



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 4, 2007

In reply refer to: A-07-57

Mr. Robert Sturgell
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On December 8, 2005, about 1914 central standard time, Southwest Airlines (SWA) flight 1248, a Boeing 737-74H, N471WN, ran off the departure end of runway 31C after landing at Chicago Midway International Airport (MDW), Chicago, Illinois.¹ 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 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, in part,² was SWA's failure to include a margin of safety in the arrival landing distance assessment to account for operational uncertainties.

¹ For more information, see *Runway Overrun and Collision, Southwest Airlines Flight 1248, Boeing 737-74H, N471WN, Midway Airport, Chicago, Illinois, December 8, 2005*, Aviation Accident Report NTSB/AAR-07/06 (Washington, DC: NTSB, 2007).

² The full statement of contributing factors adopted by the Safety Board reads as follows: "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

The Federal Aviation Administration (FAA) requires 14 CFR 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.³ The manufacturer's flight test data upon which these preflight 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.⁴ 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, which are not required by the FAA, assist pilots in ensuring that they will be able to land the airplane and safely stop on the intended runway given the actual 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.

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. In summary, depending on an operator's policies, pilots may not be required to conduct arrival landing assessments; may conduct such assessments based on variable landing

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."

³ Preflight landing distance calculations are based on forecast, not actual, conditions at the destination at time of arrival.

⁴ 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.

performance data sources, assumptions, and calculation methods; and/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 on board performance computer (OPC)⁵ did not account for reasonable operational variations. This is of particular concern because SWA's policies at the time of the accident and its 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 further notes that preflight safety margins alone may not be sufficient to ensure adequate stopping margins at arrival. After the accident, SWA incorporated an additional 15 percent safety margin to account for operational variations and uncertainties into its arrival 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 immediately 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 Operations Specification (OpSpec) N 8400.C082, which would have required 14 CFR Part 121, 135, and 91 subpart K 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 Safety Alert For Operators (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.

⁵ 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 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.⁶ 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.⁷ 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;⁸ 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.

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. The circumstances of the flight 1248 accident (among others) demonstrate that conditions⁹ 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."

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 European Aviation Safety Agency and Joint Aviation Authorities operational requirements for

⁶ 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.nts.gov/ntsb/query.asp>>.

⁷ This accident investigation is ongoing at the time of this writing. Additional information on this accident, DCA07FA037, is available on the Safety Board's Web site at <<http://www.nts.gov/ntsb/query.asp>>.

⁸ 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.

⁹ 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.

contaminated runway landing performance. Although during public hearing testimony¹⁰ 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 the Board's Safety Recommendation A-06-16. However, the FAA subsequently sought voluntary operator implementation of such actions through SAFO 06012; although SAFO 06012 contains similar information to OpSpec N 8400.C082, compliance with the SAFO is not required by the FAA.¹¹ Because the FAA has had adequate time to require landing distance assessments and implement a landing distance safety margin but has not, Safety Recommendation A-06-16 was classified "Open—Unacceptable Response" on May 8, 2007.

Because the FAA has not required actions to address urgent Safety Recommendation A-06-16, 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. The Board recognizes that development of a standardized methodology for arrival landing distance assessments will take time. Therefore, the Safety Board believes that, until a standardized methodology 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" and the superceding safety recommendation will maintain the status of "Open—Unacceptable Response."

¹⁰ The Safety Board held a public hearing on this accident on June 21 and 22, 2006, in Washington, DC. The Board may hold a public hearing as part of its investigation into an accident to supplement the factual record of the investigation. The Board calls technical experts and material witnesses to testify, and Board investigative staff and designated representatives from the parties to the investigation ask questions to obtain additional factual information. The hearing is not intended to analyze factual information for cause.

¹¹ 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.

Therefore, the National Transportation Safety Board recommends that 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

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred with this urgent safety recommendation.

[Original Signed]

By: Mark V. Rosenker
Chairman

Safety Recommendation Reiteration List

SR Number	Reiteration Number	Report Number	Report Date	Accident Description	Accident City	Accident State	Accident Date
A-07-057	1	AAR-08-02	6/10/2008	Runway Overrun During Landing Pinnacle Airlines Flight 4712 Bombardier/Canadair Regional Jet CL600-2B19, N8905F	Traverse City	MI	4/12/2007