NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

October 16, 2006

Human Performance and Operational Factors Survey

DCA06MA009

A. ACCIDENT

Location:	Chicago Midway International Airport (MDW), Chicago, IL
Date:	December 08, 2005
Time:	1914 central standard time
Operator:	Southwest Airlines, Inc. (SWA)
Airplane:	Boeing 737-7H4, N471WN

B. INVESTIGATORS

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C. SUMMARY

On December 8, 2005, at 1914 central standard time, Southwest Airlines flight 1248, a Boeing 737-7H4 registered as N471WN, over-ran runway 31C at Chicago Midway International Airport (MDW) in Chicago, Illinois, during the landing rollout. The airplane departed the end of the runway, rolled through a blast fence, a perimeter fence, and onto the roadway. The airplane came to a stop after impacting one automobile. There were 98 passengers and 5 crewmembers on board; there was one ground fatality. Instrument meteorological conditions (IMC) prevailed at the time. The airplane was substantially damaged. The flight was conducted under 14 CFR Part 121 of the Federal Aviation Regulations (FARS) and had departed from the Baltimore / Washington International Thurgood Marshall Airport (BWI), Baltimore, Maryland.

D. DETAILS OF THE SURVEY

The human performance and operational factors investigators conducted an informal survey of seven operators to document industry practices concerning en-route landing performance assessments at the time of the accident. The following topics were reviewed: (E.1) requirements, method and data, (E.2) assumptions, and (E.3) guidance related to stopping margins and landing on contaminated runways.

This survey was conducted in August 2006 with four operators using onboard performance computers[1] and three operators using traditional performance charts. In response to FAA's Ops Spec C.082 (issued in June 2006, with a September 2006 deadline), operators were in the process of identifying and implementing required changes to meet these new guidelines.[2] This document focuses on practices at the time of the accident.

E. SURVEY INFORMATION

Operators were queried regarding their practices and requirements for landing performance assessments made en-route. Operators were not chosen or excluded based on the makeup of aircraft in their fleet. Some of the operators in this survey maintain only one make and model of aircraft (e.g., Boeing 737 or Airbus A319/320), and others a variety, although effort was made to distinguish practices between aircraft if within the same operator.

E.1 Requirements, Method and Data

E.1.1 Requirements

Three of seven operators required pilots to calculate en-route landing performance assessments. One operator required this of pilots only if they were unable to contact dispatch, although dispatch was required to calculate the landing distance prior to every approach. Three operators allowed pilots to decide themselves whether a calculation was necessary or desired.

E.1.2 Method

Four operators used onboard performance computers to calculate landing distances and three operators used traditional performance charts. For three of the four operators using onboard performance computers, only one aircraft model in their fleet was equipped. For two of these three operators, it was the goal to eventually equip the entire fleet with onboard performance computers.

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[1] SWA was not included in this list. Three of the four operators used software developed and maintained by an outside source; the fourth operator developed and maintained their own software in-house.
[2] Ops Spec C.082 was later converted to SAFO 06012, September 2006.

E.1.3 Data Source and Applied Factors

For six operators, at least some of the performance calculations were based on certified, demonstrated data.[3] Certified data was presented to pilots in the unfactored format, as the actual landing distances, or re-factored according to internal company guidelines. One carrier only used certified data in factored format.[4]

Five of the operators based some of the performance calculations on uncertified data derived from modeling programs and based on rates of deceleration for various runway contamination levels.[5] The percentage factored, if at all, varied between operator, by runway contamination and by braking method. One operator only used uncertified data.

Two of the operators using performance computers were not aware of the basis of the data or the factors applied, and relied on outside software vendors to coordinate these efforts.[6]

The survey documented that the source of the data and the aircraft manufacturer determines, in part, the options for runway contamination level and/or pilot braking action. As a rule, certified data is usually associated with dry or wet surfaces only, and uncertified data with a range of contamination levels. Six operators provided data for dry and wet conditions, and one of these for dry, wet, or wet/grooved. Three of these six also provided a range of options for runway contamination (e.g., ½" slush). Two of the operators provided options only for reported braking action (e.g., fair).

E.2 Assumptions

E.2.1 Reverse Thrust Assumptions

Five of the seven operators did not include reverse thrust in the calculations. For both operators that did include reverse thrust, pilots calculated landing distances manually with a tabular chart, which included a column for pilots to adjust the landing distance with one or both reversers inoperable. For one of these two operators, reverse thrust was only included for non-normal landings.[7]

E.2.2 Wind Limit Assumptions

Three of the seven operators applied factors to the actual head and tailwinds consistent with what is required for Part 121 dispatch calculations (50% of the value of

[3] Which also is used for calculations made by dispatch prior to departure, and required of all Part 121 carriers.
[4] In accordance with Part 121 requirements for dispatch calculations.
[5] A common practice is to use certified data for normal operations and uncertified data for contaminated runways.
[6] In these cases, the information was obtained from the vendor.
[7] With runway contamination.

headwind, and 150% value of the tailwind). There were no factors applied to wind for the remaining four operators.

For each aircraft type, there is a tailwind component maximum. For operators using performance charts, this information is stated in the assumptions list on the chart itself.[8] For one of the four operators using performance computers, when the tailwind component was exceeded, landing distance data was still provided; pilots were advised of this through a flashing reference speed.[9] For the other three operators using performance computers, no landing distance data was provided, although this had not always been the case.[10]

E.2.3 Air Distance[11] Assumptions

Four of the seven operators based the landing distance calculations on 1500' air distance, two on 1000' air distance, and one operator was unable to confirm.[12]

E.2.4 Presentation of Assumptions

With performance charts, assumptions are printed on the chart itself, and two of the three operators went further to include an introductory page to the performance section outlining the assumptions for all charts. This includes information on air distance, reverse thrust, winds and margins (or lack thereof).

Assumptions for computer programs are more difficult to present, but can either be annunciated on the computer display or presented in the pilot manual. For the three operators that included wind margins in the calculations, there was no indication on the display output or in the pilot manual. For the three operators with software preventing display of the landing distance when the tailwind limit is exceeded, annunciation on the display was obvious. However, training manuals had not yet been updated to reflect this change.[13] For the operator with software that did present landing distances even when the tailwind limit is exceeded, the flashing reference speed served as a cue of this condition. However, this cue was not directly linked to wind limits. The pilot manual for this operator described the meaning of the flashing reference speed.

For all four operators using computer programs, assumptions regarding reverse thrust were not annunciated on the computer display. Only two of the four operators provided this information in the pilot manual.[14]

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[8] For example, if the maximum tailwind component is 10kts, common value options for the wind column will be 5kts and10kts, with a note at the bottom of the chart to reference that no more than 10kts is authorized.
[9] Displayed on a different portion of the screen. There was no direct indication that the tailwind limit had been exceeded, although the flashing should have prompted pilots to review the manual.
[10] In initial software versions, landing distances were still provided when tailwind limits were exceeded.
[11] Air distance is the number of feet past runway threshold to touchdown.
[12] That operator predicated his air run on a 50 foot Threshold Crossing Height (TCH).
[13] Despite the fact that, for some operators, it had been several years since the update.
[14] Two of the operators were not aware what the assumptions were regarding reverse thrust, and this information was secured from the software provider.

For all four operators using computer programs, assumptions regarding air distance were not annunciated on the computer display. Only one of the four operators provided this information in the pilot manual.[15]

E.3 Guidance

E.3.1 Stopping Margins[16]

None of the seven operators provided guidance to pilots regarding acceptable stopping margins. One operator advised pilots to consider a go-around in marginal braking conditions, but did not define marginal, nor did they provide any specific values. Another operator informed pilots that there is some "padding" in the numbers, but did not include further guidance on this matter.

E.3.2 Braking Condition Reports

None of the seven operators provided guidance to pilots regarding how to interpret or use mixed condition reports,[17] despite the fact that two operators used braking action reports as a basis for the landing distance calculations.

E.3.3 Use of Reverse Thrust on Contaminated Runways

Guidance for use of reverse thrust varied by operator and aircraft model. Two of the five operators required maximum reverse thrust for every landing, and one advised that reverse thrust is only to be used in emergency situations or with shorter runways.[18] Several operators included guidance to indicate that use of maximum reverse thrust could have adverse effects on contaminated runways (e.g., visibility, crosswinds). One operator advised of the need to deploy maximum reverse thrust when at high speeds, and an attempt to make the touchdown early in the acceptable region.

[15] One operator was not aware what the assumptions were regarding air distance, and this information was secured from the software provider.
[16] Difference between landing distance and available runway.
[17] Mixed conditions refers to reports that include terms from two different categories (e.g., fair to poor).
[18] In this case, the runway length is specified.