

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.