**National Transportation Safety Board**
**Office of Aviation Safety**
**Washington, DC**

May 15, 2006

# Survival Factors Group Chairman's Factual Report of Investigation

| | | | |
|---|---|---|---|
| A. | Accident | : | DCA06MA009 |
| | Location | : | Chicago, Illinois |
| | Date | : | December 8, 2005 |
| | Time | : | 1914 Central Standard Time [1] |
| | Airplane | : | Boeing 737-7H4, Flight 1248, N471WN |
| | Operator | : | Southwest Airlines |

B. Survival Factors Group

| | | |
|---|---|---|
| Chairman | : | Mark H. George<br>National Transportation Safety Board<br>Washington, DC |
| Member | : | Paula Gaudet<br>Southwest Airlines<br>Dallas, TX |
| Member | : | Susanne Konrath<br>Federal Aviation Administration<br>Chicago, IL |
| Member | : | John B. Lott<br>Federal Aviation Administration<br>Chicago, IL |
| Member | : | Michael Massoni<br>Transport Workers Union<br>Dallas, TX |

[1] All times are reported in Central Standard Time unless otherwise noted.

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|---|---|---|
| Member | : | Alberto Rodriguez<br>Midway Airport<br>Chicago, IL |
| Member | : | Marcy Vinyard<br>Transport Workers Union<br>Dallas, TX |
| Member | : | Thomas Wagner<br>Chicago Fire Department<br>Chicago, IL |

## C. Summary

On December 8, 2005, 1914 Central Standard Time (CST), Southwest Airlines flight 1248, a Boeing 737-7H4 registered as N471 WN, overran Runway 31C at Midway International Airport in Chicago Illinois, during the landing rollout. The airplane departed the end of the runway, rolled through a blast fence, a localizer antenna array, a perimeter fence, and onto a roadway. The airplane came to a stop after impacting two automobiles. There were several minor injuries among the 98 passengers and 5 crewmembers on board. There was one ground fatality and several other ground injuries. Instrument meteorological conditions prevailed at the time. The airplane was substantially damaged. The flight was conducted under 14 CFR Part 121 and had departed from the Washington/Baltimore International Thurgood Marshall Airport, Maryland.

## D. Details of the Investigation

## 1.0 Airplane Configuration

The airplane was configured with 137 coach-class passenger seats, 2 cockpit flight crew seats, 2 cockpit observers' seats, an aft-facing double flight attendant jump seat on the forward bulkhead, and a forward-facing double flight attendant jumpseat on the aft bulkhead (see Figure 1, cabin configuration).

## 2.0 Crew Information

### 2.1 Cockpit Crew Interviews

Summaries of flight crew interviews are included in the Operations Group Chairman's Factual Report.

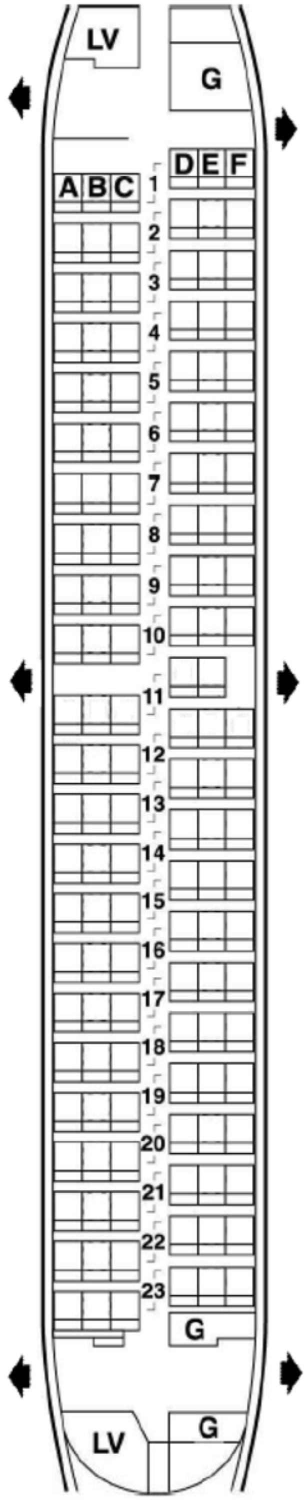


Figure 1. Boeing 737-7H4 Interior configuration

### 2.2 Cabin Crew

| Flight Attendant Name and Position | Initial Training Completion Date | Recurrent Training Completion Date | FAA Certification Number |
|---|---|---|---|
| Hsiaoming Yao (A) forward jumpseat | 11-19-2004 | 08-08-2005 | [redacted] |
| Holly Carr (B) aft jumpseat | 12-14-2000 | 08-11-2005 | [redacted] |
| Rhonda Fleming (C) forward jumpseat | 07-12-2000 | 07-07-2005 | [redacted] |

#### 2.2.1 Cabin Crew Interviews

On December 10, 2005 the Survival Factors Group interviewed the 3 flight attendants assigned to the flight. In attendance were: Mark George, NTSB; Paula Gaudet, Southwest Airlines; Susanne Konrath, FAA; Michael Massoni, Transport Workers Union; and Marcy Vinyard, Transport Workers Union. The following are summaries of those interviews.

*Hsiaoming Yao*
*Age: 36*
*Height: 5'4*
*Weight: 130 lbs.*

Ms. Yao had worked for SWA for one year. Prior to that, she worked for China Airlines in Taiwan for 5 ½ years. Ms. Yao was the "A" flight attendant (FA) on flight #1248. Her position was at the forward jumpseat, outboard.

She did not notice anything unusual about the flight prior to landing. The airplane circled for about 30 minutes prior to landing, "due to heavy snow and cleaning of the runway." She described the landing as "very smooth." She heard the reversers come on but the airplane kept going on and on, and it did not slow down. She felt four big bumps up and down, and was "bouncing fiercely" on the jumpseat. She felt her shoulder harness lock up during the bumps. After the four bumps, she heard a "big noise" that sounded like "something was breaking." When the airplane stopped she was tilted backwards in her jumpseat. After the airplane stopped moving, the cabin was dark for "about 10 seconds," and then the emergency lights came on.

All galley latches remained latched during the incident. At some point she smelled "burning rubber." She heard seatbelts being released, and the "C" FA yelling "heads down, stay down." The "C" FA also told passengers not to release their seatbelts. The "C" FA asked Ms. Yao to hand her the megaphone. Ms. Yao unbuckled her seatbelt and retrieved the megaphone from the bulkhead on the aft side of door 1L, then gave the megaphone to the "C" FA. Ms. Yao did not attempt to use PA system "because there was no power on the airplane, and it would not be operable."

Ms. Yao looked out the window on the 1L door and assessed conditions outside. She saw no smoke or fire. She saw police/fire rescue personnel outside within 30-40 seconds. She heard people outside the door saying, "Open the door, stay calm, get out of the airplane."

The captain came out of the cockpit, took the megaphone and made an announcement to the passengers to "stay calm" and not to release seatbelts. Ms. Yao asked the captain if she should open the door. He told to "go ahead." She opened the door, and the slide dropped down and inflated. The "C" FA shouted to people on the ground outside the airplane to "move away". A "couple" of the people were hit by the slide and "bumped into the snow." Ms. Yao did not think anyone was injured by the inflating slide. Ms. Yao did not initiate the evacuation on her own "because there were no life threatening conditions."

Ms. Yao took the megaphone, stood by door, and shouted, "Come this way, this way out, leave everything, jump," to the passengers. The "C" FA was standing next to Ms. Yao "comforting" passengers. The captain was on the right side of the forward cabin, taking luggage from passengers and piling it up in the 1st row, right side. Ms. Yao saw the first officer on the ground beside the escape slide helping passengers get off the airplane. The airplane was "tilted forward" and the entry door was close to the ground. Passengers jumped onto the slide and then were pulled off both sides of the slide by the rescue personnel on the ground. Most passengers landed in the center of the slide. The right forward door was not opened. The captain did not tell either of the flight attendants to open the other door.

After the last passenger evacuated, fire personnel asked Ms. Yao if any more passengers were on board. She told them "no." The captain told Ms. Yao and the "C" FA to get their bags and get off the airplane. The "B" FA was still in the back of the airplane with fire personnel. Ms. Yao and the "C" FA went aft, and all three FAs exited down the stairs at the right, rear galley door. The stairs were like the ones they used at airports where there was no jetway. Ms. Yao estimated that "from the time that the airplane stopped until the flight attendants exited the airplane was 2-3 minutes." She said that all 98 passengers evacuated from the forward entry door with no apparent injuries.

Additionally, Ms. Yao reported that two children, ages 7 or 8, and a pregnant women were on board. No handicapped persons were on board; and three to four elderly passengers between the ages 55-60 were on board. She reported that the pregnant woman had no problem evacuating.

It was snowing "very heavy" outside the airplane. The top of her head and her jacket were covered with snow in a matter of seconds. Once on the ground, passengers were directed by fire/police personnel, and everything was "very chaotic." Passengers were split into two different directions and were told to go this way, then later were told to go another way.

After she was outside the airplane, Ms. Yao felt "cold and numb." Her mind was "totally blank." She did not see the pilots exit the airplane, but she did see the captain and the first officer checking on passengers on the ground. All five crew members were transported in a small van to the crew lounge.

*Holly Carr*
*Age: 36*
*Height: 5'7"*
*Weight: 134 lbs.*

Ms. Carr had worked for SWA for 5 years. Prior to that, she had not worked in the airline industry. She was the "B" position flight attendant on flight #1248. She was seated on the aft jumpseat, door side.

During the flight, the captain told the FAs to secure the cabin early, even though they would be circling for about 20 minutes due to weather. The captain also made an announcement to the passengers, telling them about the delay. Ms. Carr described landing as "fine, nothing abnormal." She said that once on the runway, "it didn't seem like we ever started slowing down." It was "very smooth," and she did not feel the brakes at all. The end of the landing rollout became "uniformly bumpy," like the airplane had gone off the runway. Then, the airplane stopped and "shifted." She thought the airplane was off the runway, but did not believe the airplane had been damaged.

After the airplane stopped, the "regular" cabin lights were not on. Ms. Carr saw passengers begin to stand up and open the overhead bins. She was "buckled up" in her jumpseat, so she tried to use the PA system to tell passengers to sit down. The PA system did not work. Ms. Carr pressed the emergency light switch and then got up out of her jumpseat and went to check on passengers. She did not notice if the lights came on when she flipped the switch. She tried to look out the windows on the aft doors, but they were covered with snow, so she couldn't see anything. She saw "lights" reflecting from outside the airplane that looked like the lights on emergency vehicles. She heard children crying, so she went to check on them and the other passengers. At first, Ms. Carr thought the plane had gone off the runway, but did not realize they had gone into the street until she walked halfway up the aisle checking on passengers, and saw a "speed limit sign" outside a passenger window.

Ms. Carr went aft, looked forward, and saw the "C" FA with a megaphone at the front of the airplane. She saw the captain take the megaphone from the "C" FA. She could not hear what was being said, so she went forward again. She heard the captain say that they would be evacuating from the front of the airplane. During this time, she saw passengers using their cell phones.

Ms. Carr went aft, and as she approached the aft door area, she heard "pounding" on the aft right door. She heard someone outside the yelling to "open the door." She still could not see through the door window. She disarmed the slide and opened the door. There was a fireman outside standing on stairs. He "barged in" and started yelling for everyone to get off the airplane. This seemed to upset the passengers. Ms. Carr stood on the left side of the airplane and assisted passengers as they got off the airplane. The evacuation was "very orderly" and she did not shout commands because everyone was deplaning calmly. She counted passengers estimated that about 40-45 passengers that had gone down the stairs. She did not see anyone that was injured.

After the passengers were out, Ms. Carr walked forward to check on the crew. She noticed a "strong fuel smell." She told the other FAs about the smell, and that they needed to get off the airplane. The "C" FA told her "there was a car underneath the airplane." The captain told the FAs to get their bags and get out. All three FAs and the captain went out the rear of the airplane by way of the stairs. Ms. Carr said that the first officer had exited by the slide at the forward left exit, but she did not see him exit. She saw the first officer on the ground. Fire/police personnel asked how many passengers were on board. The crew told them there were 98 passengers plus five crewmembers.

Ms. Carr said it was "chaos and confusion" on the ground. Everything outside was white from the snow, and she couldn't tell the road from anything else. Passengers were taken on buses to the airport and all five crewmembers were transported in a van to the crew lounge at the airport. At the crew lounge, Ms. Carr saw that captain's shins were bloody. Ms. Carr said that she had minor muscle aches the day after the accident. None of the crew were seen by medical personnel the night of the accident.

*Rhonda Fleming*
*Age: 29*
*Height: 5'6*
*Weight: 165*

Ms. Fleming had worked for SWA for 5 years. Before that, she had no prior airline experience. She was the "C" flight attendant on flight #1248. She was seated at the forward jumpseat, aisle side.

Ms. Fleming said that the first officer told the crew that they would be circling for about ten minutes, and that they wanted the crew to secure the cabin early for landing. The cockpit crew made an announcement to the passengers, and made an additional announcement as they got closer to landing, reminding passengers to put up tray tables, put seat backs forward, etc. Ms. Fleming said that the cabin lights were set to "night light" setting for landing.

Ms. Fleming said that it was a "perfect landing". She felt a "tug on the brakes," but they were not slowing down. She described the landing rollout as "getting bumpier and progressively worse." She said that in addition to the bumpiness, the airplane swerved, there was a "bang," the airplane tilted to the front, then came to an "abrupt" stop. She said the initial bumpiness was "not as severe as an ATV," but rough, like "riding a bike on grass." She smelled rubber and thought they had "hit a snow bank." She felt her restraint "lock in place" during the sequence. None of the overhead bins opened and no panels fell.

After the airplane stopped, Ms. Fleming did not notice any “imminent danger,” and she could hear the pilots talking through the cockpit door. She could not “make out” any of the words being spoken, but described the dialogue as sounding “frenzied.” She waited to hear the “evacuate” command from the captain. The emergency light came on. Ms. Fleming attempted to use the PA system twice, and a passenger in the third row said it was “not coming through the PA.” She heard “clicking” of seatbelts being unfastened. She told the “A” FA to get the megaphone for her.

Ms. Fleming unbuckled her seatbelt and got up. She looked out the left side of the airplane and saw a man with blood on his face. She looked out the right side of the airplane, and could see cars, but was “still not sure where we were.”

Ms. Fleming “yelled” through the megaphone for passengers to “stay seated.” The passengers were “orderly.” She proceeded aft in the cabin with the megaphone, making announcements, and by the time she got to row 4, she had “repeated her announcement twice.” Ms. Fleming met the “B” FA in the middle the cabin. The “B” FA told her that the cockpit door was opening. Ms. Fleming went back toward the front of the airplane. The captain was outside the cockpit, and took the megaphone from her. He told the passengers that the airplane was “all right,” and that “they would be evacuating from the front.” Ms. Fleming estimated that it was “2 – 3 minutes” from when she first started making announcements until the captain came out of the cockpit. The captain said they would be using the boarding door to evacuate, so she did not open her assigned exit. The first officer was still in the cockpit. She saw no damage in the cabin, but she did see a panel in the cockpit hanging down.

The captain told the “A” FA to open the boarding door. While the door was being opened, Ms. Fleming “yelled” at the people on the ground to move out of the way of the slide. The airplane was “low to the ground,” so the slide was not at an incline. The passengers did not “slide,” and had to “scoot” down the slide. Ms. Fleming saw a man with a child in his arms on the ground outside the airplane. She heard the first officer ask the captain to come back into the cockpit.

The “A” FA used the megaphone and shouted commands to the passengers. Ms. Fleming stood at the exit and told passengers to “hold themselves and jump into the slide.” There was one “hiccup” in the stream of evacuating passengers, when an elderly woman stopped to tell them about her medication that was in the overhead bin. Ms. Fleming convinced the elderly woman to continue moving. Although she had briefed the four passengers seated in the emergency window exit rows, no one opened the window exits.

After all the passengers were off the airplane, the captain told the FAs to get their bags and get off the airplane. Ms. Fleming smelled “fuel” at about row 7 or 8. The “B” FA mentioned it, too. The three flight attendants took their bags and left the airplane by the back stairs. The stairs were covered with snow which was “about mid-shin” deep. It was snowing “big, heavy, wet snowflakes,” and visibility was poor. The activity on the ground was "disorganized and chaotic." After she was on the ground, she turned on her cell phone and checked he time. According to her cell phone, it was 7:32 p.m.

After the FAs left the airplane, the passengers and the first officer were at the front, left side of the airplane. The flight attendants and the captain were together at the back of the airplane. Fire/ police personnel led passengers to the back of the airplane, then to buses on the street. Fire/police personnel asked the crew "four different times" how many passengers were on board. A "ramp supervisor and 'ramper'" drove the entire crew to the airport.

Ms. Fleming experienced "lower back pain and a headache following the accident. She went to a doctor the day after the accident, and was told to "ice her back and take an analgesic."

## 2.3 Flight Attendant Training

All of the flight attendants were qualified on the B737-300/500/700 series of airplanes. Excerpts from the Southwest Airlines initial and recurrent training programs, and flight attendant manual are in Attachment 1.

## Witness Interviews

*Gary Condreva*
*Chicago Police Officer*
*December 11, 2005*

Officer Condreva has been with the Chicago Police Department for 10 years.

Officer Condreva said it was snowing really hard, blowing and that it was "roughly a blizzard during the time of the accident. You could only see about 75 feet ahead."

Officer Condreva was driving a patrol car, sitting at the traffic light facing southbound on Central about three cars north of the intersection at 55$^{th}$ and Central, when the SWA B737 came through the fence. The airplane cabin looked dark. He immediately made a radio call to report the accident, and he also asked for additional medical support to respond. The call was made at 19:14. He turned on his mars lights, and pulled his car out of line at the intersection and drove toward the airplane.

When Officer Condreva got out of his car, he smelled fuel. He did not see fuel leaking. He first encountered four individuals that were out of their vehicle. Their vehicle was not in contact with the airplane following the accident, but had extensive front-end damage. He asked these individuals if they were OK, and they responded yes. An off-duty female police sergeant was there. She had been at the intersection facing eastbound on 55$^{th}$ at Central. She asked Officer Condreva if she could help. She put passengers from the car into her car. He was not sure if it was her personal car or a police car.

Officer Condreva went toward the front of the airplane and saw a man with a bloody face who was out of his car. The man said that two of his children were trapped in their car. Officer Condreva said the father was running around "screaming" at the pilot through the closed cockpit window. Officer Condreva followed the man to his car. The father removed one child from the vehicle. Officer Condreva reached in and touched the mother who was in the front passenger seat. The mother indicated she could not get out of the car because her legs were pinned. Officer Condreva made a radio request for additional medical support. The fire department arrived "within five minutes" of the accident. Police officers directed firefighters to the trapped mother and two children in the back seat.

Officer Condreva and his partner returned to the airplane. He was wearing his CPD uniform with a black leather CPD jacket. The airplane pilot was visible in his seat. The police officers motioned for the pilot to open his window, and he did. The pilot seemed "shaken, and disgusted," but was still pretty much "in control." Officer Condreva's partner took the pilot's hand through window and asked if everything was OK. Condreva's partner asked if there were passengers on board. The pilot said that there were 98 passengers on board. Condreva's partner said, "let's get them off." Officer Condreva estimated it was about two minutes afterwards that the boarding door opened. He did not notice if the captain was still in his seat when the door opened.

A civilian had joined the two officers at this point. The evacuation slide deployed but it "didn't come out real true because there was a hill or a berm in the way." He pulled his partner out of the way of the slide and they both fell backward. The civilian appeared to be injured when the slide deployed, but he stayed and helped with the evacuation. Officer Condreva thought the civilian was transported to the hospital after the evacuation was complete, but was not certain.

The passengers exiting the airplane appeared uninjured. Officer Condreva heard flight attendants shouting commands to the passengers to keep moving. Police assisted passengers off of the slide. Officer Condreva assisted with the evacuation and told passengers to get away from the airplane. He did not see the crew come down slide but all passengers did. Officer Condreva did not know how the crew exited the airplane. He thought that from the time he saw the airplane go through the fence until the passengers were off was "5 to 10 minutes, tops."

Buses arrived on the street "after about 15 minutes." Once all the passengers had deplaned, Officer Condreva went to his squad car to complete his accident report.

*George Ferro*
*Chicago Police Officer*
*December 12, 2005*

Officer Ferro had been a police officer for 26 years. He was in his police car approximately 2-3 cars north of 55$^{th}$ St. facing southbound on Central Ave waiting at a stop light. Officer Ferro's partner, Police Officer Gary Condreva was driving the car.

Officer Ferro saw the airplane just after it had come through the fence, and watched it come to a stop on Central Ave. The airplane was "quiet, with all power off." He saw a wire that was draped over the fuselage, with a single white light "blinking or sparking" on the top of the airplane. He could not tell whether the light was attached to the airplane or the wires that were draped over the fuselage. He also saw "a little white smoke" coming from the front of the right engine.

Officer Ferro made notifications of the accident to his dispatcher via radio, and reported that a "727" had just crashed at 55th and Central. He said that he used the term "727" to emphasize the size of the airplane, not necessarily the exact type of airplane.

His police car was parked in front of the engine on the right side of the plane. He got out of the car and "jogged" over to the airplane. He saw the co-pilot sitting in his seat with his head lowered. He thought the co-pilot had been "knocked unconscious."

Officer Ferro went around the nose of the airplane, and came upon a man whose head was covered with blood. The man was "extremely agitated" and was shouting obscenities towards the pilot. Officer Ferro tried to calm the man, and asked him to move away. Officer Ferro saw an automobile that was "pinned" under the airplane, and had been pushed into a light pole. He tried to get a woman passenger out of the car, but was unsuccessful. He also tried to extricate a child from the back seat of the car, and was also unsuccessful. He told the occupants of the car that "help was on the way."

Officer Ferro went back to the left front of the airplane. He stood on a small berm of earth next to the front of the airplane, and motioned for the pilot to open his window. The pilot opened his window and Officer Ferro asked him "how he was." The pilot said that he was alright, then lowered his head and exhaled loudly. Officer Ferro said that the pilot appeared very calm and professional although "very disgusted." Officer Ferro touched the pilot's hand and told him that "more help was on the way." Officer Ferro asked the pilot how many people were on the airplane and the pilot said that there were 98 on board. Officer Ferro then told the pilot that they should "get everybody off the airplane." The pilot acknowledged that request and turned his head away from Officer Ferro. Officer Ferro thought that he saw the silhouette of a person in the doorway of the cockpit.

"About 20 seconds" after he suggested to the pilot to evacuate, he saw the boarding door open "a few inches." Officer Ferro saw a female flight attendant standing in the door with a megaphone in her hand. He told the flight attendant to "continue opening the door and begin the evacuation." The door did not continue opening, so Officer Ferro, thinking it was "jammed," grabbed the bottom of the door and opened it himself. When the door opened, the emergency escape slide deployed, and "knocked over" both Officer Ferro and a civilian that was standing with him.

Officer Ferro got up and took a position next to the slide. He told other civilian volunteers to assist in getting passengers off the slide. Officer Ferro saw "one or two" flight attendants standing inside the boarding door. Officer Ferro estimated that "between thirty to forty people" evacuated down the slide. He noticed that "a few" of the passengers coming down the slide were carrying "some sort of property" with them. Specifically, he remembered one man carrying a black toiletry bag with him down the slide. Officer Ferro thought that the passengers had been "well prepared by the cabin crew," and that the evacuation was completed in a very calm manner. None of the passengers evacuating down the slide had problems getting "stuck on the slide." Passengers that had evacuated from the airplane began walking southbound on Central Avenue, and were redirected by Officer Ferro to go northbound to 55th St..

Officer Ferro did not smell any fuel until he "actually saw fuel leaking from the left wing" of the airplane. He saw several firefighters with "a lot of tools and equipment" extricating the passengers from the car. He also saw firefighters "standing by" with hose lines ready.

After the evacuation, Officer Ferro walked around the airplane and did not see any other airplane doors that had been opened. He saw "lots" of mechanics attempting to get on the airplane. Chicago Police would not let them have access to the airplane. Officer Ferro said that the patrol car he occupied was not equipped with any video taping equipment.

*Al Perez*
*Assistant Commissioner of Operations*
*December 13, 2005*

Mr. Perez had been in his current position with the Chicago Department of Aviation for the past 16 years.

At the time of the accident, Mr. Perez was near the MDW passenger terminal, and was in the process of driving back onto the airfield. He was planning to inspect the teams that were conducting airside snow removal operations. It was snowing heavily. After entering the airfield, he drove to airport operations on the south side of the airport. He learned of the accident as he was walking into airport operations. He immediately left airport operations, and drove directly to the accident site. As he approached the Runway 31C departure end, he noticed that responding ARFF vehicles were to his right. He was "reasonably sure" that one airplane may have departed on Runway 4R after the accident because it was already positioned on the runway for takeoff.

As Mr. Perez drove toward the airplane, the ARFF stair truck was "just in front" of him and approaching the aft exit. He saw "smoke or possibly water vapor" coming off the right engine as he got closer to the airplane. He saw truck 651 positioned near the airplane. He saw additional firefighting equipment arriving from the street side. Fire Chief Raymond Weiher and Fire Chief Fox were on scene. Mr. Perez learned that Chief Fox was incident commander. Mr. Perez saw a firefighter attempting to determine the source of a fuel leak. Perez tried to find someone from CPD to take charge for law enforcement. He asked a police officer to find Jimmy Carroll to represent CPD in the incident command structure.

Mr. Perez walked around the tail of the airplane, past a heavily damaged white car, and around the nose. He saw passengers coming off the emergency evacuation slide. They were gathering at a nearby landscape berm on the southwest corner of 55th and Central. Mr. Perez saw a "conduit pipe" on top of the airplane wing and was concerned that it might still be "energized." He believed that the conduit was from "obstruction lighting" on the airport perimeter fence. He requested an electrician from operations to determine the status of the wire. Later, he learned that the wire was not connected.

Mr. Perez saw a white car with trapped passengers, and an undamaged blue car near the airplane. Chief Fox told Mr. Perez to "get out of the area because he was tracking fuel and contaminating the area." The right wing was leaking fuel. Mr. Perez wanted "foam on the fuel." He saw a Southwest Airlines mechanic and asked him to help the firefighter secure the fuel leak. Mr. Perez's emphasis was on "securing the site, establishing incident command, and assuring there was order to the recovery process."

Mr. Perez "was not sure" how many people exited via the stair truck, but he saw somewhere between 30-50 passengers standing "just inside the airport perimeter fence." He was concerned about the possibility of fuel leaking into the sewer system. He asked a firefighter how many passengers and crew had exited the airplane and received "conflicting information." The station manager for SWA was on site, and Mr. Perez asked him for a passenger manifest. Later, he found out that there were 98 passengers, three flight attendants, and two pilots.

Mr. Perez saw the pilots, but did not talk to them. The passengers needed to be moved from the accident site to the terminal, especially because it was cold. The passengers were bussed by airport-leased equipment to the terminal. Mr. Perez requested a command vehicle, Truck 278, from ORD. He also arranged for police to secure the airport perimeter. The airport kept an ARFF vehicle at the site overnight, and there was also back-up vehicle from a nearby fire station on site.

Mr. Perez directed airport personnel continue snow removal operations on Runway 4R/22L to get it operational for opening at a later time. Runway 04R/22L was reopened at 0200 for air carrier use only. It was opened to all traffic at 0600.

Following the accident, Chicago Police Department officials wanted to identify the SWA flight crew. Illinois law required an accident report to include the names of involved individuals anytime a fatality occurs. Perez said that SWA representatives were reluctant to provide that information.

## 4.0 Passengers

Southwest Airlines does not assign seats to passengers. Any reference to seat numbers in this report was provided by the passengers.

### 4.1 Passenger Questionnaires

Questionnaires were mailed to passengers after the accident. To date, 46 questionnaires were returned to the Safety Board. The questionnaires are in Attachment 2.

### 4.2 Passenger Interviews

*John and Maria Klein*
*Interviewed together by Mark George at NTSB HQ on January 20, 2006*

The Klein family (husband, age 40; wife, age 37; daughters (ages 9 and 6) were scheduled on a later SWA flight to MDW. SWA 1248 was delayed and had empty seats, so they boarded on SWA 1248. The husband was in seat 23D, the wife was in seat 23C, the 6 year-old daughter was in seat 23B, and the 9 year-old daughter was in seat 23F. Seats 23A and 23 E were not occupied. The husband and wife said that they flew on airlines “frequently,” and had “a lot of flying experience.” They said when the airplane landed there was a “big thud.” They did not hear the “reverse thrusters” come on. The husband had landed at MDW many times, and knew that the runway was not very long. He felt the airplane go off the end of the runway, and after it did, it bounced up and down “violently” several times. He said the forces were “in a vertical direction,” pulling him straight up. He was restrained by his seat belt.

After the airplane stopped, the flight attendant that had been seated behind him walked forward in the cabin “about halfway” down the aisle. She came back aft and remarked to the passengers that “there was a 30 mile-per-hour speed limit sign outside the airplane” at mid-cabin. The husband and wife put their coats on, and put coats on their children. The husband made a cell phone call.

The husband told the flight attendant that he “smelled fuel,” and asked if they ought to get off the airplane. The flight attendant told him that they would “wait for the pilot to tell them what to do.” The cabin lights went off and some other lights came on in the cabin. They saw a flight attendant at the front of the airplane with a megaphone, but could not hear what was being said. A pilot took the megaphone from the flight attendant and began addressing the passengers, but they still couldn’t hear what was being said. He talked for “a long time.” A passenger near the middle of the cabin began relaying information to the passengers in the aft part of the airplane. The husband and wife heard that passengers would evacuate out the front of the airplane, and the flight attendant near them told them that “they could not use the exits in back.” They saw passengers in front of them get up and begin filing toward the front.

The husband heard someone “knock” on one of the aft airplane doors from outside, and the flight attendant went aft to the doors. The husband heard the flight attendant ask whoever was outside the plane if she should “disarm the slide.” Two firefighters entered the airplane from an aft door and immediately began yelling for passengers to “leave their luggage,” and come to the back and go down the stairs. The firefighters took complete charge of the aft cabin.

The husband, wife and their children went out the airplane, down some stairs, and congregated with other passengers at the bottom of the stairs. Passengers that had exited the front of the airplane were walking under the right wing to join the group of passengers at the aft stairs. Firefighters became aware of fuel leaking from the airplane, and began directing passengers away from the wing. The firefighters also moved the congregation of passengers near the aft stairs to a location further away from the airplane.

After several minutes standing outside the airplane, the couple and their two daughters were directed by rescue personnel into a "Suburban" that was parked nearby. The wife made a cell phone call when they were in the vehicle. Cell phone records indicate that the call was placed at 07:34 PM CST. The family was loaded, along with other groups of passengers, into buses that were parked on the street. Passengers waited in the buses for approximately two hours, and then were taken to the terminal.

## 5.0 Description of site

Refer to the Structures Group Chairman's Factual Report for a description of the accident site.

## 6.0 Airplane Documentation

No damage was found in the airplane cabin. Other than the items documented below, the airplane cabin was unremarkable.

### 6.3 Exits

According to crew and other witness interviews, the forward left (1L), and aft right (2R) type I floor level exits were used during the evacuation. The 1L exit was opened by the "A" flight attendant. The 2R exit was disarmed and opened by the "B" flight attendant in order to accommodate airstairs that were positioned outside the 2R exit by an ARFF crewmember. The 1R, 2L, and type III overwing exits (2) were not opened.

### 6.4 Escape slides

According to crew and witness interviews, the 1L escape slide[2] deployed and inflated when the 1L exit was opened. The slide was not damaged and was found detached from the airplane, lying on the ground on the left side of the airplane. It was found inflated (approximately 12 hours following the accident). ARFF crew reported that they had removed the slide from the airplane. The 1R, 2L, and 2R escape slides were in their respective doors and their inflation bottles were fully charged.

[2] Manufactured by Goodrich; part number: 5A3307-5F; serial number: BNG 5813; Date of Mfg: 05/04.

### 6.5 Seats and restraints

All crew and passenger seats and restraints were examined and no damage was found. It was noted that in row 4, seat F, the tray table was in the "down" position. In row 5, seat E, the seat back was reclined. In rows 10, 11, 12 on the right side of the airplane, and rows 10 and 11 on the left side of the airplane, the seatbacks were pushed forward approximately 5 degrees from upright. All passenger seatbelts were checked, and were securely attached to seats.

Data tags from seats and restraints were marked as follows:

Crew Seats and Restraints

Pilot Seat:
Ipeco, Inc., Pilot 737 NG, Common Seat, Customer Part# 5232A311-13, Ipeco Part# 3A296-0007-02-1, Issue# = 1, Serial# = 41837, Inspection Stamp: Ipeco 18, Mod: (Blank), TSO C-127a, Mfd Date 03/06/04, Model# OA296-0001, Type – A – FF.

Pilot Restraint
Amsafe, Phoenix, AZ, Part # PNR 5000-1-01A-2396, Mfr = Ofwei, DMF = (Blank), Assy = (Blank), S/Assy = 5000-20301A2396, SN = 08mar04-191.

Co-Pilot Seat
Ipeco, Inc., Pilot 737 NG, Common Seat, Customer Part# 5232A311-14, Ipeco Part# 3a296-0007-02-1, Issue# = 1, Serial# = 41841, Inspection Stamp: Ipeco 18, Mod: (blank), TSO C-127a, MFD Date 03/06/04, Model# OA296-0002, Type – A – FF.

Co-Pilot Seatbelt
Amsafe, Phoenix, AZ, Part# PNR 5000-1-02A-2396, MFR = Ofwei, DMF = (Blank), Assy = (Blank), S/Assy = 5000-20302A2396, SN = 08mar04-159.

Fwd Flight Attendant Jumpseat – Aft Facing, Double
Goodrich, 1275 N. Newport Rd., Colorado Springs, CO, 80916 FSCM 31218, Fwd/Aft Facing, Wall Mnt Att Seat, Goodrich Part No.: 2110 301lH, Boeing Part No.: 5414A201-03302lH, 6.5g Down, 3.5g Up, Combined Loads, 1.5g Fwd + 3.75g Down, 3.0g Sd + 1.56 Down, 3.5g Aft + 5g Down, Max Wt: 51.6 lbs, Mfg Date: 05/27/04, Ser No.: 4385-2110, Complies With FAA TSO-C127 Type A, and FAR Para. 25.853(C) 11/26/84, See CMM For Installation Limitations. Goodrich Part No: Pnr 2110-301lh, Serial No: Ser 4387-2110, Cage Code: Mfr 31218.

Aft Flight Attendant Jumpseat – Forward Facing, Double
Goodrich, 1275 N. Newport Rd., Colorado Springs, CO, 80916 FSCM 31218, Fwd / Aft Facing, Wall Mnt Att Seat, Goodrich Part No.: 2110 302lh, Boeing Part No.: 5414A201-03302lH, 6.5g Down, 3.5g Up, Combined Loads, 1.5g Fwd + 3.75g Down, 3.0g Sd + 1.56 Down, 3.5g Aft + 5g Down, Max Wt: 51.6 lbs, Mfg Date: 05/28/04, Ser No.: 4387-2110, Complies With FAA TSO-C127 Type A , and FAR Para. 25.853(C) 11/26/84, See

CMM For Installation Limitations, Goodrich Part No: PNR 2110-302lh, Serial No: SER 4387-2110, Cage Code, Mfr 31218.

Passenger Seats, Restraints, And Flotation Devices (typical)

Seats

Seats– Triple, Forward Facing, B/E Aerospace, Spg, Kilkeel N. Ireland, Phone 44 28 4176 2471, P/N 45818045, Rev G Date of Mfr. Apr04, Type A, Batch No. Brad0234, TOF Suffix 8929T01, Seat Assy PN 87517453, Conditions & Tests Required For, Rage Code #92802, TSO C127a, Date Mfgd 05/04, Model Ba3.4-3-59, Wt lbs 88.55 Type A-FF, Pitch Range Seeiil.

Restraints

FDC 6400 Series, Davis Aircraft Products Co, Inc., Bohemia, NY 11716, Model FDC-6400-202-700-2-014, FAA TSO – C22b, Rated 3000 lbs, Date 02-04

Seat Cushions

B/E Aerospace, SPG Part #445110013000075, Rev. N, Model# C106, Date of Mfg.: 06103, Type A, TSO: C127a (When Installed On The Approved TSO C127a Seat), Complies With 14CFR25.853c, Effective Feb. 02, 1995 & TSO C72-Only When Used W/Certified Cushion & Dress Cover.

Flight Attendant Jumpseat Life Vest

Manufactured per TSO C-13f, Hoover Industries, Miami, Fl, Vest Adult/Child, Weight Limit: Above 35 lbs, Model# SCV-37, S/N UM06037101, Part N / HS3701-SWA, Re-Inspection Date – Jun 2015.

Passenger Life Vests

Manufactured per TSO C-13f, Hoover Industries, Miami, FL, Vest Adult/Child, Weight Limit: Above 35 lbs, Model# Scv-37, S/N UM06037101, Part N / HS3701-SWA, Re-Inspection Date – Jun 2015.

## 6.6 Emergency equipment

All required emergency equipment was found in its normal stowage locations, and in working order, except the forward megaphone[3]. It was found in the forward left overhead luggage stowage bin. NTSB investigators retained the megaphone for testing. The megaphone was tested by the manufacturer on February 13, 2006. Results indicated that the megaphone met all applicable performance standards with regard to basic functions and acoustical properties. The megaphone was returned to Southwest Airlines.

The emergency lights were tested by depressing the emergency light switch at the aft FA station. All floor, ceiling, and exit lights illuminated for several seconds, then went out. This test was repeated several times with similar results; however, the duration of

[3] Model A12SA, manufactured by Federal Signal Corporation, University Park, IL.

illumination was reduced each time. The results were consistent with nearly depleted batteries.

Doors/Emergency Exits

1L – Type I forward entry door. Operated normally. Slide pack was not present within containment canister. Red "door armed" flag was present and operable. Yellow barrier strap was present and operable.

1R – Type I forward galley service door. Operated normally. Slide pack present and secured within containment canister. Inflatable pressure gauge was in the green band. Red "door armed" flag was present and operable. Yellow barrier strap was present and operable.

2L – Type I Aft Entry Door. Operated normally. Slide pack present and secured within containment canister. Inflatable pressure gauge was in the green band. Red "door "armed" flag was present and operable. Yellow barrier strap was present and operable.

2R – Type I Aft Galley Service Door. Operated normally. Slide pack present and secured within containment canister. Inflatable pressure gauge was in the green band. Red "door "armed" flag was present and operable. Yellow barrier strap was present and operable.

Left over wing window exit - Type III - emergency window exit hatch with upper hinged automatic actuation was present and operable. Operation handle covers were present and secure. The exit operated normally.

Right over wing window exit - Type III - emergency window exit hatch with upper hinged automatic actuation was present and operable. Operation handle covers were present and secure. The exit operated normally.

## 7.0 Medical and Pathological

According to preliminary information provided by Southwest Airlines, thirteen people were transported to hospitals after the accident. Nine of those transported were automobile passengers with unknown injuries, and four were airplane passengers with minor injuries. Following the on-scene portion of the investigation, Southwest Airlines refused to provide the Safety Board with the names of injured passengers, motorists, or pedestrians, nor updated injury information. A subpoena was issued to the Southwest Airlines General Counsel's Office on April 24, 2006 asking Southwest Airlines to provide records containing the names of all injured parties, the names of the hospitals used, and all injuries sustained. The Survival Factors Group Chairman received a response to the subpoena on May 10, 2006. Injury information derived from the subpoena response will be added to this report at a later date.

One automobile passenger was fatally injured. The Cook County Medical Examiner's Office reported the cause of death as "compression asphyxia."

Of the 46 passenger questionnaires returned to the Safety Board, ten reported minor injuries. The table below lists these self-reported injuries.

| Seat | Age | Gender | Height | Weight | Injury |
|---|---|---|---|---|---|
| 23D | 40 | Male | 5'10" | 185 lbs | Wrist, elbow, and shoulder - sprain/strain |
| 7C | 53 | Male | 5'10" | 180 lbs | Whiplash of neck |
| Unk | 25 | Female | 5'5" | 125 lbs | Wrist, arm, leg, neck, and back - strain |
| Unk | 28 | Female | 5'11" | 205 lbs | Left knee - sprain/strain/abrasions |
| 8D | 44 | Male | 5'9" | 172 lbs | Left hip and lower back contusion |
| 1D | 67 | Male | 5'10" | 220 lbs | Arm – sprained and abrasions |
| Unk | 41 | Male | 5'10" | 215 lbs | Wrist and back - contusion and sprain |
| Unk | 24 | Male | 5'8" | 155 lbs | Neck strain |
| Unk | 26 | Female | 5'4" | 116 lbs | Neck strain |
| Unk | 47 | Female | 5'4" | 130 lbs | Rotator cuff - dislocated |

### 7.1 Preliminary Injury Table

The injury table contains preliminary injury information and self-reported injuries from passenger questionnaires.

| Injuries | Flight Crew | Flight Attendants | Passengers | Other[4] | Total |
|---|---|---|---|---|---|
| **Fatal** | 0 | 0 | 0 | 1 | 1 |
| **Serious** | 0 | 0 | 0 | 0 | 0 |
| **Minor** | 0 | 1 | 14 | 0 | 15 |
| **None** | 2 | 2 | 84 | 0 | 88 |
| **Total** | 2 | 3 | 98 | 1 | 104 |

## 8.0 Airport Information

Chicago Midway International Airport (MDW) was located approximately 10 statute miles southwest of downtown Chicago in an area that includes residential, commercial, and industrial land uses. The airport was owned by the City of Chicago, and operated by the Chicago Department of Aviation. The airport property encompassed 650 acres at an elevation of 620 feet above sea level. In 2004, MDW had approximately 340,000 total aircraft operations, with approximately 183,000 of those conducted by air carriers. The FAA certified MDW as a 14 CFR Part 139 airport with Index D aircraft rescue and firefighting (ARFF) capabilities. FAA Airport Certification/Safety Inspection Checklists for MDW for years 2003 – 2005 were examined, and no deficiencies were noted.

Midway Airport had a total of five runways (Figure 2). Two parallel runways were oriented northeast/southwest (Runway 4R/22L and Runway 4L/22R). The other

[4] Except for one fatality, injuries to automobile passengers were unknown.

three parallel runways were configured northwest/southeast (Runway 13L/31R, Runway 13C/31C, and Runway 13R/31L). The two longest runways at MDW were certificated under 14 CFR Part 139 for use by scheduled air carriers operating aircraft designed for 10 or more seats, and unscheduled air carriers operating aircraft designed for 31 or more seats. Runway 4R/22L consisted of a grooved asphalt and concrete surface that is 6,446 feet in length. Runway 13C/31C was grooved concrete and measured 6,522 feet in length. Both were precision instrument runways, with ILS approach procedures on each end except Runway 22L, which had non-precision approaches. These two runways were marked as precision instrument runways, and had precision approach path indicator (PAPI) equipment at each touchdown zone, except Runway 31C, which had visual approach slope indicator (VASI) equipment. There were runway end identifier lights (REILS) at each runway end except Runway 13C, which had an LDIN approach light system. Both runways had displaced thresholds at each end, which resulted in usable landing distances as follows: Runway 4R – 5928 feet; Runway 22L – 5,812 feet; Runway 13C – 6,059 feet; Runway 31C – 5,826 feet. The full width Runway 13C/31C safety area (RSA) extended 82 feet northwest and 48 feet southeast of the runway ends.

According to MDW Airport Operations and FAA records, Runway 13C/31C was rehabilitated[5] in 1992, and was re-grooved on October 10, 2005. The runway markings were repainted on October 28, 2005, and included glass beads in the paint to improve conspicuity and friction characteristics of the markings[6]. Runway 13C/31C underwent rubber removal procedures on November 14 and 15, 2005, using ultra high pressure (UHP) water blasting. Midway Airport typically conducts rubber removal operations between May and November, but not during winter months.[7] According to FAA AC 150/5320-12C, a runway having "91 -150 daily turbojet aircraft landing per runway end,"[8] should have rubber deposits removed at a frequency of "every 4 months." In 2005, rubber removal operations were conducted on Runway 13C/31C in May, July, September, and November.

### 8.1 MDW RSA History

FAA Advisory Circular 150/5300-13, *Airport Design*, Table 3-3, *Runway Design Standards for Aircraft Approach Categories*, specifies that the standard runway safety area (RSA) for Runway 13C/31C at MDW should have a width of 500 feet (centered on runway centerline) and a length of 1,000 feet beyond each runway end. Runway 13C/31C was originally constructed in the 1920s and Runway 4R/22L was constructed in 1941, prior to the development of current FAA airport design standards.

[5] The runway was milled and resurfaced, but not expanded in size or weight-bearing capacity.

[6] The paint was Davies Imperial Coatings, federal specification TT-P-1952D white and black waterborne; and the glass beads were Flex-O-Lite, federal specifications TT-B-1325C, type I gradation A.

[7] In accordance with FAA AC 150/5200-12, *Measurement, Construction and Maintenance of Skid-Resistant Airport Pavement Surfaces*

[8] Runway 13C/31C at Midway is categorized as such.

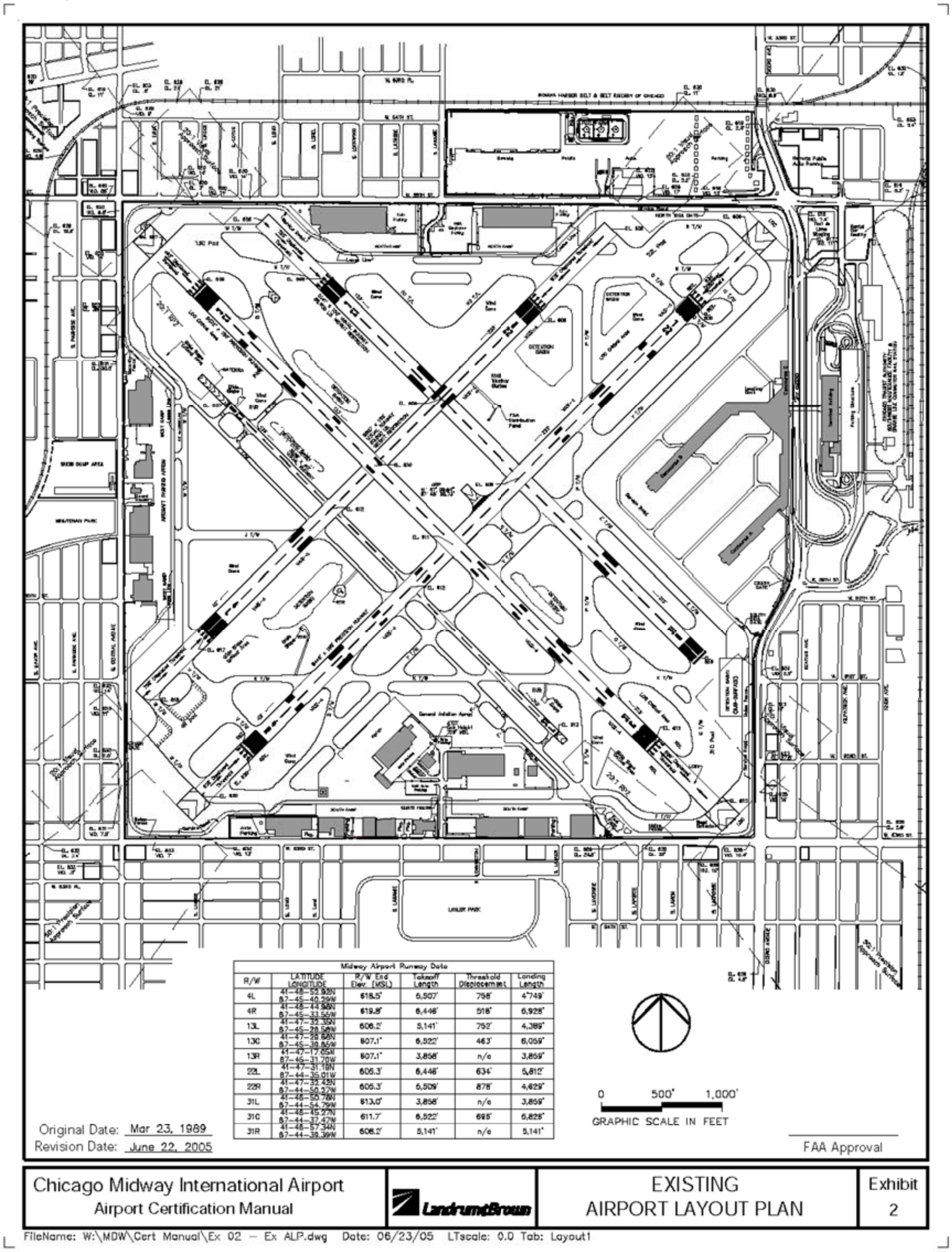


Figure 2. MDW Airport Layout Plan

Due to a regulatory change which became effective January 1, 1988, the FAA accepted existing safety area conditions at airports certificated under provisions of 14 CFR Part 139. However, after that date, any significant runway expansion or reconstruction would require that safety areas meeting standards acceptable to the FAA be constructed on the affected runway, to the extent practicable. As previously mentioned, Runway 13C/31C at MDW was rehabilitated in 1992, but was not expanded in size or weight-bearing capacity; therefore, the safety areas were not changed.

As per FAA Order 5200.8, an inventory of MDW runway safety area conditions was conducted in 2000. Using results of the inventory and other information, the FAA issued a Runway Safety Area Determination dated September 20, 2000. In their RSA determination, the FAA Great Lakes Region, Chicago Airports District Office (ADO) reviewed the practicability of upgrading the RSA and determined that "it does not appear practicable to achieve the RSA standards," because the runway could not be realigned on the 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.

In correspondence to the City of Chicago dated October 5, 2000, the Chicago ADO transmitted the September 20, 2000 memorandum to the City and instructed the City "to explore all options to bring the RSAs into full conformance with FAA standards." In 2003, the Chicago ADO asked the city to assess enhancement measures for improving the runway safety areas at MDW.

In response, the City contracted with Ricondo and Associates to conduct a practicability study of MDW RSAs, which resulted in a report, entitled Runway Safety Area Practicality Study, dated May 18, 2004. The City reported the findings of the study to the FAA in a letter dated May 21, 2004. The letter stated that, with regard to Runway 13C-31C "there were no alternatives for achieving a standard RSA." Specifically:

- 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.
- Engineered Materials Arresting System (EMAS) was assessed, but insufficient spacing existed for installation of standard EMAS without shortening the runway, thus reducing the operational capacity of the airport.

The study also concluded that RSA enhancement could potentially be obtained by certain incremental improvements, such as, relocation of light poles and service road signs in the RSAs.

In a telephone conversation with Safety Board investigators in January 2006, representatives of the Chicago ADO said that their office had contacted MDW officials by telephone in March of 2005 to discuss the RSA practicability study. According to the ADO, Midway officials were told that the alternatives provided by the study for improving RSAs were insufficient in determining practicability, and that other options, including better cost estimates for enhancements should be explored. The FAA asked that the study be revised, and explore, among other things, the use of non-standard EMAS beds at the runway ends.

Representatives of Midway Airport said that, at the March 2005 meeting with the FAA, City (of Chicago) officials informed the FAA that "there were no certified or economically feasible alternatives for improving the RSA," and that the FAA "made no request to the city for additional studies or improvements to the RSA," nor a request to "explore non-standard EMAS installation." The Airport representatives said that they learned that the FAA was waiting for a response from the City from an article in the Chicago Tribune on December 13, 2005. The City contacted the FAA Great Lakes ADO in response to the newspaper article, and they were faxed an unsigned, "draft" letter, dated December xx, 2005, addressed to the City of Chicago.

According to a representative from Engineered Arresting Systems Corporation (ESCO), an EMAS manufacturer, in January of 2006, ESCO was contacted by the Chicago ADO, requesting options for MDW. ESCO provided the FAA with cost and performance estimates for installation of EMAS at MDW.

On April 4, 2006, the acting commissioner for the Department of Aviation (City of Chicago) sent a letter and an EMAS study to the FAA Great Lakes Region, Airports Division in response to the FAA's request for a revised practicability study. The letter summarized the options for improving the RSAs, including property acquisition and realignment of surrounding roadways. According to the letter, "off-airport alternatives have been estimated by the City to range between $200 and $300 million, substantially in excess of the FAA's practicability criteria as defined in [FAA] Order 5200.9." Further, the letter states, "the City has concluded that it is not feasible or practicable to proceed with a massive land acquisition to address the Runway Safety Areas at Midway…Therefore, we have evaluated the feasibility of another on-airport alternative – the installation of arrestor beds." And, "The City would like to move forward with the installation of EMAS at Midway. The City requests that the FAA reserve the appropriate grant funding for the City's forthcoming grant application that will fund the necessary infrastructure needs and EMAS installation." The EMAS study, prepared by Ricondo and Associates for the airport, detailed installation considerations, and concluded that non-standard EMAS beds with 35-foot setbacks may be possible at the ends of Runways 04R/22L and 13C/31C, provided that ILS localizer antennae could be relocated. Additionally, an FAA NAVAID site assessment and a determination of feasibility for a non-standard EMAS setback less than 75 feet would be required.

According to an airport representative, since the above-mentioned letter was sent, the City "has been working with FAA to finalize the grant funding," and "plans to complete one EMAS installation during 2006, and proactively complete the remaining 3 non-standard EMAS installations during 2007 pending the resolution of the localizer relocations with the FAA. "

## 8.2 Regulatory History of RSAs and NTSB Actions

On April 4, 1977, in response to the November 16, 1976, Texas International Airlines flight 987 accident in which a McDonnell Douglas DC-9-14 ran off the end of Runway 8R at Stapleton International Airport, Denver, Colorado, the NTSB issued Safety Recommendation A-77-16, which asked the FAA to "amend CFR Part 139 of the *Federal Aviation Regulations* to require, after a reasonable date, that the extended runway safety area criteria[9] be applied retroactively to all certificated airports." In its July 11, 1977, response letter, the FAA stated, "Extended safety areas at all existing airports would be impractical and infeasible. The FAA will propose an amendment to 14 CFR Part 139 that will require extended safety areas concurrently with construction of new airports, new runways, and major runway extensions at existing airports."

On October 23, 1985, the FAA published Notice of Proposed Rulemaking (NPRM) 85-22, "Revision of Airport Certification Rule," which proposed changes to 14 CFR Part 139 that would require extended RSAs concurrent with the construction of new airports and runways and with major runway extensions at existing airports. On February 5, 1986, the Safety Board commented on the NPRM, stating, "we continue to believe that criteria for runway safety areas should be made mandatory at all certificated airports regardless of the date of construction." On January 1, 1988, the final rule became effective and stated the following:

> (a) To the extent practicable, each certificate holder shall provide and maintain for each runway and taxiway which is available for air carrier use—
>
> (1) If the runway or taxiway had a safety area on December 31, 1987, and if no reconstruction or significant expansion of the runway or taxiway was begun on or after January 1, 1988, a safety area of at least the dimensions that existed on December 31, 1987; or
>
> (2) If construction, reconstruction, or significant expansion of the runway or taxiway began on or after January 1, 1988, a safety area which conforms to the dimensions acceptable to the Administrator at the time the construction, reconstruction, or expansion began.

Because the final rule did not require the retroactive upgrade of RSAs to the standard criteria at existing runways or taxiways, on March 29, 1990, the Safety Board classified Safety Recommendation A-77-16 "Closed—Unacceptable Action."

On January 5, 1995, in response to the April 27, 1994, Action Air Charters flight 990 accident in which a Piper PA-31-350 Navaho Chieftain crashed into a blast fence at the end of Runway 6 at Sikorsky Memorial Airport, Stratford, Connecticut, the Safety Board issued Safety Recommendation A-94-211, which asked the FAA to inspect all 14 CFR Part 139 certificated airports for adequate RSAs and nonfrangible objects, such as

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[9] When the Safety Board issued Safety Recommendation A-77-16, 14 CFR Part 139 did not specify dimensions for RSAs. RSA criteria were established by AC 150/5300-12, effective February 28, 1983, which specified that an RSA should be at least 500 feet wide and should extend 1,000 feet beyond each runway end. AC 150/5300-12 was superseded by AC 150/5300-13 on September 29, 1989.

blast fences, and require that substandard RSAs be upgraded to the minimum standards set forth in AC 150/5300-13, "Airport Design," wherever possible. In its October 15, 1997, response, the FAA indicated that 25 percent of the runways at 14 CFR Part 139 certificated airports had RSAs that did not meet the minimum standards established by AC 150/5300-13, but that could meet those standards if feasible improvements were made. The FAA further indicated that 17 percent of the runways at 14 CFR Part 139 certificated airports had RSAs that did not meet the minimum standards and that could not be made to meet those standards with feasible improvements. The FAA added that because of the cost of RSA improvements and the infrequency of aircraft overruns and undershoots, any improvements to the runways that could be made to meet the standards would be made only as part of overall runway improvement projects. Because the delay in RSA improvements would allow substandard conditions to continue, on February 10, 1999, the Safety Board classified Safety Recommendation A-94-211 "Closed—Unacceptable Action."

As indicated by the FAA in its response to Safety Recommendation A-94-211, some airports had RSAs that could not, with feasible improvements, be made to meet the minimum standards established by AC 150/5300-13. In a 1984 Safety Study titled, A*irport Certification and Operations*, the Safety Board noted that "the continual problem of encroachment on airports by the surrounding community, which is the result of geographical barriers and conflicting interests and improper land use planning, renders unlikely any substantial increase in the size of runway end safety areas at most airports."[10] To address this problem, the Board issued Safety Recommendation A-84-37, which asked the FAA to "initiate research and development activities to establish the feasibility of soft-ground aircraft arresting systems (also known as Engineered Materials Arresting Systems (EMAS)) and promulgate a design standard, if the systems are found practical." On June 21, 1997, on the basis of the FAA's and industry's research and development activities, the Safety Board classified Safety Recommendation A-84-37 "Closed—Acceptable Action."

Since the development of EMAS, several airports have installed the systems. In addition, several airports have installed EMAS following overrun accidents. On June 1, 1999, American Airlines flight 1420, a McDonnell Douglas DC-9-82, crashed after it overran the departure end of Runway 4R during landing at Little Rock National Airport (LIT), Little Rock, Arkansas. In the fall of 2000, LIT installed an EMAS at the departure end of Runway 4R. Further, Burbank Airport (BUR) completed the installation of an EMAS at the departure end of Runway 8 in February 2002.

On October 1, 1999, the FAA issued Order 5200.8, which established its Runway Safety Area Program. The order stated that the objective of the program was that "all RSAs at federally obligated airports and all RSAs at airports certificated under 14 [CFR] Part 139 shall conform to the standards contained in AC 150/5300-13, *Airport Design*, to the extent practicable." However, Order 5200.8, Paragraph 10, "Implementation of RSA Improvements," stated the following:

[10] National Transportation Safety Board. 1984. *Airport Certification and Operations*. NTSB/SS-84/02. Washington, DC.

a. A project to improve an RSA in accordance with the determination made in Paragraph 8 may be initiated at any time.

b. Whenever a project for a runway involves construction, reconstruction (includes overlays), or significant expansion, the project shall also provide for improving the RSA in accordance with the determination made in Paragraph 8.

The determination made in accordance with Paragraph 8, "RSA Determinations," of the Order, was to be made based on information gathered in accordance with Paragraph 7, "RSA Inventory," which required that "each regional airports division shall collect and maintain data on the RSA for each runway at federally obligated airports and airports certificated under part 139 within their geographic purview." The results of the inventory were found in a November 2000 FAA document titled, *Runway Safety Areas at Certificated Airports*. According to the document, 55 percent of RSAs met the minimum standards established by AC 150/5300-13, 31 percent of RSAs did not meet the minimum standards but could meet those standards if feasible improvements were made, and 14 percent of RSAs did not meet minimum standards and could not be made to meet those standards with feasible improvements.

FAA Order 5200.8 did not provide a concrete plan (for example, specific dates by which RSA improvements should be made) for improving those RSAs that did not meet minimum standards established in AC 150/5300-13, but that could be made to meet those standards with feasible improvements. The FAA's plan to require improvements to RSAs that could meet the minimum standards established by AC 150/5300-13 if feasible improvements were made only as part of overall runway improvement projects allows that such improvements may not occur for some time.

Appendix 2 of FAA Order 5200.8 provided the following guidance to FAA regional airport division staff when making a determination whether or not a RSA could be practicably improved:

1.) Historical record of airport accidents/incidents
2.) Current and forecast runway usage
3.) Extent to which the existing RSA complies with the standard
4.) Site constraints (i.e. bodies of water, wetlands, major highway, etc.)
5.) Weather and climatic conditions
6.) Availability of visual and electronic aids for landing

Appendix 2 also prescribed the alternatives the FAA considered when determining how to obtain a standard RSA. "The first alternative to be considered in every case is constructing the traditional graded area surrounding the runway. Where it is not practicable to obtain the entire safety area in this manner, as much as possible should be obtained. Then the following alternatives shall be addressed in the supporting documentation:"

1.) Relocation, shifting, or realignment of the runway
2.) Reduction in runway length where the existing runway length exceeds that which is required for the existing or projected design aircraft
3.) A combination of relocation, shifting, grading, realignment, or reduction
4.) Declared distances
5.) Engineered Materials Arresting Systems (EMAS)

Further, the document stated, "RSA determinations must be supported by documentation that provides the rationale upon which the determination was based… in cases where it is not practicable to improve a safety area to meet current standards, the documentation must address the alternatives that were considered and explain the reasons why one was selected over the others."

On May 6, 2003, the Safety Board adopted two recommendations that addressed runway safety areas. The first recommended that the FAA require all Part 139 certificated airports to "upgrade all runway safety areas that could, with feasible improvements, be made to meet the minimum standards established by AC 150/5300-13." The recommendation stated that upgrades "should be made proactively, not only as part of other runway improvement projects." (A-03-011) The second recommendation (A-03-012) asked the FAA to require engineered materials arresting systems (EMAS) in each RSA that could not feasibly be made to meet the minimum standards. In correspondence following issuance of the recommendations, the FAA stated that it agreed with the intent of the recommendations and, in an August 2003 letter, stated that FAA Order 5200.8 "Runway Safety Area Program" established a program to bring all runway safety areas up to current standards, whenever possible. It also stated that "a project to improve an RSA… may be initiated at any time." The FAA's goal was to upgrade at least 65 RSAs per year through 2007 and it was reported that 71, 68, and 74 RSAs were upgraded in fiscal years 2000, 2001, and 2002 respectively. The Safety Board has currently classified both recommendations "Open-Acceptable Response." A written request was made to the FAA for updated information on the status of the RSA upgrades, but had not been received at the time of this report.

FAA Order 5200.9, *Financial Feasibility and Equivalency of Runway Safety Area Improvements and Engineered Materials Arresting Systems*, was published in March of 2004, as guidance for (a) comparing various RSA improvement alternatives with improvements that use EMAS; and (b) determining the maximum financially feasible cost for RSA improvements, whether they involve EMAS or not. In addition, Order 5200.9 acknowledged that a standard EMAS installation provided a level of safety that is "generally equivalent to a full RSA" constructed to the standards of AC 150/5300-13. Further, the order addressed the situation where neither a standard RSA nor a standard EMAS can be provided within maximum feasible costs. In this situation, the order states that "a non-standard EMAS that will stop the design aircraft traveling at 40 knots or more should be considered."

In September 2005, FAA issued Advisory Circular (AC) 150/5220-22A, *Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns*. The AC was an updated version of a previous AC which had been issued in August 1998. The update aligned the AC with FAA Order 5200.9, reiterated standard 70-knot EMAS equivalency to a full-length safety area, and emphasized the benefits of non-standard 40 knot EMAS systems.[11] In addition, the AC:

- Updated planning charts with more current computer modeling data.
- Confirmed standard design conditions (75 ft setback, no reverse thrust, and poor braking of 0.25 braking friction coefficient).
- Allowed a reduced setback to improve performance for short safety areas.
- Added aircraft performance data for 737-400, 757, CRJ-200, and G-III.
- Established a goal of 20 year as the service life for EMAS.
- Clarified that the EMAS "design aircraft" is the one that places the most demand on the EMAS, but may not always be the heaviest or largest aircraft that regularly uses the runway.
- Added a guideline to use maximum take-off weight (MTOW) as a general rule for design.
- Explained the "70 knots overrun goal" was for aircraft with approach category C and D only.
- Stated that EMAS modeling was not as accurate for aircraft below 25,000 lbs MTOW.
- Stated the need to repair EMAS in timely manner after use.
- Stated that any EMAS proposed design should to be submitted to FAA Headquarters 45 days prior to the bid opening date for the project.
- Added an appendix with requirements for EMAS inspection and maintenance.
- Added the need to issue NOTAM of the EMAS's reduced performance after an arrestment.
- Added figures and drawing details for typical EMAS.

### 8.3 Airport Winter Operations

The Airport Certification Manual (ACM)[12] for Chicago Midway Airport contains a required chapter that addresses snow and ice removal. Briefly, the ACM lists the airport's responsibilities as:

1) Determining when snow and ice removal are necessary;
2) Continually monitoring runway conditions and pilot reports during snow and ice events;
3) Keeping the NAVAID critical areas within snow depth limits, and notifying FAA maintenance personnel when commencing with the snow removal plan.
4) Disseminating airport condition information through NOTAMs and the Kankakee Flight Service Station (FSS).
5) Keeping the FAA ATCT, air carriers, and other users informed of the airport status and field condition, snow removal operations, PIREPS, and friction measurement readings.

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[11] The previous version of the AC did not address non-standard EMAS installations.

[12] FAA approved on June 7, 2005

The ACM also specifies "snow removal operations shall commence, as a rule, when accumulation begins on the surface of the active runway(s)." And, that, "Any runway whose central portion, within 30 feet of either side of the centerline, that has accumulations of 2" or more of dry snow, or ¼ " or more of slush or wet snow, is closed for use. Further, according to the ACM, the airport will conduct 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 at a minimum, or under the following conditions:

1) Whenever a visual runway inspection indicates that the runway friction is changing;
2) Whenever a succession of pilot reports indicate a trend of degradation of braking action;
3) Following anti-icing, plowing, brooming, or sanding operations conducted on the full length of the respective runway while snow and/or ice events are in progress
4) At least once during each 8 hour shift when contaminants are present on the runway;
5) Immediately following any aircraft incident or accident on the runway.

The snow and ice removal chapter of the MDW ACM lists the apparatus available at MDW as:

1) Friction testers: KJ Law, ASFT, or Bowmonk AFM2 Mark 3 (two each)
2) 19 foot swing plows (11)
3) Runway brooms (9)
4) 4000 gallon anti-icers (4)[13]
5) 14 foot plows/sanders (5)
6) snow blowers (4)
7) Payloaders/ highlifts (3)
8) Alternate spreaders/plows/scrapers (5)

In addition to the snow and ice removal chapter in the ACM, MDW airport operation has compiled a reference document called the *2005-2006 Snow Removal Manual* for use by the airlines, the Air Transport Association, the Midway Corporate Tenants and Fixed Base Operators, the administrative branch of the City of Chicago, and for informational purposes by the FAA. The stated purpose of the manual is to, "provide an overview of the procedures utilized by the Department of Aviation (DOA) as part of its snow removal operations at Chicago Midway International Airport. It describes the procedures followed during snow removal from the Midway airport operations area (AOA), its parking lots, and public roadway systems."

According to airport officials, the *2005-2006 Snow Removal Manual* contained detailed plans divided into three sections: 1) Pre-season Planning; 2) Tools and

[13] Since the ACM was approved, and prior to the 2005 snow season, MDW acquired a fifth anti-icer.

Equipment; and 3) Implementation. The Preseason Planning section addressed creation of snow removal plans, letting of relevant contracts, and preventative maintenance on snow removal equipment. The Tools and Equipment section outlined the operation of the airport's fleet of snow/ice removal equipment, and the acquisition and use of snow/ice melting substances. The Implementation section included four phases: Phase One: Notification (when the Department of Aviation (DOA) receives adverse weather indications, it then notifies ATC, the airlines, and contractors); Phase Two: Mobilization (mobilization of necessary DOA and contractor staff, and deployment of relevant equipment and/or positions); Phase Three: Implementation (commencement of snow removal operations achieving snow/ice control and airfield condition reporting); and Phase Four: Termination of alert status.

According to MDW operations officials, on the day of the accident, the City had received adverse weather reports and initiated the Notification and Mobilization phases of the "snow operation plan." Staff were assembled and assigned to their respective equipment and positions shortly after noon. Snow began falling at the airport at approximately 01:47 PM, and snow removal operations commenced. Snow removal procedures used that day consisted of nine[14] snow brooms in a staggered configuration across the runway, followed a snow plow and a snow blower. Those vehicles were followed by three deicer machines that applied a 50% mixture of potassium acetate deicing fluid[15] the length of the runway. After all of the snow removal and deicing apparatus had exited the runway, a friction tester took a reading on the runway. During the five and one-half hours of snowfall prior to the accident, Runway 13C/31C had been broomed and treated five times.

According to MDW personnel, snow removal and anti-icing operations are conducted from "runway end to runway end." The runway friction surveys are also conducted from runway end to runway end; the results are reported in thirds with an overall average. However, due to the need for test vehicles to accelerate prior to the tests, and to stop safely before going off the end of the runways, the actual friction survey recording begins and ends approximately 500 ft. from the runway ends.

Through a letter of agreement with FAA,[16] MDW staffs an airport operations supervisor in the control tower during snow removal operations. The operations supervisor acts as liaison between snow removal teams on the airfield and air traffic controllers (ATC) in the tower. While a tower liaison is not required by the FAA, this coordination effort is intended to optimize use of the runways, while minimizing delays for either group. In addition, the operations supervisor receives pilot reports (PIREPS) from ATC regarding field conditions and/or braking action, and relays theses reports to Airport Operations for dissemination to airport tenants (including airlines), and to other operations staff for evaluation on the airfield. The operations supervisor in the tower also

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[14] The Airport Snow Log indicated "brooms have eight brooms up," at 1609. According to an airport official, one snow broom experienced a mechanical problem, and was removed from service.

[15] Applied at the rate of .75 gallon per 1000 square feet.

[16] Included in the MDW Airport Certification Manual (ACM).

maintains a handwritten "snow log" that records timing activities of the snow removal teams and runway friction tests during snow removal operations.

MDW operations uses three methods to disseminate airfield condition information during winter operations: 1) A website is maintained by the airport that contains field condition reports. The website is accessible by all airport tenants, and is periodically updated when new information is received from personnel on the airfield; 2) Runway availability and advisories of unusual conditions are disseminated to the FAA Kankakee Flight Service Station (FSS) in the form of Notices to Airmen (NOTAMs); and 3) Personnel in airport operations are available by telephone to relay airfield conditions during winter operations events. At the time of the accident, the website for field conditions had been updated at 18:50, and contained the following information for air carrier runways:

4R-22L CLOSED – SNOW REMOVAL IN PROGRESS
13C-31C 90% trace-1/16" wet snow, 10% clear and wet. Snow removal in progress.
MU friction value (Bowmonk) 1847 hrs .72/.59/.68 avg .67

According to the Assistant Commissioner of Operations at MDW, and corroborated by the airport "snow log," and "friction test log," (Attachment 3) Runway 31C had a friction test performed at 1839 using the ASFT[17] tester, which produced readings of .59/.45/.37 for an average of .47. At 1845, Runway 31C had just been broomed, plowed and deiced. A friction test performed at 1847 using a Bowmonk AFM2 device[18] produced results of .72/.59/.68 for an average reading of .67. Runway 31C did not receive snow removal procedures again prior to the accident. Following the accident, at 1922, a friction survey was conducted on Runway 13C/31C using the Bowmonk device which produced values of .41/.40/.38 for an average of .40.

Sequence of Events

The following table is a compilation of independently recorded information from the airport snow log (Snow), airport friction test log (Friction), Air Traffic Control radio transmission transcripts (ATC), and the Aircraft Performance Group Study (APGS). The times shown are as they appeared in the independent source documents, and were not synchronized. Entries for the snow and friction logs were arbitrarily selected to begin at 1607 and end at 1955, and no entries between those times were omitted. The ATC transcriptions began approximately 30 minutes prior to the accident, and include only those transmissions in which braking action reports were mentioned. The APGS data shows airplane landing times based on radar, FDR, and ACARS data. The purpose of the table is for reference only; and while it accurately reflects the data *as it was entered* into

[17] The ASFT was installed in a Ford Taurus.

[18] The Bowmonk AFM2 was mounted in a 1999 Ford Expedition with rear wheel drive, rear wheel-only antilock braking system (ABS), and Firestone Destination P255 70R16 tires. The decelerometer was calibrated on May 11, 2005.

the original sources, assumptions about the accuracy or timing of the original entries, or the relationships between the various sources, are conjectural.

| Time | Source | Entry |
|---|---|---|
| 1607 | Snow | O 2153Z 0811 V ½ SN FzFg VV 003 -4/-6/3016 ILS 31C L:31C D:4R |
| 1607 | Friction | Ford 4R .36 .45 .46 = .42 |
| 1609 | Snow | Brooms have 8 brooms up |
| 1611 | Snow | SWA PIREP Fair |
| 1612 | Snow | Plow Team on W to N to terminal ramp |
| 1617 | Snow | Brooming in progress on 31C |
| 1617 | Snow | FT 4R .36 .45 .46 = .42 Ford |
| 1617 | Friction | Bowmonk 4R .62 .62 .50 = .58 |
| 1622 | Snow | Airtran reports F 1st 2 3rds & nil at the end |
| 1629 | Friction | Bowmonk 31C .58 .61 .64 = .57 |
| 1634 | Friction | Ford 4R .28 .31 .30 = .30 |
| 1635 | Snow | Broom team continuing on 31C from 4L to B hysd |
| 1641 | Snow | Broom on W to 4R |
| 1643 | Snow | Brooming in progress on 4R |
| 1643 | Snow | SWA 737 PIREP F 31C |
| 1648 | Snow | SWA 737 PIREP F 31C |
| 1654 | Snow | Brooms on way to 31C.<br>SWA 737 PIREP F to P at the end of 31C |
| 1655 | Snow | Rwy 4R clsd. In/Out on 31C |
| 1702 | Snow | Brooming in progress on 31C |
| 1706 | Snow | Brooming complete on 31C |
| 1707 | Friction | Bowmonk 31C .52 .50 .54 = .52 |
| 1707 | Snow | FT .52 .50 .54 = .52 31C |
| 1712 | Snow | SWA 737 PIREP P on 31C |
| 1715 | Snow | SWA PIREP |
| 1717 | Snow | Brooms on 31C |
| 1727 | Snow | SWA PIREP Poor 31C |
| 1727 | Friction | Bowmonk 31C .57 .48 .49 = .51 |
| 1731 | Snow | RVR 31C 3000 |
| 1737 | Snow | Plowing in progress on F to 13C appch. |
| 1737 | Snow | An arrival has been slowed to taxiing speed at 4L on 31C |
| 1747 | Friction | Taurus 13C .23 .28 .25 = .25 |
| 1752 | Friction | Bowmonk 13C .42 .43 .41 = .42 |
| 1752 | Snow | Brooms on the way to 4R |
| 1754 | Snow | SWA 737 PIREP F |
| 1757 | Snow | Brooming in progress on 4R |
| 1801 | Snow | 7.7" as of 1400hrs. |
| 1802 | Snow | Plows on 4R NW edge |
| 1806 | Snow | Brooms going to 31C. Plows on P& N txy. |

| Time | Source | Entry |
|---|---|---|
| 1806 | Friction | Bowmonk 4R .63 .67 .77 = .69 |
| 1813 | Snow | SWA 737 F-P |
| 1814 | Snow | SWA PIREP F 31C |
| 1820 | Snow | SWA 737 PIREP F-P 31C |
| 1825 | Snow | Const. labors notified to meet the brooms on the 31C pad |
| 1828 | Snow | SWA 737 F-P PIREP 31C |
| 1832 | Snow | Brooms on 31C, Plow turn off Deicer 9 on 31C |
| 1834 | Snow | Departure off 4R |
| 1839 | Snow | Plowing in progress on B hysd to N to twy P to twy E |
| 1839 | Friction | Taurus 31C .59 .45 .37 = .47 |
| 1843 | Snow | ATIS U 0024Z 0911 V ¾- SN BR OVC 003-3/-4/3007 ILS 31C L:31C D:4R |
| 1844 | Snow | Broom on 31C pad being cleaned |
| 1847 | Friction | Bowmonk 31C .72 .59 .68 = .67 |
| 1847:05 | ATC | ATC issued braking action to UAL 1446, "fair to poor." |
| 1848 | Snow | Plows on twy P |
| 1849 | APGS | UAL 1446 landed |
| 1849 | Snow | UAL A319 PIREP 31C |
| 1850:06 | ATC | UAL 1446 reported to tower, braking action "fair." |
| 1850:19 | ATC | ATC issued braking action to SWA 2920, "fair, by an Airbus that just landed." |
| 1851 | Snow | Bowmonk .72 .59 .68 = .67 31C 1/8 – 1/4 scattered wet snow |
| 1852 | APGS | SWA 2920 landed |
| 1853 | Snow | PIREP SWA 737 F-P at the end |
| 1853:10 | ATC | SWA 2920 reported to tower, braking action "fair, and it's poor at the end here." |
| 1857:42 | ATC | ATC issued braking action to SWA 231, "fair, and then poor at the end, by your company, a couple minutes ago." |
| 1859:52 | ATC | ATC issued braking action to SWA 2947, "fair, and then poor at the end." |
| 1900:38 | APGS | SWA 321 landed |
| 1901:15 | ATC | SWA 321 reported to tower, "braking action at the far end of the runway is poor." |
| 1901:33 | ATC | SWA 321 reported to tower, "good first half of 31 center, poor the second half." |
| 1901:52 | ATC | ATC issued braking action to SWA 1830, "good for the first half, poor for the second half, reported by your company." |
| 1902 | APGS | SWA 2947 landed |
| 1904 | APGS | SWA 1830 landed |
| 1906:38 | ATC | ATC issued braking action to N565CC, C500, "good for the first half, poor for the second half." |
| 1907:44 | ATC | ATC issued braking action to N603KF, G-IV, "good for the first half, poor for the second half." |
| 1909 | Snow | PIREP SWA 737 G 1st 2 3rds poor last 3rd |

| Time | Source | Entry |
|---|---|---|
| 1909 | APGS | N565CC, C500 landed. |
| 1909:00 | ATC | N565CC, C500 reported to tower, "It's poor right now." (crew indicated they were past taxiway A) |
| 1909:47 | ATC | ATC issued braking action to SWA 1248, "Good for the first half, poor for the second half." |
| 1910 | APGS | N603KF, G-IV landed |
| 1910:35 | ATC | N603KF, G-IV reported to tower, "fair to poor." |
| 1912:15 | ATC | ATC issued braking action to SWA 1248, "fair to poor." |
| 1913 | APGS | SWA 1248 landed |
| 1914 | Snow | SWA 737 1248 went off the end of 31C. Through the fence at 13C. CFD on the scene at 1920 hrs. C8, TT |
| 1914 | Snow | Btn Kilo and twy Y wheel tracks of the SWA 1248 |
| 1922 | Friction | Bowmonk 31C .41 .40 .38 = .40 |
| 1923 | Snow | Broom 3 and plow on 4R |
| 1928 | Snow | Plows on 22L turn offs |
| 1955 | Snow | 1 broom is down on 4R-22L. 377 is down to 8 brooms |

Runway Friction testing

There are two types of friction measurement equipment used to conduct friction surveys during winter airport operations. One type is a *decelerometer* (DEC), and the other is *continuous friction measurement equipment* (CFME). DEC-type units determine friction values by measuring vehicular deceleration (i.e., g-force of the vehicle). They are typically a self-contained unit that is installed in an appropriate vehicle. CFME units use a 5th-wheel that is in constant contact with the surface being measured, and may be "built-in" to an airport vehicle, or can also be a separate, towed device. Midway Airport uses both CFME (ASFT AB 2000 measuring device, and KJ Law), and a DEC (Bowmonk Model AFM2 Mark 3), to determine runway friction values. The Bowmonk uses an accelerometer to measure the deceleration (g-force) experienced by the transporting vehicle. FAA Advisory Circular (AC) 150/5200-31A, *Airport Winter Safety and Operations* lists FAA-approved decelerometers; FAA AC 150/5320-12C, *Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces* lists FAA-approved CFME equipment.

The output from friction measuring equipment is reported as a numerical value with "Mu" as the unit of measure. Mu 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 obtainable. Mu values are usually reported in whole numbers rather than fractions. For example, a Mu value of .40 (point four) is typically reported as 40 (forty). Friction testing devices provide values for the first 1/3, the second 1/3, and the third 1/3 of the length of the runway. These "thirds" are then averaged for an overall reading representing the entire runway surface friction.

FAA Advisory Circular (AC) 150/5200-31A, *Airport Winter Safety and Operations*, acknowledges both types of friction testers for use on runways during winter operations, and specifies the type of conditions that are acceptable for conduct of friction surveys on frozen contaminated surfaces. The FAA considers both types of friction testers to be "generally considered reliable" when the surface is contaminated by 1) ice or wet ice; and 2) compacted snow (any depth). However, the AC also says, "It is generally accepted that friction surveys will be reliable as long as the depth of dry snow does not exceed 1 inch (2.5 cm), and/or the depth of wet snow/slush does not exceed 1/8/inch (3mm)."

Appendix 5 to the advisory circular states that, "Decelerometers should not be installed on vehicles that are equipped with full ABS (antilock braking systems) because the ABS tends to distort the sensitivity of the decelerometer resulting in friction readings that are lower than actually exist. This could result in premature closing of runways." Appendix 5 also states that if the ABS system for the front wheels is disengaged, then "the vehicle's brake system becomes a single sensor ABS installed on the rear axle, which will then qualify the vehicle for conducting friction tests with decelerometers." FAA CertAlert No. 05-01, issued 1/14/2005, restated the FAA's position that "the decelerometer is not recommended for use on a vehicle equipped with an ABS braking system [sic]."

In contrast, Bowmonk, Ltd. literature states:

> By using the new AFM2 airfield friction meter it is possible to accurately determine runway friction even when the test vehicle is fitted with an anti-lock braking system (ABS). The electronic deceleration sensor used in the AFM2 is set to have response time as short as 2/100 of a second. In other words, much faster than the on-off cycle time of the antilock braking system of the vehicle. Since the AFM2 records the peak value of friction at the instant the wheels start to lock, the instrument can be used to determine runway friction even with vehicles fitted with anti-lock brake systems (ABS).

A report[19] produced by The Winter Runway Friction Measurement and Reporting Group[20] addressed correlation between DECs and CFMEs, and noted:

> Extensive tests and trials of various friction-measuring equipment carried out to date by FAA and Transport Canada confirm that as long as such equipment is working properly and calibrated in accordance with manufacturers' instructions, all of them will provide similar friction readings for any of the allowable surface contaminant conditions. Thus, the so obtained friction values can be considered accurate and reliable, and entirely suitable for the intended purposes. This makes the process very convenient and easy to use, because it is not necessary to specify what equipment was used to obtain such information when transmitting such

[19] *An Evaluation of Winter Operational Runway Friction Measurement,* Section 3.3, January 25, 1995.

[20] Comprised of representatives from the FAA, Transport Canada, NASA, Airports Council International, American Association of Airport Executives, Regional Airline Association, Air Transport Association, and ALPA.

friction readings to the various users. Any of the approved friction-measuring equipment will give the same results under similar surface conditions. Furthermore, this applies irrespective of whether one uses a CFME, or DEC type of equipment. The only difference between the results obtained from these two generic types of equipment is that the former provides a continuous record of friction over any desired length of pavement, while the latter gives what is known as the spot value of friction, which represents the short length of the pavement over which the friction is measured. The above difference in the fundamental way in which the friction measurement is obtained is, however, of no operational consequence, because in any case such readings are taken over the entire length of the runway and then averaged for each third of it (the touchdown, the midpoint and the rollout zones). Thus the actual friction-measuring process and the kind of equipment used is entirely transparent to the ultimate user of such information, who is simply provided with a single friction value for each of the three zones. This eliminates any possibility of misunderstanding and misinterpretation and assures consistency in the friction taking process as well as in its ultimate use.

Correlation of Friction Tests to Aircraft Braking Performance

FAA

The FAA maintains that it is not possible to predict aircraft braking performance from Mu values obtained from runway friction surveys. FAA's Airman's Information Manual (AIM) asserts:

> No correlation has been established between MU values and the descriptive terms "good," "fair," "poor," and "nil" used in braking action reports.

Similarly, FAA Advisory Circular (AC) 150/5200-31A, *Airport Winter Safety and Operations* states:

> While it is not yet possible to calculate aircraft stopping distances from friction measurements, data have been shown to relate to aircraft stopping performance under certain conditions of pavement contamination, and are considered helpful by pilots' organizations.

The FAA position was restated in CertAlert 95-06, October 1, 1995, *Reporting Braking Action and Friction Measurements*;

> The FAA does not support this table[21] because there is no correlation between braking action and MU Value. Braking action is subjective whereas MU Value is

[21] Ground Friction Reading Correlation Table, presented by Thomas J. Yager at the International Aviation Snow Symposium in Buffalo, NY, 1987.

> quantitative. A pilot should know how the aircraft will react to a given MU Value. Whereas what is considered "Good" braking action for one person may be "Poor" or "Nil" to another.

And, in CertAlert 05-01, 1/14/2005, *Airport Winter Operations (Friction Measurement Issues)*:

> Although the International Civil Aviation Organization (ICAO) has published a comparison table for "MU" readings and braking action, the FAA is not in harmony with ICAO on this determination and publication. The FAA has no approved publication that provides a comparable assessment rating between "MU" readings and braking action. Further, the FAA feels that there is currently no conclusive correlation between braking action and MU value. Braking action is subjective and dependent on may factors, whereas MU value is an objective measurement.
>
> Either MU values or braking action reports are acceptable for reporting pavement conditions to the Notice to Airman (NOTAM) system. However there is no correlation between the two. THEY ARE NOT INTERCHANGABLE!

<u>ICAO</u>

Attachment A to ICAO's July 2004, *Annex 14*, *Aerodromes*, provides a comparison table between "measured [friction] coefficient" and "estimated braking action." The text preceding the table cautions:

> The table below with associated descriptive terms was developed from friction data collected only in compacted snow and ice and should not therefore be taken to be absolute values applicable in all conditions. If the surface is contaminated by snow and ice and the braking action is reported as "good," pilots should not expect to find conditions as good as on a clean dry runway (where the available friction may well be greater than that needed in any case). The value "good" is a comparative value and is intended to mean that aeroplanes should not experience directional control or braking difficulties, especially when landing.

ICAO table:

| *Measured coefficient* | *Estimated braking action* | *Code* |
|---|---|---|
| 0.40 and above | Good | 5 |
| 0.39 to 0.36 | Medium to good | 4 |
| 0.35 to 0.30 | Medium | 3 |
| 0.29 to 0.26 | Medium to poor | 2 |
| 0.25 and below | Poor | 1 |

Canadian Runway Friction Index (CRFI)

In Canada, a method of measuring and reporting friction on contaminated runways has been in use for about 30 years. Runway friction values obtained from decelerometers are reported as Canadian Runway Friction Index (CRFI) values, and are included in surface condition reports and NOTAM information. Thus, CRFI values are available to pilots and may be applied to the *CRFI Tables of Recommended Landing Distances*, which are published as guidance material in the *Canadian Aeronautical Information Publication* and the Canada Flight Supplement.

The information contained in the CRFI tables is based upon field test performance data of aircraft braking on winter-contaminated surfaces, and provides recommended landing distances based on the CRFI values. In order to use the tables, a pilot would look up the minimum landing distances published in their Aircraft Flight Manual (AFM) for landing on a bare and dry surface, then refer to the CRFI table to derive the minimum landing distance for a contaminated runway, based on the CRFI value (Figure 3).

### Canadian Runway Friction Index (CRFI)
### Recommended Landing Distances
### (No Discing/Reverse Thrust)

| Landing Distance (Feet) Bare and Dry Unfactored | Reported Canadian Runway Friction Index (CRFI): 0.60 | 0.55 | 0.50 | 0.45 | 0.40 | 0.35 | 0.30 | 0.27 | 0.25 | 0.22 | 0.20 | 0.18 | Landing Field Length (Feet) Bare and Dry 60% Factor | Landing Field Length (Feet) Bare and Dry 70% Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recommended Landing Distances (no Discing/Reverse Thrust) | | | | | | | | | | | | | |
| 1 800 | 3 120 | 3 200 | 3 300 | 3 410 | 3 540 | 3 700 | 3 900 | 4 040 | 4 150 | 4 330 | 4 470 | 4 620 | 3 000 | 2 571 |
| 2 000 | 3 480 | 3 580 | 3 690 | 3 830 | 3 980 | 4 170 | 4 410 | 4 570 | 4 700 | 4 910 | 5 070 | 5 250 | 3 333 | 2 857 |
| 2 200 | 3 720 | 3 830 | 3 960 | 4 110 | 4 280 | 4 500 | 4 750 | 4 940 | 5 080 | 5 310 | 5 490 | 5 700 | 3 667 | 3 143 |
| 2 400 | 4 100 | 4 230 | 4 370 | 4 540 | 4 740 | 4 980 | 5 260 | 5 470 | 5 620 | 5 880 | 6 080 | 6 300 | 4 000 | 3 429 |
| 2 600 | 4 450 | 4 590 | 4 750 | 4 940 | 5 160 | 5 420 | 5 740 | 5 960 | 6 130 | 6 410 | 6 630 | 6 870 | 4 333 | 3 714 |
| 2 800 | 4 760 | 4 910 | 5 090 | 5 290 | 5 530 | 5 810 | 6 150 | 6 390 | 6 570 | 6 880 | 7 110 | 7 360 | 4 667 | 4 000 |
| 3 000 | 5 070 | 5 240 | 5 430 | 5 650 | 5 910 | 6 220 | 6 590 | 6 860 | 7 060 | 7 390 | 7 640 | 7 920 | 5 000 | 4 286 |
| 3 200 | 5 450 | 5 630 | 5 840 | 6 090 | 6 370 | 6 720 | 7 130 | 7 420 | 7 640 | 8 010 | 8 290 | 8 600 | 5 333 | 4 571 |
| 3 400 | 5 740 | 5 940 | 6 170 | 6 430 | 6 740 | 7 110 | 7 550 | 7 870 | 8 100 | 8 500 | 8 800 | 9 130 | 5 667 | 4 857 |
| 3 600 | 6 050 | 6 260 | 6 500 | 6 780 | 7 120 | 7 510 | 7 990 | 8 330 | 8 580 | 9 000 | 9 320 | 9 680 | 6 000 | 5 143 |
| 3 800 | 6 340 | 6 570 | 6 830 | 7 130 | 7 480 | 7 900 | 8 410 | 8 770 | 9 040 | 9 490 | 9 840 | 10 220 | 6 333 | 5 429 |
| 4 000 | 6 550 | 6 780 | 7 050 | 7 370 | 7 730 | 8 170 | 8 700 | 9 080 | 9 360 | 9 830 | 10 180 | 10 580 | 6 667 | 5 714 |

Figure 3. CRFI Table

In addition, Figure 4. contains average equivalent values of CRFI produced by typical runway surface conditions, and, according to Transport Canada, may be used as a guide when CRFI numbers are not available.

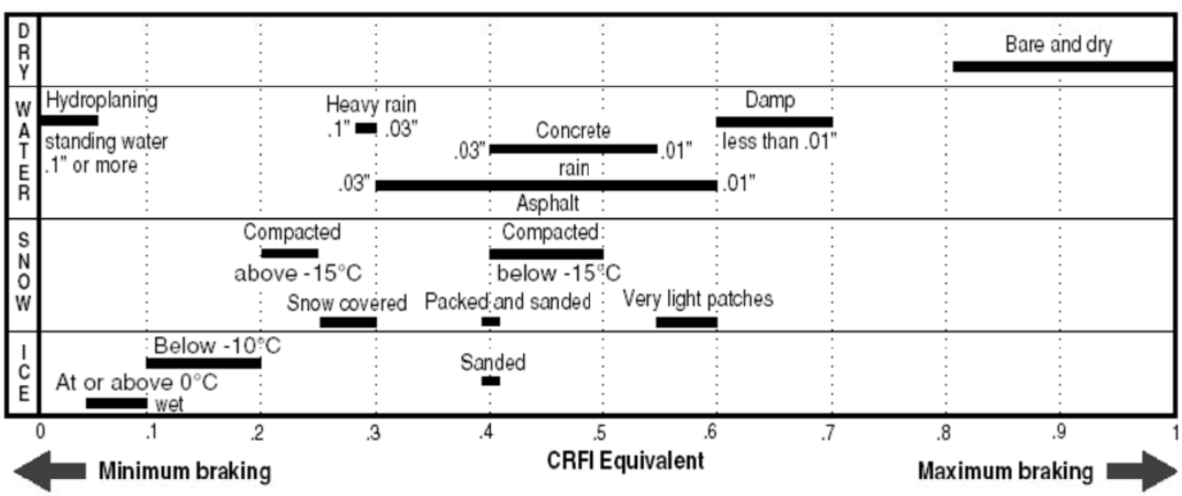


Figure 4. CRFI Equivalents

## IRFI

In December 1995, the National Aeronautics and Space Administration (NASA) and Transport Canada (TC) signed a memorandum of understanding for a five-year initiative to study winter runway friction measurement. With the addition of other organizations, including the FAA, Norwegian, and French authorities, and assistance from Austria, Germany, Scotland, Sweden, and Switzerland, the Joint Winter Runway Friction Measurement Program (JWRFMP) was established in January 1996. The stated objectives of the JWRFMP were:

- to study methods of friction measurement and define an International Runway Friction Index (IRFI) for worldwide use;
- to establish an international methodology whereby a common indication of runway conditions could be established worldwide; and
- to study the operational performance of aircraft on contaminated surfaces and establish a relationship with the harmonized index (IRFI).

To achieve these objectives, the JWRFMP team planned a five-phase approach: 1) acquisition of data through ground vehicle tests; 2) acquisition of data through tests with instrumented aircraft; 3) data analysis, correlation, and interpretation; 4) application of the knowledge gained to the development of an IRFI; and 5) validation of the IRFI development.

In contrast to CRFI, which used only decelerometers in deriving values, IRFI was designed to harmonize readings from a variety of friction testing devices (DEC and CFME, from multiple manufacturers). Based on thousands of friction surveys over a ten-year period, the harmonization effort was codified as American Society for Testing and Materials (ASTM) 2100-02, *Standard Practice for Calculating the International Runway Friction Index*. The ASTM standard defines and prescribes how to calculate the IRFI for winter surfaces, and produces a harmonized value, regardless of the type of friction equipment used to measure pavement friction characteristics. Preliminary work has shown that IRFI can be used to predict aircraft braking performance on contaminated runways, however, IRFI Tables of recommended landing distances do not exist.

## Other Research

Penn State University professor, Dr. Zoltan Rado, developed a method for calculating runway friction from data acquired from digital flight data recorders (DFDR) from commercial airplanes. In his paper, *Correlation of Ground Friction Measurements to Aircraft Braking Friction Calculated From Flight Data Recorders*[22], Dr. Rado explained the methodology used to subtract the effects of aerodynamic drag, thrust reverses, engine power settings, and other factors from the observed airplane

[22] Proceedings from the International Conference on Surface Friction, Christchurch New Zealand, 2005.

performance to derive the "true retardation" actually inflicted by the aircraft main gear's braking system. From this, an estimate of the runway friction coefficient could be achieved in "real-time." Continuous friction measuring equipment was run on the same runway as the landing airplanes for validation of the derived friction coefficients.

NTSB Recommendations Related to Contaminated Runways

Following the investigations of an Air Florida B-737 at Washington, DC on January 13, 1982, and a World Airways DC-10 at Boston, MA on January 23, 1982, the Safety Board conducted a special investigation to examine commercial airplane operations on contaminated runways. From the investigation, a report was produced[23] which contained numerous safety recommendations to the FAA. The following are recommendations from the report that relate to airport operations on contaminated runways:

A-82-152: Amend 14 CFR 139.31 and 14 CFR 139.33 to require that airports certificated 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.

Status: Closed-Acceptable Action. FAA issued a final rule (Amendment 139-14), on November 18, 1987, which revised 14 CFR 139 to require a snow and ice control plan in certification manuals at airports where snow and icing conditions regularly occur.

A-82-168: In coordination with the National Aeronautics and Space Administration, 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.

Status: Closed – Unacceptable Action. The FAA's response dated May 5, 1987 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. The Safety Board did not believe that sufficient research had been accomplished to conclude that objective measurements taken from dissimilar airplanes would not be meaningful.

Following the Tower Air B-747 accident at JFK International Airport on December 20, 1995, the Safety Board issued the following recommendation to the FAA:

[23] NTSB/SIR-83/02, *Large Airplane Operations on Contaminated Runways*; Washington, DC; April 22, 1983.

A-96-164: 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 superseded.

Status: Closed – Reconsidered. The FAA did not consider it technologically feasible to establish runway friction measurements that were operationally meaningful to pilots and air carriers for their slippery runway operations. The FAA noted their participation in the Joint Winter Runway Friction Measurement Program whose goal was to develop the International Runway Friction Index (IRFI) and to correlate the IRFI 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 in attempts to correlate ground friction measurements with airplane performance. The FAA did not expect any new developments related to this recommendation.

## 8.4 Aircraft Rescue and Firefighting and Emergency Response

Midway Airport is a 14 CFR Part 139 certificated airport with scheduled and nonscheduled operations of transport category airplanes. The airport operates as an index "D" airport with regard to aircraft rescue and firefighting (ARFF) capabilities. ARFF service, fire protection, and emergency medical services (EMS) are provided by the City of Chicago Fire Department (CFD). All ARFF equipment and personnel operate out of one CFD station located on the south border of the airfield at 5200 W. 63rd St. The following ARFF apparatus are assigned to the CFD station at MDW:

ARFF 6-5-1 (2 personnel)
2001 Oshkosh TI-3000 with 3000 gallons of water, 410 gallons of Aqueous Film Forming Foam (AFFF), and 500 lbs of Halotron. This unit is also equipped with a device called a "Snozzle" which is an elevated waterway with an attached penetrating nozzle.

ARFF 6-5-2 (2 personnel)
1992 Oshkosh T-3000 with 3000 gallons of water, 410 gallons of AFFF, and 500 lbs. of Halon.

ARFF 6-3-7 (2 personnel)
2002 Pierce/Ford Rapid Intervention Vehicle (RIV) with 200 gallons of water, 25 gallons of AFFF, and 450 lbs. of "PKP" a dry chemical extinguishing agent.

ARFF 6-5-9 (Reserve)
Oshkosh T-1500 with 1500 gallons of water, 205 gallons of AFFF, and 700 lbs. of PKP. This unit is quartered at a fire station located off of the airfield.

In addition, the CFD station at MDW houses Engine Company 127 (5 personnel), Stairway Truck 6-3-4 (1 person), Battalion 16 (1 person) and ALS Ambulance Company 54 in the ARFF station. Engine 127 and Unit 6-3-4 are not listed in the MDW Airport Emergency Plan; however, personnel assigned to these units receive training that complies with FAR Part 139.319 ARFF requirements. If additional fire department resources are required to respond to an emergency, the incident commander can request resources through the Office of Emergency Management and Communications (OEMC).

Dispatch and Communications

Emergency notifications to MDW ARFF units can originate from 2 sources: 1) the MDW Airport Traffic Control Tower (ATCT), which has a direct "ring down" line that activates an alarm and announces voice communication through a loudspeaker and phone line in the ARFF station; and, 2) the City of Chicago OEMC is able to notify all units in the fire station through both computer and voice systems of the nature and location of the emergency.

Alert notifications for the SWA 1248 accident were made through both the MDW ATCT direct "ring down" line and the OEMC notification system. According to interviews, a Chicago Police Department (CPD) officer, located at the intersection of Central and 55th St. at the time of the accident, notified the OEMC of the accident. The OEMC alerted CFD units from the OEMC dispatch center. A representative of the OEMC said the incident occurred at 1915 hours.

The CFD ARFF commander's journal indicated that the MDW ATCT "ring down" came at 1916 hours, and reported a "Crash Alert at Runway 13C." The ATCT directed ARFF crews to "take the south ramp to the Papa taxiway to Runway 31C, and proceed to the accident site." Upon receipt of the alarm, the three ARFF units listed above responded to the accident site. In addition, a mobile stairway truck from the MDW fire station responded. Seven ARFF personnel arrived at the accident site in the four trucks.

At the time of the accident, CFD Engine 127 was "out of quarters" performing other duties. According to the Engine 127 company journal, Engine 127 was directed to the accident by the OEMC at 1921 hours. Ambulance 54 was also out of quarters and was not initially dispatched to the accident. In accordance with CFD and OEMC policy, the OEMC dispatched a "still and box alarm" and "EMS Plan 1," which directed additional engine, truck, and ambulance companies to the scene. The CFD incident commander later requested five additional ambulances (EMS Plan 2). All units working at the scene communicated through common radio frequencies, or by communicating with the command post/communications van.

Upon notification of the accident at MDW, O'Hare International Airport (ORD) dispatched a 3000-gallon ARFF unit with two personnel, a squad company with an ARFF rapid intervention vehicle staffed with six ARFF-trained personnel to the MDW fire station to provide ARFF coverage.

The following times were based on information provided by the City of Chicago:

- 1915 On view of accident by CPD unit 815
- 1916 CFD Still and Box alarm and EMS Plan 1
- 1920 CFD Battalion 16 on scene
- 1921 CFD Engine 32 on scene
- 1928 passenger removal from airplane is initiated
- 1938 per CFD Battalion 16, all passengers removed from airplane
- 1957 CFD Ambulance 49 (with 1) to Christ Hospital ALS
- 2004 CFD Ambulance (with 1 to McNeil Hospital ALS
- 2005 CFD Ambulance (with 1) to McNeil Hospital BLS
- 2008 CFD Ambulance 18 (with 2) to Christ Hospital ALS
- 2031 CFD Ambulance (with 1) to McNeil Hospital ALS
- 2039 CFD Ambulance (with 1) to Holy Cross ALS
- 2058 CFD Ambulance (with 1) to Holy Cross ALS
- 2101 Still and Box alarm and EMS Plan 2 struck out and secured.
- 2226 CFD Ambulance (with 1) to Little Company of Mary Hospital ALS.

Fire Suppression and Rescue Activities

In accordance with Chicago Fire Department rules and regulations, an Incident Command system was established during the emergency response. The initial incident commander (IC) was the Battalion Chief first dispatched to the accident. As higher-ranking fire department chief officers began arriving on the scene of the accident, the IC position changed accordingly. Typically, the IC was positioned in the area that the CFD calls "sector 1;" at the front of the aircraft. The IC was in constant contact with the command post at all times via radio communication.

An initial Command Post was established utilizing a CFD command van. This unit was later replaced with CFD command van 2-7-8 that responded from ORD. Unit 2-7-8 was a specially designed unit, which accommodated the various agencies involved in an aircraft accident.

Under the supervision of a representative from the NTSB and with the assistance of Southwest Airlines (SWA) maintenance personnel, CFD personnel secured both the CVR and FDR which were placed into NTSB custody.

Midway Airport Operations conducted an "after action review" of the accident on December 13, 2005 at 1530 hours at the Department of Aviation Offices at Midway Airport. In attendance were City of Chicago Department of Aviation, Chicago Fire Department, Chicago Police Department, Chicago Department of Aviation Special Police, Midway Airport Emergency Communication Center, FBI, Office of Emergency Management and Communications.

The CFD conducted an "after action review" of this accident on December 14th at 1000. The meeting took place at the MDW ARFF station.

Interviews

On December 12, 2005 the Survival Factors Group interviewed members of the Chicago Fire Department. In attendance were: Mark George, NTSB; Paula Gaudet, Southwest Airlines; Susanne Konrath, FAA; John Lott, FAA; Michael Massoni, Transport Workers Union; Marcy Vinyard, Transport Workers Union; and Thomas Wagner, Chicago Fire Department. The following are summaries of those interviews

*Raymond Weiher*
*16th Battalion Chief*
*December 11, 2005*

Chief Weiher had been in his current position at the MDW ARFF station for 1 year and four months, and had been on the Chicago Fire Department about 33 years. He was out doing nightly visits at Engine 32 (another CFD fire station, located approximately one mile west and one block south). As he was leaving Engine 32, he heard the alarm for the accident.

While enroute, he heard Lt. Kochan over the radio ask where the plane was located. Road conditions were very slippery, and "almost white-out" conditions. All around the airplane, the road was "very slippery." Chief Weiher was the first CFD representative to arrive at the scene. He notified the alarm office that the airplane was in the street and there was no fire. There was already a police officer on the scene when he arrived. When he arrived, the "chute" was deployed and passengers were coming out. He saw a flight attendant at the door of the airplane. He also saw a man with a bloody face and a conscious child. The man said there were two more kids trapped in his car.

Chief Weiher didn't notice if the pilot window was open and didn't see the pilots. When he first arrived, he made a "complete loop" around the airplane. He was concerned about the fuel. He made a second "loop" later, and he saw stairs in place at the rear of the airplane, and he saw Lt. Kochan on them.

He saw 15-20 people at the bottom of the evacuation slide assisting passengers. He was not sure if these individuals were passengers or "civilians." The slide was at a shallow angle because of the way the airplane was sitting. The airplane engines were already "shut down," but he "smelled fuel."

Engine 32 and Truck 60 arrived. They dropped "2 ½ inch hand lines." Truck 60 had a Hurst tool and began to extricate victims from the vehicle. Chief Weiher "elevated emergency status" from Plan 1 (5 ambulances) to Plan 2 (5 more ambulances) because of concern for the number of injuries. Chief Weiher separated the staging areas because of traffic in the area. Eleven people were transported with injuries: 5 red, 3 yellow, 3 green, and 1 black. He saw one woman with a "shoulder injury," but did not know if she was transported to a hospital. After the passengers were out, concern shifted from rescue/medical response to concern for fuel on airplane. Fuel was leaking from the right wing. Hazmat officers on scene "estimated 15 – 17 gallons had leaked out on to the ground." The spilled fuel was covered with foam and dry chemical agent by ARFF. Fuel was removed from airplane between 0130-0200.

*Freddie Mahoney*
*Firefighter 1st Class, assigned to MDW*
*December 11, 2005*

At the time of initial alarm, Firefighter Mahoney was outside blowing/shoveling snow. Lt. Kochan stepped outside to and told Mahoney of the alarm.

After departing the fire station driving Stair Truck 634, he turned onto the south ramp, north on Taxiway P, then northwest on Runway 31C to the crashed airplane. Mahoney was third in a line of responding vehicles, starting with Truck 651, then Truck 652, Stair Truck 634, followed by Truck 637. Engine 127 (structural) was out on another run (landside).

On his way to the accident, Mahoney couldn't see the airplane. Visibility was "very limited," and he estimated visibility at "50 – 150 feet." He was not able to drive as fast as normal because of the reduced visibility. He was "really paying attention" to the ARFF vehicle in front of his stair truck while enroute to the accident site. Mahoney said the runway surface was slippery, that it was bad. He drove past the end of the runway, through the perimeter fence and other debris, and then drove to the aft, right airplane door. When he got there, he saw Chicago Police Department officers present. He was not sure if any other Chicago Firefighters were on the scene when he arrived. The ARFF vehicles were positioned upwind from the airplane, mostly on the airport side of the airplane.

Mahoney drove to the right, rear section of the airplane. The stair truck goes right up to the airplane door. The airplane has a "silver plate" at the door bottom, so he positioned stairs just below the silver plate to allow the door to open. He set the stabilizer jacks on the stair truck while Lt. Kochan and Firefighter Tibbs climbed up to the right, rear door. By the time Mahoney finished setting the jacks, passengers were already starting to deplane via the stairs. Mahoney directed passengers at the base of stairs toward the airfield, and then corralled them so they wouldn't wander off. "About 35 to 40" passengers deplaned via the aft exit. Passengers seemed to be coming down stairs in an orderly fashion. Everyone seemed calm. One of the pilots was the last to come down stairs. "Three or four" flight attendants came down the stairs, also.

Mahoney walked around the airplane to the left forward section. The forward entry door was open and the evacuation slide was deployed. He did not know when the slide had been deployed. He did not go inside the airplane. The evacuation slide "was not vertical because of the nose gear collapse," but instead, "it was nearly horizontal and uphill." He did not see passengers deplane from the chute. He saw firefighters exit on the slide and they "had to slide themselves along" the slide to exit the airplane.

*Lt. Gary Kochan*
*ARFF Commander in charge of rescue units at MDW*
*December 11, 2005*

Lt. Kochan had been with the CFD for 17 years, and had been at MDW 3 years. He was in his office at the time of the alarm. He heard the crash phone ring and the ATCT announce "Runway 31C for a plane that slid off the runway." As he pulled out onto the apron of the firehouse, he contacted the ATC ground control by radio to get clarification on the location of the accident airplane. He asked the ground controller if the airplane was located at the approach end of Runway 13C or the approach end of Runway 31C. The ground controller responded that the airplane was at the approach end of 13C. The ground controller then instructed the ARFF crews to take the "Papa" taxiway to Runway 31C, then 31C to the accident.

In order to get on the airfield, he had to drive through two security gates. The security gates are opened by security guards at the security post, near the gates. The guards are alerted to open the gates before the ARFF trucks leave the firehouse. Visibility enroute to the accident was "bad" and he could not see very far. The runway was not "clean;" it was "snow covered" and he could not see the centerline while looking down the runway. The runway was "pretty much white." He did not know how braking conditions were because he did not attempt to stop while enroute to the airplane. He could not see "the path of the airplane" in the snow on the runway.

ATC did not know if the airplane was on or off the airfield, and asked Kochan to confirm this. He could not see the airplane until he was approximately 500 feet away from it. When he arrived at the scene, he reported to the Englewood Fire Alarm Office (EFAO) that the airplane was "off the field," and he requested a "Still and Box" alarm and an Emergency Services Plan 1. He also set the staging area for all incoming CFD personnel at Staging Area "D" (Approximately $60^{th}$ and Central).

Lt. Kochan's truck was the first CFD unit on the scene. He did not see Chief Weiher on the scene but he did see a policeman (maybe more than one). The area between the runway and the perimeter fence was smooth. He saw "debris" where the airplane gone through the fence and the entire area including the street was "very slick." ARFF Unit 6-5-2 and Unit 6-3-4 (Stairway) were staged to his left. He directed the other ARFF trucks so that there was good coverage for foam application should the need arise. Due to the location of the airplane, there was "no way" to get ARFF equipment around to the front of the airplane. However, with the wind conditions as they were (being upwind), coverage of the airplane was "adequate."

Lt. Kochan got out of his truck went to front of airplane. He saw a man with a bloody face and the evacuation slide deployed. The slide was positioned parallel to the ground "about two feet" off the ground. He saw "lots" of people around the slide, but could not tell who they were. He went back to his truck and told the driver of the stair truck (Unit 6-3-4) to take position at the aft, right door. He then told Unit 6-3-7 (RIV) to "pull a line" (hose) off to provide more protection in case of fire.

Lt. Kochan and Firefighter Tibbs went up the stairs to the right, rear airplane door. He brushed snow off the window to see inside, and could tell that the door was armed because of the "orange strip" across the window. He "pounded" on the door to get the attention of a flight attendant. A flight attendant opened the door and "said nothing." The flight attendant was alone in the galley area. Lt Kochan entered the airplane and saw "30 to 40 passengers." He was "surprised" there were that many still on board. He did not see any injured passengers. He announced that there was "no fire, and that everyone should exit the airplane using the stairs." He did not see any passengers deplaning with luggage.

While he was in the airplane, Lt. Kochan noticed that "it was dark" but not "totally dark" due to some light being reflected into the airplane from the snow and streetlights. He did not remember seeing the emergency floor lighting. He could smell "fuel fumes" in the airplane. Some of the overhead bins were open, and there were several bags up against the bulkhead wall in the first two rows.

After the passengers had left the airplane, Lt. Kochan went through the cabin to ensure all passengers were off the airplane. He saw a pilot and a flight attendant. The pilot was "doing something" in the cockpit. Lt. Kochan told them to exit the airplane. A SWA mechanic went in the cockpit and reported that "everything was shut down and he had pulled the batteries."

## 9.0 Evacuation

The first officer and approximately one-half of the passengers evacuated the airplane through the 1L door. The captain, three flight attendants, and approximately one-half of the passengers evacuated from the 2R door, and used mobile stairs (provided by ARFF) to deplane. The 1R, 2L and both left and right overwing exits were not opened.

## 10. Attachments

1. Excerpts from the Southwest Airlines Initial and Recurrent Training Programs, and Flight Attendant Manual
2. Passenger Questionnaires
3. MDW Friction Test Log, Snow Log, Airfield Temperature Logs, and Airfield Condition Reports

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Mark H. George
Survival Factors Investigator