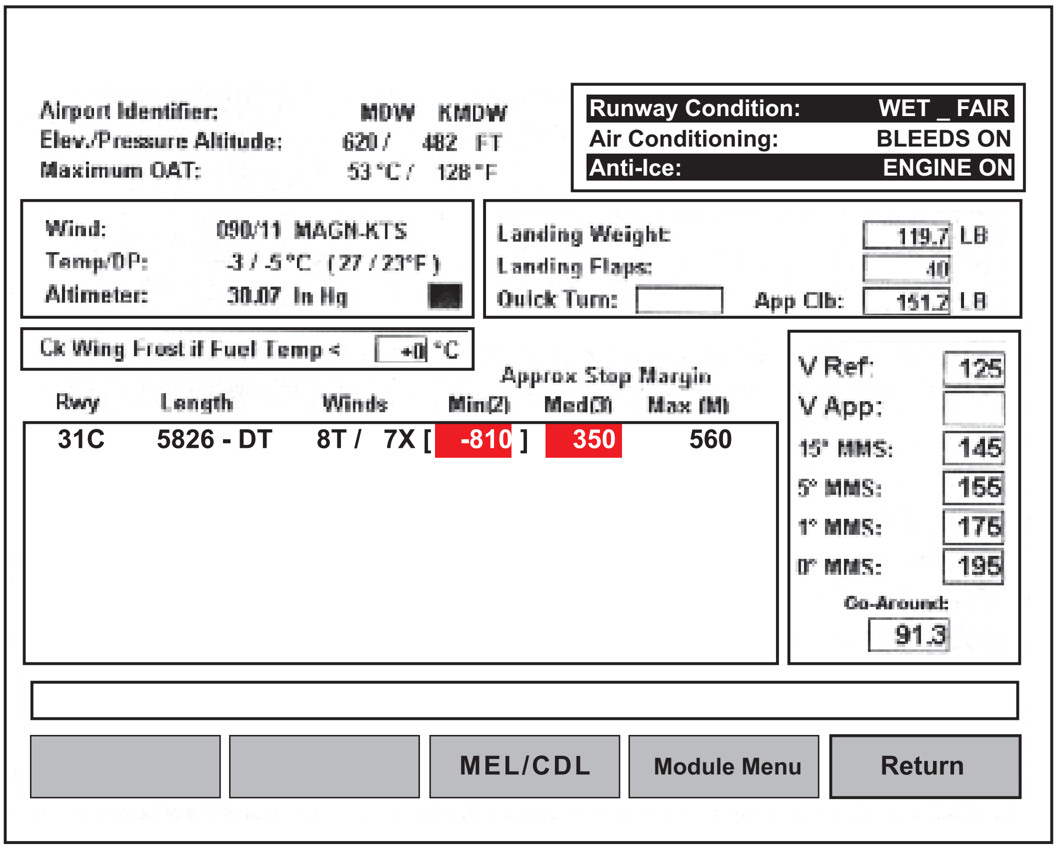
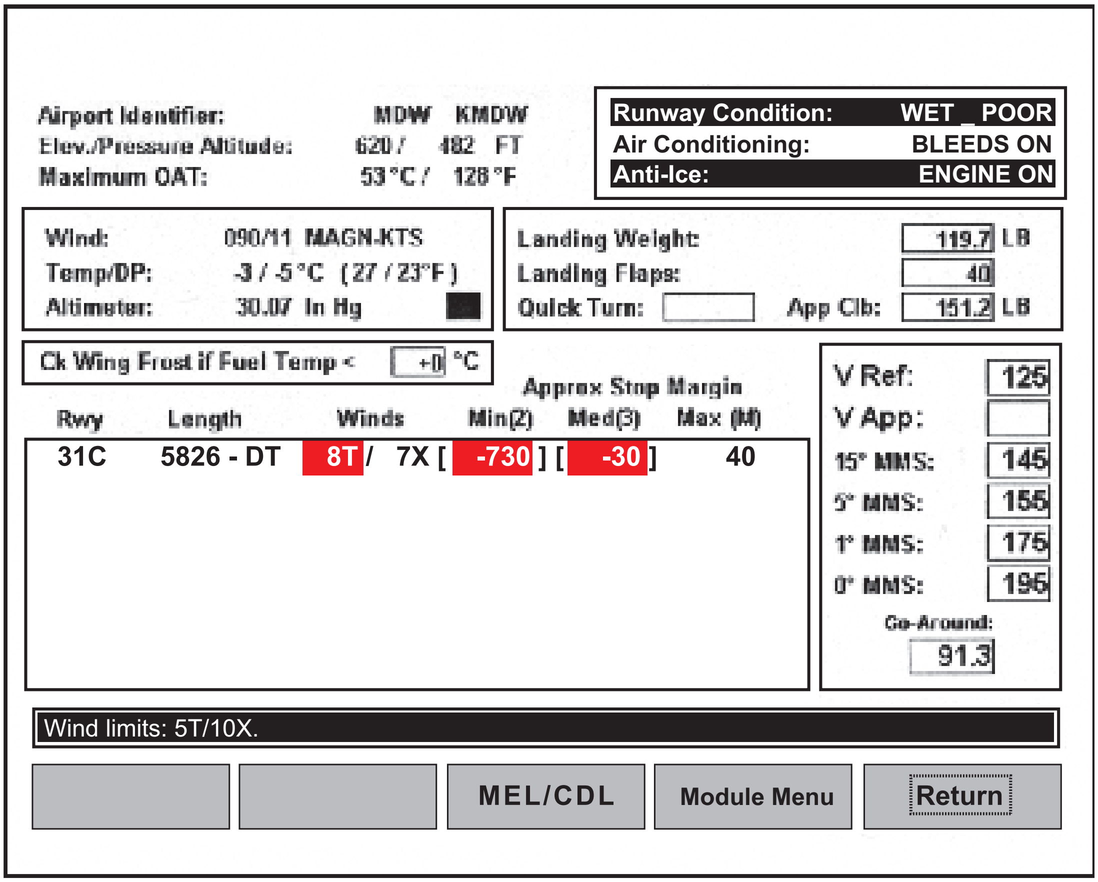


Figure 4. OPC display showing the results of OPC calculations based on the accident conditions with fair braking action.

The Safety Board's investigation revealed that if SWA OPCs had used the actual tailwind component of 8 knots instead of the company limit of 5 knots, the stopping margin for poor braking action would have been -260 feet. Because of its negative value, this number would have been presented as bracketed white digits inside of a red block (instead of the standard black digits against white background) to alert the pilots that they could not safely land on the runway. The Board notes that calculations performed using Boeing's more conservative data, an 8-knot tailwind component, and poor braking action indicated that the airplane would have stopped 2,070 feet beyond the end of the runway. Similar calculations performed using fair braking action indicated that the airplane would have stopped 260 feet beyond the end of the runway. A review of SWA guidance and training regarding OPC assumptions revealed one reference in the OPC section of the flight reference manual (FRM) but none in the FOM. Further, no references were made to this topic during initial, recurrent, or OPC-related ground training.



Note: the white "8T" with a red background and the "Wind limits: 5T/10X" remark in white with a black background near the bottom of the display indicate that the tailwind limits for poor braking action were exceeded.

Figure 5. OPC display showing the results of OPC calculations based on the accident conditions with poor braking action.

As a result of its investigation of the July 31, 1997, accident involving a Federal Express McDonnell Douglas MD-11 that crashed while landing on runway 22R at Newark International Airport, Newark, New Jersey,[49] the Safety Board determined that some flight crewmembers may lack proficiency in the operation of airplane performance computing devices and that confusion about calculated landing distances may result in potentially hazardous miscalculations of available runway distances after touchdown. In August 2000, the Safety Board issued Safety Recommendation A-00-95, which asked the FAA to require principal operations inspectors (POI) assigned to Part 121 operators that

[49] National Transportation Safety Board, *Crash During Landing, Federal Express, Inc., McDonnell Douglas MD-11, N611FE, Newark International Airport, Newark, New Jersey, July 31, 1997*, Aircraft Accident Report NTSB/AAR-00/02 (Washington, DC: NTSB, 2000).

use auxiliary performance computers[50] to review and ensure the adequacy of training and procedures regarding the use of this equipment and interpretation of the data generated, including landing distance data.

As a result of this recommendation, in August 2002, the FAA issued Flight Standards Information Bulletin for Air Transportation 02-03, which was intended to 1) call attention to the importance of operating procedures and pilot training related to OPCs and 2) cause operators and POIs to review those procedures and related training to ensure their adequacy, if OPCs are to be used by the operator. In December 2002, Safety Recommendation A-00-95 was classified "Closed—Acceptable Action."

1.17.2.4 Mixed Braking Action Report and Tailwind Limitation Guidance

SWA guidance indicates that mixed braking action reports are not unexpected during routine operations and company policy requires pilots to defer to the more critical braking action assessment when mixed braking action conditions are reported. Specifically, SWA's FAA-approved FOM, chapter 3, "Normal Operations," pages 3.23.1 through 3.23.5, states the following:

> Braking action reports less than good are classified according to the **most critical term** [emphasis added] (fair, poor, nil, or combinations). Operations are prohibited on all surfaces classified as nil.

The Safety Board's review of SWA training materials revealed that, at the time of the accident, the topic of mixed conditions was not routinely or explicitly introduced to pilots during training. Further, the topic was not addressed in the FOM sections regarding braking action and runway friction reports, entering runway conditions into the OPC, and/or programming the OPC for landing. After the accident, SWA published a revision to chapter 3 of the FOM, which added, "If a combination is given (e.g., fair to poor), use the more restrictive of the two." In addition, SWA implemented pilot training specific to interpretation of braking action reports, including mixed conditions.[51]

According to SWA's FOM, chapter 2 ("Operational Considerations"), page 2.2.6 "landing is not authorized … when wind limitations are exceeded." The FOM, chapter 2, page 2.2.9, indicates that SWA's maximum tailwind component for landing under poor braking action conditions is 5 knots; under all other conditions, the maximum tailwind component for landing is 10 knots. As previously noted, when the wind limits for a given braking action are exceeded, the OPC displays a description of the limits on the bottom of the screen in white letters with black background, but uses SWA's programmed maximum tailwind component (not the actual computed component) to calculate landing distance. For an example, see the OPC display in figure 5 ("Wind limits: 5T/10X").

50 "Auxiliary performance computer" is another term for an electronic computing device or OPC.

51 For additional information regarding postaccident SWA actions, see section 1.17.3.

1.17.3 Southwest Airlines Postaccident Actions

As a result of this accident, SWA revised its operational policies and procedures and guidance as follows:

- Amended sections of its FOM to reinforce the company's policy requiring pilots to enter the most restrictive braking action report in the OPC for landing distance assessments and provided additional training specific to braking action reports, including mixed conditions.[52]
- Revised its OPC to standardize the use of thrust reverser credit in landing distance assessments for all airplane types and to modify the landing output screens to show the amount of reverse thrust needed to obtain the calculated distances.
- Reinforced thrust reverser policies regarding the immediate deployment of thrust reversers after landing.
- Revised the procedures for use of thrust reverse to be consistent with the Boeing guidance, such that pilots are to begin reducing the reverse thrust at 60 knots instead of 80 knots.
- Clarified FOM guidance regarding the responsibility of the monitoring pilot to monitor thrust reverser deployment and to call out any specific related deviation.
- Implemented an autobrake familiarization period before autobrake use (in addition to the existing flight crew autobrake training and related information package) and revised FOM to include a technical description of the autobrake system. SWA required that pilots complete at least four familiarization landings (two as the flying pilot and two as the monitoring pilot) on dry runways with ample stopping margins before using the autobrake system on a routine basis.
- Added a 15 percent safety margin to its arrival landing distance calculations and revised its OPC to reflect the additional margin.[53]

1.18 Additional Information

1.18.1 Airplane Landing Performance Information

Two categories of airplane landing distance performance information are pertinent to normal commercial airplane operations. The first, preflight (or dispatch) landing distance

[52] Preaccident SWA guidance regarding braking action reports was consistent with the postaccident guidance, stating, "braking action reports less than good are classified according to the most critical term (fair, poor, nil, or combinations)."

[53] The added safety margin was consistent with that recommended in the FAA's August 31, 2006, Safety Alert for Operators 06012. For more information, see section 1.18.2.

performance data, is used during flight planning to determine the maximum takeoff weight at which the airplane can depart an airport and, after its planned fuel burn, land on the available landing distance at the destination/alternate airport. This determination is based on specific 14 CFR requirements for dry or wet/slippery runway conditions. Dispatch landing distance calculations are intended to ensure that dispatched airplanes will be able to land safely at the intended destination airport or a planned alternate and are based on estimated landing weights and forecast conditions. According to Federal regulations, the dry and wet/slippery landing performance data used for dispatch calculations are obtained by multiplying the numbers demonstrated[54] during certification landings on a level, smooth, dry, hard-surfaced runway by factors of 1.67 and 1.92, respectively.[55]

The second category, arrival (or operational) landing distance information, is used by pilots while en route and uses updated information, including runway conditions, weather, and planned configurations, to determine the landing distance required. Airplane landing performance data for conditions other than bare and dry are typically calculated rather than demonstrated via a flight test. Operational landing distance assessments are intended to ensure that the arrival weather and runway surface conditions and the planned airplane configuration, pilot technique, and deceleration devices will result in a safe landing distance at the arrival weight.

Dispatch planning distance calculations are required and standardized by U.S. and international aviation authorities. However, U.S. Federal regulations do not require or standardize arrival landing distance assessments, nor do they specify safety margins for such assessments.

1.18.1.1 Previously Issued Urgent Safety Recommendation Related to Landing Distance Assessments

As a result of this accident, on January 27, 2006, the Safety Board issued urgent Safety Recommendation A-06-16, which asked the FAA to do the following:

> Immediately prohibit all 14 CFR Part 121 operators from using the reverse thrust credit in landing performance calculations.

The stated intent of this recommendation was to ensure adequate landing safety margins for landings on contaminated runways. The FAA responded in part by conducting an internal review of existing regulations, orders, notices, ACs, International Civil Aviation Organization (ICAO) and foreign country requirements, airplane manufacturer-developed material, independent source material, and the current practices of air carrier operators.

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54 For these demonstrations, the airplane is decelerated using maximum manual braking and full spoiler deployment but no reverse thrust during the landing roll.

55 U.S.-based airplane manufacturers have not historically demonstrated landing performance on all possible runway surface conditions, including a wet/slippery runway, largely because of the difficulties involved in attaining representative and repeatable conditions during a finite flight test program.

The FAA does not require landing performance calculations at the time of arrival, nor does it impose standards for these manufacturer-supplied or operator-packaged landing performance data or the use of such data. Therefore, the FAA observed numerous inconsistencies and wide variation in operators' practices regarding airplane landing performance calculations at the time of arrival. These inconsistencies were observed in numerous related areas, including the circumstances under which the landing distance for the time of arrival was calculated; the data used for such calculations, which were either provided by the manufacturer or developed by the operator or a third-party vendor; the currency of landing distance assessment data; application of safety margins; the existence of landing distance performance information; and the application of credit for the use of thrust reversers. Landing distance performance information is available in a wide variety of informational documents and is available for a range of runway or braking action conditions using various airplane deceleration devices and settings under a variety of meteorological conditions, depending on the operator and the source.

During the Safety Board's investigation of the SWA flight 1248 accident, investigators determined that two different operators were using manufacturer-supplied landing performance data that were not the most suitable or currently available. Further, in some cases, the landing performance data presented by the operator and/or third-party vendor were less conservative (provided a larger stopping margin) than the manufacturer's data for the same conditions (as was the case with SWA's data in this accident). The operational landing performance data used to define landing limitations may be based on a wide range of assumptions, depending on the manufacturer and whether the data have been modified before presentation to pilots. Although operators practices may differ, manufacturer-provided dispatch landing performance data are typically included in an airplane flight manual, while arrival landing performance data are included in the airplane's quick reference handbook for accessibility in the cockpit. (Both dispatch and arrival landing performance data are typically available to operators using electronic flight bags [EFB].)

On June 7, 2006, the FAA published an "Announcement of Policy for Landing Performance After Departure for All Turbojet Operators," which stated, in part, that the FAA considered a 15 percent margin as the minimum acceptable safety margin between the expected actual airplane landing distance and the available runway landing distance at the time of arrival. In a June 13, 2006, letter to the Safety Board, the FAA stated its belief that the actions described in its June 7 notice would yield a greater safety benefit than a blanket prohibition against taking credit for use of thrust reversers. The Board supported the FAA's planned action and its timely implementation. As a result, the FAA planned to issue mandatory Operations Specification (OpSpec) N 8400.C082 to all 14 CFR Part 91 subpart K, 121, 125, and 135 turbojet operators, requiring the following:

- Use of an operationally representative air distance;
- Use of data at least as conservative as the manufacturer's data;

- Use of the worst reported braking action for the runway during landing distance assessments; and
- Operators' addition of an extra margin of at least 15 percent to the landing distance calculation.[56]

Further, OpSpec N 8400.C082 would require POIs to ensure that operators' flight crew and dispatcher training programs provide information about all aspects and assumptions of actual landing distance performance determinations.

The FAA intended that operators comply with OpSpec N 8400.C082 by October 2006. However, the FAA encountered considerable industry opposition to its June 7 proposal, and, on August 31, 2006, decided not to issue the mandatory OpSpec but, rather, to pursue formal rulemaking regarding these issues. In the interim, the FAA published Safety Alert for Operators (SAFO) 06012, compliance with which was voluntary. SAFO 06012 suggested that operators (1) establish procedures that require assessing the landing distance as close as practicable to the time of arrival if conditions have adversely changed since the preflight landing distance assessments, (2) apply a safety margin of at least 15 percent to the calculated airplane landing distance when such assessments are required at the time of arrival, and (3) provide information regarding all aspects of actual landing distance performance assessments in their flight crew and dispatcher training programs, among others. FAA personnel told Safety Board staff that the FAA intended to pursue formal rulemaking in the area of landing distance assessments and believed that operators would voluntarily comply with SAFO 06012 in the interim.

The Safety Board is currently investigating two additional accidents involving contaminated runway overruns by air carrier airplanes. On February 18, 2007, a Shuttle America Embraer EMB-170 ran off the end of snow-contaminated runway 28 at Cleveland Hopkins International Airport in Cleveland, Ohio. This ongoing investigation has revealed that Shuttle America did not require its pilots to perform landing distance assessments based on conditions at the time of arrival.[57] Additionally, on April 12, 2007, a Pinnacle Airlines Bombardier Regional Jet CL600-2B19 ran off the end of snow-covered runway 28 at Cherry Capital Airport in Traverse City, Michigan. This ongoing investigation has revealed that Pinnacle had incorporated an arrival landing distance assessment

[56] The FAA-advocated minimum safety margin of 15 percent was established based on historic links to the FAA-mandated additional 15 percent factor for wet/slippery dispatch requirements and the 15 percent factor embedded in the European Aviation Safety Agency and the European Joint Aviation Authorities' operational requirements for landing on a contaminated runway.

[57] More information on this accident, CHI07MA072, is available on the Safety Board's Web site at <http://www.ntsb.gov/ntsb/query.asp>.

requirement consistent with SAFO 06012;[58] however, the accident flight crew in this case did not perform an arrival landing distance assessment.[59]

In a May 8, 2007, response regarding Safety Recommendation A-06-16, the Safety Board stated, "A year after this urgent recommendation was issued, the FAA has not yet taken any effective action in response to it." The Board cited FAA-issued guidance advising the use of a 15 percent safety factor in landing distance assessments but noted that the FAA was unable to say how many Part 121 operators had adopted that guidance. In its letter, the Board classified Safety Recommendation A-06-16, "Open—Unacceptable Response."

1.18.1.2 Landing Distance Assessment Technical Bulletin

In January 2007, Safety Board staff attended a meeting with FAA, Boeing, SWA, and SWA Pilots Association (SWAPA) personnel at which the history and practices related to landing distance assessments at the time of arrival were discussed. Figure 6 shows a related draft winter operations guide that was developed by an industry group.

SWA is currently incorporating the information contained in this guide, which it plans to incorporate in October 2007, and Boeing attached similar guidance to a bulletin, dated August 23, 2007, that was issued to all operators of Boeing turbojet airplanes.[60] The Boeing guidance recommends that operators develop arrival landing distance assessment procedures for their flight crews to use to ensure that a full-stop landing can be made on the arrival runway in the conditions (weather and runway) existing at the time of arrival and with the deceleration means and airplane configuration to be used. The Boeing guidance also recommends that the landing distance assessment use the most adverse braking condition in the landing distance assessment and that an additional safety margin be applied to the resultant landing distance.

[58] If requested by an operator, the FAA may approve another OpSpec, which would require that operator to conduct arrival landing distance assessments and include a minimum 15 percent safety margin for every landing. As a result of Pinnacle's request, the FAA issued an OpSpec. Pinnacle's resultant documentation states, "When landing on a contaminated runway, the landing runway must have a minimum safety margin of 15 percent available length beyond the calculated landing distance. The landing distance must take into account the actual runway conditions existing at the time of arrival, the expected deceleration means, and aircraft configuration to be used. If the safety margin is not available, the pilot should not land the aircraft, absent an emergency. This will be considered the minimum acceptable safety margin. These requirements are separate from the regulatory landing distance calculations required by FAR [*Federal Aviation Regulation*] 121.195 for dispatch, and are only necessary when a contaminated landing runway is expected."

[59] More information on this accident, DCA07FA037, is available on the Safety Board's Web site at <http://www.ntsb.gov/ntsb/query.asp >.

[60] Boeing plans to issue similar guidance to all operators of Douglas airplanes in October 2007.

BRAKING ACTION

PIREPS

When braking action conditions less than Good are encountered, pilots are expected to provide a PIREP based on the definitions provided in the table below. Until FAA guidance materials are revised to replace the term Fair with Medium, these two terms may be used interchangeably. The terms "Good to Medium" and "Medium to Poor" represent an intermediate level of braking action, not a braking action that varies along the runway length. If braking action varies along the runway length, such as the first half of the runway is Medium and the second half is Poor, clearly report that in the PIREP (*e.g., "first half Medium, last half Poor"*).

Correlating Expected Runway Conditions

The correlation between different sources of runway conditions (e.g., PIREPs, runway surface conditions and MU values) ***are estimates***. Under extremely cold temperatures or for runways that have been chemically treated, the braking capabilities may be better than the runway surface conditions estimated below. When multiple sources are provided (e.g., braking action medium, runway covered with ice and runway MU is 27/30/28) conflicts are possible. If such conflicts occur, consider all factors including data currency and the type of airplane a PIREP was given from. A valid PIREP or runway surface condition report are more reliable indicators of what to expect than reported runway MU values.

Runway Friction MU Reports

MU values in the U.S. are typically shown as whole numbers (40) and are equivalent to the ICAO standard decimal values (.40). Zero is the lowest friction and 100 is the highest MU friction. When the MU value for any one-third zone of an active runway is 40 or less, a report should be given to ATC by airport management for dissemination to pilots. The report will identify the runway, the time of measurement, the type of friction measuring device used, MU values for each zone and the contaminant conditions (e.g., wet snow, dry snow, slush, deicing chemicals). While the table below includes information published by ICAO correlating runway friction measurements to estimated braking actions, the FAA cautions that ***no reliable correlation exists***. Runway MU values ***can vary significantly*** for the same contaminant condition due to measuring techniques, equipment calibration, the effects of contamination on the friction measuring device and the time passage since the measurement. ***Do not*** base landing distance assessments solely on runway MU friction reports. If MU is the only information provided, attempt to ascertain the depth and type of runway contaminants to make a better assessment of actual conditions.

BRAKING ACTION

Braking Action		Estimated Correlations		
Term	Definition	Runway Surface Condition	ICAO Code	Mu
Good	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	• Water depth of 1/8" or less • Dry snow less than ¾" in depth • Compacted snow with OAT at or below -15ºC	5	40 & above
Good to Medium	-		4	39 - 36
Medium (Fair)	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	• Dry snow ¾" or greater in depth • Sanded snow • Sanded ice • Compacted snow with OAT above -15ºC	3	35 –30
Medium to Poor	-		2	29 - 26
Poor	Braking deceleration is significantly reduced for the wheel braking effort applied. Potential for hydroplaning exists. Directional control may be significantly reduced.	• Wet snow • Slush • Water depth more than 1/8" • Ice (not melting)	1	25 - 21
Nil	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may be uncertain. **Note:** *Taxi, takeoff, and landing operations in Nil conditions are prohibited.*	• Ice (melting) • Wet Ice	-	20 & below

Note: The ICAO term **Unreliable** and SNOTAM code of "9" indicates contamination is outside the approved operational range for the friction measuring equipment in use and therefore Mu values are not provided. This typically occurs in Poor or worse conditions (greater than 1/8" of wet snow, slush or standing water) whereby a potential for hydroplaning should be expected. *Use PIREPs and the depth and type of runway contaminants to assess actual braking conditions.*

*This page is advisory information as developed by a team of US airline technical pilots and other interested parties. The creation of the table was initiated by a FAA workshop on runway condition reporting in held in August of 2006.

Figure 6. Draft winter operations guide that was developed by an industry group.

1.18.2 Contaminated Runway and Landing Information

1.18.2.1 Runway Surface Condition Reports

Three methods typically used to describe a runway's surface condition are: 1) runway contaminant type and depth observations, 2) ground surface vehicle friction measurements,[61] and 3) pilot braking action reports. Safety Board public hearing testimony indicated that, regardless of the method used, the reported runway surface conditions may differ from the actual runway surface conditions encountered by a landing flight.

In SAFO 06012, the FAA stated that joint industry and international government tests have not established a reliable correlation between any of these runway surface condition description methods and an airplane's braking ability. In part, the FAA attributed this to the fact that runway surface conditions can change significantly in very short periods of time, depending on precipitation, accumulation, usage, temperature, direct sunlight, and runway maintenance/treatment. Runway contaminant type and depth reports may also be adversely affected by the observer's vantage point and/or a lack of uniformity of contaminants across the runway's surface. The FAA also stated that operators should not base their landing distance calculations solely on ground surface vehicle runway friction measurements because extensive testing did not indicate that "a repeatable correlation exists through the full spectrum of runway contaminant conditions."[62]

Further, pilot braking action reports are subjective, reflecting individual pilot expectations, perceptions, and experiences, and are sensitive to airplane type and the actual deceleration methods used to slow or stop the airplane. Mixed pilot braking action reports (for example, fair for the first half of the runway and poor for the second half), and conflicting braking action reports from different sources (for example, an air carrier pilot, a general aviation pilot, or a ground vehicle) can also make the interpretation and use of such reports more difficult. The FAA acknowledges that braking action reports are subjective and advises pilots to consider all available information and make landing decisions based on the most restrictive reports, the pilots' experience, and sound judgment.

1.18.2.2 Correlation Between Runway Surface Condition and Airplane Braking Ability

During its investigation of this accident, the Safety Board noted that different methods and terminologies were used throughout the aviation industry to define the relationship between runway surface condition and an airplane's braking ability (also

[61] Runway contaminant type and depth observations and ground surface vehicle friction measurements are provided by airport operations personnel and may be broadcast in an ATIS message. According to AC 150/5200-30A, "Airport Winter Safety and Operations," the FAA considers two types of friction testers—the decelerometer (DEC) and the continuous friction measurement equipment (CFME)—to be "generally…reliable" when the runway surface is contaminated by ice (or wet ice) or compacted snow. (MDW uses both DEC and CFME friction testers.) AC 150/5200-30A also states that friction tests "…will be reliable as long as the depth of dry snow does not exceed 1 inch and the depth of wet snow or slush does not exceed 1/8 inch."

[62] Variability in equipment design and calibration is also an issue with ground surface vehicle friction measurements.

termed "airplane braking coefficient" in this report). For example, the European Aviation Safety Agency (EASA) and Joint Aviation Authorities (JAA) state that a correlation between contaminant type and depth and the effective braking ability of an antiskid-controlled braked wheel "may be used to [calculate airplane landing performance conservatively] in the absence of any direct test evidence." Both Boeing and SWA calculate operational airplane landing performance based on correlations between airplane braking ability and braking action reports.[63] Transport Canada provides guidance that can be used to correlate ground surface vehicle friction survey measurements to airplane performance on certain winter-contaminant surfaces in the form of Canadian Runway Friction Index (CRFI) tables in its *Aeronautical Information Manual*.[64]

Existing FAA guidance on runway surface condition reporting, contained in AC 91-6A, "Water, Slush, and Snow on the Runway," dated May 24, 1978, does not correlate runway braking action and an airplane's braking ability. In August 1989, the FAA issued a draft AC (91-6B), "Performance Information for Operation with Water, Slush, Snow, or Ice on the Runway," that proposed that such a correlation be used "if the braking performance is based on analysis rather than tests." However, the draft AC was never published, and the guidance contained in AC 91-6A remains in effect.

The FAA allows airplane manufacturers and operators (like Boeing and SWA) to define custom braking action/airplane braking ability correlations. SAFO 06012 advocates the use of a specific correlation between reported braking action and runway contaminant type and depth to predict turbojet landing performance when manufacturer-supplied wet or contaminated runway landing distance data are unavailable. In addition, SAFO 06012 stated, "The FAA considers the data developed for showing compliance with the European contaminated runway certification…to be acceptable for making landing distance assessments for contaminated runways at the time of arrival."

ICAO published yet another method used to define the relationship between runway surface condition and an airplane's estimated braking action. This correlation of the measured runway braking action (MU reading) to estimated braking action is shown in table 4.

Table 4. Correlation of the measured runway braking action to estimated braking action.

Measured Runway Braking Action (MU Reading)	Estimated Braking Action
0.40 and above	Good
0.39 to 0.36	Medium to good
0.35 to 0.30	Medium
0.29 to 0.26	Medium to poor
0.25 and below	Poor

[63] Although both are based on correlations between airplane braking ability and braking action reports, Boeing and SWA correlations differ in the numeric values and the braking action report terminology used.

[64] For additional information, see section 1.18.2.2.1.

1.18.2.2.1 Canadian Runway Friction Index

A detailed method of measuring and reporting friction on contaminated runways to determine landing distances has been in use in Canada for about 30 years. Runway friction values obtained from decelerometers (DEC) are reported as CRFI values and are included in surface condition reports and notices to airmen. The information contained in the CRFI tables is based on field test performance data of airplanes braking on winter-contaminated surfaces and provides recommended landing distances based on the CRFI values. Figure 7 shows the CRFI values for various runway surface conditions, highlighting the CRFI values for loose snow 3 millimeters (mm) deep or less on pavement, which ranged from 0.16 to 0.76.

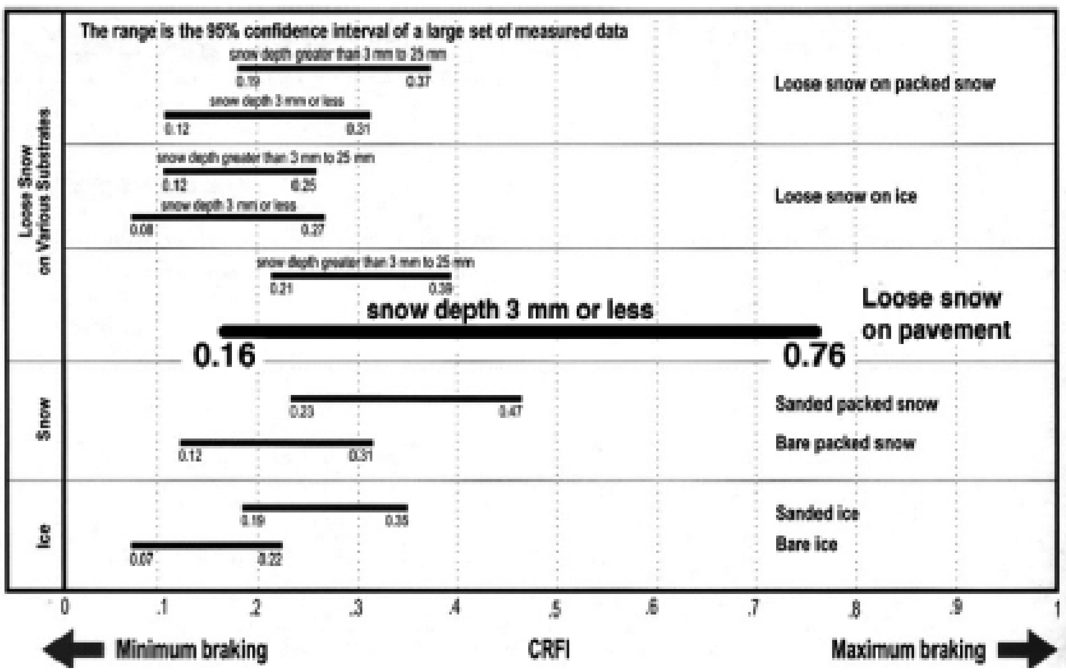

Figure 7. CRFI values for various runway surface conditions. Note that the CRFI values for loose snow 3 mm deep or less on pavement ranged from 0.16 to 0.76 (see the bold horizontal line).

1.18.2.2.2 International Runway Friction Index

In January 1996, the Joint Winter Runway Friction Measurement Program (JWRFMP), consisting of a group of representatives from international organizations,[65] convened to do the following:

- Study methods of friction measurement and define an International Runway Friction Index (IRFI) for worldwide use;

[65] Thirty international organizations from 12 countries, including the United States, Canada, Japan, Norway, France, Austria, Germany, Scotland, Sweden, and Switzerland, participated in this program.

- Establish an international methodology whereby a common indication of runway conditions could be established worldwide; and
- Study the operational performance of aircraft on contaminated surfaces and establish a relationship with the harmonized IRFI.

In contrast to the CRFI, which used only DECs in measuring friction values, the IRFI was designed to use readings from a variety of friction testing devices (DEC and continuous friction measurement equipment [CFME] from multiple manufacturers). The results of this study were incorporated into American Society for Testing and Materials report 2100-02, "Standard Practice for Calculating the International Runway Friction Index," which prescribed methods for calculating the IRFI for winter surfaces and produced a harmonized scale for expressing pavement friction characteristics, regardless of the friction measurement equipment used. The IRFI obtained by using this practice has not been extended to address the braking performance of an aircraft; therefore, no tables of recommended landing distances based on the IRFI exist at this time.

Several FAA publications[66] indicate that the FAA does not believe that it is possible to predict aircraft braking performance from MU values obtained from runway friction surveys. Further, according to the FAA's *Aeronautical Information Manual*, "no correlation has been established between MU values and the descriptive terms 'good,' 'fair,' 'poor,' and 'nil' used in braking action reports."

1.18.2.3 Previous Contaminated Runway-Related Safety Recommendations

In 1982, the Safety Board conducted a special investigation to examine commercial airplane operations on contaminated runways.[67] As a result of this investigation, the Board issued several contaminated runway-related safety recommendations to the FAA. Safety Recommendation A-82-152 asked that the FAA do the following:

> Amend 14 CFR 139.31 and … 139.33 to require that airports certified under 14 CFR Part 139 and located in areas subject to snow or freezing precipitation have an adequate snow removal plan, which includes criteria for closing, inspecting, and clearing contaminated runways following receipt of "poor" or "nil" braking action reports and to define the maximum snow or slush depth permissible for continued flight operations.

On November 18, 1987, the FAA issued Amendment 139-14 to Part 139, requiring snow and ice control plans in ACMs at airports where snow and icing conditions regularly occur. As a result of this action, the Safety Board classified Safety Recommendation A-82-152 "Closed—Acceptable Action."

[66] These FAA publications include AC 150/5200-31A, CertAlert 95-06, CertAlert 05-01, and the FAA's *Aeronautical Information Manual*.

[67] National Transportation Safety Board, *Large Airplane Operations on Contaminated Runways*, Special Investigation Report NTSB/SIR-83/02 (Washington, DC: NTSB, 1983).

Safety Recommendation A-82-155 asked that the FAA do the following:

> Convene an industry-government group to develop standardized criteria for pilot braking assessments and guidance for pilot braking action reports for incorporation into pilot training programs and operations manuals.

The FAA formed the Joint Aviation/Industry Landing and Takeoff Performance task group to review this recommendation, among others. The task group included representatives from Aerospace Industries Association, Air Line Pilots Association, Air Transport Association of America, Flight Safety Foundation, Inc., National Air Carrier Association, Inc., and the Regional Airline Association. However, because the FAA provided no evidence of progress in this area after 4 years, the Safety Board classified Safety Recommendation A-82-155 "Closed—Unacceptable Action."

Safety Recommendation A-82-168 asked that the FAA do the following:

> In coordination with the National Aeronautics and Space Administration [NASA], expand the current research program to evaluate runway friction measuring devices which correlate friction measurements with airplane stopping performance to examine the use of airplane systems such as antiskid brake and inertial navigation systems to calculate and display in the cockpit measurements of actual effective braking coefficients attained.

In a response letter dated April 1, 1983, the FAA indicated that it was working with NASA to form a runway braking action test program. In a January 1984 letter, the FAA indicated that it was involved with NASA in efforts to develop a method for obtaining runway braking condition information with a more quantitative basis than subjective pilot reports. However, in a May 5, 1987, letter, the FAA expressed concern that such a system would encourage operations from a runway with a very low friction coefficient and, further, that it would be of little value because of the differences in braking performance between dissimilar aircraft models.

In response, the Safety Board stated that it did not believe that the FAA and NASA had conducted sufficient research to conclude that objective measurements taken from dissimilar airplanes would not be meaningful and that "such reports would be very useful to airport operators as a means of detecting the degradation of runway conditions in winter weather and would provide a basis upon which the pilots of large airplanes could make better decisions." Therefore, in April 1988, the Board classified Safety Recommendation A-82-168 "Closed—Unacceptable Action."

As a result of the December 20, 1995, accident involving a Tower Air 747 at John F. Kennedy International Airport,[68] the Safety Board issued Safety Recommendation A-96-164, which asked that the FAA do the following:

[68] National Transportation Safety Board, *Runway Departure During Attempted Takeoff, Tower Air Flight 41, Boeing 747-136, N605FF, JFK International Airport, December 20, 1995.* Aircraft Accident Report NTSB/AAR-96-04 (Washington, DC: NTSB, 1996).

> Require the appropriate Aviation Rulemaking and Advisory Committee to establish runway friction measurements that are operationally meaningful to pilots and air carriers for their slippery runway operations (including a table correlating friction values measured by various types of industry equipment), and minimum coefficient of friction levels for specific airplane types below which airplane operations will be suspended.

In its response, the FAA stated that it did not consider it technologically feasible to establish runway friction measurements that were operationally meaningful to pilots and air carriers for slippery runway operations. The FAA noted its participation in the JWRFMP, which had a goal of developing the IRFI and correlating it with airplane stopping capability. However, the FAA maintained that there were serious shortcomings in several operationally significant aspects of the IRFI standard, in addition to the historical record of failures attempting to correlate ground friction measurements with airplane performance. The FAA did not expect any new developments related to this recommendation.

In June 2002, the Safety Board responded that, although the FAA's effort to develop an operationally meaningful runway friction measurement tool was unsuccessful, it did result in the development of an international standard for determining a runway friction index. The Board also stated that proposed testing might yield more meaningful tools and encouraged the FAA to continue its efforts in this area. However, the Board acknowledged that the technology to convert the runway friction index into an operational tool did not exist at the time and, therefore, classified Safety Recommendation A-96-164 "Closed—Reconsidered."

As a result of the June 1, 1999, accident involving an American Airlines MD-82 at Little Rock National Airport in Little Rock, Arkansas,[69] the Safety Board issued Safety Recommendation A-01-54, which asked that the FAA do the following:

> For all 14 CFR Part 121 and 135 operators, require the use of automatic brakes, if available and operative, for landings during wet, slippery, or high crosswind conditions, and verify that these operators include this procedure in their flight manuals, checklists, and training programs.

On June 21, 2004, the FAA issued a notice (N8400.68) to its POIs, recommending the use of autobrakes for landings in adverse conditions caused by weather and directing POIs to convey the information in N8400.68 to their respective certificate holders. Because issuance of this notice met the intent of the recommendation, the Safety Board classified Safety Recommendation A-01-54 "Closed—Acceptable Alternate Action." According to SWA representatives, the company's efforts to equip its airplanes with autobrakes and develop and implement related procedures stemmed, in part, from these actions.

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[69] National Transportation Safety Board, *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, DC: NTSB, 2001).

1.18.3 Previous Runway Safety Area Safety Recommendations

As a result of its investigation of the May 6, 2003, accident involving a Southwest Airlines airplane that overran the end of the runway after landing at Burbank, California,[70] the Safety Board issued Safety Recommendations A-03-11 and -12, which addressed RSAs and asked that the FAA do the following:

> Require all 14 *Code of Federal Regulations* Part 139 certificated airports to upgrade all runway safety areas that could, with feasible improvements, be made to meet the minimum standards established by Advisory Circular 150/5300-13. These upgrades should be made proactively, not only as part of other runway improvement projects. (A-03-11)
>
> Require all 14 *Code of Federal Regulations* Part 139 certificated airports to install engineered materials arresting systems in each runway safety area available for air carrier use that could not, with feasible improvements, be made to meet the minimum standards established by Advisory Circular 150/5300-13, "Airport Design." The systems should be installed proactively, not only as part of other runway improvement projects. (A-03-12)

In an August 7, 2003, letter, the FAA indicated that it agreed with the intent of these recommendations and stated that FAA Order 5200.8, "Runway Safety Area Program," established a program to bring all RSAs up to current standards, whenever possible. The letter stated that the FAA's goal was to upgrade 456 RSAs by 2007 and that such improvements "may be initiated at any time." The FAA stated that its goal was to upgrade at least 65 RSAs per year through 2007 and that 71, 68, and 74 RSAs were upgraded in fiscal years 2000, 2001, and 2002, respectively. The FAA also noted that eight EMAS beds had already been installed and that several more installations were planned. The Board asked the FAA to provide annual updates on RSAs that could not meet the standards and the specific alternatives that would be used to improve the safety of these RSAs.

The issue of RSA improvements was discussed at the Safety Board's June 2006 public hearing that was held for the accident involving SWA flight 1248. In response to questioning during this hearing, FAA personnel indicated that, under current FAA policy, it is possible that some RSAs will not meet the dimensional standards or have arrester beds installed even after the FAA considers its improvement projects successfully completed. In a July 7, 2006, letter, the FAA indicated that 208 RSA upgrades and 15 EMAS installations had been completed though fiscal year 2005. The letter further stated that more than 90 percent of the RSA upgrades would be completed by 2010, and all RSA

[70] For additional information, see National Transportation Safety Board, Aircraft Accident Brief NTSB/AAB-02/04 (Washington, DC: NTSB, 2002).

upgrades would be completed by 2015. A recent update from FAA personnel indicated that 303 RSA improvement projects were completed. The update further indicated that 37 RSA upgrades and 5 EMAS installations were completed in fiscal year 2006 and that 20 RSA upgrades and 1 EMAS installation had been accomplished to date in fiscal year 2007. Safety Recommendations A-03-11 and -12 are currently classified "Open—Acceptable Response."

2. Analysis

2.1 General

The pilots were properly certificated and qualified under Federal regulations. No evidence indicated any medical or behavioral conditions that might have adversely affected their performance during the accident flight. There was no evidence of flight crew fatigue.

The accident airplane was properly certificated and was equipped, maintained, and dispatched in accordance with industry practices.

No evidence indicated any failure of the airplane's powerplants, structures, or systems that would have affected the airplane's performance during the accident landing.[71]

The pilots received thorough weather information for MDW and two alternate airport destinations in their dispatch documents and were well aware of the winter weather conditions in the area. They obtained numerous weather updates while en route from BWI to MDW and discussed conditions under which they would divert to one of the alternate destinations. Therefore, the Safety Board concludes that the pilots had adequate initial and updated weather information throughout the flight.

About 10 inches of snow accumulated at MDW on the day of the accident, and snow was falling at a moderate rate at the time of the accident. However, the accident runway had been recently cleared and treated with deice fluid, and four other SWA 737-700 airplanes landed and successfully stopped on runway 31C in the 21 minutes before the accident.[72] On the basis of this information, the Safety Board concludes that MDW personnel monitored runway conditions and provided appropriate snow removal services on the night of the accident.

This analysis will discuss the flight crew's decisions and actions, the clarity of assumptions used in OPCs, company policies and guidance, arrival landing distance assessments and safety margins, runway surface condition assessments and braking action reports, airplane-based friction measurements, and RSAs.

[71] Section 2.2.3 discusses the thrust reverser operation.

[72] The pilots of another SWA flight, which would have arrived at MDW minutes before the accident flight, elected to divert to an alternate airport because of airplane landing weight considerations.

2.2 Pilots' Decision to Land, Knowledge, and Actions

During its investigation, the Safety Board evaluated the pilots' decision to land at MDW and their actions during the approach and landing. Section 2.2.1 details the pilots' use of braking action reports, which included mixed braking actions, during their arrival landing distance assessments. Section 2.2.2 discusses the information displayed by the OPC during the arrival landing distance assessment and the pilots' awareness of the underlying OPC assumptions. Section 2.2.3 explains the pilots' use of autobrakes and reverse thrust during the accident landing. Integral to these issues is the pilots' awareness of SWA guidance and policies relevant to their decision and actions during the accident landing. These issues are addressed in this and subsequent sections.

2.2.1 Interpretation and Use of Mixed Braking Action Reports

As previously noted, the accident pilots were aware of the inclement weather in the Chicago area before they left BWI and obtained updated weather information throughout the flight. The Safety Board's review of recorded CVR information indicated that weather, landing performance assessments, landing criteria (including autobrake usage), and suitable alternates dominated the crew's conversation during the 2-hour flight.

Although not required by FAA regulations, SWA policies required the company's pilots to perform a landing distance calculation before the approach, using updated weather, airplane configuration,[73] and runway conditions. On the basis of the most current ATIS report for MDW, the accident pilots evaluated and discussed performance calculations for both fair and poor reported braking conditions. Although the pilots' calculations resulted in positive stopping margins for both fair and poor braking conditions (560 and 40 feet, respectively), and company policy indicated that landing was authorized with any positive stopping margin, the crew was concerned about the small positive stopping margin with poor braking action. Information from the CVR and postaccident interviews indicates that the pilots were also aware of a company policy for a maximum 5-knot tailwind component with a reported braking action of poor. Updated wind information resulted in a landing tailwind component of 8 knots. The pilots verbalized the decision not to land if the braking action was reported as poor for the full length of the runway.

As the airplane neared MDW, air traffic controllers provided the accident pilots with mixed runway 31C braking action reports. These reports indicated that the braking action was good or fair for the first half of runway 31C and poor for the second half. (The Safety Board notes that the accident flight was cleared for the approach to runway 31C because approach visibility requirements precluded approaches to all other MDW runways on the night of the accident.) However, the MDW controller did not routinely follow FAA procedures requiring controllers to include the type of airplane from which the braking action reports were made; in this case, the reports were provided by the pilots of several arriving 737s. Further, the controller did not provide the accident pilots with a report obtained from the pilot of a smaller airplane that described the braking action as

[73] For example, although the dispatch calculations were based on 30° of flaps, the actual configuration at the time of landing was 40° of flaps.

poor, as required. Therefore, the Safety Board concludes that the MDW ATCT controller did not follow FAA guidance when he did not provide all of the required braking action report information.[74]

All of the braking action reports provided by ATC to the accident pilots were mixed and reported poor braking action on some portion of the runway. For example, 8 to 9 minutes before touchdown, the pilots received a braking action report of "fair…except at the end it's poor," and 3 minutes before touchdown they received a braking action report of "good for the first half, poor for the second half." SWA policy requires pilots to defer to the more critical braking action assessment when they receive mixed braking action reports. Therefore, because "poor" braking conditions were reported for a portion of the runway and SWA guidance indicates a maximum 5-knot tailwind to land if such conditions are reported, the pilots should not have landed at MDW. The Safety Board concludes that because the pilots did not use the more critical braking action term (poor) during their landing distance assessment (which, combined with the associated tailwind limitation, would have required them to divert), they were not in compliance with SWA's policies.

The pilots did not discuss interpretation of mixed runway condition reports, although their behavior and other discussion suggests that they interpreted the runway condition as closer to fair than poor. They stated during postaccident interviews (and CVR evidence indicates) that they were not aware of SWA's guidance regarding mixed braking action reports. On the day of the accident, three preceding company aircraft (same make, model, policies, and procedures) landed with braking action reports containing the term poor and with similar wind conditions. Based on this and information obtained from postaccident interviews, it appears that other SWA pilots also were not aware of the mixed braking action report guidance in the FOM or did not adhere to it. The fact that other SWA pilots decided to land at MDW in these conditions likely influenced the accident pilots' decision to land; the accident pilots were less likely to consider their decision to land as contrary to company guidance if other SWA crews landed in similar conditions.

SWA guidance regarding how to provide a braking action report includes an example of a mixed condition report, indicating that mixed conditions were not unexpected during routine operations. However, the Safety Board's review of SWA training materials revealed that the topic of mixed conditions was not routinely introduced to pilots during training and was absent in the FOM for the topics of braking action and runway friction reports, entering runway condition into the OPC, and programming the OPC for landing, all of which defined the runway condition categories.

The Safety Board notes that, after this accident, SWA amended the wording in its FOM to clarify its policy regarding mixed braking action reports and provided its pilots with additional training specific to braking action reports, including mixed conditions.

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[74] The influence this information would have had on the pilots' decision to land is unknown, although it is unlikely that it would have led them to divert. SWA guidance specifies that its pilots should use braking action information provided by "other **commercial** airplanes (emphasis added)." Also, the accident pilots were aware that several of the airplanes preceding them to MDW, and from which braking action reports were obtained, were commercial airplanes (including several SWA 737s).

2.2.2 On Board Performance Computer Displays and Underlying Assumptions

The Safety Board evaluated the clarity of the information displayed to the pilots on the SWA OPC and the underlying assumptions (including reverse thrust credit) upon which the resultant landing distance assessments were based. Pilots use a variety of aids to accomplish airplane performance calculations, including tabular performance charts. The information on tabular charts is designed to be clear and readily available;[75] however, pilots must survey rows and columns and select the most appropriate value, apply required adjustments, and sometimes interpolate between listed values. SWA provides its pilots with an OPC for such calculations. Using an OPC or similar electronic computing device instead of tabular charts can decrease the pilots' workload because the computing device can automatically apply adjustments and interpolate based on the operator's programming. However, if pilots misunderstand the output because they are unaware of critical performance calculation assumptions, use of an electronic computing device can lead to errors in decision-making.

For example, as the accident pilots neared MDW, they used the OPC to calculate the airplane's landing distance multiple times, assessing updated weather conditions and stopping margins on runway 31C under both fair and poor braking action conditions. All of the resultant OPC calculations indicated that they could land and stop the airplane in the available runway length. The OPC indicated a stopping margin of about 560 feet before the end of the runway for fair braking action and about 40 feet before the end of the runway for poor braking action. However, evidence indicates that the landing distances displayed on the OPC could have been misleading to the crew because the pilots were not aware of at least two underlying OPC assumptions, neither of which was displayed on the OPC. Both of these assumptions resulted in OPC indications showing larger (more favorable) stopping margins.

One OPC assumption that the accident pilots were not aware of was that stopping margins displayed by the OPC for poor runway conditions were in some cases based on a lower tailwind component than that which was presented. Typically, the stopping margin output corresponded to the presented tailwind component. However, the tailwind component exceeded the 5-knot limit for poor runway conditions, but the displayed stopping margin was instead based on the tailwind limit of 5 knots, not the actual 8-knot tailwind component, as entered by the flight crew. Although in these cases the actual tailwind component is highlighted with white text on a red background, and the tailwind component limits are presented at the bottom of the display in white text on a black background, there is no indication that the stopping margin is not based on the presented tailwind component.

[75] Tabular charts present critical information and assumptions through notations either directly on the applicable chart or on an introductory overview page.

For the accident landing, the OPC-calculated stopping margin of 40 feet for poor runway braking action was based on the company-programmed 5-knot tailwind component limit, despite the fact that the display showed the actual 8-knot tailwind component based on the winds input by the pilots. Calculations based on the 5-knot tailwind limit resulted in more favorable displayed stopping margins. If the OPC calculations had been based on the actual 8-knot tailwind component, the stopping margin would have been -260 feet (or 260 feet beyond the departure end of the runway), indicating that there was not enough runway available to land with poor braking action. This information would have provided the pilots with a more conservative and realistic indication of the expected landing performance. To highlight negative stopping margin values and to alert pilots that it is not safe to land on a particular runway, SWA's OPC uses alternate graphics and the color red on the display.[76] CVR and postaccident interview evidence indicated that both pilots were uncomfortable with the low positive stopping margins exhibited by the OPC. Had a negative stopping margin been shown and highlighted on the OPC display, the pilots would have been further alerted to the potential hazards involved in a landing on runway 31C at MDW under the accident conditions.

The accident pilots were also not aware that the 737 stopping margins computed by the SWA OPC were designed to incorporate the use of reverse thrust for the 737-700 model only,[77] which resulted in more favorable stopping margins. Postaccident interviews with SWA pilots indicated that some (including the accident crew) assumed that none of the 737 OPC landing distance calculations took into account the use of reverse thrust. Because of this, the accident pilots believed that their intended use of reverse thrust during the landing roll would provide them with several hundred feet more stopping margin than the OPC estimated.

A review of SWA guidance and training regarding the OPC revealed one reference regarding wind calculation assumptions in the FRM. However, no related information was provided in the FOM, and no slides were devoted to this topic during initial, recurrent, or OPC-related ground training. This review also revealed that although pilots were taught that thrust reverser use was assumed for the -700 and not for the -300 or -500 models during "differences" training when qualifying for the -700 model, SWA's FOM guidance on OPC assumptions regarding the use of reverse thrust was inconsistent and may have been misleading to pilots. Until 1 week before the accident, information was incorrect in two of three locations in the FOM, stating that reverse thrust was not included in the landing distance calculations.78 Interviews with SWA pilots indicated that they were not uniformly aware of this and other landing distance assumptions, such as air distance.[79]

[76] Negative values are presented in brackets as white digits inside of a red block instead of the standard black digits against a white background.

[77] SWA pilots were type-rated in one of three 737 models owned by SWA (-300/-500/-700), but were expected to fly all three 737 models. Therefore, they had to be aware of differences between the models, as they switched between these models on a day-by-day or flight-by-flight basis.

[78] At the time of the accident, the information was correct in two of the three FOM locations.

[79] Air distance is the distance allowance from the threshold crossing point at 50 feet agl to the estimated touchdown point, upon which the landing performance calculations are based.

Therefore, the Safety Board concludes that if the pilots had been presented with stopping margins associated with the input winds or had known that the stopping margins calculated by the OPC for the 737-700 already assumed credit for the use of thrust reversers, the pilots may have elected to divert.

Another OPC-programming factor observed by the Safety Board is that the airplane performance data programmed into the OPC by SWA was less conservative than the airplane performance data recommended by Boeing for braking action reports worse than good; this resulted in more favorable displayed stopping margins. Calculations performed using the Boeing-recommended data for a landing on runway 31C and the actual tailwind component of 8 knots showed that the airplane would require a longer landing distance than available under both fair and poor braking action conditions (an additional 260 and 2,070 feet beyond the departure end of the runway, respectively).[80] The Safety Board concludes that if Boeing's recommended airplane performance data were used in SWA's OPC calculations, the resulting negative stopping margins for even fair braking action conditions would have required the pilots to divert.

After this accident, SWA redesigned its arrival landing distance performance calculations to consistently reflect the assumption of two-engine reverse thrust and revised its OPC display to show the reverse thrust level assumed based on the conditions. Additionally, SWA modified its OPC display to consistently present output associated with the actual tailwind component. When the tailwind component exceeds authorized limits for landing (5 knots for poor braking action, 10 knots for good or fair braking action) a numeric stopping margin value is not presented. Finally, SWA amended its FOM guidance and policies regarding OPC reverse thrust assumptions to ensure consistency and to clarify the assumption of reverse thrust use across all 737 models. In response to this accident, the FAA issued SAFO 06012 to all turbojet operators, encouraging them to require pilots to perform arrival landing assessments if the weather conditions, runway, or airplane landing configuration has changed since the dispatch calculation and to train pilots regarding all aspects and assumptions used in these assessments. However, the Safety Board notes that operators are not required to comply with FAA guidance material such as this SAFO.[81]

FAA advisory material regarding electronic flight performance calculations[82] suggests that the output be displayed in a manner that is understood easily and accurately and that users of such devices should be aware of any assumptions upon which the flight performance calculations are based. There is no specific guidance suggesting that these assumptions be as clear to pilots as similar information would be on a tabular chart, however. Such clarity is critical because airplane performance data and related OPC assumptions are not consistent across manufacturers, airplane models, or operators

[80] As previously mentioned, SWA's OPC display would have alerted the pilots to these negative stopping margin values by presenting the numbers as bracketed white digits inside a red block instead of the standard black digits against a white background.

[81] Although not required by the FAA, SWA did require its pilots to conduct arrival landing distance assessments at the time of the accident.

[82] There are currently no requirements for the design and certification of airplane OPCs; all current guidance is advisory in nature.

and may be based on information other than what the pilots entered. In the case of the accident flight, the SWA OPC screen did not display OPC assumptions (for example, the thrust reverser credit assumptions) when they were applicable; this information would have been readily available on a tabular chart. Therefore, the Safety Board concludes that presentation of the OPC assumptions upon which landing distance calculations are based is critical to a pilot's decision to land. Therefore, the Safety Board believes that the FAA should require all 14 CFR Part 121 and 135 operators to ensure that all on board electronic computing devices they use automatically and clearly display critical performance calculation assumptions.

As a result of its evaluation of the accident pilots' decision to land and their actions during the approach and landing, the Safety Board determined that if the pilots had been aware of existing company guidance and policies in several areas, including runway braking action reports and the underlying assumptions factored into OPC stopping margin calculations, they would have made a better-informed landing decision. Accident evidence indicated that other SWA pilots were similarly unaware of SWA's guidance and policies in these areas. Therefore, the Safety Board concludes that SWA did not provide its pilots with clear and consistent guidance and training regarding company policies and procedures in several areas, including interpretation of braking action reports and the assumptions affecting landing distance assessments. Therefore, the Safety Board believes that the FAA should require all 14 CFR Part 121 and 135 operators to provide clear guidance and training to pilots and dispatchers regarding company policy on surface condition and braking action reports and the assumptions affecting landing distance/stopping margin calculations, to include use of airplane ground deceleration devices, wind conditions and limits, air distance, and safety margins.

2.2.3 Thrust Reverser Usage and Autobrakes

According to SWA procedures, the flying pilot was required to deploy the thrust reversers as soon as possible after nosewheel touchdown for all landings. SWA guidance especially emphasized immediate deployment of reverse thrust when braking actions were reported to be less than good. The accident pilots reported that they were aware of the company's reverse thrust policies and routinely carried them out; however, for the accident landing, the captain (the flying pilot) did not deploy reverse thrust immediately after the airplane touched down. During postaccident interviews, the captain stated that he tried to deploy the thrust reversers promptly after touchdown but was not successful. SWA procedures also required the monitoring pilot to be attentive for procedural deviations during all landings. The first officer stated that, when he realized that the captain had not deployed the thrust reversers, he moved the thrust levers to command reverse thrust (thrust reverser activation was initiated about 15 seconds after touchdown according to FDR data). FDR data indicated that the thrust reversers were eventually fully deployed about 18 seconds after touchdown, and the pilots held maximum reverse thrust until the airplane came to a stop off the end of the runway.

The Safety Board's review of FDR data from four SWA 737s that landed and came to a stop on runway 31C at MDW during the 21 minutes before the accident indicated that reverse thrust on these airplanes was deployed promptly after landing. Postaccident calculations showed that, if the pilots had promptly initiated and maintained maximum reverse thrust throughout the landing roll, the airplane would not have run off the end of the runway. Therefore, the Safety Board concludes that the pilots would have been able to stop the airplane on the runway if they had commanded maximum reverse thrust promptly after touchdown and maintained maximum reverse thrust to a full stop.

Despite the captain's reported difficulties in his initial attempt to deploy the thrust reversers, they extended normally in a coordinated manner for the first officer. The captain's seat position was the same as he routinely used, and the CVR recorded no comments or utterances indicating that the pilots were having difficulty with the thrust reverser levers. Further, postaccident examination of the throttle quadrant and reverse thrust systems provided no evidence of mechanical irregularity or failure; the levers were in a position to be deployed at any time during the landing rollout. In addition, postaccident interviews with other SWA pilots indicated that most had not experienced any difficulty deploying the thrust reversers, nor had they heard of others doing so, aside from occasionally not waiting long enough at the interlock position. Any difficulties that were described by SWA pilots were reportedly resolved immediately upon second attempt.[83] Finally, the pilots who had flown the accident airplane for the 10 flights before the accident reported experiencing no difficulties in deploying the thrust reversers in that airplane. Therefore, the Safety Board concludes that the pilots' delay in deploying the thrust reversers cannot be attributed to mechanical or physical difficulties.

SWA planned to implement a new policy the week after the accident that would have required the use of autobrakes during landings under some conditions, including the accident landing conditions.[84] In preparation, SWA provided its pilots with a self-study training module on the system and related procedures. Despite having completed the training module, neither of the accident pilots had previous operational experience with autobrakes. Information from the CVR indicates that although both pilots expressed concern, the captain, in particular, was hesitant to use the autobrakes for the first time in the weather and runway conditions that existed for the accident landing. The pilots discussed possible contingencies (for example, autobrake failure, loss of directional control, and reversion to manual braking). They ultimately agreed that use of the autobrakes would allow them to stop in the shortest distance and used the autobrakes on maximum setting during the accident landing.

Use of autobrakes when landing on short or slippery runways required a change in the sequence of landing tasks for both the flying pilot and the monitoring pilot. Before

[83] A review of ASRS data revealed no history of difficulty in deploying the thrust reversers for the Boeing 737 series airplanes.

[84] In part, SWA developed this new policy because of FAA guidance resulting from a Safety Board recommendation (A-01-54). The company issued a series of autobrake-related bulletins, some of which estimated policy implementation dates. The most recent bulletin, issued by SWA the morning before the accident, indicated that required autobrake usage would begin 4 days later (on December 12); however, the accident pilots mistakenly believed that the company's autobrakes policy was already effective the day of the accident. At the time of the accident, the cockpit checklists and the pilots' FOM guidance had already been updated to reflect the new autobrake procedures. Had this new policy been in effect at the time of the accident, the pilots would have been required to use the maximum autobrake setting for that landing.

SWA's new autobrakes procedures took effect, procedures required the flying pilot to manually apply wheel brakes and deploy the thrust reversers simultaneously as soon as possible after touchdown. However, with the use of autobrakes, only one of these two tasks was required at touchdown; the prompt manual application of wheel brakes was no longer necessary. Research indicates that carrying out new procedures requires more effort and cognitive resources than does carrying out routine procedures and limits the number of tasks that can be carried out simultaneously.[85] Because of the pilots' concerns regarding the autobrakes and their unfamiliarity with the system's operation, it would have been natural for them to focus on the autobrake system's performance after the airplane touched down.

During postaccident interviews, both pilots reported that they were preoccupied by the autobrake system during the accident landing. The captain reported that his focus on the autobrake system performance distracted him from trying to deploy the thrust reversers again after his first attempt was unsuccessful. The first officer had the additional task of monitoring the autobrakes light on the front instrument panel during the landing rollout, although he reported that he maintained his focus outside of the cockpit and on their stopping performance. Research also indicates that activities that have been grouped together in an automatic task sequence require substantial effort to separate.[86] In this case, applying the wheel brakes would normally be accomplished with deployment of the thrust reversers, and omitting one of these linked activities (wheel brakes) could help explain omission of the other (thrust reversers). The pilots stated that, as the landing roll continued, they were not satisfied with the airplane's deceleration, and FDR data indicated that, about 12 seconds after touchdown, they transitioned from autobrakes to maximum manual wheel braking. FDR data indicated that the thrust reversers deployment was initiated 15 seconds after touchdown, with full thrust reverser deployment occurring 18 seconds after touchdown.

According to postaccident interviews with SWA personnel, similar distractions were observed in SWA pilots during the development of the company's autobrake program. SWA check airmen and their first officers reported concern prior to use and difficulty with the transition from using autobrakes to manual braking after touchdown; some were so distracted that they delayed reverse thrust application. Pilots also indicated that these challenges persisted for the first few landings only, until they had the chance to acclimate to the new procedures. At the time of the accident, SWA's planned implementation of its autobrakes procedures did not include a familiarization period with the use of the

[85] See (a) S. Shiffrin and W. Schneider, "Controlled and Automatic Human Information Processing: II. Perceptual Learning, Automatic Attending and a General Theory," *Psychological Review*, vol. 84, no. 2, pages 127-190, 1977; (b) G. Logan, "Toward an Instance Theory of Automatization," *Psychological Review*, vol. 95, no. 4, pages 492-527, 1988; and (c) G. Logan and W.B. Cowan, "On the Ability to Inhibit Thought and Action: A Theory of an Act of Control," *Psychological Review*, vol. 91, no. 3, pages 295-327, 1984.

[86] See G. Logan, "On the Ability to Inhibit Complex Movements: A Stop-Signal Study of Typewriting," *Journal of Experimental Psychology: Human Perception and Performance*, vol. 8, no. 6, pages 778-792, 1982.

autobrakes,[87] nor was one required by regulations.[88] However, feedback from other SWA pilots should have alerted SWA management and the company's FAA POI to the need for a familiarization or transition period.

The Safety Board concludes that the pilots' first use of the airplane's autobrake system during a challenging landing situation led to the pilots' distraction from the otherwise routine task of deploying the thrust reversers promptly after touchdown. Had SWA implemented an autobrake familiarization period in advance, such a period would have allowed pilots to become comfortable with the changed sequence of landing tasks. The Safety Board further concludes that the implementation of procedures requiring thrust reverser status confirmation immediately after touchdown may prevent pilots from inadvertent failure to deploy the thrust reversers after touchdown. Therefore, the Safety Board believes that the FAA should require all Part 121 and 135 operators of thrust reverser-equipped airplanes to incorporate a procedure requiring the non-flying (monitoring) pilot to check and confirm the thrust reverser status immediately after touchdown on all landings.

The Safety Board notes that the timing and nature of this autobrake policy change was specific to SWA, based on its operation of a fleet of only one model airplane (the 737) and the company's desire to implement the policy simultaneously throughout that fleet. After this accident, the company voluntarily amended its autobrake policy and training program, delaying the implementation date and requiring a familiarization period, which allowed SWA pilots to first use the autobrakes in good conditions and with large stopping margins.[89] In addition, SWA provided its pilots with specific instructions that the monitoring pilot was to monitor the reverse thrust levers during the landing sequence and to make a specific callout in the event of deviation from SWA reverse thrust procedures.

2.3 Landing Distance Assessments

Preflight landing distance calculations (assessments) are required by Federal regulation while arrival landing distance calculations (assessments) are not. This section discusses the differences between preflight and arrival landing distance calculations and evaluates the need for both. This section also discusses related content in the FAA's proposed OpSpec, recent SAFO, and observed industry landing distance practices.

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[87] SWA had not initially planned to implement the new autobrake policy during the winter; however, delays associated with other procedures implemented simultaneously delayed the autobrake implementation date.

[88] The FAA POI approved the SWA autobrakes policy in accordance with Federal regulations and guidelines. Guidance for POIs when reviewing these types of changes is general but requires the POI to consider the impact of such changes and the best training method suitable to the change.

[89] Pilots were required to use autobrakes under certain conditions only after they completed at least four familiarization landings on dry runways with ample safety margins. Even under these circumstances, there were reported instances of pilot failure to immediately deploy the thrust reverse during initial landings with use of autobrakes.

2.3.1 Preflight and Arrival Landing Distance Calculations/ Assessments

The FAA requires Part 121 operators to perform preflight landing distance calculations before they depart on a flight, in part, to determine the maximum takeoff weight at which the airplane can depart, travel to the destination, and safely land on the available landing distance at the destination and/or alternate airport. Although preflight landing distance assessments are standardized by Federal regulations, the assessments do not attempt to comprehensively account for the actual conditions, configuration, and pilot techniques that exist and/or occur at the time of arrival.[90] The manufacturer's flight test data upon which these calculations are based are primarily accumulated during demonstrated landings on a dry, smooth, hard-surfaced runway without the effects of reverse thrust. To account for variations in landing conditions, pilot techniques, and other operational uncertainties, the FAA requires operators to factor in a significant safety margin in excess of the demonstrated landing distance during their preflight landing distance assessments.[91] The Safety Board's review of SWA dispatch documents for the accident flight indicated that, based on preflight calculations, the accident airplane was legal to depart BWI intending to land at MDW.

Arrival landing distance assessments assist pilots in ensuring that they will be able to land the airplane and safely stop on the intended runway given the arrival weather and runway surface conditions and the planned airplane configuration, landing technique, and use of deceleration devices. Like preflight landing distance calculations, arrival landing distance calculations/assessments are typically developed by an operator or contractor based on data provided by the manufacturer. However, unlike the preflight data, specific FAA approval is not required for the data used by operators in their arrival landing distance assessments because those assessments are not required.

Although the FAA does not require operators to perform arrival landing distance assessments, many Part 121 operators (including SWA) do require their pilots to perform landing distance assessments before every landing. However, because the FAA does not require or standardize arrival assessments as it does preflight assessments, operators are allowed to set their own policies and use data from various sources (for example, the manufacturer, in-house personnel, an outside contractor, etc.). Depending on the source, the data used may be less conservative than the manufacturer's data and may contain embedded assumptions related to landing and deceleration techniques, the airplane's braking ability for a given runway surface condition report, and/or the application of additional safety margins. If pilots are unaware of these embedded assumptions, they might believe that they need less landing distance than they actually do or have an inaccurate perception of how much braking effort will be needed on landing. Depending on an operator's policies, pilots may not be required to conduct arrival landing assessments; may conduct such assessments based on variable landing performance data sources,

[90] Preflight landing distance calculations are based on conditions that are forecast for the destination at time of landing.

[91] The FAA requires operators to factor safety margins of 67 and 92 percent (for dry and wet/slippery runways, respectively) into their preflight landing distance calculations.

assumptions, and calculation methods; or may conduct such assessments based on data that include no additional safety margin.

SWA required its pilots to perform arrival landing distance assessments for each landing and developed a system, primarily based on Boeing's performance data, to account for actual conditions and planned procedures/techniques. However, FAA personnel did not approve the data or calculation methods developed by SWA. The resultant system used data that were less conservative than Boeing recommended for braking reports worse than good. Although SWA and FAA personnel were aware that actual arrival conditions cannot be perfectly defined, planned procedures cannot always be accomplished, and the resultant variations will not always yield a conservative safety margin, the data programmed into SWA's OPC did not account for reasonable operational variations. This is of particular concern because SWA's policies at the time of the accident and its new autobrake policy authorize landing with even the smallest of positive calculated stopping margins.

The Safety Board notes that, although not required by the FAA, SWA's arrival landing distance assessment practices exceeded those of many other operators; yet, the safety margin was inadequate to prevent this accident. The Safety Board notes that preflight safety margins alone may not be sufficient to ensure adequate stopping margins at arrival. This investigation has shown that an arrival landing distance assessment should be conducted before arrival and should incorporate the following six basic components:

- Approved aerodynamic performance data obtained from demonstrated flight test landings;
- A set of defined operational procedures and assumptions (for example, touchdown at 1,500 feet, reverse thrust deployment promptly after touchdown, etc.);
- Actual arrival condition data (weather, airplane configuration, runway surface condition, etc.);
- A physics-based method for calculating airplane performance;
- A minimum acceptable standard for correlating the airplane's braking ability to the runway surface condition; and
- A minimum acceptable safety margin/factor that accounts for reasonable operational variations and uncertainties.

At the time of the accident, SWA had incorporated the first four components into their arrival landing distance assessments and prescribed the fifth component. After the accident, SWA incorporated the sixth component by adding an additional 15 percent safety margin to account for operational variations and uncertainties into its arrival landing distance assessments.

2.3.2 Safety Alert for Operators Discussion and Industry Practice Regarding Landing Distance Assessments

As previously noted, although the FAA is on record as advocating arrival landing distance assessments, there is currently no requirement, FAA-approved data, minimum correlation standards, or minimum safety margin for such assessments. As a result, operators remain free to choose whether and how they perform such assessments.

As a result of the SWA flight 1248 accident, the Safety Board issued urgent Safety Recommendation A-06-16, which asked the FAA to prohibit all 14 CFR Part 121 operators from using reverse thrust credit in landing performance calculations. The stated intent of this recommendation was to ensure adequate landing safety margins on contaminated runways. In response, in June 2006, the FAA issued an advance notice of its intent to issue mandatory OpSpec N 8400.C082, which would have required all Part 121, 135, and 91 subpart K turbojet operators to conduct landing performance assessments (not necessarily a specific calculation) before every arrival based, in part, on planned touchdown point, procedures and data at least as conservative as the manufacturer's, updated wind and runway conditions, and an additional 15 percent safety margin. However, the FAA subsequently decided not to issue the mandatory OpSpec at that time and, in August 2006, published SAFO 06012 as an interim guidance measure. SAFO 06012 addressed similar issues to the mandatory OpSpec, but operator compliance with the SAFO is, by definition, voluntary. Although the FAA published SAFO 06012 with the intent of pursuing rulemaking in the area of landing distance assessments, in the interim, operators are still not required to comply with its recommendations and, currently, many operators do not.

For example, on February 18, 2007, a Shuttle America Embraer ERJ-170 ran off the end of snow-contaminated runway 28 at Cleveland Hopkins International Airport, Cleveland, Ohio.[92] The investigation to date has revealed that Shuttle America did not require its pilots to perform (and therefore did not incorporate landing distance safety margins into) arrival landing distance assessments. About 2 months later, a Pinnacle Airlines Bombardier Regional Jet CL600-2B19 ran off the end of snow-covered runway 28 at Cherry Capital Airport in Traverse City, Michigan.[93] By contrast, the investigation into this accident showed that Pinnacle's OpSpecs required its pilots to perform arrival landing distance assessments (including a minimum 15 percent safety margin) per SAFO 06012;[94] however, the pilots did not perform the required assessment before the accident landing. If an arrival landing distance assessment had been performed, given the existing conditions, Pinnacle's OpSpecs would have dictated that a diversion was required.

[92] This accident investigation is ongoing at the time of this writing. Additional information about this accident, CHI07MA072, is available on the Safety Board's Web site at <http://www.ntsb.gov/ntsb/query.asp>.

[93] More information on this accident, DCA07FA037, is available on the Safety Board's Web site at <http://www.ntsb.gov/ntsb/query.asp>.

[94] The OpSpec developed by Pinnacle and approved by the FAA required pilots to perform arrival landing distance calculations taking into account actual runway conditions, expected deceleration means, and airplane configuration, and including a minimum safety margin of 15 percent when landing on a contaminated runway.

The Safety Board is concerned that, because of operational and conditional variations, it is possible for an airplane to use more of the landing runway than preflight (dispatch) calculations predicted and for pilots to continue to run off the end of contaminated runways. During a January 2007 meeting, Safety Board, FAA, Boeing, SWA, and SWAPA personnel discussed landing distance assessment and runway surface condition issues. A subsequent Boeing document recommended that operators develop arrival landing distance assessment procedures for their flight crews to use to better ensure that a full-stop landing can be made on the arrival runway in the conditions existing at the time of arrival (weather and runway) and with the deceleration means and airplane configuration to be used, consistent with SAFO 06012. The circumstances of the flight 1248 accident (among others) demonstrate that conditions[95] can change between dispatch and arrival and that there is a safety benefit to landing distance assessments at both times.

The Safety Board notes that the FAA concluded in SAFO 06012 that operator compliance with preflight landing distance planning requirements alone "does not ensure that the airplane can safely land within the distance available on the runway in the conditions that exist at the time of arrival, particularly if the runway, runway surface condition, meteorological conditions, airplane configuration, airplane weight, or use of airplane ground deceleration devices is different than that used in the preflight calculation." In addition, the FAA stated that "a landing distance assessment should be made under the conditions existing at the time of arrival in order to support a determination of whether conditions exist that may affect the safety of the flight and whether operations should be restricted or suspended."

2.3.3 Landing Distance Assessments Summary

Existing FAA regulations do not specify either the type of arrival landing distance assessment that should be performed or specify a safety margin that should be applied. The FAA-advocated minimum safety margin of 15 percent for arrival landing distance assessments published in SAFO 06012 is based on historic links to the FAA-mandated additional 15 percent factor for wet/slippery preflight planning requirements and the 15 percent factor embedded in the EASA and JAA operational requirements for contaminated runway landing performance. Although during public hearing testimony the FAA stated that the 15 percent landing safety margin has not been substantiated by a specific data collection and evaluation effort, the Safety Board is convinced that a defined landing safety margin is necessary for air carrier operations on contaminated runways. The Board was encouraged when the FAA proposed OpSpec N 8400.C082, which would have required operators of transport-category airplanes to incorporate a 15 percent safety margin in arrival landing distance calculations. The proposed 15 percent safety margin identified in FAA OpSpec N 8400.C082 would have satisfied the intent of Safety Recommendation A-06-16. However, the FAA subsequently sought voluntary operator implementation of such actions through SAFO 06012; although SAFO 06012 contains

[95] For example, between SWA flight 1248's dispatch from BWI and its arrival at MDW, the airplane's landing conditions were affected by many factors, including continuing snowfall, the timing of runway clearing operations, and an updated landing weight.

similar information to OpSpec N 8400.C082, compliance with the SAFO is not required by the FAA.[96]

Because the FAA has not required actions to address the Board's urgent safety recommendation, flight crews of transport-category airplanes may still be permitted to land in wet, slippery, or contaminated runway conditions, without performing arrival landing distance assessments that incorporate adequate safety margins. As another winter season approaches, the urgent need for such margins becomes more critical. The Safety Board concludes that because landing conditions may change during a flight, preflight landing assessments alone may not be sufficient to ensure safe stopping margins at the time of arrival; arrival landing distance assessments would provide pilots with more accurate information regarding the safety of landings under arrival conditions. Further, the Safety Board concludes that although landing distance assessments incorporating a landing distance safety margin are not required by regulation, they are critical to safe operation of transport-category airplanes on contaminated runways. Therefore, the Safety Board believes that the FAA should require all 14 CFR Part 121, 135, and 91 subpart K operators to accomplish arrival landing distance assessments before every landing based on a standardized methodology involving approved performance data, actual arrival conditions, a means of correlating the airplane's braking ability with runway surface conditions using the most conservative interpretation available, and including a minimum safety margin of 15 percent. The Board recognizes that development of such a standardized methodology will take time. Therefore, the Safety Board further believes that, until a standardized methodology as described in the previous recommendation can be developed, the FAA should immediately require all 14 CFR Part 121, 135, and 91 subpart K operators to conduct arrival landing distance assessments before every landing based on existing performance data, actual conditions, and incorporating a minimum safety margin of 15 percent. Because the objectives of this recommendation and Safety Recommendation A-06-16 are identical, the Safety Board classifies A-06-16 "Closed—Unacceptable Action/Superceded." Because the FAA has had adequate time to require landing distance assessments and implement a landing distance safety margin, but has not, A-06-16 was classified "Open—Unacceptable Response" on May 8, 2007. The superceding safety recommendation will maintain the status of "Open—Unacceptable Response."

[96] The Safety Board is currently investigating two more recent runway overruns involving air carrier operators landing on snow-contaminated runways; landing distance calculations were not conducted in either of these cases.

2.4 Runway Surface Condition Assessments

The Safety Board has long been concerned about runway surface condition assessment issues.[97] During this investigation, the Safety Board reevaluated the three methods currently used to assess a runway's surface condition before landing: 1) pilot braking action reports, 2) runway contaminant type and depth observations, and 3) ground surface vehicle friction measurements. The Board notes that all three methods have limitations and that, regardless of the method used, runway surface conditions may vary over time because of changes in precipitation, accumulation, traffic, direct sunlight, temperature, or as a result of runway maintenance/treatment. The Board further notes that no standardized and universally accepted correlation exists to define the relationship between the runway surface condition (using any of the three runway surface assessment methods) and an airplane's braking ability.

This section discusses the accuracy and limitations associated with each method of runway surface condition assessment. Pilot braking action reports, contaminant type and depth reports, and airport runway surface friction measuring devices are discussed in sections 2.4.1, 2.4.2, and 2.4.3, respectively. Runway surface condition assessments are summarized in section 2.4.4, and correlating runway surface condition to airplane landing performance/braking ability is discussed in section 2.4.5.

2.4.1 Braking Action Reports

Pilot braking action reports are commonly used by arriving pilots to predict landing runway conditions. However, Safety Board safety recommendation communications, public hearing testimony, and flight 1248 accident evidence indicate that pilot braking action reports are subjective and can vary significantly depending on the reporting pilot's experience level and the type of airplane in use.

The FAA has frequently acknowledged (most recently in SAFO 06012) that pilot braking action reports are subjective and reflect individual pilot expectations, perceptions, and experiences. Further, braking action reports are sensitive to airplane type and the actual deceleration methods used to slow or stop the airplane. In addition, an arriving pilot may have to interpret mixed pilot braking action reports (for example, fair-to-poor braking action reported on a landing runway) or conflicting runway condition

[97] In 1983, the Safety Board issued a special investigation report titled, *Large Airplane Operations on Contaminated Runways*, which recommended that research be conducted to identify reliable and consistent methods for determining runway conditions. Although several industry working groups have convened to address this issue, no consensus has been reached to date regarding the preferred method for doing so, and no significant advances have been developed to eliminate the subjectivity or minimize the variances between reports. In addition, there is no standardized correlation between pilot braking action reports and runway contaminant type and depth, nor is there an internationally recognized and standardized terminology for braking action reports or contaminant type and depth reports. The Board classified Safety Recommendation A-82-155, "Closed—Unacceptable Action."

reports (for example, a pilot braking action report that conflicts with a runway friction measurement).[98]

In SAFO 06012, the FAA defined a reliable braking action report as a braking action report submitted from a turbojet airplane with landing performance capabilities similar to those of the airplane being operated. The FAA recommends in the SAFO that pilots should use all available information and make decisions based on experience and sound judgment; however, the FAA has not yet provided standardized procedures or specific criteria for pilots to use in the development and delivery of braking action reports.[99]

Since this accident, the FAA has hosted an industry workshop that attempted to address this issue. A mid-2006 industry working group produced guidance regarding runway surface condition assessments that has since been disseminated to all operators of Boeing turbojet airplanes in an August 2007 bulletin. SWA is incorporating the working group guidance into its materials and training and plans to publish related revisions in October 2007 (see figure 6).[100]

2.4.2 Contaminant Type and Depth

A field report or observation of the type and depth of contaminant on the runway, typically conducted by airport personnel, may also be used to assess the runway surface condition. However, these observations may also be subjective and dependent on the observer's experience and vantage point, the timing of the observation, and rapidly changing conditions. The FAA has not established and defined a standard correlation between an airplane's braking ability and reports of contaminant type and depth.

The Safety Board notes, however, that many airplane manufacturers worldwide (for example, Airbus and Embraer) provide their operators with contaminant type and depth options for landing distance calculations. Further, European agencies (EASA and JAA) require operators to account for contaminated runway conditions and define a minimally acceptable standard that manufacturers can use to correlate contaminant type and depth to airplane landing performance. In practice (and as stated in SAFO 06012), the FAA considers the data developed for showing compliance with EASA and JAA contaminated runway certification or operating requirements acceptable for U.S. arrival landing distance assessments.

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98 A postaccident Safety Board survey of seven operators (not including SWA) indicated that none of them provided their pilots with guidance regarding mixed and/or conflicting braking action or runway condition reports. However, most of the operators surveyed based landing distances on runway contaminant type and depth, not braking action reports.

99 The FAA does have standards and requirements for ATC's delivery of a pilot's braking action report to other pilots.

100 The draft industry product addressing landing distance assessments (see figure 6) contained winter operational guidance that was developed by a team of aviation industry representatives and included proposed braking action and contaminant type and depth terminology, definitions, and estimated correlations. The Safety Board's review of this document indicated that it represents a good initial effort in the development of standardized guidelines for runway surface condition assessments.

2.4.3 Airport Runway Surface Friction Measuring Devices

Runway friction measuring devices were originally developed for use by airports for runway maintenance purposes and were not intended for use in assessing airplane landing performance. Although the FAA funds purchase of these devices for airports and believes that measurements are useful in identifying trends in runway surface condition, FAA representatives have stated that these devices cannot be reliably correlated with airplane performance or pilot braking action reports. Specifically, FAA statements and testimony at the Safety Board's public hearing on this accident indicate that ground surface vehicle friction measurements should not be used to predict airplane stopping performance, in part, because of 1) unresolved variability in equipment design and calibration; 2) changes over time in temperature, sunlight, precipitation, accumulation, and operating traffic; and 3) the results of maintenance and/or treatment of a runway.

MDW friction readings were less conservative than the available braking action reports and the postaccident calculated runway 31C surface condition. The runway 31C friction measurement taken at MDW 30 minutes before the accident landing (immediately after the most recent runway cleaning) was 0.67, which a Transport Canada public hearing witness correlated with expected "bare and dry" runway surface condition performance. A measurement taken just after the accident was 0.40, which was considered fairly good according to a public hearing witness from NASA. According to CRFI data for various runway surface conditions, both measurements (0.67 and 0.40) were within the range of normal values observed with 3 mm or less of loose snow on the runway. Measurements for this surface condition ranged from 0.16 to 0.76 (see figure 7 in section 1.18.2.2.1). The broad range of measurements possible with a single contaminant demonstrates that this type of runway friction measurement device cannot reliably be used to predict airplane stopping performance under these contaminant conditions (3 mm or less of loose snow).

The Safety Board has previously issued safety recommendations supporting efforts to correlate friction measurement device readings to airplane performance. Boeing does not attempt to correlate runway friction measurements to airplane performance; however, many operators (including SWA) have developed tables that correlate friction measurements to braking action reports. Internationally, Transport Canada provides CRFI tables that correlate ground surface vehicle friction survey measurements to airplane performance for certain contamination conditions; however, use of the CRFI is optional. The Canadian academic community and members of the international research community also support the use of the IRFI, which is not fully operational or widely supported by the aviation industry. For both the CRFI and the IRFI, runway friction measurements are subject to contaminant type and depth constraints.

2.4.4 Runway Surface Condition Assessments Summary

The Safety Board concludes guidance on braking action and contaminant type and depth reports would assist pilots, ATC, operator dispatch, and airport operations personnel in minimizing the subjectivity and standardization shortcomings of such reports. Further, the Safety Board concludes that using the most conservative interpretation of runway braking action or surface condition reports from mixed or conflicting reports (for example, a fair-to-poor braking action report or a pilot braking action report that conflicts with a runway friction measurement) would increase the landing safety margin. Therefore, the Safety Board believes that the FAA should develop and issue formal guidance regarding standards and guidelines for the development, delivery, and interpretation of runway surface condition reports.

2.4.5 Correlating Runway Surface Condition to Airplane Landing Performance

The Safety Board is concerned that the FAA currently provides no minimally acceptable standard for U.S. operators to use to correlate runway surface condition reports to airplane braking ability.[101] Although a draft AC, dated August 1989, proposed a correlation between runway condition (braking action) and an airplane's braking ability, the FAA never published it. SAFO 06012, issued by the FAA in 2006, also advocated the use of a specific correlation between reported braking action and runway contaminant type and depth to predict turbojet landing/stopping performance but only if the manufacturer-supplied wet or contaminated runway data were unavailable.

Operators need a method to relate any of the three runway surface condition reports and airplane braking ability to determine an airplane's landing performance. However, because the FAA has defined no acceptable correlation standards, manufacturers, operators, and/or third-party suppliers develop their own standards to fulfill their needs.[102] This practice results in variable estimates of an airplane's actual landing performance capability and different landing safety margins being used across even operators of the same make and model airplane. The Safety Board notes that flight crews preparing to land similar airplanes on similar runways, under similar actual conditions should not obtain arrival landing distance results that permit one flight crew to land while the other flight crew cannot, based solely on the operator's choice of how to correlate a runway surface condition report to the airplane's braking ability.

Further, required arrival landing distance assessments should include an additional safety margin to account for variations in actual landing conditions and operational techniques. The current lack of standards in manufacturer-supplied and operator-packaged arrival landing data complicates the validation of both the airplane's basic landing performance capability and adequate safety margins. The Safety Board's investigation of this accident revealed arrival landing distance implementation errors that resulted in latent safety risks at two air carriers. The Safety Board concludes that an

[101] In Europe, EASA and JAA provide a default relationship between an airplane's braking ability and contaminant type and depth.

[102] The Safety Board notes that operators and third-party suppliers do not generally possess the expertise needed and should not be given license to define (or redefine) basic airplane performance capability. During its investigation of the SWA flight 1248 accident, the Safety Board noted several instances of manufacturer-supplied errors and operator use of outdated or otherwise inaccurate data for their landing performance calculations. Although manufacturers and operators should be allowed to base arrival landing distance assessments on more conservative airplane braking ability correlations, the use of less conservative data should be prohibited.

adequate safety margin would account for operational variations and uncertainties when factored into arrival landing distance assessments. Further, the Safety Board concludes that establishment of a means of correlating the airplane's braking ability with the runway surface condition would provide a more accurate assessment of the airplane's basic landing performance capability. Therefore, the Safety Board believes that the FAA should establish a minimum standard for 14 CFR Part 121 and 135 operators to use in correlating an airplane's braking ability to braking action reports and runway contaminant type and depth reports for runway surface conditions worse than bare and dry.

2.5 Airplane-Based Friction Measurements

The circumstances of this accident demonstrate the need for a method of quantifying the runway surface condition in a more meaningful way to support airplane landing performance calculations.[103] The Safety Board and industry practice of analyzing an airplane's actual landing performance in the aftermath of an accident based on airplane-recorded data demonstrates that runway surface condition and braking effectiveness information can be extracted from recorded data.[104] These practices have shown that if the necessary parameters are recorded, specific calculations and operational procedures performed at lower rollout speeds (for example, wheel brake application for several seconds below 60 knots) can be used to quantify the runway surface condition and estimate the airplane's potential braking ability.[105] Thus, airplane braking coefficient/runway surface condition data derived from one type of landing airplane could be used to estimate another type of airplane's braking ability and landing distance.[106]

During a postaccident meeting in January 2007, Boeing, FAA, SWA, and SWAPA personnel agreed that this approach to obtain runway surface condition and braking effectiveness data has technical merit. However, the technical and operational feasibility issues associated with an airplane-based friction measurement system have not been evaluated on a test bed or an in-service air carrier airplane to date. A measurement

[103] The Safety Board has previously issued a safety recommendation on this subject (A-82-168), urging the FAA to conduct research to determine whether the characteristic variables of aircraft systems could be correlated to an airplane's stopping ability and related information displayed to pilots for objective braking action reports. The Board did not believe that the FAA's resultant actions were sufficient and subsequently classified Safety Recommendation A-82-168 "Closed—Unacceptable Action."

[104] Specifically, the Safety Board's airplane performance study for this accident demonstrated the technical feasibility of calculating an airplane's braking ability during the landing roll based on recorded FDR data (including accelerometer, attitude, speed, control input, control surface position, deceleration device usage, and air/ground logic parameters), the airplane configuration, and existing airplane simulation models. Conceptually, the calculation determines how much of the energy (initial energy and any added forward thrust) is dissipated by aerodynamic drag and reverse thrust forces acting during the landing rollout. The remaining energy is used together with airplane weight, aerodynamic lift, and any applicable thrust force data to derive the airplane braking coefficient. If wheel brakes are not applied, the calculated result should correspond to the rolling coefficient of friction, assuming no contaminant drag exists.

[105] Operational procedures at lower rollout speeds could be used to estimate the maximum or bound the minimum airplane braking coefficient available.

[106] The airplane braking coefficient report from the preceding airplane would be used to perform a rational arrival assessment for the trailing airplane, after correcting for known airplane type, loading, configuration, braked wheel configuration, and antiskid efficiency differences.

system installed on in-service airplanes could provide runway surface condition data that would surpass information produced by methods currently in use (including ground friction surveys, pilot braking action reports, and type and depth reports), without interfering with traffic flow. Such a system could provide unparalleled runway surface condition quantification and trend information of direct use to pilots, ATC, and airport maintenance.

The Safety Board concludes that development and implementation of an operationally feasible, airplane-based, airplane braking ability/runway surface condition measurement and communication system would provide high value information to subsequent landing airplanes; the benefits of such a system during inclement weather would likely meet or exceed all existing runway surface condition reporting systems, with no resultant interruption to traffic operations. Therefore, the Safety Board believes that the FAA should demonstrate the technical and operational feasibility of outfitting transport-category airplanes with equipment and procedures required to routinely calculate, record, and convey the airplane braking ability required and/or available to slow or stop an airplane during the landing roll. If feasible, the FAA should also require operators of transport-category airplanes to incorporate use of such equipment and related procedures into their operations.

2.6 Runway Safety Areas

The Safety Board's investigation of this accident revealed that FAA and MDW airport personnel had been discussing RSA improvements off the ends of MDW runways for about 5 years before the accident; however, no such improvements had been made when the accident occurred. Correspondence between the FAA and MDW personnel indicated that the option of acquiring land to develop dimensionally standard RSAs (which would extend 1,000 feet beyond the ends of the MDW runways) was determined to be both undesirable[107] and economically infeasible. Further, realigning the runways on the available airport property was not possible, and shortening the runways to improve RSAs was not practical given the operational requirements of the airplanes operating at MDW.

A practicability study contracted by MDW concluded that insufficient space existed for standard EMAS installations off the ends of MDW runways. The study did not address nonstandard EMAS installations, and, throughout most of the FAA/MDW correspondence, the FAA did not reference the installation of nonstandard EMAS beds off the end of MDW runways. However, although the FAA had no official guidance regarding nonstandard EMAS installations until 2005, agency personnel were aware of the feasibility of such installations and had approved nonstandard EMAS installations at several other airports at the time of the accident. The Board's postaccident calculations indicated that even a nonstandard EMAS installation off the end of runway 31C at MDW would have stopped the accident airplane before it left airport property and thus would have prevented the collision with the automobile.

[107] Acquisition of the required land would result in the forced relocation of businesses, residences, and roadways in the surrounding area.

Therefore, the Safety Board concludes that the absence of an EMAS installation in the limited overrun area for runway 31C contributed to the severity of the accident; even a nonstandard EMAS installation would have safely stopped the airplane before it left airport property. After the accident, the FAA approved the installation of nonstandard EMAS beds at the ends of runways 31C, 13C, 4R, and 22L at MDW. By early December 2006, the first portion (170 feet long and 170 feet wide) of an EMAS bed had been installed off the departure end of runway 31C, with an additional, 40-foot long portion planned. Airport and City officials indicated that the installation of EMAS beds at the ends of affected MDW runways would be completed by winter 2007, pending relocation of localizer antennas at the ends of runways 13C, 4R, and 22L.

3. Conclusions

3.1 Findings

1. The pilots were properly certificated and qualified under Federal regulations. No evidence indicated any medical or behavioral conditions that might have adversely affected their performance during the accident flight. There was no evidence of flight crew fatigue.

2. The accident airplane was properly certificated and was equipped, maintained, and dispatched in accordance with industry practices.

3. No evidence indicated any failure of the airplane's powerplants, structures, or systems that would have affected the airplane's performance during the accident landing.

4. The pilots had adequate initial and updated meteorological information throughout the flight.

5. Chicago Midway International Airport personnel monitored runway conditions and provided appropriate snow removal service on the night of the accident.

6. The Chicago Midway International Airport air traffic control tower controller did not follow Federal Aviation Administration guidance when he did not provide all of the required braking action report information.

7. Because the pilots did not use the more critical braking action term (poor) during their arrival landing distance assessment (which, combined with the associated tailwind limitation, would have required them to divert), they were not in compliance with Southwest Airlines' policies.

8. If the pilots had been presented with stopping margins associated with the input winds or had known that the stopping margins calculated by the on board performance computer for the 737-700 already assumed credit for the use of thrust reversers, the pilots may have elected to divert.

9. If Boeing's recommended airplane performance data were used in Southwest Airlines' on board performance computer calculations, the resulting negative stopping margins for even fair braking action conditions would have required the pilots to divert.

10. Presentation of the on board performance computer assumptions upon which landing distance calculations are based is critical to a pilot's decision to land.

11. Southwest Airlines did not provide its pilots with clear and consistent guidance and training regarding company policies and procedures in several areas, including

interpretation of braking action reports and the assumptions affecting landing distance assessments.

12. The pilots would have been able to stop the airplane on the runway if they had commanded maximum reverse thrust promptly after touchdown and maintained maximum reverse thrust to a full stop.

13. The pilots' delay in deploying the thrust reversers cannot be attributed to mechanical or physical difficulties.

14. The pilots' first use of the airplane's autobrake system during a challenging landing situation led to the pilots' distraction from the otherwise routine task of deploying the thrust reversers promptly after touchdown. Had Southwest Airlines implemented an autobrake familiarization period in advance, such a period would have allowed pilots to become comfortable with the changed sequence of landing tasks.

15. The implementation of procedures requiring thrust reverser status confirmation immediately after touchdown may prevent pilots from inadvertent failure to deploy the thrust reversers after touchdown.

16. Because landing conditions may change during a flight, preflight landing assessments alone may not be sufficient to ensure safe stopping margins at the time of arrival; arrival landing distance assessments would provide pilots with more accurate information regarding the safety of landings under arrival conditions.

17. Although landing distance assessments incorporating a landing distance safety margin are not required by regulation, they are critical to safe operation of transport-category airplanes on contaminated runways.

18. Guidance on braking action and contaminant type and depth reports would assist pilots, air traffic control, operator dispatch, and airport operations personnel in minimizing the subjectivity and standardization shortcomings of such reports.

19. Using the most conservative interpretation of runway braking action or surface condition reports from mixed or conflicting reports (for example, a fair-to-poor braking action report or a pilot braking action report that conflicts with a runway friction measurement) would increase the landing safety margin.

20. An adequate safety margin would account for operational variations and uncertainties when factored into arrival landing distance assessments.

21. Establishment of a means of correlating the airplane's braking ability with the runway surface condition would provide a more accurate assessment of the airplane's basic landing performance capability.

22. Development of an operationally feasible, airplane-based, airplane braking ability/ runway surface condition measurement and communication system would provide

high value information to subsequent landing airplanes; the benefits of such a system during inclement weather would likely meet or exceed all existing runway surface condition reporting systems, with no resultant interruption to traffic operations.

23. The absence of an engineering materials arresting system (EMAS) installation in the limited overrun area for runway 31C contributed to the severity of the accident; even a nonstandard EMAS installation would have safely stopped the airplane before it left airport property.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the pilots' failure to use available reverse thrust in a timely manner to safely slow or stop the airplane after landing, which resulted in a runway overrun. This failure occurred because the pilots' first experience and lack of familiarity with the airplane's autobrake system distracted them from thrust reverser usage during the challenging landing.

Contributing to the accident were Southwest Airlines' 1) failure to provide its pilots with clear and consistent guidance and training regarding company policies and procedures related to arrival landing distance calculations; 2) programming and design of its on board performance computer, which did not present inherent assumptions in the program critical to pilot decision-making; 3) plan to implement new autobrake procedures without a familiarization period; and 4) failure to include a margin of safety in the arrival assessment to account for operational uncertainties. Also contributing to the accident was the pilots' failure to divert to another airport given reports that included poor braking actions and a tailwind component greater than 5 knots. Contributing to the severity of the accident was the absence of an engineering materials arresting system, which was needed because of the limited runway safety area beyond the departure end of runway 31C.

4. Recommendations

4.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following recommendations to the Federal Aviation Administration:

> Immediately require all 14 *Code of Federal Regulations* Part 121, 135, and 91 subpart K operators to conduct arrival landing distance assessments before every landing based on existing performance data, actual conditions, and incorporating a minimum safety margin of 15 percent. (A-07-57) Urgent (Supercedes Safety Recommendation A-06-16 and classified "Open—Unacceptable Response.")
>
> Require all 14 *Code of Federal Regulations* Part 121 and 135 operators to ensure that all on board electronic computing devices they use automatically and clearly display critical performance calculation assumptions. (A-07-58)
>
> Require all 14 *Code of Federal Regulations* Part 121 and 135 operators to provide clear guidance and training to pilots and dispatchers regarding company policy on surface condition and braking action reports and the assumptions affecting landing distance/stopping margin calculations, to include use of airplane ground deceleration devices, wind conditions and limits, air distance, and safety margins. (A-07-59)
>
> Require all 14 *Code of Federal Regulations* Part 121 and 135 operators of thrust reverser-equipped airplanes to incorporate a procedure requiring the non-flying (monitoring) pilot to check and confirm the thrust reverser status immediately after touchdown on all landings. (A-07-60)
>
> Require all 14 *Code of Federal Regulations* Part 121, 135, and 91 subpart K operators to accomplish arrival landing distance assessments before every landing based on a standardized methodology involving approved performance data, actual arrival conditions, a means of correlating the airplane's braking ability with runway surface conditions using the most conservative interpretation available, and including a minimum safety margin of 15 percent. (A-07-61)
>
> Develop and issue formal guidance regarding standards and guidelines for the development, delivery, and interpretation of runway surface condition reports. (A-07-62)

> Establish a minimum standard for 14 *Code of Federal Regulations* Part 121 and 135 operators to use in correlating an airplane's braking ability to braking action reports and runway contaminant type and depth reports for runway surface conditions worse than bare and dry. (A-07-63)
>
> Demonstrate the technical and operational feasibility of outfitting transport-category airplanes with equipment and procedures required to routinely calculate, record, and convey the airplane braking ability required and/or available to slow or stop the airplane during the landing roll. If feasible, require operators of transport-category airplanes to incorporate use of such equipment and related procedures into their operations. (A-07-64)

4.2 Previously Issued Recommendation Resulting From This Accident Investigation and Classified in this Report

As a result of the SWA flight 1248 accident investigation, the Safety Board issued the following urgent safety recommendation to the FAA on January 27, 2006:

> Immediately prohibit all 14 *Code of Federal Regulations* Part 121 operators from using reverse thrust credit in landing performance calculations. (A-06-16)

This recommendation (previously classified "Open—Unacceptable Response" on May 8, 2007) is classified "Closed—Unacceptable Action/Superceded" by Safety Recommendation A-07-57 in section 2.3 of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

Mark V. Rosenker
Chairman

Robert L. Sumwalt
Vice Chairman

Deborah A. P. Hersman
Member

Kathryn O'Leary Higgins
Member

Steven R. Chealander
Member

Adopted: October 2, 2007

5. Appendixes

Appendix A

Investigation and Public Hearing

Investigation

The National Transportation Safety Board was notified about the accident on December 8, 2005, shortly after it occurred. A full go-team arrived at the accident scene early the next morning. The go-team was accompanied by representatives from the Safety Board's Office of Transportation Disaster Assistance and Public Affairs and by then Chairman-designee Ellen Engleman Conners.

The following investigative groups were formed during the course of this investigation: Structures, Systems, Powerplants, Air Traffic Control, Meteorology, Operations, Human Performance, Airport/Survival Factors, Airplane Performance, Flight Data Recorder, and Cockpit Voice Recorder.

Parties to the investigation were the Federal Aviation Administration (FAA); Boeing Commercial Airplane Company; Southwest Airlines, Inc. (SWA); Southwest Airlines Pilots Association (SWAPA); National Air Traffic Controllers Association (NATCA); the City of Chicago; CFM International; SWA Employee Association Dispatch; Transport Workers Union #556; and SWA AMFA. The Safety Board received submissions on this accident from SWA, SWAPA, Boeing, and the City of Chicago.

Public Hearing

A public hearing was held on June 21 and 22, 2006, in Washington, D.C. Then-Acting Chairman Mark V. Rosenker presided over the hearing.

The issues discussed at the public hearing were the accuracy and dissemination of runway friction measurements, the adequacy of runway safety areas on the ends of runways, and aircraft landing performance. Parties to the public hearing were the FAA, SWA, SWAPA, Boeing Commercial Airplane Company, and the City of Chicago.

Appendix B

Cockpit Voice Recorder

The following is a transcript of the Honeywell model 6022 cockpit voice recorder installed on Southwest Airlines flight 1248, a Boeing 737-74H, N471WN, which ran off the departure end of runway 31C after landing at Chicago Midway International Airport, Chicago, Illinois, on December 8, 2005.

LEGEND

CAM	Cockpit area microphone voice or sound source
CTR	Transmission from FAA Center controller
EXEC902	Transmission from Exec Jet 902
G3KF	Transmission from landing aircraft G3KF
HOT	Crewmember hot microphone voice or sound source
NAV	Signal from ground-based navigational aid
OPS	Transmission Company operations center at Midway airport
RDO	Radio transmission from N471WN
SW1952	Transmission from Southwest Airlines Flight 1952
TWR	Transmission from Midway tower
-1	Voice identified as the captain
-2	Voice identified as the first officer
-?	Voice unidentified
*	Unintelligible word
#	Expletive
$	Proper name
( )	Questionable insertion
...	Pause
--	Voice cut-off

Note 1: All times are Central Standard Time (CST).

Note 2: Words shown with excess vowels, letters, or drawn out syllables are a phonetic representation of the words as spoken.

Note 3: A non-pertinent word or phrase, where noted, refers to a word or phrase not directly related to the operation, control or condition of the aircraft.

Note 4: Only radio transmissions to and from the accident aircraft were transcribed.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
Start of Transcript			
17:12:58.2 [start of recording]			
17:13:15.9 CAM-2	I thought it said that read before fly said actually it was in the weather packet. (the) front page said don't do the new procedures until you post the change and then then have at it.		
17:13:26.5 CAM-1	oh really?		
17:13:28.2 CAM-2	there was a big long thing on it and it's not on there any more.		
17:13:32.8 CAM-2	have to read that that little blurb again.		
		17:15:37.2 CTR	Southwest twelve forty eight climb maintain flight level three three zero.
		17:15:41.0 RDO-2	flight level three three zero Southwest twelve forty.
17:15:43.5 CAM-1	well?		
		17:15:43.6 CTR	Southwest twelve forty eight contact Washington one one eight point zero two she'll have higher.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		17:15:48.2 RDO-2	eighteen oh two have a great night Southwest twelve forty eight.
		17:15:50.7 CTR	goodnight.
		17:15:54.3 RDO-2	center Southwest twelve forty eight leavin' thirty for flight level three three zero.
		17:15:57.6 CTR	Southwest twelve forty eight Washington center roger climb maintain flight level three niner zero.
17:16:04.1 HOT-1	three nine zero now.		
17:16:05.2 HOT-2	thirty nine.		
17:16:13.6 CAM-1	(see) anything exciting in there?		
17:16:16.2 CAM-2	if I knew how to read it would be a lot easier.		
17:16:17.9 CAM-1	ahuh.		
17:16:18.5 CAM-2	[sound similar to laughter].		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:16:21.6 CAM-2	you know we're gonna get rid of all the two, two hundred (stuff). that should make it (a) little bit skinnier.		
17:17:53.3 HOT-1	talkin' to a buddy a mine $. said yesterday the winds, most they got were the winds hundred and eighty eight knots dead on their nose.		
17:18:02.4 HOT-2	man.		
17:18:03.0 HOT-1	yea.		
17:18:03.7 HOT-2	the highest I ever saw and it made me wonder what the plane what the computer went up to we're over Atlanta like couple months ago and it was two seven zero at one ninety nine. we were goin' north to Baltimore but...		
17:18:15.1 HOT-1	yeah yeah.		
17:18:16.3 CAM-2	...(that) made me wonder if it didn't go any higher, sure it does but.		
17:18:27.2 HOT-2	its a lot a wind, that blows [sound similar to laughter].		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:18:29.7 HOT-1	yup.		
17:19:58.5 CAM-1	gonna do it huh?		
17:19:59.7 CAM-2	I don't want to but.		
17:20:03.2 HOT-1	kinda light drinkin' the spittoon.		
17:20:04.6 HOT-2	[sound similar to laughter].		
17:20:11.2 CAM	[sound similar to altitude alert warning tone].		
17:20:12.7 HOT-1	(thirty) eight one fer thirty nine.		
17:20:14.6 CAM-2	eight one thirty five.		
17:20:39.9 HOT-1	same all the way up.		
17:20:41.2 CAM-2	yea (looks), no penalty.		
17:20:43.0 CAM-1	unchanged two sixty five oh one fifty.		
17:20:48.8 HOT-1	for the last nine thousand feet.		
17:20:50.8 HOT-2	man, well.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:20:59.5 CAM-2	* * * *.		
17:21:01.6 CAM-1	yea.		
17:21:02.7 CAM-1	(think) we have a ninety eight on board wow.		
17:21:04.9 CAM-2	(that's good) we're supposed to only have fifty one right when we started?		
17:21:07.6 CAM-1	yea it kept on gettin' more and more.		
17:21:17.1 HOT-1	I'll put three nine zero in there I don't know if we're goin' up or not but.		
17:21:19.6 CAM-2	'kay.		
17:21:23.5 HOT-1	yeah.		
17:21:55.0 CAM-1	okay.		
17:22:01.6 CAM-2	okay now or you want me to wait till we get (up)?		
17:22:04.1 CAM-1	you can let 'em up.		
17:22:04.6 CAM-2	okay cool I'll be right back.		

INTRA-COCKPIT COMMUNICATION | **AIR-GROUND COMMUNICATION**

TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
	and folks good evenin' ah again from the guys up front thank you so much for your patience this evenin' ah with our troubles with mother nature we sure do appreciate your understanding * * * are at thirty nine thousand feet we're gonna make a slow climb to forty thousand feet here in just a couple minutes our friends at air traffic controller (tell) us its gonna be a pretty smooth flight this evenin' [sound similar to seatbelt warning tone] the seatbelt signs comin' off so folks if you wanna get up and stretch your legs or move about you sure can do so well please folks while you're in your seats always stay buckled up just in case we do find a few unexpected bumps along the way. ah folks as long as the flight attendants are busy trying to get their service out you sure can do them a big favor by trying to keep those aisles clear they really do appreciate it and so do we * * * no lines up by the forward lavatory and you can't stand up in the forward galley area ah these are FAA security regulations		
17:22:07.8 PA-2	and each of us want to thank you here in advance for complyin'. ahhh pretty strong headwinds right now folks are out of the West at about a hundred and fifty knots 'bout a hundred seventy five mile an hour right on the nose ah normal a normally our speed across the ground is close to about five hundred miles an hour right now it's only about three hundred and fifty or so so it's not gonna help us make up any time at all right now about four hundred and fifty miles to go. showin' us ah - touchin' down in Chicago at about and hour twenty minutes or so 'bout an hour twenty five minutes we should have you safely at the gate. folks as we get closer * we'll keep you posted get you up to date on the latest for the Chicago weather. for now folks again ah thanks so much for your patience and understanding this evening we really do appreciate it and finally folks one extra note ah we have three great flight attendants and I promise ya they didn't have a single thing to do with us gettin' off to the late start this evenin' so folks please be kind to them 'cause they're gonna take excellent care of you thanks so much folks again and good evenin'.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:23:51.7 CAM-1	wow whaddya say?		
17:23:53.8 CAM-2	yadda yadda yadda. yadda yadda yadda. good flight attendants yadda yadda. we like visitors yadda yadda.		
17:24:01.6 CAM-1	wow.		
17:24:03.7 CAM-2	I always give 'em the be good to our flight attendants 'cause it's not their fault we're late. they're they always say ohh that's so nice thank you.		
17:24:13.9 HOT-1	huh.		
17:24:14.2 HOT-2	it's all lies and garbage.		
17:24:15.5 HOT-1	yeap.		
17:24:17.0 HOT-2	windy windy windy.		
17:25:01.0 HOT-1	big three hundred and thirteen knots a groundspeed.		
17:25:04.2 HOT-2	man oh man.		
17:25:11.6 HOT-1	hope this stays with us for the last day.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:25:14.0 CAM-2	yea no kidding.		
17:25:14.9 CAM-1	although it doesn't matter.		
17:25:16.3 CAM-2	that's true.		
17:25:17.0 CAM-1	ain't no flights I can make.		
17:25:18.6 CAM-2	yea me neither.		
17:25:22.0 HOT-1	see.		
17:25:23.4 HOT-2	it's not even close for me.		
17:25:28.1 HOT-1	Albany?		
17:25:29.2 HOT-2	I think it's like eight, actually Saturday it's earlier it's seven somethin'.		
17:25:33.6 HOT-1	(no) it's five somethin' on Saturday.		
17:25:35.5 HOT-2	five.		
17:25:36.0 HOT-1	yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:25:36.6 HOT-2	man.		
17:25:37.3 HOT-1	(see) I better turn this off I guess (huh)?		
17:25:38.8 HOT-2	[sound similar to laughter].		
17:25:40.4 HOT-1	(ah) it is off how 'bout that it's smarter than I think.		
17:25:42.6 HOT-2	my battery's probably dead already.		
17:26:32.5 CAM-1	wow wow wow.		
17:26:35.2 CAM-2	big stuff right here.		
17:26:36.4 CAM-1	yeah.		
17:26:37.2 CAM-2	be sleep *.		
17:26:37.9 CAM-1	be the next leg for me.		
17:26:39.0 CAM-2	[sound similar to laughter].		
17:27:10.7 CAM-2	you know this is some heavy stuff. (think I'm) gonna be sorry I (got into this).		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:27:14.8 CAM-1	yup.		
		17:29:56.8 CTR	Southwest twelve forty eight contact Indianapolis center one two zero point two seven.
		17:30:01.4 RDO-2	twenty twenty seven have a great night Southwest twelve forty eight.
		17:30:04.0 CTR	'kay.
		17:30:21.4 RDO-2	and center Southwest twelve forty eight flight level three nine zero.
		17:30:24.6 CTR	Southwest twelve forty eight Indy center roger.
17:31:12.0 CAM	[sound similar to ACARS chime].		
17:31:22.6 HOT-1	landin' north Salt Lake ten miles fifteen thousand.		
17:31:28.3 HOT-2	alright nice from Vegas.		
17:31:32.5 HOT-2	alright here's the autobrakes. autobrakes if operational will be used when min two stopping margin is less than five hundred feet and the reported or anticipated runway condition is not dry.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:31:49.1 CAM-1	alright.		
17:31:50.8 CAM-2	use the lowest autobrake setting resulting in a stopping margin of five hundred feet or more.		
17:31:56.7 CAM-2	if stopping margin of at least five hundred feet cannot be achieved with autobrake setting landing is still authorized using MAX provided a positive stopping margin is computed.		
17:32:08.6 CAM-1	alright what does that mean? I cause I can't...		
17:32:12.4 CAM-2	I have no idea. [sound similar to laughter].		
17:32:14.1 CAM-1	I gotta read it.		
17:32:15.2 CAM-2	it (has it) in here I'll show you. (you) get a good idea now.		
17:32:20.1 HOT-1	yeah.		
17:32:22.0 CAM-2	I guess if you use MAX my buddy flew whales for Atlas and he said when you land at max it'll get your freakin' attention.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:32:30.3 HOT-2	I mean it's a mega-stop. it like throws ya for you know he said I when they used max he used to do the - he never did the crotchstrap till he did his first MAX.		
17:32:36.1 HOT-1	yeah.		
17:32:40.9 HOT-1	really?		
17:32:41.4 HOT-2	yeah.		
17:32:42.6 HOT-2	he said after that I use it every time.		
17:32:53.7 HOT-2	let's see.		
17:32:54.8 HOT-1	crossfeedin' the centers.		
17:32:55.9 HOT-2	alright.		
17:33:11.3 CAM	[sound similar to ACARS chime].		
17:33:13.3 CAM-1	Romeo. Romeo Romeo where art thou?		
17:33:17.7 HOT-2	half a mile snow freezing fog two hundred who hoo.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:33:22.3 CAM-2	you wanted to go first.		
17:33:24.1 HOT-1	half a mile we can't do it can we?		
17:33:26.6 HOT-2	three one center we can if they're using three one center.		
17:33:32.3 CAM-2	you need three thousand RVR.		
17:33:35.2 CAM-2	you prob - you probably won't get in but.		
17:33:35.3 CAM-1	* *.		
17:33:37.5 CAM-1	you got a different one? it says four thousand or three quarters unless you got a...		
17:33:40.5 CAM-2	you can do that ILS-Z.		
17:33:42.6 HOT-1	I haven't got that one.		
17:33:43.8 HOT-2	you don't?		
17:33:46.6 CAM-2	pretty sure it's a (V).		
17:33:47.7 CAM-1	okay. it's a HUD one?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:33:51.2 CAM-2	it's the same approach but.		
17:33:53.2 CAM-1	yeah get a little lower.		
17:33:55.4 CAM-1	no where it went.		
17:33:55.8 CAM-2	I I don't know if we'll see it.		
17:33:57.2 HOT-2	'cause there's no approach lights.		
17:34:00.6 CAM-2	(see).		
17:34:03.9 CAM-1	(two hundred broken).		
17:34:04.4 CAM-2	there's a lead in that's it three one center.		
		17:34:07.7 CTR	Southwest twelve forty eight cleared direct Fort Wayne.
		17:34:10.5 RDO-2	wow direct Fort Wayne thanks Southwest twelve forty eight.
		17:34:12.9 CTR	you're welcome.
17:34:13.3 CAM-1	direct Fort Wayne.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:34:15.4 CAM-2	you had the the Zee.		
17:34:17.8 CAM-1	well let me take a peak then how's that look direct Fort Wayne.		
17:34:20.5 CAM-2	good to me.		
17:34:22.6 CAM-2	here we go three thousand or five (E).		
17:34:27.5 CAM-1	yeah.		
17:34:31.5 HOT-2	(well) there's.		
17:34:32.9 HOT-1	okay.		
17:34:33.8 HOT-2	probably a two -- what's the --		
17:34:39.0 HOT-2	the so what's to altitude on it though a * two hundred.		
17:34:41.7 HOT-1	eight seventeen.		
17:34:42.7 HOT-2	two hundred and fifty.		
17:34:43.6 HOT-1	two hundred and four.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:34:44.5 HOT-2	oh two oh four so we'll probably see it.		
17:34:47.2 HOT-1	neh heh.		
17:34:50.1 CAM-2	temperature.		
17:34:52.3 CAM-1	but five eighths is not a half a mile.		
17:34:54.9 CAM-2	no I know (the).		
17:34:55.8 CAM-1	gotta have three thousand.		
17:34:57.1 HOT-2	he sent me a a dispatch message.		
17:35:00.3 HOT-1	okay.		
17:35:00.8 HOT-2	and he said fair and three thousand RVR.		
17:35:03.4 HOT-1	alright it's three thousand RVR we can do it.		
17:35:09.5 CAM-2	I can type him a little message and see what he's got now.		
17:35:11.3 CAM-1	nah 'at's all right.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:35:14.9 CAM-2	* * *.		
17:35:18.9 CAM-2	so I'll do I'll do wet fair just for # and giggles.		
17:35:29.5 CAM-?	I'm with you.		
17:35:34.9 HOT-2	four point five.		
17:35:58.6 HOT-2	so the - the way I get it since this is the one that has five hundred.		
17:36:03.9 HOT-1	yeah.		
17:36:07.2 HOT-2	and you can't use one.		
17:36:10.0 HOT-2	two is - min so you'd have to use ah three.		
17:36:13.1 HOT-1	three.		
17:36:14.7 HOT-2	that's the way I get it but.		
17:36:15.9 HOT-1	okay.		
17:36:19.1 HOT-2	if its ah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:36:20.2 HOT-1	Hmmm.		
17:36:21.0 HOT-2	use those.		
17:36:21.2 HOT-1	I would I would agree with that.		
17:36:22.4 HOT-2	yeah yeah I think that's what I get.		
17:36:24.2 HOT-2	you can't use one so it starts at two.		
17:36:26.5 HOT-2	like two three from MAX.		
17:36:28.3 HOT-1	you got wet fair.		
17:36:29.8 HOT-2	and then ah ice on.		
17:36:32.0 HOT-1	okay.		
17:36:34.0 HOT-1	'kay.		
17:36:34.6 HOT-2	no clutter we'll see.		
17:36:36.4 HOT-1	didn't say any clutter add some clutter if they got any.		
17:36:37.7 HOT-2	yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:36:38.7 HOT-2	yeah.		
17:36:39.5 HOT-1	add some clutter see what it says.		
17:36:40.8 HOT-2	okay ah.		
17:36:44.1 HOT-1	please.		
17:36:44.7 HOT-2	sure.		
17:36:47.6 HOT-2	well lemee see.		
17:36:49.7 HOT-2	do ya just do clutter fer ahhh.		
17:36:53.9 HOT-1	(ten).		
17:36:54.3 HOT-2	maybe you just do clutter for takeoff I think you just do...		
17:36:56.2 HOT-1	yeah.		
17:36:56.5 HOT-2	...clutter.		
17:36:57.4 HOT-2	but if it was wet poor we'll do wet poor and see.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:36:59.8 HOT-1	yeah we can.		
17:37:05.3 HOT-1	hmm ha.		
17:37:07.4 HOT-2	wow. wooo. if it's poor it's scary.		
17:37:12.0 HOT-1	I ain't doin' it.		
17:37:12.8 HOT-2	max is thirty that's really scary.		
17:37:15.2 HOT-1	yeah.		
17:37:16.5 HOT-1	naw that's no good.		
17:37:21.1 CAM-2	six knot tailwind.		
17:37:23.4 HOT-1	did ya put in ah go back to wet fair did ya put in a.		
17:37:29.0 HOT-2	HGS?		
17:37:29.9 HOT-1	yeah.		
17:37:30.8 HOT-2	well do we?		
17:37:32.9 HOT-1	says it's a requirement.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:37:34.1 HOT-2	it is?		
17:37:36.7 HOT-2	I did less than four thousand.		
17:37:39.7 HOT-2	*.		
17:37:39.7 HOT-1	ah you did less than four okay. ah that's good enough.		
17:37:41.7 CAM-2	when when you put in the HGS I've never seen that before.		
17:37:45.6 CAM-1	runway limited.		
17:37:47.2 CAM-2	maybe it maybe it 'cause I don't think we're...		
17:37:50.4 HOT-1	yeah just do wet poor ah ah poor and then ah below four yeah not HGS though.		
17:37:56.4 HOT-1	you just have to be HGS cert- certified.		
17:37:57.3 HOT-2	...maybe 'cause they don't have... we'll do it we'll see as we get the next one but. (oh).		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:38:02.2 HOT-1	alright it's gotta have the lead in gotta have the REIL gotta have the VASI gotta have the HIRL and RVR for three one center must be operating. and DME is required.		
17:38:11.2 HOT-2	let's see if they got a the fi- there's a field condition one in here.		
17:38:14.9 HOT-1	yeah.		
17:38:16.7 HOT-2	it didn't have the RVR in there before but.		
17:38:21.7 HOT-2	field METAR.		
17:38:26.4 HOT-2	that's really the only reason I wanna look.		
17:38:29.3 CAM-2	hate to have somethin' happen when ya got the.		
17:38:38.1 HOT-2	then the only other stuffs that really is gonna (bra-).		
17:38:40.7 HOT	okay? [sound similar to ACARS chime]		
17:38:41.1 HOT-2	yeah.		
17:38:43.8 HOT-1	there's field conditions and the METAR too.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:38:47.0 HOT-2	field condition.		
17:38:49.1 HOT-1	wet poor.		
17:38:50.0 HOT-2	wow.		
17:38:51.0 HOT-1	can't do it.		
17:38:52.3 HOT-2	I (I oh).		
17:38:53.1 HOT-1	wait a minute that was ah.		
17:38:55.9 HOT-2	it says ya can but I don't wanna. [sound similar to laughter]		
17:38:58.2 HOT-1	what's ah thirty one center though? wet snow no clutter wet poor.		
17:39:04.3 HOT-2	so that I mean it the books says you can as long it's positive but man that's whoo.		
17:39:09.6 HOT-1	yeah.		
17:39:15.6 HOT-2	I mean it's (what is it) thirty feet at max braking whao #.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:39:20.1 HOT-1	I know.		
17:39:20.2 HOT-2	know you're good but.		
17:39:25.3 HOT-2	I mean that's really tight.		
17:39:29.3 HOT-1	nope		
17:39:30.8 HOT-2	and then you know what's funny like if if you know we got we got that thirty feet of stopping MAX.		
17:39:36.1 HOT-1	ah ha.		
17:39:36.5 CAM-2	no procedure if that sucker fails when you touch down? we just go through the fence? we never talk about any of that stuff ya know?		
17:39:45.1 HOT-2	er if it fails on * on landing?		
17:39:47.3 HOT-1	yeah.		
17:39:47.7 HOT-2	you do I tell you to go around? what you know what what if it doesn't there's no guidance on it.		
17:39:53.7 HOT-1	yeah I don't know stand on the brakes?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:39:55.9 HOT-2	maybe there is once we get in here there might be something further down the road that.		
17:40:01.3 HOT-2	that tells us what to do but.		
17:40:24.1 HOT-1	what's the date on this thing?		
17:40:29.7 HOT-2	it's August ah.		
17:40:34.9 HOT-1	what's it say ah hey where's the date?		
17:40:36.3 HOT-1	November ninth oh five.		
17:40:38.8 HOT-1	what is it?		
17:40:39.5 CAM-2	November ninth.		
17:40:41.9 CAM-1	on these revisions?		
17:40:43.4 CAM-2	yeah.		
17:40:43.7 CAM-1	oh yea there it is down there.		
17:40:45.4 HOT-1	#.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:40:48.6 CAM-1	we haven't had it that long.		
17:40:49.9 CAM-2	no.		
17:41:06.9 HOT-1	where's that sucker * *.		
17:41:11.5 HOT-2	I'm hoping that in the like the normal.		
17:41:14.5 CAM-2	or in the approach it might have some guidance on it.		
17:41:21.9 HOT-1	zero eight zero at ten. huh.		
17:41:26.8 HOT-2	yeah it's a eight knot tailwind.		
17:41:28.3 HOT-1	#.		
17:41:33.4 HOT-1	let's go ah.		
17:41:38.1 HOT-1	one three zero at ten.		
17:41:38.3 HOT-2	I put in fair.		
17:41:43.4 HOT-1	wet fair landing *.		
17:41:53.0 HOT-1	close to ten knots can't do it.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:41:55.2 HOT-2	ahmm did you check in HGS?		
17:42:00.4 HOT-1	no.		
17:42:01.3 HOT-2	did I not take it out?		
17:42:02.9 HOT-1	RVR four thousand.		
17:42:06.3 HOT-1	with one three zero at ah ten.		
17:42:08.4 HOT-2	oh yeah.		
17:42:08.8 HOT-2	yeah with a ten knot tailwind you can't do it.		
17:42:10.6 HOT-1	yeah.		
17:42:11.5 HOT-2	well (do I) eh ah that's a less than four thousand thing.		
17:42:15.1 HOT-2	it's like a five with anything less than with wet poor I think it's a five knot tailwind.		
17:42:15.1 HOT-1	okay.		
17:42:20.0 HOT-2	if it's poor you can only have a five - oh.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:42:22.0 HOT-1	that would make sense.		
17:42:22.7 HOT-2	yeah. I think.		
17:42:23.1 HOT-1	(they).		
17:42:24.6 HOT-2	I think it is.		
17:42:24.7 HOT-1	how 'bout one three zero at nine?		
17:42:28.4 HOT-2	peak gust tailwind brakin' poor five knots.		
17:42:33.9 HOT-1	can't do it there either.		
17:42:37.2 HOT-1	so what is our?		
17:42:39.9 HOT-1	you had a zero eight zero at ah.		
17:42:43.8 HOT-2	eh I can throw it back up quick.		
17:42:48.8 HOT-2	the I think it was. ahhh. oh.		
17:42:56.1 HOT-1	Romeo wasn't it?		
17:42:57.1 HOT-2	(L M) P Q R I think it was Romeo.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:43:00.4 HOT-2	zero eight zero at ten, must be right on the limit.		
17:43:17.4 HOT-1	that gives us six knots a tailwind.		
17:43:20.5 CAM-2	and it still says it's legal?		
		17:43:20.6 CTR	Southwest twelve forty eight contact Indy center one tree tree point seven seven.
		17:43:25.8 RDO-2	thirty three seventy seven have a great night Southwest twelve forty eight.
		17:43:28.7 CTR	see ya.
17:43:29.6 HOT-2	*.		
17:43:34.2 CAM-1	(but) like you say.		
17:43:36.6 CAM-2	that thing says five knot tailwind.		
17:43:38.2 CAM-1	yeah. so really.		
		17:43:39.6 RDO-2	howdy center Southwest twelve forty at flight level three nine zero.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:43:42.3 HOT-2	well that's kinda scary that that doesn't save your # you know?		
		17:43:46.7 CTR	who's that checkin' in?
17:43:47.8 HOT-1	peak gust.		
		17:43:48.4 RDO-2	Southwest twelve forty eight at flight level three nine zero good evening.
		17:43:51.1 CTR	Southwest twelve forty eight ** rog.
17:43:57.2 HOT-1	that's braking poor.		
17:43:59.7 CAM-1	braking fair is ten knots.		
17:44:01.9 CAM-2	yeah but the field conditions was poor.		
17:44:04.4 CAM-1	yeah.		
17:44:04.8 HOT-2	which means we couldn't do it anyway.		
17:44:06.3 HOT-1	right.		
17:44:06.5 HOT-2	well * we could but -		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:44:08.2 CAM-2	I'm my butt's gonna be squeezed so tight * you never seen a butt squeezed tighter.		
17:44:11.4 HOT-1	no.		
17:44:12.1 HOT-2	[sound similar to laughter].		
17:44:14.0 HOT-1	we got too much tailwind we can't do it.		
17:44:15.6 HOT-2	yea with six.		
17:44:16.2 HOT-1	that's our savior.		
17:44:17.4 HOT-2	yup.		
17:44:17.6 HOT-1	[sound similar to laughter].		
17:44:18.1 HOT-2	get another one in a few.		
17:44:19.7 HOT-1	ah huh.		
17:44:21.0 HOT-2	let's see.		
17:44:34.9 HOT-1	well you want your own copy?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:44:36.8 HOT-2	yeah that'd be great.		
17:44:45.5 HOT-2	ah I don't feel like doin' the rest of this.		
17:44:47.9 HOT-2	we got the meat 'n potatoes.		
17:44:50.3 HOT-2	let's see.		
17:45:13.7 HOT-2	oh there is some more stuff in here. three nine one (that's).		
17:45:20.4 CAM-2	kinda gives ya the --		
17:45:21.7 CAM-1	[sound similar to violent sneeze]. * *.		
17:45:22.7 CAM-2	bless ya.		
17:45:40.6 HOT-1	alright let me look in there.		
17:46:00.4 HOT-1	alright. I said I sent ah. okay what is it? (Maryland's) I'm Midway status for zero zero five zero ETA.		
17:46:07.5 HOT-2	cool.		
17:46:09.0 HOT-1	sent.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:46:42.1 HOT-2	ah it says you can put clutter in but if there is clutter you can only have a twenty knot crosswind limit. which that won't be a big deal.		
17:46:51.5 HOT-1	'kay.		
17:46:58.7 HOT-2	I got a PC next month ha ha this is good ha ha.		
17:47:00.9 HOT-1	yah hah.		
17:47:02.5 CAM-1	I gotta PT.		
17:47:05.8 CAM-2	select autobrakes as required here's the operational part of it.		
17:47:11.7 HOT-1	'kay.		
17:47:14.8 HOT-2	if it's operational it must be used. use the lowest...		
17:47:19.1 CAM	[sound similar to ACARS chime].		
17:47:20.0 HOT-2	...brake level that gets you five hundred feet.		
17:47:24.6 CAM-2	if neither setting results in a stopping margin of five hundred feet or more *		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:47:29.3 HOT-1	huh oh.		
17:47:30.8 CAM-1	not good back to you in a minute.		
17:47:32.2 CAM-2	[sound similar to laughter].		
17:47:32.5 CAM-1	[sound similar to laughter].		
17:47:39.4 HOT-2	wow it says if neither setting results in a stopping margin of five hundred feet or more landing is still authorized using MAX provided a positive (starch) stopping margin is computed.		
17:48:02.4 HOT-1	what are we hurryin' to get there for then? [sound similar to laughter].		
17:48:04.9 HOT-2	yeah really.		
17:48:08.7 HOT-2	uh well that I see that's in here really.		
17:48:28.2 CAM-1	I'm gettin' ri- rid of all these (received messages).		
17:48:30.9 HOT-2	that's cool delete delete delete.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:48:51.4 CAM-1	well let's see here our alternate happens to be Kansas City or St. Louis.		
17:48:57.0 CAM-2	think ah Kansas City was a little better weather.		
17:49:02.3 CAM-1	let's look. **		
17:49:04.0 HOT-2	think a St. Louis was snowin' a little bit (I mean) either way.		
17:49:13.3 HOT-1	let's look a St. Louie first that's the closest.		
17:49:18.8 HOT-2	oh I can show you somethin' cool in here too you probably seen it before.		
17:49:28.1 CAM	[sound similar to ACARS chime].		
17:49:30.2 HOT-1	alright there's St Louis. alright five miles light snow mist twenty three hundred broken forty five hundred broken. twenty five thousand broken. 'kay.		
17:49:55.7 HOT-2	okay if we touch down and we get this -- where's the auto --		
17:50:02.3 HOT-1	hang on hang on a second lets ah let's sit the passengers down a little bit here.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:50:07.1 HOT-2	okay.		
17:50:07.9 HOT-1	since we're gettin' in that area.		
17:50:10.6 PA-2	and folks from the guys up front a few bumps [sound of single chime] seatbelts signs comin' back on so please folks if you're up (and about) head on back to your seats and buckle up thanks so much.		
17:50:15.9 HOT-1	**.		
17:50:20.2 HOT-1	okay.		
17:50:24.8 CAM	[sound similar to ACARS chime].		
17:50:26.5 HOT-1	I'm gonna sit the flight attendants down too.		
17:50:27.9 HOT-2	okay.		
17:50:28.7 PA-1	ah flight attendants go ahead and take your seats for a few minutes as well. folks I've asked the flight attendants to take their seats so ah make sure that you're in your seats as well seatbelts fastened thank you.		
17:50:39.4 CAM-2	(yeah).		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:50:40.8 HOT-1	Kansas City is - clear I like that. cold but clear.		
17:50:44.6 HOT-2	clear. woo hoo.		
17:50:47.9 HOT-2	that's alright aw I wanted to do this thirty eleven fer Midway.		
17:50:51.3 HOT-1	alright.		
17:51:07.4 HOT-2	this one.		
17:51:08.9 HOT-1	okay get that on?		
17:51:09.9 HOT-2	if that pops on it says you can achieve the OPC stopping distance by applying brakes as it would do so if it comes on you just jam 'em baby and.		
17:51:21.3 HOT-1	hmm kay.		
17:51:22.2 HOT-2	hold on.		
17:51:26.4 HOT-1	sounds good I can do that except where it says a -		
17:51:27.6 HOT-2	et cetera da da tada.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:51:32.3 CAM-1	maximum thirty feet.		
17:51:34.0 CAM-2	yeah that's.		
17:51:34.8 CAM-1	that's outside my limits.		
17:51:36.2 CAM-2	yeah.		
17:51:38.1 HOT-1	that plus the tailwind.		
17:51:41.4 HOT-1	wet poor tailwind.		
17:51:46.6 HOT-2	eh and it says like if you want it to disarm - wow that was a nice shooting star.		
17:51:50.4 HOT-1	what was it?		
17:51:50.9 HOT-2	once you land.		
17:51:51.8 HOT-1	yeah.		
17:51:52.2 HOT-2	if you want it to disarm ah if you start pushing on the brakes and it's not letting go it says you might have to go a little further to get it to to pop off.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:52:01.4 HOT-1	okay.		
17:52:01.9 HOT-2	that's about the only thing that I see in here that's different.		
17:52:20.0 CAM-2	it's in my flow now so if we use it hit me or remind me to turn that stupid thing off after we land.		
17:52:37.1 HOT-1	okay I'm turnin' this off.		
17:52:39.0 HOT-2	alright.		
17:53:01.6 CAM-1	oh boy ah uh oh oh huh.		
17:53:12.9 CAM-1	let's see here checking the just for the # of it here.		
17:53:18.8 HOT-2	hey know we can do?		
17:53:21.5 CAM-1	last I heard that was even worse.		
17:53:24.1 HOT-2	yeah I heard 'em sayin' ah. ah they asked if there was a ground...		
17:53:29.0 CAM-2	...groundhold but it wasn't a groundhold.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:53:30.8 HOT-1	just delayed.		
17:53:31.0 HOT-2	they had a little bit of a delay though.		
17:53:33.0 CAM	[sound similar to ACARS chime].		
17:53:37.9 CAM-1	quarter mile snow freezing fog.		
17:53:40.2 CAM-2	wo hoo.		
17:53:40.7 CAM-1	* *.		
17:53:47.8 HOT-1	ILS five right approach in use.		
17:53:52.1 HOT-2	I got mine out if you don't wanna dig.		
17:53:53.7 HOT-1	Indy?		
17:53:55.6 CAM-1	ah take a look and see what they got there they got a HGS I think.		
17:53:58.9 CAM-2	yeah I think so.		
17:54:00.3 HOT-2	five five *.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:54:02.5 CAM-1	five right.		
17:54:03.7 CAM-2	*.		
17:54:10.8 HOT-2	ah brakin' action advisories I'll pull in the field conditions for them too and see what the the brakin' action is.		
17:54:19.3 HOT-1	'kay.		
17:54:22.5 HOT-2	five right CAT two and CAT three eight forty one fifty foot seven hundred RVR.		
17:54:30.4 HOT-1	okay yeah.		
17:54:31.8 HOT-2	we'll see what this is.		
17:54:35.1 HOT-2	ahhh.		
17:54:35.7 HOT-1	one forty at ten there too.		
17:54:37.5 HOT-2	yeah let's do this (field)		
17:54:42.2 HOT-1	crosswind.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:54:43.1 HOT-2	here's some completely useless knowledge for ya. this is great when you have two alternates.		
17:54:50.9 HOT-1	one right.		
17:54:55.1 HOT	[sound similar to ACARS chime].		
17:54:58.0 HOT-2	I didn't mean to have it on my side (but). this thing kicks # [sound similar to laughter] it'll give ya ETA and fuel from your present position.		
17:55:07.7 HOT-1	alright. how about that how'd ya do that?		
17:55:11.7 HOT-2	$ showed me that a long time ago he's a great guy outta Chicago.		
17:55:14.1 HOT-1	huh.		
17:55:15.7 HOT-1	huh.		
17:55:16.2 HOT-2	I said how the # did you learn that he said I don't know somebody else showed me.		
17:55:18.7 HOT-1	ahah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:55:22.1 HOT-1	Indy field.		
17:55:24.5 HOT-1	wet good.		
17:55:25.0 HOT-2	wet good see that's not a bad alter-		
17:55:27.4 CAM-1	no.		
17:55:27.8 CAM-2	what was the ceiling?		
17:55:29.4 HOT-2	do you remember?		
17:55:29.9 HOT-1	four hundred.		
17:55:30.7 HOT-2	now see that's not bad.		
17:55:37.4 HOT-1	and that'll keep changin huh?		
17:55:40.2 HOT-2	yeah.		
17:55:40.5 HOT-2	I.		
17:55:41.5 CAM-2	oh let's see thought it did.		
17:55:49.0 CAM-2	is it clicking down?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:55:50.1 HOT-1	(I don't).		
17:55:50.6 HOT-2	yeah it is clicking down.		
17:55:50.6 HOT-1	no.		
17:55:52.2 CAM-2	St. Louis just *.		
17:55:58.5 HOT-1	sixty seven five fifty seven.		
17:56:00.7 CAM-2	takin' an awful long time.		
17:56:03.9 CAM-2	(see if we) go out (then go) back.		
17:56:09.0 HOT-1	sixty six.		
17:56:12.8 HOT-2	guess maybe ya go back and forth.		
17:56:14.5 CAM-2	but if you go between 'em		
17:56:16.4 CAM-1	the (S) changed a minute earlier.		
17:56:18.3 HOT-2	it also gives you ah like the closest airports.		
17:56:21.7 HOT-1	'kay.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:56:22.6 HOT-2	it's kinda cool.		
17:56:23.1 HOT-1	closest one is Columbus.		
17:56:25.6 CAM-1	how did ya get to that point.		
17:56:27.5 CAM-2	this.		
17:56:28.2 CAM-1	say I'm right here.		
17:56:29.4 CAM-2	yeah.		
17:56:30.1 HOT-1	you have to do it on (both)?		
17:56:30.1 HOT-2	ya have to.		
17:56:31.2 CAM-2	yeah.		
17:56:32.3 HOT-2	* I guess you can pay fer the software but we didn't pay for it so you gotta do like jump through a bunch of hoops.		
17:56:37.6 HOT-2	hit that INIT reference page.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		17:56:38.4 CTR	Southwest twel- twelve forty eight descend maintain flight level three eight zero.
17:56:42.7 PA-2	flight level three eight zero Southwest.		
		17:56:45.4 RDO-2	flight level three eight zero Southwest twelve forty eight.
17:56:47.3 HOT-2	hate when I do that.		
17:56:47.3 HOT-1	(three) eight zero.		
17:56:48.7 CAM-2	people in the back know we're goin' to three eight zero.		
17:56:50.2 HOT-1	ha ha.		
17:56:51.9 HOT-2	if ya hit ya hit this button.		
17:56:56.1 CAM-2	ya get to the index wa --		
17:56:58.5 HOT	[sound similar to single chime].		
17:56:59.7 HOT-1	I'm sorry say eh which one?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:57:01.0 HOT-2	hit the INIT REF.		
17:57:01.6 HOT-1	initial reference at same time		
17:57:03.3 CAM-2	* you don't have to a -- [sound similar to single chime] the only thing you have to do at the same time is.		
17:57:06.6 CAM-1	delete 'em.		
17:57:07.4 CAM-2	so you can just go. go to the main index page. and go to the offset mode.		
17:57:13.4 CAM-1	alright.		
17:57:14.0 CAM-2	and then you can you can have this guy do it er have me do it or you can do it. and then go to offset.		
17:57:17.6 CAM-1	go to offset alright and then what?		
17:57:19.3 HOT-2	either side you just put in any offset. (just) one right er one left er.		
17:57:21.3 HOT-1	okay.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:57:23.2 HOT-1	'kay.		
17:57:24.6 HOT-2	and eh ya only have to do it in one.		
17:57:26.3 HOT-2	the only thing you have to do at the same time is you have to hit erase right at the same time.		
17:57:30.1 HOT-1	alright.		
17:57:30.8 HOT-2	eh I think if you do yours a little bit quicker it'll put 'em on yer side if you do mine like a split second quicker. I'll try to do it on-.		
17:57:36.0 HOT-1	alright.		
17:57:39.5 CAM-2	see now I'll put it on your side. now you can kinda play back and forth.		
17:57:43.1 CAM-1	alright.		
17:57:43.9 CAM-2	there'll be a test later. [sound similar to chuckle].		
17:57:49.9 HOT-1	zero zero two one huh? to Columbus.		
17:57:54.5 HOT-1	it's close.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:57:56.3 HOT-2	yeah.		
17:57:58.5 CAM-2	we should be able to get the new weather now.		
17:58:00.3 CAM-1	just passed over.		
17:58:01.3 CAM-2	the bummer is like.		
17:58:02.8 HOT-2	if you click out of that 'cause you wanna see a progress page you gotta do the whole thing again to get back to it.		
17:58:08.0 HOT-1	yeah.		
17:58:26.1 CAM	[sound similar to ACARS chime].		
17:58:27.8 HOT-1	Sierra.		
17:58:30.7 HOT-2	quarter mile. can't do that.		
17:58:32.5 HOT-1	can't do it.		
17:58:35.6 HOT-2	see. oh.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
17:58:40.6 HOT-1	well if they call that quarter mile and three thousand we can do it.		
17:58:44.5 HOT-2	four left two two right three one only runway open's three one center.		
17:58:47.6 HOT-1	yeah.		
17:59:09.1 CAM	[sound similar to ACARS chime].		
17:59:10.5 HOT-2	see what that has to say.		
17:59:14.5 HOT-2	wet poor wet poor no clutter wet poor.		
17:59:17.4 HOT-1	yeah but its what they tell us.		
17:59:19.0 HOT-2	yeah.		
17:59:21.5 HOT-1	verbally that counts.		
17:59:22.8 HOT-2	yup.		
17:59:27.0 CAM-2	well the weather outside. [in a sing song voice].		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		17:59:28.1 CTR	Southwest twelve forty eight contact Indy center one two eight point seven seven.
		17:59:32.0 RDO-2	two eight seven seven you have a great night Southwest twelve forty eight.
		17:59:35.1 CTR	you too.
		17:59:37.8 RDO-2	howdy center Southwest twelve forty eight at flight level three eight zero.
		17:59:40.6 CTR	Southwest twenty forty eight Indy center roger.
17:59:45.4 HOT-1	[unintelligible vocalizations].		
17:59:49.3 HOT-2	* * *.		
18:00:23.3 HOT-2	the weather outside is frightful [in a sing song voice].		
18:00:27.2 HOT-1	the weather outside is rosey.		
18:00:29.4 HOT-2	[sound similar laughter].		
18:00:30.8 HOT-1	[sound similar to humming].		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:00:31.2 HOT-2	and I -- ten thousand at AWSUM.		
18:00:40.0 HOT-2	oh'right.		
18:00:50.1 CAM	[sound similar to ACARS chime].		
18:00:51.4 CAM-2	uh oh there he is it's your friend dispatch.		
18:01:02.2 CAM-1	well alright aloha. [sound similar to laughter] alright.		
18:01:05.8 CAM-2	I'll ask him how's the RVR.		
18:01:53.3 HOT-1	$.		
18:01:54.9 HOT-2	[sound similar to laughter].		
18:01:57.5 CAM-1	* and $. [in a sing song voice]		
18:02:09.2 CAM-2	the weather outside is. [in a sing song voice]		
18:02:12.7 CAM	[sound similar to ACARS chime].		
18:02:14.2 CAM-2	oh oh oh oh oh oh. [in a sing song voice]		
18:02:23.9 HOT-2	right now it's at fifty five hundred.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:02:27.1 CAM-2	whoo.		
18:02:28.5 CAM-1	alright that's good.		
18:02:30.2 CAM-2	that's is das'n zere gud.		
18:03:17.3 CAM-1	da da da da da. [in a sing song voice].		
18:03:22.3 HOT-2	you working Christmas $?		
18:03:23.9 HOT-1	say again?		
18:03:24.5 HOT-2	you working Christmas?		
18:03:25.5 HOT-1	I am working Christmas.		
18:03:26.8 HOT-1	be where ya gotta be.		
18:03:28.5 CAM-1	I picked it up for a guy so he could be home with his three year old and ah six year old.		
18:03:33.3 CAM-2	aren't you a nice guy.		
18:03:35.9 CAM-2	where ya gonna be.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:03:37.5 CAM-1	ah I just do a turn.		
18:03:39.0 CAM-2	oh cool.		
18:03:39.9 CAM-1	back through Baltimore unfortunately.		
18:03:42.4 CAM-1	there's nothin' there.		
18:03:43.4 CAM-2	yeah.		
18:03:45.9 CAM-2	you're a good man.		
18:03:50.8 HOT-1	hmmm.		
18:04:13.8 HOT-2	do you wanna let the girls up again.		
18:04:15.4 HOT-1	oh yeah.		
18:04:18.0 HOT-1	yeah go ahead.		
18:04:18.6 HOT-2	I'll be right back.		
18:04:20.7 HOT-2	let everybody up?		
18:04:21.8 HOT-1	sure.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:04:23.2 HOT	[sound similar to double chime].		
18:04:28.3 INT	[non-pertinent conversation between pilots and flight attendants not transcribed].		
18:05:00.7 PA-2	hey folks and from the guys up front you have a few minutes if you need to get up again ah you sure can do so * * * * * into Chicago in ah about another thirteen minutes and that's when I'll turn the seatbelt sign back on thanks so much folks a total distance two hundred twelve miles looks good to be in the gate ah touchin' down at fifty after in the gate about fifty five past. thanks so much folks.		
18:05:26.3 CAM-2	alright.		
18:05:28.3 CAM-1	yeah.		
18:05:37.5 CAM-2	one hundred at (nine). * *.		
18:05:45.9 CAM-2	* *.		
18:05:48.3 CAM-2	vertical visibility a hundred feet. woo hoo.		
18:05:52.1 CAM-1	huh.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:05:53.6 CAM-2	*. go around thrust TOGA. [sound similar to laughter]		
18:05:57.6 CAM-1	yeah.		
18:05:59.6 CAM-2	ah they got four right open.		
18:06:05.7 CAM-2	I'll put in ah well he said it was good I'll put in fair just for # and giggles.		
18:06:10.5 HOT-1	okay.		
18:06:11.6 HOT-1	yeah.		
18:06:13.4 CAM-1	still snowin' isn't it?		
18:06:14.5 CAM-2	yeah freezin' fog.		
18:06:16.8 HOT-2	which means type four on the way out.		
18:06:20.2 HOT-1	yup.		
18:06:23.1 HOT-2	gonna be an expensive night tonight.		
18:06:24.8 HOT-1	yeah that is.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:07:35.6 HOT-1	you I don't know if I'm comfortable usin' the autobrakes * in --		
18:07:39.2 HOT-2	yeah.		
18:07:39.5 HOT-1	in ah in this ah situation.		
18:07:43.4 HOT-2	first time.		
18:07:44.3 CAM-1	you know havin' not even seen 'em operate before and then all of a sudden go in with a.		
18:07:47.9 CAM-2	yeah.		
18:07:50.7 CAM-2	it's MAX now.		
18:07:51.3 CAM-1	number three.		
18:07:52.8 CAM-2	yeah you gotta use MAX now.		
18:07:55.6 CAM-2	to get five sixty it's a eight knot tailwind.		
18:08:00.9 CAM-1	#.		
18:08:02.9 CAM-2	we gotta check if it's fair.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:08:06.2 CAM-1	yeah.		
		18:08:07.1 CTR	ah Southwest twelve forty eight descend and maintain flight level three six zero.
		18:08:10.7 RDO-2	flight level three six zero Southwest twelve forty eight you have any complaints about the rides in the descent?
		18:08:14.9 CTR	I think what's - in this area anyway its ah twenty and below are the only bad rides.
		18:08:21.1 RDO-2	okay thanks alot.
18:08:23.4 CAM-2	alright.		
18:08:24.5 CAM-1	three six zero down.		
18:08:31.2 CAM-2	this is wet fair.		
18:08:35.1 CAM-1	wet good we don't need it right?		
18:08:43.1 CAM-2	there's ten.		
18:08:46.2 CAM-2	can't do poor.		

INTRA-COCKPIT COMMUNICATION TIME (CST) SOURCE	CONTENT	AIR-GROUND COMMUNICATION TIME (CST) SOURCE	CONTENT
18:08:49.3 CAM	[sound similar to metallic clank].		
18:09:03.7 CAM-2	(let me make) sure nothing's broke.		
		18:09:05.7 CTR	*** if able cross three five ah thirty miles south of Fort Wayne at maintain flight level three zero zero.
18:09:13.1 CAM-2	* (percent) *.		
		18:09:13.2 RDO-2	thirty this side of (Fort Wayne).
18:09:17.1 CAM-1	(stay) this side at three zero zero.		
18:09:18.9 CAM-2	should be able to do that.		
18:09:20.4 CAM-1	so let me put ah I've already got twenty so another ten huh?		
18:09:24.5 CAM-2	thirty this side of Fort Wayne not *.		
18:09:26.2 CAM-1	oh Fort Wayne.		
18:09:27.2 CAM-2	yeah.		
18:09:27.4 CAM-1	oh yeah that's thirty nine miles.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:09:29.4 CAM-1	there ya go.		
18:09:30.5 CAM-2	'at's.		
18:09:33.9 CAM-1	three zero zero.		
18:09:35.0 CAM-2	(got it).		
18:09:39.1 HOT-1	(it's) *.		
18:09:40.6 CAM-2	(operative).		
18:09:50.9 HOT-2	why does it do that?		
18:09:52.6 HOT-1	hm hm.		
18:09:55.0 HOT-2	sometimes they.		
18:09:55.8 CAM-1	well I got sixteen miles to get down I'll just get on (down).		
18:09:58.5 CAM-2	it's really crazy sometimes I don't know why (yeah).		
18:10:05.7 HOT-1	I can do it.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:10:07.7 CAM-2	(maybe it) won't let you the next one *.		
18:10:10.5 HOT-2	yeah I don't know why ah.		
18:10:15.7 CAM-1	oh well we're gonna make it. got fourteen miles to do it.		
18:10:17.8 CAM-2	yeah.		
18:10:19.0 CAM-2	yup.		
18:10:20.1 CAM-1	(my side) ten fifteen (we're good).		
18:10:23.0 HOT-1	not a problem.		
18:10:23.8 HOT-2	nope.		
18:10:25.0 HOT-2	it's sure not.		
18:10:27.9 HOT-2	and he said below twenty it's kinda yucky.		
18:10:30.2 HOT-1	yeah that's what I heard yeah. 'kay.		
18:10:33.8 HOT-1	well. why don't ya hand me the doodly bopper there for a ILS zay Z.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:10:40.8 HOT-2	Zee.		
18:10:41.2 HOT-1	and ah or should say. not much difference really.		
18:10:46.6 HOT-2	nah.		
18:10:49.2 CAM-1	twenty May oh five eleven seven.		
18:10:55.3 HOT-1	ten miles.		
18:10:55.9 CAM-?	* one thousand (three).		
18:11:02.4 CAM-1	one oh nine nine three fifteen inbound seventeen hundred at HOBEL that's (ten ten) eighty seven.		
18:11:07.9 HOT-1	eight seventeen the decision height two hundred we'll keep in the radar altimeter.		
18:11:12.2 CAM-1	six thirteen is touchdown.		
		18:11:26.7 CTR	Southwest twelve forty eight * * * speed your discretion (expect) vectors * * * comin' out.
18:11:34.7 HOT-1	'kay.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		18:11:35.3 RDO-2	okay where's everybody holdin'?
18:11:39.3 CAM-1	(alright) we'll slow 'er down.		
18:11:43.4 HOT-1	so anyway six thirteen touchdown ah we got the minsafes there they're at twenty eight and thirty four north.		
18:11:50.0 HOT-1	ahmm.		
18:11:53.0 HOT-1	we got all those special aircrew certification required we got that ah lead in REILs VASIs HIRLs RVR three one center must be operating and DME required. ahmm need three thousand RVR three degree glideslope. if we have to go missed approach it's climb to eleven hundred feet then ah climbing left turn to twenty one via heading one five zero * the PEON VOR zero zero one until crossing the IGECY.		
18:11:56.6 HOT	[sound similar to ACARS chime].		
18:12:00.4 CAM	[sound similar to altitude warning horn].		
18:12:31.2 HOT-2	you're at thirty.		
18:12:31.9 HOT-1	- intersection then climb to twenty six. fracken a.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:12:35.8 HOT-2	(I know).		
18:12:36.1 HOT-1	what a #.		
18:12:38.0 HOT-1	so anyway what we'll do we'll (hook) it up. if we have to go around it's ah go around thrust TOGA flaps fifteen landing gear up.		
18:12:48.9 CAM-2	L-NAV [sound similar to laughter].		
18:12:50.2 CAM-1	L-NAV [sound similar to laughter].		
18:12:52.7 CAM-2	yeah # it.		
18:12:53.6 CAM-1	L-NAV # it and then we'll clean it up as required okay.		
18:12:56.5 HOT-2	okay.		
18:12:56.9 HOT-1	you double check that get a good IDENT.		
18:12:59.3 HOT-2	I'll just write it down.		
18:13:00.3 HOT-1	yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:13:01.1 CAM-2	and you - since you're gonna be flying it.		
18:13:04.7 CAM-2	eight seventeen.		
18:13:09.1 CAM-1	and.		
18:13:14.0 CAM-1	we'll probably take her down the end turn off see what the weather's like. [sound similar to chuckle]		
18:13:20.5 HOT-1	flaps forty.		
18:13:23.0 HOT-2	MAX brakin'.		
18:13:28.5 CAM-1	('kay) hold airspeed.		
18:13:36.2 HOT-2	* *.		
		18:13:46.0 CTR	Southwest twelve forty eight * *direct GOSHN descend and maintain flight level two eight zero.
		18:13:51.5 RDO-2	direct GOSHN flight level two eight zero Southwest.
18:13:53.7 CAM-1	direct GOSHN how's that look?		
18:13:55.1 CAM-2	yeah GOSHN (you can) * *.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:13:56.6 CAM-1	two eight zero.		
18:13:57.7 CAM-2	okay.		
18:13:58.0 CAM-1	here we go.		
18:14:11.2 CAM-2	ah we have this missed in here? ah three one center eleven hundred one fifty IGECY * .		
18:14:19.7 HOT-1	and all the altitudes in there good.		
18:14:21.5 HOT-2	ahhh what's the eight seventeen. we need three thousand. or five (eighths). okay. that's good enough for me.		
18:14:40.5 HOT-1	I'll hold around two twenty does that sound good to you?		
18:14:42.8 HOT-2	sure.		
18:14:43.1 HOT-1	you know actually I don't need this anymore.		
18:14:44.9 HOT-2	you don't need it?		
18:14:46.1 HOT-1	I don't believe so.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:14:47.2 HOT-2	okay.		
18:14:49.5 CAM-1	see.		
18:14:52.9 CAM-2	I looked in the NOTAMS on the on the ATIS and it didn't say anything was out.		
18:14:56.5 CAM-1	okay good.		
18:14:57.1 CAM-2	it looks like all that stuff * *.		
18:14:59.2 CAM-1	'kay.		
18:14:59.5 CAM-2	if you want it 'cause you're flyin' it's cool I wrote it down.		
18:15:01.6 HOT-1	no you need you need it. yeah you need it there.		
18:15:03.9 HOT-2	okay.		
18:15:04.2 HOT-1	I'm good with it.		
18:15:05.1 HOT-2	okay.		
18:15:05.5 HOT-1	I trust ya.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:15:06.3 HOT-2	whatever makes you happy I don't care. twenty nine twenty eight.		
18:15:10.6 HOT-1	twenty nine twenty eight.		
18:15:12.1 HOT-2	how we doin' here?		
18:15:13.1 CAM	[sound similar to altitude warning horn].		
18:15:14.9 CAM-?	* * .		
18:15:47.2 CAM-1	and I think as far as the autobrakes go.		
18:15:49.6 HOT-1	I think I will use ah manual braking.		
18:15:53.8 CAM-?	*.		
18:15:54.7 HOT-1	yeah.		
18:15:55.3 HOT-2	(okay).		
18:15:55.3 HOT-1	we'll try 'em into Vegas. if that's alright with you.		
18:15:59.7 HOT-2	do you really wanna?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:16:01.0 HOT-1	huh?		
18:16:01.5 HOT-2	you really wanna?		
18:16:03.0 CAM-1	you want to try 'em into Midway?		
18:16:04.9 CAM-2	I know they work better than we do at least that's what my buddy told me. he said they kick ass. like you'll be when you land in MAX you it it is gonna get maximum braking out of the aircraft.		
18:16:14.8 CAM-1	yeah.		
18:16:17.5 CAM-1	I you know I just I don't know I don't know what to do. like if it starts to and it starts.		
18:16:18.8 CAM-2	[sound similar to laughter].		
18:16:25.4 CAM-2	yeah.		
18:16:25.9 CAM-1	takin' us off course ya know?		
18:16:27.7 CAM-2	yeah.		
18:16:28.1 CAM-1	then I gotta come in ah brake it.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:16:31.1 CAM-1	I guess.		
18:16:31.9 CAM-2	I *.		
18:16:32.1 CAM-1	let me think about maybe we can do it.		
18:16:34.1 CAM-2	eh I would be cool with whatever your decision is.		
18:16:36.7 CAM-1	okay.		
18:16:37.9 CAM-2	fine.		
18:16:39.4 CAM-1	it's the old guys fear of.		
18:16:41.3 CAM-2	[sound similar to laughter].		
18:16:42.1 CAM-1	[sound similar to laughter].		
18:16:42.5 CAM-2	they say it's better it's better than we could ever be.		
18:16:45.4 CAM-1	yeah okay.		
18:16:46.1 CAM-2	but that's cool I will you know what I'll be happy with whatever you decide.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:16:49.4 HOT-1	well keep talkin' I I I guess we could do it let's let's see what the conditions are up there. we'll do it.		
18:16:58.7 HOT-1	if you're comfortable with that I am too.		
18:17:00.8 CAM-2	I will be happy with whatever you decide.		
18:17:08.3 CAM-1	if it goes to ah autobrake.		
18:17:10.8 CAM	[sound similar to ACARS chime].		
18:17:11.3 CAM-1	eh uh oh.		
18:17:14.9 CAM-2	then you just jump on it as hard as you can.		
18:17:17.0 HOT-1	yup.		
18:17:19.5 CAM-2	if I'm not already there for ya. [sound similar to laughter]		
18:17:21.2 HOT-1	yeah.		
18:17:23.3 HOT-2	hey it's bumpy.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:17:24.5 CAM-2	Pennsylvania New Jersey Ohio Indiana Wisconsin my # Detroit. eastern Kentucky western Kentucky West Virginia Virginia.		
18:17:34.3 HOT-2	code three one eight oh to three two oh.		
18:17:37.8 HOT-1	'kay.		
18:17:38.2 HOT-2	mostly below thirty.		
18:17:45.7 HOT-2	well the weather -- [in a sing song voice]		
18:17:46.6 HOT-1	the other part of my briefing is.		
18:17:49.0 HOT-2	*.		
18:17:49.4 HOT-1	on this day If we're all together here. if. sometimes when we do a descent checklist you know we're so far out that ya switch things around a little bit.		
18:17:57.6 HOT-2	oh.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:17:58.0 HOT-1	so if I'm ever in a position down there and I'll do the same for you. on approach or whathaveyou and you would normally have the localizer course in or the frequency in and and I don't have it in there say sumpin'.		
18:18:07.4 HOT-2	okay.		
18:18:11.1 HOT-2	and ah you can't hurt my feelings you can try if I'm not doin' what - .		
18:18:12.9 HOT-1	[sound similar to laughter].		
		18:18:14.2 CTR	Southwest twelve forty eight turn right heading three five zero for sequence maintain, two hundred and fifty knots. well what are you doing right now actually for knots?
18:18:23.2 HOT-1	two ten.		
		18:18:23.8 RDO-2	we're slowed to two ten we're heading right to three fifty for Southwest twelve forty eight.
		18:18:27.6 CTR	and Southwest twelve forty eight you can keep your current airspeed fly heading three five zero they're out of the hold they gotta sequence you now.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		18:18:33.0 RDO-2	okay great three fifty heading and two ten Southwest twelve forty eight.
18:18:38.4 CAM-1	two fifty heading.		
18:18:39.3 CAM-2	if I'm not doin' what you asked me to do it's not because I'm disobeying you it's 'cause I'm stupid and so sometimes this this is the most effective thing that ya ha ha.		
18:18:49.7 CAM-1	well sometimes I might not hear ya.		
18:18:51.6 CAM-2	[sound similar to laughter].		
18:18:54.5 HOT-1	ya can't hurt my feelings by yelling.		
18:18:56.1 HOT-2	you can feel free to smash me right over the head with that thing.		
18:18:58.5 HOT-1	yeah.		
18:19:02.0 CAM-1	now we're gonna pick up some speed.		
18:19:03.7 CAM-2	yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:19:05.9 CAM-2	I told you two ten not three ten.		
18:19:08.0 CAM-1	uhuh.		
18:19:08.4 CAM-2	[sound similar to laughter].		
18:19:10.8 CAM-1	alright three five zero come on baby. what's the story here?		
		18:19:14.3 CTR	Northwest twelve forty correction Southwest twelve forty eight descend and maintain flight level * five zero.
		18:19:19.7 RDO-2	* level two five zero Southwest twelve forty eight.
18:19:22.1 HOT-1	alright two five zero there we go.		
18:19:23.6 CAM-1	go ahead and * * * *.		
18:19:25.0 CAM-2	yeah.		
18:19:27.7 HOT-1	five zero.		
18:19:28.4 HOT-2	(three) fifty (now).		
18:19:29.3 CAM-1	down to a two five.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:19:30.4 CAM-2	alright.		
18:19:31.3 CAM-2	I'm gonna sit 'em down. * *.		
18:19:32.9 CAM-1	okay yeah yeah. sounds good.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
	* * * * startin' our very gradual descent into Chicago Midway airport [sound similar to single chime] ah seatbelt signs comin' back on so folks please if you're up and about head on back to your seats * * * for the duration. there's only a hundred and twenty three miles between us and the airport. ah that's the good news * * * get our sequence into arrival * * * * into Chicago * * * * ah out of the east a ten miles an hour ah low visibility due to on and off light snow and it's very chilly it's only twenty five degrees. folks again		
18:19:36.4 PA-2	ah * * * * * this evenin' ah we sure do appreciate all your patience and understanding and all and we welcome you to Chicago folks if you're continuing ah da ah Las Vegas and then ah finally to Salt Lake City with us we're gonna be on the ground in Chicago hopefully for only about twenty five minutes and we're gonna get you (safely on your way) yeah folks thanks so much for your patience and understanding tonight (and we hope) everybody has a wonderful night on your way home buckle up drive safely and next time you're gonna go flying we'd sure love for you to come back and see us again here at Southwest thanks so much folks good night.		
		18:20:23.8 CTR	Southwest twelve forty eight turn left heading three one zero.
		18:20:27.6 RDO-1	three one zero Southwest ah twelve forty (eight).

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:20:48.7 HOT-1	down ta two four zero now.		
18:20:50.3 HOT-2	twenty four I am back.		
18:20:52.5 HOT-?	'kay.		
18:21:04.2 CAM-2	try try to grab a gate.		
18:21:06.4 CAM-1	okay.		
18:21:06.6 CAM-2	I'll be right back.		
18:21:07.8 CAM-1	we won't have one.		
18:21:08.9 CAM-2	yeah.		
18:21:09.6 CAM-1	[sound similar to laughter].		
		18:21:09.6 RDO-2	hey Midway Twelve forty eight.
		18:21:13.8 OPS	twelve forty eight go ahead.
		18:21:16.2 RDO-2	we're not on time I guess you probably knew that by now though we're gonna be there around fifty with thirteen eight.

INTRA-COCKPIT COMMUNICATION TIME (CST) SOURCE	CONTENT	AIR-GROUND COMMUNICATION TIME (CST) SOURCE	CONTENT
		18:21:23.8 OPS	okay your gate is Alpha eleven A eleven with gate services.
		18:21:28.2 RDO-2	A eleven with the service ah you think it's gonna be open?
		18:21:31.7 OPS	ah yeah I mean the visibility is better ah the last one we had ah the braking action was was fair snow covered taxiways that's the last report I have.
		18:21:40.7 RDO-2	it was fair you said?
		18:21:42.1 OPS	ah that's the last flight that came into Chicago that's how he reported it.
		18:21:46.3 OPS	okay thanks eh and I I meant d-do you know if eleven gonna be open?
18:21:46.7 CAM-1	she doesn't know, she doesn't know.		
		18:21:50.7 OPS	ah yes it will.
		18:21:52.0 RDO-2	great.
18:21:52.2 HOT-2	thanks.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		18:21:53.1 RDO-2	thank you.
18:21:54.4 CAM-2	yeah [sound of chuckle] we oughta get a little better report than hers.		
18:21:58.0 CAM-1	well our.		
18:22:00.5 HOT-2	she made it sound like there hasn't been anybody that landed for a while.		
18:22:02.8 HOT-1	yeah our twenty one year old at at a a operations said it was poi fair.		
18:22:07.9 CAM-2	[sound similar to laughter].		
18:22:08.5 CAM	[sound similar to altitude warning horn].		
18:22:09.0 CAM-2	whaddya mean we did sumpin' wrong?		
18:22:10.1 CAM-1	twenty four nine twenty four.		
18:22:14.8 CAM-2	twenty four nine is twenty four.		
18:22:23.7 CAM-1	Alpha eleven.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:22:25.2 CAM-2	yeah.		
18:22:25.5 CAM-1	that's right way the # over there.		
18:22:26.2 CAM-2	* *.		
18:22:27.1 CAM-2	horrible Potbellies * *.		
18:22:29.6 CAM-2	ah it's not so bad.		
18:22:30.4 CAM-1	it's not so bad.		
18:22:32.0 CAM-1	somebody had the number.		
18:22:34.7 CAM-1	let me (ask 'em) * there.		
18:22:40.1 CAM-1	what are you going to have?		
18:22:41.7 CAM-2	ahhh.		
18:22:44.9 INT-1	hello.		
18:22:45.9 INT-1	hey you guys got the number to Potbellies?		
18:22:48.2 FA	no.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:22:49.7 INT-1	why not?		
18:22:50.6 FA	I don't know.		
18:22:51.6 FA	do you have the number to Potbellies?		
18:22:53.5 FA	(bummer) (good job) * * * (I don't know how) * * (I can't believe it). [sound similar to laughter]		
		18:22:53.9 CTR	Southwest twelve forty eight cleared direct GOSHN * * * * at two hundred and ten knots.
		18:22:59.5 RDO-2	kay two hundred ten knots direct GOSHN * * Southwest *.
18:23:02.8 INT-1	ya don't have it.		
18:23:03.8 FA	nooo.		
18:23:04.7 INT-1	okay well we'll just have ta we're goin' to A eleven.		
18:23:12.0 CAM-1	direct GOSHN.		
18:23:12.8 CAM-2	direct GOSHN two ten she said still * *.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:23:16.3 INT-1	oh well all right we'll see ya later. bye.		
18:23:17.3 FA	*.		
18:23:28.5 CAM-1	two ten.		
		18:23:33.6 RDO-2	* * Southwest twelve forty eight.
		18:23:40.4 RDO-2	...two hundred and ten knots.
		18:23:41.9 CTR	* twelve forty eight * confirmed good evening descend and maintain one six thousand and * altimeter * three zero one three.
		18:23:49.3 RDO-2	Southwest twelve forty eight do you still * * *.
		18:23:52.1 CTR	ah now ah what do you wanna do? * * *.
18:23:55.3 CAM-1	(I don't know).		
		18:23:58.7 CTR	...how 'bout two fifty or less (from now)?
18:24:00.2 CAM-2	okay.		
18:24:02.6 CAM-1	two fifty or less.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:24:06.9 CAM-1	okay sir we're goin' down to one six thousand.		
18:24:09.8 CAM-2	(sixteen).		
18:24:13.8 CAM-1	* slowly picked up speed.		
18:24:15.4 CAM-2	ohhhh.		
18:24:19.4 HOT-2	nice night up here.		
18:24:41.9 HOT	[sound similar to ACARS chime].		
18:24:43.6 HOT-2	Tango.		
18:24:43.9 HOT-1	Tango another new one huh?		
18:24:45.8 HOT-2	quarter snow freezin' fog hundred feet.		
18:24:48.2 HOT-1	oh well.		
18:24:51.8 HOT-1	# man.		
18:24:53.1 HOT-2	three thousand feet what's * * * .		
18:24:57.1 HOT-1	[sound similar to laughter].		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:24:58.4 HOT-2	snow (inch) three ninths?		
18:25:01.0 HOT-1	I don't know.		
18:25:03.3 HOT-1	snow NCR?		
18:25:04.6 HOT-2	[sound similar to laughter].		
18:25:07.9 HOT-1	what's that mean?		
18:25:08.7 HOT-2	[sound similar to laughter] # if I know.		
18:25:10.3 HOT-1	snow increasing.		
18:25:12.2 HOT-2	snow increasing.		
18:25:16.1 HOT-1	three to nine four to nine.		
18:25:18.8 HOT-2	[sound similar to laughter].		
18:25:28.7 CAM-1	one hundred at nine?		
18:25:30.7 CAM-2	# I don't know.		
18:25:31.4 CAM-1	alright anti-ice comin' on.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:25:40.1 CAM-2	* three thousand RVR * * *.		
18:25:42.5 CAM-1	that what it says?		
18:25:43.6 CAM-2	three thousand feet ah yeah.		
18:25:44.9 CAM-1	oh three thousand feet.		
18:25:46.7 CAM-2	snow increasing.		
18:25:56.7 HOT-2	uh. hey now.		
		18:25:58.6 CTR	Southwest twelve forty eight you can resume normal airspeed and cross AWSUM at and maintain one zero (ten) thousand.
		18:26:04.2 RDO-2	Normal speed AWSUM at ten Southwest twelve forty eight.
18:26:07.5 HOT-2	AWSUM at ten.		
18:26:08.5 CAM-1	'kay. got it AWSUM at ten.		
18:26:13.3 HOT-1	well lets see. we aren't there yet. at eighteen but.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:26:33.9 CAM-1	nice.		
18:26:46.4 CAM-2	* * * * * (it) up here *.		
18:26:48.4 CAM-1	yeah.		
18:26:49.9 CAM-1	ahhh (pickin') some out there. don't ya get the lights on there for a second.		
18:26:54.4 HOT-2	you got it.		
18:26:56.2 CAM-2	little bit.		
18:26:56.9 CAM-1	eh let's put it on.		
18:26:58.0 CAM-2	alright.		
18:26:58.8 HOT-1	there we go.		
18:27:11.7 HOT-2	one hundred and nine is a eight knot tailwind so if anybody says poor. we can't do it.		
18:27:18.1 HOT-1	yeah.		
18:27:22.9 HOT-1	it's comin' off it's comin' on.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:27:27.5 HOT-1	haven't gotten any on the outside on the very eh outer edge do we?		
18:27:31.4 HOT-2	ah vee looks like ah on top --		
18:27:33.9 HOT-1	I mean we have it there but we don't have any anti-ice on there.		
18:27:36.0 HOT-2	(anti-) no no.		
18:27:38.8 HOT-2	not there the tail. bummer.		
18:27:40.3 HOT-1	eh.		
		18:27:45.8 CTR	* three Kilo Fox * * * * forty eight they are plowing the runway at Midway now so the next sector is in the hold you can expect to hold on the next frequency reaching one zero thousand slow to two hundred and fifty knots.
18:27:50.8 CAM-2	uh oh.		
18:28:09.1 CAM-1	hmm.		
		18:28:09.2 CTR	Southwest twelve forty eight reaching one zero thousand maintain a speed of two five zero.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:28:10.3 CAM-2	* *.		
		18:28:13.9 RDO-2	'kay two fifty knots at ten thousand Southwest twelve forty eight.
18:28:18.1 HOT-1	two fifty at ten.		
18:28:21.6 HOT-1	'kay.		
18:28:23.4 HOT-2	what do we say thirty thirty oh nine when we get there.		
18:28:24.0 HOT-1	we can do that.		
18:28:27.5 HOT-1	alright lets do it thirty oh nine		
18:28:35.2 HOT-1	wow.		
18:28:42.3 CAM-1	well let's see what kinda lights we got here and a descent check please.		
18:28:46.8 CAM-2	altimeters and bugs.		
18:28:48.8 HOT-1	well eight seventeen and ah altimeters and bugs set and crosschecked.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:28:54.6 HOT-2	Vref and target.		
18:28:56.4 HOT-1	whadda we got here?		
18:28:58.1 HOT-2	twenty.		
18:28:59.3 HOT-1	we have --		
		18:29:00.0 CTR	Southwest twelve forty eight expedite your descent to one zero ten thousand please.
		18:29:04.0 RDO-2	'kay we'll hurry down to ten Southwest twelve forty eight.
18:29:08.2 CAM-1	hurryin' down. alright let me see ah one twenty five one thirty?		
18:29:13.0 CAM-2	yeah.		
18:29:23.6 CAM-1	alright.		
18:29:25.7 HOT-1	twenty five thirty set.		
18:29:27.1 HOT-2	autobrake. [sound similar to laughter]		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:29:29.3 HOT-1	alright four ah three four?		
18:29:31.3 HOT-2	four.		
18:29:31.9 HOT-1	four.		
18:29:32.4 HOT-2	the big boy.		
18:29:33.3 HOT-1	four for now.		
18:29:34.6 HOT-1	set #.		
18:29:36.5 HOT-2	[sound similar to chuckle] hey to get there you have to pull it out.		
18:29:39.0 HOT-1	alright.		
18:29:40.3 HOT-1	that's what she said.		
18:29:41.2 HOT-2	[sound similar to laughter] *.		
18:29:43.8 HOT-1	are auto.		
18:29:45.7 HOT-2	start switches.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:29:46.5 CAM-1	are continuous.		
18:29:48.2 CAM-2	and a recall.		
18:29:50.3 HOT-1	clear.		
18:29:51.3 HOT-2	Alpha eleven.		
18:29:53.0 CAM-1	alright.		
18:29:55.6 HOT-2	descent check is complete.		
18:30:02.1 HOT-1	oh no.		
18:30:02.1 HOT-2	* * Elmo.		
18:30:03.4 HOT-1	uh oh.		
18:30:08.3 HOT-1	hm hm I don't like Elmo.		
18:30:10.9 CAM-2	(usually) what follows Elmo. [sound similar to chuckle].		
18:30:10.9 CAM-1	Elmo's good.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:30:14.6 CAM-2	is a da da da da I got a four year old I love Elmo.		
18:30:19.8 CAM-1	yeah Elmo's good. that respect.		
18:30:22.5 HOT-2	how many kids did you have.		
18:30:23.7 CAM-1	I have three ah --.		
		18:30:25.6 CTR	-- two five zero.
18:30:27.0 HOT-1	two five zero.		
		18:30:27.2 RDO-2	heading two five zero Southwest twelve forty eight.
18:30:29.6 HOT-1	I have uhm.		
18:30:33.2 CAM-1	yeah three children and two grandchildren.		
18:30:37.5 HOT-2	two grandkids any more grandkids on the horizon?		
18:30:39.9 HOT-1	nah not yet.		
18:30:41.0 HOT-2	yeah.		
18:30:41.8 CAM-1	although my oldest son got just got married so.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:30:44.9 HOT-2	ah that's cool.		
18:30:45.4 HOT-1	and ah he (he) been married a little over a year so they're thinkin' about it. (they) weren't thinkin' about it before but they are now.		
18:30:49.6 HOT-2	I.		
18:30:51.0 HOT-2	yeah.		
18:30:52.1 CAM-2	I never told the girls to sit either.		
18:30:54.6 CAM-1	well * I know I haven't told 'em to clean up yet.		
18:30:57.8 CAM-2	yeah. * too.		
18:31:01.7 HOT-?	*.		
18:31:03.4 PA-1	ah flight attendants take your seat if you haven't already just keep your seats 'till we let ya up thanks.		
18:31:19.8 HOT-1	well we're hurryin' down.		
18:31:21.0 CAM-2	yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:31:23.0 CAM-1	on the heading now.		
18:31:29.4 HOT-1	(looks) good out there.		
18:31:33.3 HOT-1	well let's see let's try it we'll turn it off turn the wing off for a minute.		
18:31:37.6 HOT-2	looks pretty clean to me.		
18:31:39.0 HOT-1	alright and then we'll look back a little bit later.		
18:31:41.9 HOT-2	(go).		
18:31:47.9 HOT-1	I don't want the people back there seein' it.		
18:31:49.8 HOT-2	ah don't blame ya.		
18:32:06.5 HOT-1	(that's) a little better.		
18:32:07.8 HOT-2	yeah not too bad.		
18:32:15.8 HOT-1	little bit of stuff out there uh?		
18:32:17.5 HOT-2	yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:32:28.2 HOT-1	let's see.		
18:32:31.1 HOT-1	eh its stayin' off.		
18:32:32.1 HOT-2	yeah much better than before.		
18:32:35.6 HOT-2	eleven for ten.		
18:32:37.4 HOT-1	eleven for ten.		
18:32:40.7 HOT-1	huh huh huh.		
18:32:43.1 HOT-2	zero three two.		
		18:32:59.0 CTR	Southwest twelve forty eight maintain a speed of two five zero knots and contact Chicago center one three two point niner five goodnight.
		18:33:05.1 RDO-2	two fifty and thirty two ninety five you have a good night too Southwest twelve forty eight.
		18:33:11.2 RDO-2	hello Chicago Southwest twelve forty eight just levelin' a * * fifty * * * *.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		18:33:17.1 CTR	* Midway altimeter (three) zero zero * and I have holding instructions advise when you're able to copy.
		18:33:22.7 RDO-2	thirty oh seven go ahead.
		18:33:24.6 CTR	Southwest twelve forty eight you're cleared to the LUCIT intersection via direct hold southeast as published expect further clearance zero zero five five and now maintain one zero thousand.
		18:33:37.8 RDO-2	okay LUCIT hold southeast as published zero zero five five can you spell the fix for us?
18:33:38.3 CAM-1	spell it.		
		18:33:43.1 CTR	and ah Southwest twelve forty eight LUCIT intersection is Lima Uniform Charlie India Tango ah and ah one zero mile DME (right) there * *.
		18:33:52.3 RDO-2	* * * * * * * *.
18:33:58.2 CAM-2	(LUCIT).		
18:33:59.8 CAM-1	LUCIT huh? one zero miles.		
18:34:02.3 CAM-2	L-U-C.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:34:03.3 CAM-1	how ya spell it L?		
18:34:05.3 CAM-2	L-U-C-I-T.		
18:34:09.6 CAM-1	C-I-T.		
18:34:14.0 CAM-2	* (to go).		
18:34:14.2 CAM-1	forty three miles away.		
18:34:15.5 CAM-2	(we're) okay.		
18:34:16.9 HOT-2	so we can go direct to there.		
18:34:18.3 HOT-1	alright and then we can hold there if you would set that I'm gonna put us LNAV into LUCIT.		
18:34:41.6 CAM-2	so here's the * * Boiler Two.		
18:35:08.7 CAM-1	alright can you (hit) that?		
18:35:10.4 CAM-2	yeah.		
18:35:11.4 CAM-1	I got LUCIT down here.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:35:13.9 CAM-2	hold. LUCIT		
18:35:15.5 CAM-1	there ya are grab it.		
18:35:16.9 CAM-2	southeast one fifty six outbound.		
18:35:22.1 CAM-1	'kay.		
18:35:22.6 CAM-2	right turns. ten DME legs.		
18:35:23.8 CAM-1	* * okay.		
18:35:28.3 CAM-2	zero zero five five.		
18:35:42.2 HOT-1	'kay there it is then.		
		18:35:43.4 RDO-2	(Indy) Center Southwest twelve forty eight.
		18:35:47.6 CTR	ah Southwest twelve forty eight go ahead --
		18:35:49.2 RDO-2	* * * as well LUCIT you want us to hold as published on the Boiler Two arrival?
		18:35:54.2 CTR	ah yes sir that is correct * * *...

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		18:35:56.8 RDO-2	... * * * west twelve forty eight.
18:35:59.6 CAM-1	yup.		
18:36:00.8 CAM-2	* we weren't on that arrival I mean you they kinda give ya.		
18:36:03.9 CAM-1	right turn is that the arrival LUCIT there?		
18:36:06.6 CAM-2	yeah yeah.		
18:36:07.3 CAM-1	okay.		
18:36:07.8 HOT-2	I I'll back it up too for ya inbound the Chicago Heights fourteen two. and it is three thirty six inbound.		
18:36:14.9 HOT-1	uhmm best speed is two oh seven but he gave us he gave two fifty didn't he?		
18:36:18.8 HOT-2	yeah I'll ask him too.		
		18:36:20.3 RDO-2	hey center Southwest twelve forty eight.
		18:36:22.1 CTR	Southwest twelve forty eight go ahead.

INTRA-COCKPIT COMMUNICATION TIME (CST) SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	AIR-GROUND COMMUNICATION TIME (CST) SOURCE	AIR-GROUND COMMUNICATION CONTENT
		18:36:23.6 RDO-2	can we slow down as well?
		18:36:25.0 CTR	ah yes sir airspeed at your discretion sir.
		18:36:27.5 RDO-2	okay thanks a lot.
		18:36:28.9 RDO-2	you think the fifty five will be hard time?
		18:36:32.6 CTR	ah right now my understanding is ah they're just clearin' the runway and ah I should get an update here shortly it looks like I've got ah three jets from the west ah just starting to go in at this time.
		18:36:45.4 RDO-2	okay thanks a lot and after we exit the hold do you want us to set the box up for the Boiler Two?
		18:36:52.1 CTR	ah yes sir that would be correct ahm ah it'll be right around * * (Midway).
18:36:56.2 CAM-1	okay good.		
18:36:56.9 CAM-2	** (thank you much).		
18:36:59.0 CAM-1	alright very good.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:37:00.3 CAM-2	that's cool. I'll save that one * ah *ah little holding action.		
18:37:02.0 CAM-1	alright.		
18:37:11.1 HOT-2	L-U.		
18:37:14.0 CAM-1	alright.		
18:37:15.2 HOT-1	(can you) monitor the -- I'm gonna I'll talk to the folks real quick.		
18:37:21.2 HOT-2	okay *.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:37:24.0 PA-1	well folks you've probably felt that ah we've slowed here ahm we're gonna have to hold here for about ah twenty minutes it looks like ah 'till they clear the runway off they've been off and on doing that ah as we've been flying into Chicago to get the braking action ah such that we can land. so ah it's still snowing so ah the plows are workin' on the runway we're gonna hold and let 'em do their job and then ah and then ah once they ah get * * * * then we'll be heading into Chicago so they gave us a fifty five after the hour expected approach clearance time and ah that's when we expect to ah leave the holding pattern and head to (Chicago) * * * * * * *.		
18:38:12.3 FA	ladies and gentlemen we are ah (about to make our) final approach into Chicago * * * make sure your seatbelts are fastened * * lean forward and press the silver button * * * ...		
18:38:14.1 HOT-2	fer ah alternate forty seven. seventy seven. like eight thousand would be as low as you we could go that's probably what he's figuring out. maybe eight five hundred be extra *.		
18:38:28.9 HOT-1	* ETA zero zero four three eh? alright then we'll have about ah twelve minutes in the fix eleven twelve. ten thousand feet.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:38:42.0 HOT-2	we got a lot a extra gas so that's not.		
18:38:43.6 HOT-1	got enough gas ah holding (avail) at one plus fifteen *.		
18:38:46.8 CAM-1	before we go to.		
18:38:56.6 CAM-2	(where we goin') to Kansas City?		
18:38:59.5 CAM-1	(let's see our worst run) Kansas City.		
18:39:02.0 CAM-2	we need ah * * * *.		
18:39:08.6 CAM-2	just (checking) *.		
18:39:17.6 CAM-1	* (thrown it away).		
18:39:19.3 CAM-2	huh.		
18:39:48.1 HOT-2	yeah.		
18:40:15.9 CAM-1	well let's take a peek here.		
18:40:17.3 CAM-2	yeah I (knew) while you were talkin'.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:40:18.4 CAM-1	eh it's still good.		
18:40:19.7 CAM-2	yeah.		
18:40:32.9 CAM-1	got us holdin' all over the place.		
18:40:34.5 CAM-2	yeah.		
18:40:42.3 HOT-1	alright what so us comin' in this way whaddya think it's gonna do?		
18:40:46.7 CAM-1	left turn isn't it?		
18:40:47.0 CAM-2	well let's see.		
18:40:49.5 CAM-1	parallel?		
18:40:50.1 CAM-2	outbound. (it is) one fifty six so it should be. right turn. parallel.		
18:41:01.7 HOT-1	so right turn you think? then the seventy?		
18:41:03.8 HOT-2	yeah should turn.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		18:41:04.6 CTR	Southwest twelve forty eight expect further clearance zero one one five.
		18:41:08.5 RDO-2	zero one one five thank you.
18:41:10.7 HOT-1	alright zero one one five now. #. 'kay.		
18:41:17.9 CAM-2	I think it's gonna go.		
18:41:20.1 CAM-1	right?		
18:41:20.7 HOT-2	right turn so right now left should be a parallel it's gonna turn left there.		
18:41:22.2 HOT-1	whadda we got here oh he's telling' us what we're gonna do.		
18:41:27.0 CAM-1	yeah that’s gonna be my guess.		
18:41:27.1 CAM-2	(should) should turn left to one fifty six.		
18:41:30.2 CAM-1	there ya go look at it.		
18:41:31.5 CAM-2	do another lap.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:41:32.3 CAM-1	ha ha ha.		
18:41:33.8 CAM-1	I love it.		
18:41:34.6 CAM-2	that's cool.		
18:41:38.1 CAM-2	the map this is this is such a great deal. man		
18:41:40.1 CAM-1	yeah aw yeah.		
18:41:44.4 HOT-2	such a great great great aw hey (let's see) ATIS Golf quarter mile and snow Indy is not a good idea.		
18:41:45.1 HOT-1	I'm slowin' her down a little here.		
18:41:51.7 HOT-1	naw Indy's not good.		
18:41:53.4 CAM-2	so MCI? MCI was better right?		
18:41:56.7 CAM-1	STL?		
18:41:58.4 CAM-2	MCI?		
18:41:59.0 CAM-1	yes MCI was great but that's a ways away.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:42:01.7 CAM-2	how much further though?		
18:42:17.1 HOT-1	there he is.		
18:42:17.6 HOT-2	(they're at nine).		
18:42:22.0 CAM-2	(they're not).		
18:42:33.8 HOT-2	nine miles at St Louis.		
18:42:36.3 HOT-1	ah that's good.		
18:42:37.2 HOT-2	yeah.		
18:42:38.6 HOT-2	thirty right.		
18:42:40.5 HOT-1	yeah we can do a St Louis that'd be best.		
18:42:40.7 HOT-2	let's do this S-T-L.		
18:42:44.9 HOT-1	two hundred five miles.		
18:42:45.3 HOT-2	two oh five.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:42:47.0 HOT-2	well let's do this wa how many we don't really have two much time forty three.		
18:42:49.9 HOT-1	ah let's just enter here.		
18:42:51.1 HOT-2	I was gonna put in the # again but. two oh five so really. really this is even extra cautious 'cause I'm sure the alternate gas is all the way to Kansas City.		
18:43:02.2 HOT	[transients and sounds similar to telephone keypad touchtone].		
18:43:03.8 HOT-?	*.		
18:43:04.7 HOT-2	so if we did like eight or eighty five hundred we'd still have plenty ah gas to go.		
18:43:09.3 HOT-1	yeah what does it say we're gonna go over there at?		
18:43:12.1 HOT-2	forty seven and thirty two, seventy nine. plus whatever your fudge factor is.		
18:43:21.3 CAM-1	'kay.		
18:43:22.8 CAM-2	forty seven and then ah reserve.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:43:24.5 CAM-1	oh yeah yeah.		
18:43:31.4 CAM-2	seems like they're startin' to get 'em goin'.		
18:43:33.2 HOT-1	yeah.		
18:43:38.5 HOT-2	you're gonna make some extra money tonight.		
18:43:40.6 HOT-1	yeah.		
18:44:03.2 HOT-1	here we go.		
		18:44:04.1 RDO-2	Southwest twelve forty eight's enterin' the hold at LUCIT ten thousand.
		18:44:08.8 CTR	Southwest twelve forty eight ah roger thanks.
18:44:12.8 HOT-2	my pleasure.		
18:44:35.0 HOT-2	it shoulda showed right turn.		
18:45:13.6 CAM-2	diversion plan uplink. wow.		
18:45:18.5 CAM-2	eight point * point five so that's pretty about what we figured.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:45:23.0 CAM-1	that's to go where St. Louis?		
18:45:24.6 CAM-2	yea that's pretty cool.		
18:45:25.7 HOT-1	alright.		
18:45:26.5 HOT-1	where did you get that?		
18:45:27.7 CAM-2	it just said it on the bottom its.		
18:45:29.1 HOT-1	huh.		
18:45:30.7 CAM-2	'kay.		
18:45:31.1 HOT-2	so I guess we accept.		
18:45:36.0 HOT-1	hmm.		
18:45:36.8 CAM-2	Detroit must be # too.		
18:45:44.3 HOT-2	that'd be a lot closer too.		
18:45:46.6 HOT-1	hmm oh yea some weather out here.		
18:45:52.3 HOT-2	how we doing.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:45:52.4 HOT-1	the weather... thank you. the weather out here is rosey.		
18:45:55.0 HOT-2	ohp sorry.		
18:45:55.9 HOT-1	still good uh?		
18:45:56.7 HOT-2	yea looks real good.		
18:45:59.3 HOT-2	oh the weather out -- here's Detroit.		
18:46:03.9 HOT-1	[sound of whistling].		
18:46:03.9 HOT-2	a one and a half.		
18:46:08.2 HOT-1	light snow there.		
18:46:09.7 HOT-2	yeah (fourteen it may not send it).		
18:46:10.6 HOT-1	did they send that to us too?		
18:46:12.0 HOT-2	no I just typed that in.		
18:46:13.1 HOT-1	okay		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:46:15.3 HOT-2	light to moderate rime.		
		18:46:16.3 CTR	and Southwest twelve forty eight ah are you flyin' inbound ahm on the Chicago Heights one fifty (*) radial ah right hand turns or do ya are you set up for somethin' else.
		18:46:27.1 RDO-2	uh that that's what we're set up for we're doin' a parallel entry so we're gonna make a left turn back to the fix in about four more miles.
		18:46:35.1 CTR	Southwest twelve forty eight roger thanks.
18:46:41.8 HOT-1	very good.		
18:46:42.6 HOT-2	we're not doin' a parallel the mighty box is.		
18:46:45.1 HOT-1	yeah.		
18:46:47.7 HOT-2	I always check and I hate when they give you fixes that aren't on your route because then you gotta go diggin' through the charts to see how they're depicted. It would be easier if they just gave you the whole instruction.		
18:46:52.2 HOT-1	yeah. yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:47:01.9 HOT-1	here we go.		
18:48:01.6 HOT-1	this is awesome.		
18:48:02.7 HOT-2	[sound similar to laughter].		
18:48:05.7 HOT-2	we're in a three hundred it wouldn't be so awesome.		
18:48:07.5 HOT-1	no.		
		18:48:16.5 CTR	Southwest twelve forty eight descend and maintain seven thousand.
		18:48:20.5 RDO-2	seven thousand Southwest twelve forty eight.
18:48:23.6 HOT-1	seven thousand.		
18:48:24.2 HOT-2	seven.		
18:48:26.5 HOT-2	glad we're not in a two hundred.		
18:48:28.4 HOT-1	oh man. done enough of that.		
18:48:31.5 HOT-2	yea I bet you have.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:48:43.0 HOT-1	let's see. we got ah okay AWSUM HALIE we probably can - get rid of those but we got -		
18:48:50.4 HOT-2	yeah (he said he) ah.		
18:48:52.2 HOT-1	bring bring HILLS up or something.		
18:48:53.6 HOT-2	I was gonna put in COKED an HEIGHTS but. he said he'll probably take us to like a vector for the thirty one center or somethin'.		
18:48:59.4 HOT-1	yea.		
18:49:02.3 HOT-2	HEIGHTS we could do 'cause that’s really what's what's next. will it take you out of the hold though?		
18:49:09.0 HOT-1	hmmm.		
18:49:09.9 HOT-2	if we put in HEIGHTS now like in the discontinuity it'll take you out of the hold next time won't it?		
18:49:14.8 HOT-1	I'm not sure.		
18:49:16.3 HOT-2	I I think it does.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:49:22.4 HOT-2	I think it would draw a line.		
18:49:26.6 HOT-2	ah no I guess it didn't. yea it did.		
18:49:35.6 HOT-2	yea it draws the line so.		
18:49:37.1 HOT-1	yeah its over there.		
		18:49:37.2 CTR	Southwest three twenty one ah fly heading of a two seven five intercept three one center localizer cleared to Midway airport via radar vectors and maintain ah six thousand.
18:49:38.2 CAM-2	that’s right. yeah.		
18:49:44.8 HOT-1	alright.		
18:49:45.7 CAM-2	that's good.		
18:49:48.4 CAM-2	we're next they're at six thousand.		
18:50:12.9 HOT-2	ah we might get one more.		
18:50:20.7 HOT-1	alright. eh.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:50:25.8 HOT-2	what ya do before? where did you fly before?		
18:50:29.0 HOT-1	what'd I fly before?		
18:50:30.0 HOT-2	yeah.		
18:50:30.4 HOT-1	I was Air Force guy.		
18:50:31.6 HOT-2	how how long, did you retire?		
18:50:32.9 HOT-1	eight for seven.		
18:50:33.8 HOT-1	I was ah I been ah here eleven years so.		
18:50:36.7 HOT-2	eleven years.		
18:50:37.4 HOT-1	yeah.		
18:50:38.8 CAM	[sound similar to altitude warning horn].		
18:50:38.9 HOT-1	on my eleventh year.		
18:50:42.0 CAM-2	how long did you stay in the Air Force for?		
18:50:43.6 HOT-1	twenty six.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:50:44.4 CAM-2	twenty six years how old are you?		
18:50:46.8 HOT-1	I'm fifty nine.		
18:50:47.9 HOT-2	are you serious?		
18:50:48.5 HOT-1	yeah.		
18:50:49.2 HOT-2	jeeze you'd never freakin' know it you gonna make it its gonna change? (whaddya).		
18:50:52.8 HOT-1	I don't know if the if they cha- I a November I've got ah till November eight.		
18:50:58.5 CAM-2	I hope it does.		
18:51:00.2 HOT-1	yeah I hope so.		
18:51:00.9 HOT-2	some of my favorite people had to go and it was too bad $ he was * awesome guy to fly with outta Chicago.		
18:51:07.6 HOT-2	I flew ah with $ his second to last night.		
18:51:11.9 HOT-1	is that right?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:51:12.6 CAM-2	# there's some good guys and it just # to see 'em go.		
18:51:14.9 HOT-1	you ever fly with ah $?		
18:51:22.8 CAM-2	fifty nine man. you'd never know it.		
18:51:25.7 HOT-1	ha tell me about it.		
18:51:27.6 CAM-2	my #.		
18:51:31.3 CAM-1	seven thousand feet here we are.		
18:51:33.4 CAM-2	seven.		
18:51:52.1 HOT-2	ah I'm gonna give em a quick update since we told 'em fifty.		
18:51:54.2 HOT-1	'kay.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:51:56.4 PA	ah folks just to give you a fast update we are estimating one more turn in the hold they're accepting aircraft back in ah Chicago Midway right now I think we're about three or four in the stack so hopefully we'll be heading that way as soon as we are we'll get back to ya but in the meantime folks thanks so much for your patience and hopefully we'll have you headin' towards the airport here in just a couple a minutes thanks.		
18:52:18.6 HOT-1	well eighteen thirty's goin'.		
18:52:21.9 HOT-2	yea and there is one more behind them and eh I thought they're at six the guys in front of us but.		
18:52:26.4 HOT-1	yeah.		
18:52:33.0 HOT-1	the other two seven zero.		
18:52:34.7 HOT-2	yeah they're heading back up.		
18:52:46.1 HOT-2	it's good that they're plowin'.		
18:52:58.9 HOT-1	Uniform.		
18:53:00.5 HOT-2	yeah that's another new one.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:53:03.4 HOT-2	zero zero two four		
18:53:03.9 HOT-1	light snow three quarter mile three hundred alright.		
18:53:08.4 HOT-2	zero nine zero at eleven I think I'm gonna put that in there.		
18:53:10.3 CAM	[sounds similar to two very faint clicks].		
18:53:12.3 HOT-1	alright.		
18:53:13.3 CAM-2	just in case.		
18:53:19.2 CAM-2	well this this for sure kills Salt Lake City for me.		
18:53:23.5 CAM-1	yeah.		
18:53:32.7 HOT-2	zero nine zero at eleven.		
18:53:40.3 HOT-2	thirty oh seven now oh we got that.		
18:53:44.8 HOT-1	on the altimeter? okay.		
18:53:44.8 HOT-2	three zero zero seven.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:53:49.0 HOT-2	at three quarters I could probably undo the RVR less than four thousand. we'll leave it in just in case.		
18:53:53.1 HOT-1	ahhhh well leave it in for now yeah that's the worst case.		
18:54:02.6 HOT-1	well yeah.		
18:54:04.4 HOT-2	eight knot tailwind.		
		18:54:10.4 CTR	Southwest ah twelve forty eight fly heading of ah two two zero.
		18:54:14.8 RDO-2	heading two two zero Southwest twelve forty eight.
18:54:17.4 HOT-1	two two zero here we go.		
18:54:39.9 CAM	[sound similar to two loud clicks]		
18:54:47.5 HOT-2	HILLS that sounds good.		
18:54:47.6 HOT-1	I got a HILLS up there but.		
18:54:53.5 CAM-1	I guess we can do that and extend it.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:54:56.4 CAM-2	cool.		
18:55:06.8 HOT-2	two fifty.		
18:55:07.3 HOT-1	'kay.		
		18:55:07.8 CTR	Southwest twelve forty eight maintain ah two one five knots please.
		18:55:11.6 RDO-2	okay ah two fifteen on the knots Southwest twelve forty eight.
18:55:14.3 HOT-1	three one five.		
18:55:16.6 HOT-1	how's that look to you.		
18:55:17.8 CAM-2	s'good.		
18:55:18.8 CAM-1	'kay.		
18:55:28.7 HOT	[Morse code signal for G S H].		
18:55:28.8 HOT-1	fifteen.		
18:55:43.4 HOT-1	(oh).		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:55:44.0 CAM-2	my side's up (the) DME for thirty one center.		
18:55:44.0 HOT	[Morse code signal for I M X T].		
18:55:47.1 HOT-1	okay.		
18:55:50.2 HOT-2	and (then) my side ID's.		
18:55:52.5 HOT-1	I might as well come over there with ya.		
		18:55:57.8 CTR	Southwest twelve forty eight turn further right heading zero one zero.
		18:56:01.7 RDO-2	heading zero one zero southwest twelve forty eight.
18:56:03.7 CAM-1	wow right turn zero one zero.		
18:56:05.9 CAM-2	yeah.		
18:56:15.4 HOT	[Morse code signal for I M X T].		
18:56:19.6 CAM-2	your side ID's so I'm gonna take off just for real quick second.		
18:56:22.3 CAM-1	'kay.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		18:56:23.6 RDO-2	hey Midway twelve forty eight.
18:56:25.5 HOT-1	lookin' good, still lookin' good okay.		
		18:56:26.1 OPS	twelve forty eight go.
		18:56:27.7 RDO-2	hey guys ha sorry for the late update looks like about ten after now they're just lettin' us leave holding now.
		18:56:36.1 OPS	okay copy that sir.
		18:56:37.5 RDO-2	thank you.
18:56:40.7 PA	and folks good news we're headin' towards the airport forty seven miles to go should be in the gate by about ten after thanks so much. and again everybody have a great night thanks so much for your patience.		
18:56:50.1 HOT-2	I'm back.		
18:56:51.2 HOT-1	okay.		
		18:56:52.2 CTR	Southwest twelve forty eight turn further right heading zero two zero.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		18:56:55.9 RDO-2	zero two zero Southwest twelve forty eight.
18:56:57.9 HOT-1	zero two zero now.		
18:57:00.2 HOT-2	whohoo.		
18:57:10.1 HOT-1	they're everywhere they're everywhere, okay.		
18:57:11.2 HOT-2	I know it.		
18:57:13.1 HOT-1	well I'll be sittin' up lookin'.		
18:57:27.1 HOT-1	we're gonna have a ah zero eight zero. or was it one zero zero?		
18:57:32.4 HOT-2	uhm you know what I'm sorry I didn't (even) write it down.		
		18:57:34.1 CTR	Southwest twelve forty eight turn right heading zero five zero.
		18:57:37.5 RDO-2	zero five zero for Southwest twelve forty eight.
18:57:39.5 HOT-1	zero five zero.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:57:40.4 HOT-2	it was.		
18:57:41.0 HOT-1	one hundred. at nine.		
18:57:41.8 HOT-2	yea * I think it was ninety. T-U-V.		
18:57:45.3 HOT-1	zero five zero.		
18:57:47.6 HOT-2	zero nine zero at eleven.		
18:57:48.8 HOT-1	alright zero nine zero so.		
18:57:50.3 HOT-2	little bit of a right crosswind.		
18:57:51.5 HOT-1	right cross so. comin' like this so I'll be lookin out this way here. little bit *.		
18:57:57.4 HOT-2	yeah.		
18:58:05.7 HOT-1	we'll be kinda doin' HUD. * doin' it on the HUD. once we get down there.		
18:58:09.9 HOT-2	yeah HGS.		
18:58:14.6 HOT-2	whatta we got six?		

INTRA-COCKPIT COMMUNICATION / AIR-GROUND COMMUNICATION

TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:58:15.3 HOT-1	two hundred.		
18:58:16.8 HOT-2	six thirteen.		
18:58:18.5 HOT-1	at six thirteen sixty five twenty two at three degrees.		
18:58:20.9 HOT-2	three degrees and three one center is sixty five twenty two.		
18:58:27.6 HOT-2	alright.		
18:58:30.2 HOT-2	# this is a long Chicago flight.		
18:58:33.6 HOT-2	I probably could have finished that revision.		
18:58:36.2 HOT-1	yeah so what'll they do ma- a stop ya here?		
18:58:39.8 CAM-2	I don’t know ah say we got out a here by it would be stupid to push us back have a half hour de-icing and then have it be a four hour five minute.		
18:58:49.6 CAM-2	right now nineteen. its four hours and five minutes of block to Vegas. so say nineteen forty five at the earliest.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:59:00.2 CAM-1	Hmmum.		
18:59:05.6 CAM-2	so it'll be nineteen *.		
18:59:11.0 CAM-2	yea I could go to Vegas I'd have twenty five minutes extra. even if we get out by twenty hundred.		
18:59:18.5 HOT-1	twenty hundred outta hear?		
18:59:19.8 CAM-2	That'd be five about five minutes early. and I.		
18:59:22.5 CAM-1	you got an hour.		
18:59:23.5 CAM-2	if it's.		
18:59:24.8 CAM-1	to get outta here.		
18:59:26.0 CAM-2	yea. that would give us five minutes. if it was.		
18:59:30.3 HOT-2	I mean if it was five minutes on the other end would you care if we called it in early so I didn't make a big problem? you know.		
18:59:36.5 HOT-1	no no I don't have a problem.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
18:59:37.3 HOT-2	if it's gonna be close then.		
18:59:38.6 HOT-1	yea do whatever you got the pencil.		
18:59:41.5 HOT-2	okay.		
18:59:42.2 HOT-1	[sound similar to laughter].		
18:59:48.2 HOT-2	looking good.		
18:59:48.3 HOT-1	we're looking good man.		
18:59:50.1 CAM-2	looking good Billy Ray.		
18:59:54.4 CAM-2	feeling good Mortimer.		
19:00:23.1 CAM-2	I bet they're gonna switch me here and do something else.		
19:00:26.0 CAM-1	think so?		
19:00:26.7 CAM-2	probably.		
19:00:28.6 CAM-1	I don't know if they've got that far ahead --		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:00:30.5 CAM-2	yea.		
19:00:30.7 CAM-1	they can think that far ahead today.		
19:00:40.0 CAM-1	you might wanna call 'em I don't know.		
19:00:41.1 CAM-2	yea I'm gonna just give 'em a (call).		
19:00:44.9 CAM-2	he said call me at Midway.		
		19:00:45.5 CTR	Southwest twelve forty eight fly heading of ah zero three zero.
		19:00:48.8 RDO-2	zero three zero southwest twelve forty eight.
19:00:52.6 HOT-1	zero tree zero here we go.		
19:00:54.5 HOT-2	yeah V-P-Z Valperazo.		
19:01:11.7 HOT-1	he might take us through uh.		
19:01:13.4 HOT-2	yea I'm going to hard altitude these.		
		19:01:15.9 CTR	Southwest twelve forty eight descend and maintain six thousand.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		19:01:19.3 RDO-2	six thousand Southwest twelve forty eight
19:01:21.4 HOT-1	down to six.		
19:01:24.1 CAM-2	six.		
19:01:27.3 CAM-2	seven for six.		
19:01:33.9 CAM	[sound similar to altitude warning horn].		
19:01:35.5 HOT-1	six point nine for six.		
19:01:41.3 HOT-1	its alive we're gonna go through it, yea.		
19:01:43.1 HOT-2	yea.		
		19:01:53.1 RDO-2	you don't want us Southwest twelve forty eight to join do ya?
		19:01:55.5 CTR	ah not yet sorry about that vector through the localizer fly heading of ah three six zero please.
		19:02:01.0 RDO-2	heading three six zero no problem Southwest twelve forty eight.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:02:06.0 HOT-1	three six zero.		
		19:02:27.1 CTR	Southwest twelve forty eight turn further left heading of ah three er correction a two niner zero intercept three one center localizer.
		19:02:35.1 RDO-2	heading two nine zero to join three one center loc Southwest twelve forty eight.
19:02:39.0 HOT-1	two nine zero to intercept.		
19:02:40.2 CAM-2	two ninety.		
		19:03:02.6 EXEC 902	ah yes sir do you know if the runway is contaminated at Midway?
19:03:05.7 CAM-2	[sound similar to laugh].		
		19:03:06.8 CTR	it is contaminated?
		19:03:08.7 EXEC 902	that's the question is it contaminated?
19:03:13.0 HOT-1	don't even think that. [sound similar to laughter].		
		19:03:13.9 CTR	exec jet nine zero two standby.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:03:15.2 HOT-2	there's the ah extended if you wanna use the L-NAV again.		
19:03:19.2 HOT-1	okay.		
19:03:24.0 HOT-1	we'll pick one.		
19:03:25.3 HOT-2	[sound similar to laughter]. whichever one it likes better.		
		19:03:31.6 CTR	Southwest twelve forty eight contact Chicago approach one one eight point four.
		19:03:35.5 RDO-2	eighteen four you have a great night Southwest twelve forty eight.
19:03:39.5 HOT-1	it's alive.		
19:03:40.6 HOT-2	yea.		
		19:03:41.6 RDO-2	hello Chicago Southwest twelve forty eight at six thousand.
		19:03:44.3 APR	Southwest twelve forty eight Chicago approach Victor current intercept three one center localizer runway three one center RVR five thousand five hundred.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:03:50.3 HOT-1	alright.		
		19:03:50.7 RDO-2	thanks alot southwest twelve forty eight we'll get Victor.
19:03:53.2 CAM-2	we're on Victor?		
19:03:53.3 CAM-1	* backup.		
19:03:57.5 HOT-2	time we got.		
19:04:06.0 HOT-2	* capture.		
19:04:06.9 CAM-1	alright capturing.		
19:04:08.8 CAM-1	victory.		
19:04:11.0 CAM-2	half a mile four hundred over thirty o' six.		
		19:04:12.8 APR	Southwest twelve forty eight is one eight miles from GLEAM cross GLEAM at four thousand cleared ILS three one center approach maintain ah you're doin' two ten correct?
19:04:14.3 CAM-1	I don't think that means - they can't keep up *.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:04:17.4 CAM-1	fifty five hundred (is the).		
19:04:20.2 HOT-1	beautiful day.		
		19:04:20.7 RDO-2	we're at two ten cleared for the ILS three one center * missed altitude if you gave us one.
		19:04:24.8 APR	ah four thousand cross GLEAM and two ten speed.
		19:04:28.3 RDO-2	GLEAM at four thousand two ten speed and we're cleared for the ILS three one center southwest twelve forty eight.
19:04:32.5 CAM-1	alright here we go.		
		19:04:32.6 APR	Southwest twelve forty eight braking action reported fair except at the end its ah poor.
		19:04:37.1 RDO-2	okay thanks.
19:04:38.8 HOT-1	we got fair in there right?		
19:04:40.2 HOT-2	yea.		
19:04:40.7 HOT-1	we got the max?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:04:42.6 HOT-2	[sound similar to laughter] we're all we're all counting on you.		
19:04:44.2 HOT-1	[sound similar to laughter].		
19:04:48.8 HOT-2	picked the wrong day to stop sniffin' glue.		
19:04:51.0 HOT-1	yea.		
19:04:52.4 CAM	[sound similar to two clicks].		
19:04:53.3 HOT-2	one more look for good measure.		
19:04:56.3 HOT-2	I think you look good and clean my man.		
19:04:58.0 HOT-1	alright.		
19:05:02.4 HOT-2	four until GLEAM.		
19:05:03.3 HOT-1	cleared the approach huh?		
19:05:04.8 HOT-2	yea.		
19:05:12.8 HOT-1	HILLS at four GLEAM at four.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:05:14.1 HOT-2	well yea he said GLEAM at four so we just have to make sure it doesn't wanna take you lower than GLEAM. lower than four at GLEAM.		
19:05:20.4 HOT-1	yea okay.		
19:05:22.7 HOT-2	I don't think it does but.		
19:05:26.6 HOT-1	cleared the approach though.		
19:05:31.0 HOT-2	one hundred at eleven.		
19:05:33.7 HOT-2	that's just about a *.		
19:05:34.1 HOT-1	[sound similar to autopilot disconnect warning horn].		
19:05:38.5 HOT-1	well that was nice.		
19:05:39.5 HOT-2	yea.		
19:05:40.0 HOT-1	[sound similar to laughter].		
19:05:42.6 CAM	[sound similar to altitude warning horn].		
19:05:44.0 HOT-1	alright forty nine for four.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:05:46.2 HOT-2	forty nine for four.		
19:05:47.3 HOT-1	try it again.		
19:05:51.2 HOT-1	alright.		
19:05:51.8 HOT-2	yea it's I remember this you were here for a while weren't ya.		
19:05:55.8 HOT-2	were you based in Chicago for a while?		
19:05:57.0 HOT-1	yea.		
19:05:58.0 HOT-2	is that where I'd flown with you?		
19:06:00.1 HOT-1	it was ah buh five years ago.		
19:06:02.2 HOT-2	five but I wasn't I wasn't here that long.		
19:06:20.7 HOT-1	what is it gonna be bumpy too or what?		
19:06:22.2 HOT-2	[sound similar to laughter] what Chicago sheee.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		19:06:44.2 APR	southwest nineteen fifty two Chicago approach intercept three one center localizer Victor's current the runway three one center RVR now four thousand five hundred.
19:06:51.5 HOT-2	forty five hundred.		
19:06:54.6 HOT-1	# [sound similar to laughter].		
		19:06:56.8 APR	Southwest twelve forty eight reduce speed one seven zero to RUNTS contact the tower at RUNTS.
		19:07:01.4 RDO-2	one seventy to RUNTS tower there have a great night southwest twelve forty eight.
19:07:04.1 HOT-1	alright slowin'.		
		19:07:05.1 APR	Southwest nineteen fifty two last report I had for runway three one center on the braking was ah braking fair except at the end it was poor.
19:07:10.5 HOT-1	go flaps to ah five please.		
19:07:12.9 HOT-2	flap-o de cinco.		
		19:07:19.1 APR	southwest ninety fifty two you copy last?

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		19:07:20.8 SW1952	I'm sorry sir no.
		19:07:22.3 APR	yea braking action on runway three one center is fair and then poor at the end as reported by company seven three.
19:07:51.2 HOT-1	let's see there's sixteen miles.		
19:07:54.1 HOT-1	still GLEAM is at eleven uh?		
19:07:55.5 HOT-1	yea.		
19:08:00.8 CAM-2	once we get over to tower I'll tell him that you wanna circle to two two left. [sound similar to laughter].		
19:08:05.7 CAM-1	yea.		
		19:08:18.7 SW1952	and ah was that braking action ah was that that poor was just or the fair was just at the end or what was the main part of the runway?
		19:08:25.0 APR	okay braking action was fair except at the end it was poor.
		19:08:31.8 APR	and we're just havin a Citation land now I'll get a new pilot report.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:08:34.5 HOT-1	oh we don't want him.		
19:08:35.5 HOT-2	no [sound similar to laughter].		
19:08:37.4 HOT-2	if it's poor we don't wanna hear it.		
19:08:38.8 HOT-1	no.		
19:08:42.2 HOT-2	GLEAM at four.		
19:08:44.3 HOT-2	after GLEAM you can go to twenty five.		
19:08:45.0 HOT-1	alright landing gear down here sir.		
19:08:47.8 HOT-2	landing gear down.		
19:08:50.0 HOT-1	down to twenty five here we go.		
19:08:55.0 HOT-1	at eleven point two huh? yea.		
19:08:56.2 HOT-2	yea after GLEAM.		
19:08:57.2 HOT-1	yea alright.		
19:08:57.5 HOT-2	you're close.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:08:58.5 HOT-1	ah we're close.		
19:09:00.0 HOT-2	I'll never tell.		
19:09:00.8 HOT-1	yea I know.		
19:09:08.0 HOT-1	close enough.		
19:09:09.0 HOT-2	yea.		
19:09:10.6 HOT-2	and after RUNTS we go to seventeen.		
19:09:13.1 HOT-1	I'll follow the glideslope down here.		
19:09:14.9 HOT-2	that's cool.		
19:09:41.6 HOT-1	alright let's go flaps to ah fifteen.		
19:09:43.8 HOT-2	flaps fifteen.		
19:09:44.2 CAM	[sound similar to metallic click].		
19:09:46.4 CAM	[sound similar to altitude warning horn].		
19:09:53.4 HOT-1	hmm.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		19:09:53.7 RDO-2	Southwest twelve forty eight three one center.
		19:09:57.6 TWR	Southwest twelve forty eight Midway tower continue for three one center the winds zero nine zero at nine brakin' action reported good for the first half, poor for the second half.
		19:10:06.2 RDO-2	thank you.
19:10:07.6 HOT-1	'kay.		
19:10:09.4 HOT-2	glideslope's good I'm gonna throw a twenty one for the missed.		
19:10:09.7 HOT-1	good for the first half.		
19:10:11.9 HOT-1	RUNTS is six point seven alright.		
19:10:16.2 HOT-1	alright glideslope looks like it's captured.		
19:10:18.3 HOT-2	yea and twenty one's the missed approach altitude.		
19:10:21.1 HOT-1	say again twenty one.		
19:10:21.8 HOT-1	okay.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:10:21.9 HOT-2	that's the missed if we need it.		
19:10:22.8 HOT-1	alright.		
19:10:25.0 HOT-1	ah let's go flaps to thirty sir.		
19:10:27.0 HOT-2	flaps thirty.		
19:10:38.3 CAM-1	yea good old tailwind *.		
19:10:39.9 CAM-2	yea.		
		19:10:41.2 TWR	Gulfstream three Kilo Foxtrot say brakin' action.
19:10:41.4 CAM-1	alright flaps forty.		
19:10:43.5 HOT-2	flaps forty.		
		19:10:46.0 G3KF	fair to poor.
		19:10:47.6 TWR	Three Kilo Foxtrot than ah thank you very much can you make a left on Alpha?
		19:10:52.8 G3KF	standby.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:10:54.1 HOT-1	before landing check.		
		19:10:54.7 TWR	if unable just let me know and go to the end.
19:10:56.1 CAM-2	speedbrake.		
		19:10:56.5 G3KF	yea we can make a left on Alpha.
19:10:57.1 HOT-1	armed green light.		
19:10:58.1 HOT-2	landing gear.		
19:10:59.2 HOT-1	down three green.		
19:10:59.9 HOT-2	flaps		
19:11:00.4 HOT-1	forty green light.		
19:11:01.4 HOT-2	before landing checks complete.		
19:11:03.9 HOT-1	thank you.		
19:11:04.4 CAM-2	no landing clearance yet.		
19:11:05.9 HOT-1	nope.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:11:16.7 HOT-1	I got (a) A three just disregard the ah approach warning if we get one.		
19:11:20.4 CAM-2	got it.		
19:11:31.3 HOT-1	'kay.		
19:11:34.6 CAM-2	comin' over HOBEL at seventeen.		
19:11:37.0 HOT-1	alright and a thousand feet one thirty six sink is a nine hundred.		
19:11:42.2 HOT-2	you can see the ground already.		
19:11:43.4 HOT-1	(yea) * (good).		
19:11:44.5 HOT-2	(one).		
19:11:46.5 HOT-1	no peaking.		
19:11:47.1 HOT-2	we're almost up to a thousand feet.		
19:11:50.0 HOT-2	now we're at a thousand feet.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:11:51.9 HOT-1	alright yea you're right thousand feet. one thirty two sink is ah eight fifty.		
19:11:53.2 HOT-2	I always.		
19:11:57.4 CAM	[sound similar to autopilot disconnect warning].		
19:12:00.3 HOT-2	we're all counting on you.		
19:12:01.6 HOT-1	uhmhmm.		
19:12:02.2 HOT-2	[sound similar to laughter].		
19:12:07.8 CAM	[sound similar to two clicks].		
19:12:16.9 HOT-1	never autobraked here huh?		
19:12:18.3 HOT-2	yeah. hang on tight [sound similar to laughter].		
19:12:21.6 HOT-1	yeah.		
19:12:25.3 HOT-2	five hundred.		
		19:12:26.6 RDO-2	landing clearance for Southwest twelve forty eight.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		19:12:28.4 TWR	Southwest twelve forty eight runway three one center cleared to land wind zero nine zero at nine brakin' action fair to poor.
19:12:35.3 HOT-2	four hundred.		
19:12:36.3 HOT-1	alright.		
19:12:37.2 HOT-2	five green lights cleared to land.		
19:12:41.0 HOT-2	approaching minimums.		
19:12:42.4 HOT-1	goin' outside. landing sir.		
19:12:45.6 HOT-2	alright.		
19:12:46.3 CAM	[sound of thump].		
19:12:47.2 HOT-1	might help.		
19:12:49.9 HOT-2	* a touch high on the glideslope.		
19:12:50.6 CAM	[sound similar to two thumps].		
19:12:56.5 HOT-2	one hundred.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:13:01.4 HOT-2	fifty. thirty. ten.		
19:13:02.7 CAM	[sound similar to click].		
19:13:07.1 CAM	[sound similar to click and squeak].		
19:13:07.8 CAM	[sounds similar to aircraft touchdown].		
19:13:08.5 HOT-1	oh baby I guess it comes on.		
19:13:11.5 HOT-1	come on baby.		
19:13:13.4 CAM-2	about two thousand feet to go.		
19:13:14.7 HOT-1	feel it.		
19:13:15.9 HOT-2	you jumpin' on the?		
19:13:16.3 HOT-1	son of a #.		
19:13:17.3 HOT-2	jump on the brakes are ya?		
19:13:18.4 HOT-1	ah huh.		
19:13:19.5 HOT-2	I'm ahnna.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:13:21.2 CAM-2	whaddya.		
19:13:22.3 HOT-1	#.		
19:13:23.2 CAM	[sound similar to double clunk].		
19:13:23.4 HOT-1	get that back there.		
19:13:25.3 HOT-1	we aint goin' man.		
19:13:27.5 HOT-2	we're #.		
19:13:28.7 HOT-1	we are #.		
19:13:30.6 HOT-1	alright keep it straight.		
19:13:31.2 CAM	[sound similar to increased engine noise].		
19:13:35.0 HOT-2	#.		
19:13:35.4 HOT-1	# hang on.		
19:13:35.9 HOT-2	hang on.		
19:13:36.5 CAM	[sound similar to impact].		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
19:13:37.3 HOT-2	*.		
19:13:39.0 CAM	[sound similar to impact].		
19:13:39.4 HOT-2	oh #.		
19:13:42.2 HOT-2	[sound similar to groan].		
19:13:43.3 HOT-1	[sound similar to grunt] # me.		
19:13:46.5 HOT-2	#.		
19:13:47.1 HOT-1	#.		
		19:13:47.5 TWR	what was that? Southwest twelve forty eight are you cleared three one center?
19:13:48.1 CAM	[sound similar to stick shaker].		
19:13:49.1 CAM	[sound similar to chime].		
19:13:51.0 CAM	[sound similar to clunk].		
		19:13:51.4 RDO-2	Southwest twelve forty eight went over the end.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME (CST) SOURCE	CONTENT	TIME (CST) SOURCE	CONTENT
		19:13:53.5 TWR	say again.
		19:13:54.3 RDO-2	we went off the end of the runway.
19:13:54.4 HOT-1	shut down.		
19:13:58.4 HOT-2	#.		
19:14:00.6 HOT-1	shuttin' down.		
[end of recording] 19:14:01.3			

End of Transcript

Appendix C

FAA Safety Alert For Operators 06012

SAFO

Safety Alert for Operators

U.S. Department
of Transportation
**Federal Aviation
Administration**

SAFO 06012
DATE: 8/31/06

Flight Standards Service
Washington, DC

http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo

A SAFO contains important safety information and may include recommended action. SAFO content should be especially valuable to air carriers in meeting their statutory duty to provide service with the highest possible degree of safety in the public interest.

Subject: Landing Performance Assessments at Time of Arrival (Turbojets)

1. Purpose. This SAFO urgently recommends that operators of turbojet airplanes develop procedures for flightcrews to assess landing performance based on conditions actually existing at time of arrival, as distinct from conditions presumed at time of dispatch. Those conditions include weather, runway conditions, the airplane's weight, and braking systems to be used. Once the actual landing distance is determined an additional safety margin of at least 15% should be added to that distance. Except under emergency conditions flightcrews should not attempt to land on runways that do not meet the assessment criteria and safety margins as specified in this SAFO.

2. Discussion: This SAFO is based on the FAA's policy statement published in the Federal Register on June 7, 2006, and incorporates revisions based on public comments received by the FAA. Accordingly, the FAA has undertaken rulemaking that would explicitly require the practice described above. Operators may use Operation/Management Specification paragraph C382 to record their voluntary commitment to this practice, pending rulemaking.

> **Operators engaged in air transportation have a statutory obligation to operate with the highest possible degree of safety in the public interest.**

3. Applicability:

a. This SAFO applies to all turbojet operators under Title 14 of the Code of Federal Regulations (14 CFR) parts 121, 135, 125, and 91 subpart K. The intent of providing this information is to assist operators in developing methods of ensuring that sufficient landing distance exists to safely make a full stop landing with an acceptable safety margin on the runway to be used, in the conditions existing at the time of arrival, and with the deceleration means and airplane configuration that will be used. The FAA considers a 15% margin between the expected actual airplane landing distance and the landing distance available at the time of arrival as the minimum acceptable safety margin for normal operations.

b. The FAA acknowledges that there are situations where the flightcrew needs to know the absolute performance capability of the airplane. These situations include emergencies or abnormal and irregular configurations of the airplane such as engine failure or flight control malfunctions. In these circumstances, the pilot must consider whether it is safer to remain in the air or to land immediately and must know the actual landing performance capability (without an added safety margin) when making these evaluations. This guidance is not intended to curtail such evaluations from being made for these situations.

c. This guidance is independent of the preflight landing distance planning requirements of part 121, section 121.195, part 135, section 135.385, and part 91, section 91.1037.

d. This 15% safety margin should not be applied to the landing distance determined for compliance with any other OpSpec/MSpec requirement. The landing distance assessment of this guidance is independent of any other OpSpec/MSpec landing distance requirement. The minimum landing distance should comply with all applicable landing distance requirements. Hence, the minimum landing distance at the time of arrival should be the longer of the landing distance in this guidance and that determined to be in compliance with any other applicable OpSpec/MSpec.

e. This guidance does not apply to Land and Hold Short Operations (LAHSO).

4. Definitions: The following definitions are specific to this guidance and may differ with those definitions contained in other published references.

a. Actual Landing Distance. The landing distance for the reported meteorological and runway surface conditions, runway slope, airplane weight, airplane configuration, approach speed, use of autoland or a Head-up Guidance System, and ground deceleration devices planned to be used for the landing. It does not include any safety margin and represents the best performance the airplane is capable of for the conditions.

b. Airplane Ground Deceleration Devices. Any device used to aid in the onset or rate of airplane deceleration on the ground during the landing roll out. These would include, but not be limited to: brakes (either manual braking or the use of autobrakes), spoilers, and thrust reversers.

c. At Time of Arrival. For the purpose of this guidance means a point in time as close to the airport as possible consistent with the ability to obtain the most current meteorological and runway surface conditions considering pilot workload and traffic surveillance, but no later than the commencement of the approach procedures or visual approach pattern.

d. Braking Action Reports. The following braking action reports are widely used in the aviation industry and are furnished by air traffic controllers when available. The definitions provided below are consistent with how these terms are used in this guidance.

> Good – More braking capability is available than is used in typical deceleration on a non-limiting runway (i.e., a runway with additional stopping distance available). However, the landing distance will be longer than the certified (unfactored) dry runway landing distance, even with a well executed landing and maximum effort braking.
>
> Fair/Medium – Noticeably degraded braking conditions. Expect and plan for a longer stopping distance such as might be expected on a packed or compacted snow-covered runway.

Poor – Very degraded braking conditions with a potential for hydroplaning. Expect and plan for a significantly longer stopping distance such as might be expected on an ice-covered runway.

Nil – No braking action and poor directional control can be expected.

NOTE: Conditions specified as "nil" braking action are not considered safe, therefore operations under conditions specified as such should not be conducted. Do not attempt to operate on surfaces reported or expected to have nil braking action.

e. Factored Landing Distance. The landing distance required by 14 CFR part 25, section 25.125 increased by the preflight planning safety margin additives required by the applicable operating rules. (Some manufacturers supply factored landing distance information in the Airplane Flight Manual (AFM) as a service to the user.)

f. Landing Distance Available. The length of the runway declared available for landing. This distance may be shorter than the full length of the runway.

g. Meteorological Conditions. Any meteorological condition that may affect either the air or ground portions of the landing distance. Examples may include wind direction and velocity, pressure altitude, and temperature. An example of a possible effect that must be considered includes crosswinds affecting the amount of reverse thrust that can be used on airplanes with tail mounted engines due to rudder blanking effects.

h. Reliable Braking Action Report. For the purpose of this guidance, means a braking action report submitted from a turbojet airplane with landing performance capabilities similar to those of the airplane being operated.

i. Runway Surface Conditions. The state of the surface of the runway: either dry, wet, or contaminated. A dry runway is one that is clear of contaminants and visible moisture within the required length and the width being used. A wet runway is one that is neither dry nor contaminated. For a contaminated runway, the runway surface conditions include the type and depth (if applicable) of the substance on the runway surface, e.g., standing water, dry snow, wet snow, slush, ice, sanded, or chemically treated.

j. Runway Friction or Runway Friction Coefficient. The resistance to movement of an object moving on the runway surface as measured by a runway friction measuring device. The resistive force resulting from the runway friction coefficient is the product of the runway friction coefficient and the weight of the object.

k. Runway Friction Enhancing Substance. Any substance that increases the runway friction value.

l. Safety Margin. The length of runway available beyond the actual landing distance. Safety margin can be expressed in a fixed distance increment or a percentage increase beyond the actual landing distance required.

m. Unfactored Certified Landing Distance. The landing distance required by section 25.125 without any safety margin additives. The unfactored certified landing distance may be different from the actual landing distance because not all factors affecting landing distance are required to be accounted for by section 25.125. For example, the unfactored certified landing distances are based on a dry, level (zero slope) runway at standard day temperatures, and do not take into account the use of autobrakes, autoland systems, head-up guidance systems, or thrust reversers.

5. Background: After any serious aircraft accident or incident, the FAA typically performs an internal audit to evaluate the adequacy of current regulations and guidance information in areas that come under scrutiny during the course of the accident investigation. The Southwest Airlines landing overrun accident involving a Boeing 737-700 at Chicago Midway Airport in December 2005 initiated such an audit. The types of information that were evaluated in addition to the regulations were FAA orders, notices, advisory circulars, ICAO and foreign country requirements, airplane manufacturer-developed material, independent source material, and the current practices of air carrier operators. This internal FAA review revealed the following issues:

a. A survey of operators' manuals indicated that approximately fifty percent of the operators surveyed do not have policies in place for assessing whether sufficient landing distance exists at the time of arrival, even when conditions (including runway, meteorological, surface, airplane weight, airplane configuration, and planned usage of decelerating devices) are different and worse than those planned at the time the flight was released.

b. Not all operators who perform landing distance assessments at the time of arrival have procedures that account for runway surface conditions or reduced braking action reports.

c. Many operators who perform landing distance assessments at the time of arrival do not apply a safety margin to the expected actual landing distance. Those that do are inconsistent in applying an increasing safety margin as the expected actual landing distance increased (i.e., as a percentage of the expected actual landing distance).

d. Some operators have developed their own contaminated runway landing performance data or are using data developed by third party vendors. In some cases, these data indicate shorter landing distances than the airplane manufacturer's data for the same conditions. In other cases, an autobrake landing distance chart has been misused to generate landing performance data for contaminated runway conditions. Also, some operators' data have not been kept up to date with the manufacturer's current data.

e. Credit for the use of thrust reversers in the landing performance data is not uniformly applied and pilots may be unaware of these differences. In one case, there were differences found within the same operator from one series of airplane to another within the same make and model. The operator's understanding of the data with respect to reverse thrust credit, and the information conveyed to pilots, were both incorrect.

f. Airplane flight manual (AFM) landing performance data are determined during flight-testing using flight test and analysis criteria that are not representative of everyday operational practices. Landing distances determined in compliance with 14 CFR part 25, section 25.125 and published in the FAA-approved AFM do not reflect operational landing distances (Note: some manufacturers provide factored landing distance data that addresses operational requirements.) Landing distances determined during certification tests are aimed at demonstrating the shortest landing distances for a given airplane weight with a test pilot at the controls and are established with full awareness that operational rules for normal operations require additional factors to be added for determining minimum operational field lengths. Flight test and data analysis techniques for determining landing distances can result in the use of high touchdown sink rates (as high as 8 feet per second) and approach angles of -3.5 degrees to minimize the airborne portion of the landing distance. Maximum manual braking, initiated as soon as possible after landing, is used in order to minimize the braking portion of the landing distance. Therefore, the landing distances determined under section 25.125 are shorter than the landing distances achieved in normal operations.

g. Wet and contaminated runway landing distance data are usually an analytical computation using the dry, smooth, hard surface runway data collected during certification. Therefore, the wet and contaminated runway data may not represent performance that would be achieved in normal operations. This lack of operational landing performance repeatability from the flight test data, along with many other variables affecting landing distance, are taken into consideration in the preflight landing performance calculations by requiring a significant safety margin in excess of the certified (unfactored) landing distance that would be required under those conditions. However, the regulations do not specify a particular safety margin for a landing distance assessment at the time of arrival. This safety margin has been left largely to the operator and/or the flightcrew to determine.

h. Manufacturers do not provide advisory landing distance information in a standardized manner. However, most turbojet manufacturers make landing distance performance information available for a range of runway or braking action conditions using various airplane deceleration devices and settings under a variety of meteorological conditions. This information is made available in a wide variety of informational documents, dependent upon the manufacturer.

i. Manufacturer-supplied landing performance data for conditions worse than a dry, smooth runway is normally an analytical computation based on the dry runway landing performance data, adjusted for a reduced airplane braking coefficient of friction available for the specific runway surface condition. Most of the data for runways contaminated by snow, slush, standing water, or ice were developed to show compliance with European Aviation Safety Agency and Joint Aviation Authority airworthiness certification and operating requirements. The FAA considers the data developed for showing compliance with the European contaminated runway certification or operating requirements, as applicable, to be acceptable for making landing distance assessments for contaminated runways at the time of arrival.

6. Recommended Action:

a. A review of the current applicable regulations indicates that the regulations do not specify the type of landing distance assessment that must be performed at the time of arrival, but operators are required to restrict or suspend operations when conditions are hazardous.

b. 14 CFR part 121, section 121.195(b), part 135, section 135.385(b), and part 91, section 91.1037(b) and (c) require operators to comply with certain landing distance requirements at the time of takeoff. (14 CFR part 125, section 125.49 requires operators to use airports that are adequate for the proposed operation). These requirements limit the allowable takeoff weight to that which would allow the airplane to land within a specified percentage of the landing distance available on: (1) the most favorable runway at the destination airport under still air conditions;

and (2) the most suitable runway in the expected wind conditions. Sections 121.195(d), 135.385(d), and 91.1037(e) further require an additional 15 percent to be added to the landing distance required when the runway is wet or slippery, unless a shorter distance can be shown using operational landing techniques on wet runways. Although an airplane can be legally dispatched under these conditions, compliance with these requirements alone does not ensure that the airplane can safely land within the distance available on the runway actually used for landing in the conditions that exist at the time of arrival, particularly if the runway, runway surface condition, meteorological conditions, airplane configuration, airplane weight, or use of airplane ground deceleration devices is different than that used in the preflight calculation. Part 121, sections 121.533, 121.535, 121.537, part 135, section 135.77, part 125, section 125.351, and part 91, sections 91.3, and 91.1009 place the responsibility for the safe operation of the flight jointly with the operator, pilot in command, and dispatcher as appropriate to the type of operation being conducted.

c. Sections 121.195(e) and 135.385(e), allow an airplane to depart even when it is unable to comply with the conditions referred to in item (2) of paragraph 5b above if an alternate airport is specified where the airplane can comply with conditions referred to in items (1) and (2) of paragraph 5b. This implies that a landing distance assessment is accomplished before landing to determine if it is safe to land at the destination, or if a diversion to an alternate airport is required.

d. Part 121, sections 121.601 and 121.603, require dispatchers to keep pilots informed, or for pilots to stay informed as applicable, of conditions, such as airport and meteorological conditions, that may affect the safety of the flight. Thus, the operator and flightcrew use this information in their safety of flight decision making. Part 121, sections 121.551, 121.553, and part 135, section 135.69, require an operator, and/or the pilot in command as applicable, to restrict or suspend operations to an airport if the conditions, including airport or runway surface conditions, are hazardous to safe operations. Part 125 section 125.371 prohibits a pilot in command (PIC) from continuing toward any airport to which it was released unless the flight can be completed safely. A landing distance assessment should be made under the conditions existing at the time of arrival in order to support a determination of whether conditions exist that may affect the safety of the flight and whether operations should be restricted or suspended.

e. Runway surface conditions may be reported using several types of descriptive terms including: type and depth of contamination, a reading from a runway friction measuring device, an airplane braking action report, or an airport vehicle braking condition report. Unfortunately, joint industry and multi-national government tests have not established a reliable correlation between runway friction under varying conditions, type of runway contaminants, braking action reports, and airplane braking capability. Extensive testing has been conducted in an effort to find a direct correlation between runway friction measurement device readings and airplane braking friction capability. However, these tests have not produced conclusive results that indicate a repeatable correlation exists through the full spectrum of runway contaminant conditions. Therefore, operators and flightcrews cannot base the calculation of landing distance solely on runway friction meter readings. Likewise, because pilot braking action reports are subjective, flightcrews must use sound judgment in using them to predict the stopping capability of their airplane. For example, the pilots of two identical aircraft landing in the same conditions, on the same runway could give different braking action reports. These differing reports could be the result of differences between the specific aircraft, aircraft weight, pilot technique, pilot experience in similar conditions, pilot total experience, and pilot expectations. Also, runway surface conditions can degrade or improve significantly in very short periods of time dependent on precipitation, temperature, usage, and runway treatment and could be significantly different than indicated by the last report. Flightcrews must consider all available information, including runway surface condition reports, braking action reports, and friction measurements.

(1) Operators and pilots should use the most adverse reliable braking action report, if available, 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 prior to landing. Operators and pilots should consider the following factors in determining the actual landing distance: the age of the report, meteorological conditions present since the report was issued, type of airplane or device used to obtain the report, whether the runway surface was treated since the report, and the methods used for that treatment. Operators and pilots are expected to use sound judgment in determining the applicability of this information to their airplane's landing performance.

(2) Table 1 provides an example of a correlation between braking action reports and runway surface conditions:

Braking Action	Dry (not reported)	Good	Fair/Medium	Poor	Nil
Contaminant	Dry	Wet Dry Snow (< 20mm)	Packed or Compacted Snow	Wet Snow Slush Standing Water Ice	Wet ice

Table 1. Relationship between braking action reports and runway surface condition (contaminant type)

NOTE: Under extremely cold temperatures, these relationships may be less reliable and braking capabilities may be better than represented. This table does not include any information pertaining to a runway that has been chemically treated or where a runway friction enhancing substance has been applied.

f. Some advisory landing distance information uses a standard air distance of 1000 feet from 50 feet above the runway threshold to the touchdown point. Unfactored dry runway landing distances in AFMs reflect the distances demonstrated during certification flight testing. These unfactored AFM landing distance data include air distances that vary with airplane weight, but are also nominally around 1000 feet. A 1000 foot air distance is not consistently achievable in normal flight operations. Additionally, the use of automatic landing systems (autoland) and other landing guidance systems (e.g., head-up guidance systems) typically result in longer air distances. Operators are expected to apply adjustments to this air distances to reflect their specific operations, operational practices, procedures, training, and experience.

g. To ensure that an acceptable landing distance safety margin exists at the time of arrival, the FAA recommends that at least a 15% safety margin be provided. This safety margin represents the minimum distance margin that must exist between the expected actual landing distance at the time of arrival and the landing distance available, considering the meteorological and runway surface conditions, airplane configuration and weight, and the intended use of airplane ground deceleration devices. In other words, the landing distance available on the runway to be used for landing must allow a full stop landing, in the actual conditions and airplane configuration at the time of landing, and at least an additional 15% safety margin.

h. Operator compliance can be accomplished by a variety of methods and procedurally should be accomplished by the method that best suits the operator's current procedures. The operator's procedures should be clearly articulated in the operations manual system for affected personnel. The following list of methods is not all inclusive, or an endorsement of any particular methods, but provided as only some examples of methods of compliance.

- Establishment of a minimum runway length required under the worst case meteorological and runway surface conditions for operator's total fleet or fleet type that will provide runway lengths that comply with this guidance.

- The requirements of this paragraph could be considered along with the other applicable preflight landing distance calculation requirements and the takeoff weight adjusted to provide for compliance at the time of arrival under the conditions and configurations factored in the calculation. This information, including the conditions/configurations/etc. used in the calculation, would be provided to the flightcrew as part of the release/dispatch documents. (However, this method may not be sufficient if conditions/configurations/etc. at the time of arrival are different than those taken into account in the preflight calculations; therefore, the flightcrew would need to have access to the landing performance data applicable to the conditions present upon arrival.

- Tab or graphical data accounting for the applicable variables provided to the flightcrew and/or dispatcher as appropriate to the operator's procedures.

- Electronic Flight Bag equipment that has methods for accounting for the appropriate variables.

  NOTE: These are only some examples of methods of compliance. There are many others that would be acceptable.

7. Summary of Recommendation.

a. Turbojet operators have procedures to ensure that a full stop landing, with at least a 15% safety margin beyond the actual landing distance, can be made on the runway to be used, in the conditions existing at the time of arrival, and with the deceleration means and airplane configuration that will be used. This assessment should take into account the meteorological conditions affecting landing performance (airport pressure altitude, wind velocity, wind direction, etc.), surface condition of the runway to be used for landing, the approach speed, airplane weight and configuration, and planned use of airplane ground deceleration devices. The airborne portion of the actual landing distance (distance from runway threshold to touchdown point) should reflect the operator's specific operations, operational practices, procedures, training, and experience. Operators should have procedures for compliance with this guidance, absent an emergency, after the flightcrew makes this assessment using the air carrier's procedures, if at least the 15% safety margin is not available, the pilot should not land the aircraft.

(1) This assessment does not mean that a specific calculation must be made before every landing. In many cases, the before takeoff criteria, with their large safety margins, will be adequate to ensure that there is sufficient landing distance with at least a 15% safety margin at the time of arrival. Only when the conditions at the destination airport deteriorate while en route (e.g., runway surface condition, runway to be used, winds, airplane landing weight/configuration/speed/deceleration devices) or the takeoff was conducted under the provisions described in paragraph 5 (c) of this guidance, would a calculation or other method of determining the actual landing distance capability normally be needed. The operator should develop procedures to determine when such a calculation or other method of determining the expected actual landing distance is necessary to ensure that at least a 15% safety margin will exist at the time of arrival.

(2) Operators may require flight crews to perform this assessment, or may establish other procedures to conduct this assessment. Whatever method(s) the operator develops, its procedures should account for all factors upon which the preflight planning was based and the actual conditions existing at time of arrival.

b. Confirm that the procedures and data used to comply with paragraph 6 (a) above for actual landing performance assessments yield results that are at least as conservative as the manufacturer's approved or advisory information for the associated conditions provided therein. Although the European contaminated runway operations requirements are applied differently than the requirements of this guidance, the operator may choose to use data developed for showing compliance with the European contaminated runway operating requirements for making these landing distance assessments for contaminated runways at the time of arrival.

c. A safety margin of 15% should be added to the actual landing distance and require that the resulting distance be within the landing distance available of the runway used for landing. Note that the FAA considers a 15% margin to be the minimum acceptable safety margin.

d. If wet or contaminated runway landing distance data are unavailable, the factors in Table 2 should be applied to the pre-flight planning (factored) dry runway landing distances determined in accordance with the applicable operating rule (e.g., sections 91.1037, 121.195(b) or 135.385(b). Table 2 should only apply when no such data are available. The factors in Table 2 include the 15% safety margin recommended by this guidance, and are considered to include an air distance representative of normal operational practices. Therefore, operators do not need to apply further adjustments to the resulting distances to comply with the recommendations of this guidance.

Runway Condition	Reported Braking Action	Factor to apply to (factored) dry runway landing distance*
Wet Runway, Dry Snow	Good	0.9
Packed or Compacted Snow	Fair/Medium	1.2
Wet snow, slush, standing water, ice	Poor	1.6
Wet ice	Nil	Landing is prohibited

Table 2. Multiplication factors to apply to the factored dry runway landing distances when the data for the specified runway condition are unavailable.

* The factored dry runway landing distances for use with Table 2 must be based on landing within a distance of 60% of the effective length of the runway, even for operations where the preflight planning (factored) dry runway landing distances are based on landing within a distance other than 60% of the effective length of the runway (e.g., certain operations under part 135 and subpart K of par t91). To use unfactored dry runway landing distances, first multiply the unfactored dry runway landing distance by 1.667 to get the factored dry runway landing distance before entering Table 2 above.

> **NOTE: These factors assume maximum manual braking, autospoilers (if so equipped), and reverse thrust will be used. For operations without reverse thrust (or without credit for the use of reverse thrust) multiply the results of the factors in Table 2 by 1.2. These factors cannot be used to assess landing distance requirements with autobrakes.**

e. The landing distance assessment should be accomplished as close to the time of arrival as practicable, taking into account workload considerations during critical phases of flight, using the most up-to-date information available at that time. The most adverse braking condition, based on reliable braking reports or runway contaminant reports (or expected runway surface conditions if no reports are available) for the portion of the runway that will be used for the landing should be used in the actual landing performance assessment. For example, if the runway surface condition is reported as fair to poor, or fair in the middle, but poor at the ends, the runway surface condition should be assumed to be poor for the assessment of the actual landing distance. (This example assumes the entire runway will be used for the landing). If conditions change between the time that the assessment is made and the time of landing, the flightcrew should consider whether it would be safer to continue the landing or reassess the landing distance.

f. The operator's flightcrew and dispatcher training programs should include elements that provide knowledge in all aspects and assumptions used in landing distance performance determinations. This training should emphasize the airplane ground deceleration devices, settings, and piloting methods (e.g., air distance) used in determining landing distances for each make, model, and series of airplane. Elements such as braking action reports, airplane configuration, optimal stopping performance techniques, stopping margin, the effects of excess speed, delays in activating deceleration devices, and other pilot performance techniques should be covered. All dispatchers and flightcrew members should be trained on these elements prior to operations on contaminated runway surfaces. This training should be accomplished in a manner consistent with the operator's methods for conveying similar knowledge to flight operations personnel. It may be conducted via operations/training bulletins or extended learning systems, if applicable to the operator's current methods of training.

g. Procedures for obtaining optimal stopping performance on contaminated runways should be included in flight training programs. All flight crewmembers should be made aware of these procedures for the make/model/series of airplane they operate. This training should be accomplished in a manner consistent with the operator's methods for conveying similar knowledge to flight operations personnel. It may be conducted via operations/training bulletins or extended learning systems, if applicable to the operator's current methods of training. In addition, if not already included, these procedures should be incorporated into each airplane or simulator training curriculum for initial qualification on the make/model/series airplane, or differences training as appropriate. All flight crewmembers should have hands on training and validate proficiency in these procedures during their next flight training event, unless previously demonstrated with their current employer in that make/model/series of airplane.