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

SURVIVAL FACTORS

Group Chairman's Factual Report

October 31, 2018

A. ACCIDENT

Operator	:	Southwest Airlines
Airplane	:	Boeing 737-7H4 (N772SW)
Location	:	Philadelphia, PA
Date	:	April 17, 2018
Time	:	1103 eastern daylight time (EDT)[1]
NTSB #	:	DCA18MA142

B. SURVIVAL FACTORS GROUP[2]

Chairman	:	Peter Wentz National Transportation Safety Board Washington, DC
Member	:	Nancy Walsh Federal Aviation Administration Pittsburgh, PA
Member	:	Elise May Southwest Airlines Dallas, TX
Member	:	Michael Massoni Transport Workers Union Local 556 Dallas, TX
Member	:	Michele Moore Transport Workers Union Local 556 Dallas, TX

[1] All times in this report are eastern daylight time, based on a 24-hour clock.
[2] Not all group members were present for all activities.

C. SUMMARY

On April 17, 2018, at 1103 eastern daylight time, Southwest Airlines flight 1380, a Boeing 737-7H4, N772SW, experienced a left engine failure and loss of engine inlet and cowling during climb at about flight level 320. Fragments from the engine inlet and cowling struck the wing, fuselage, and one cabin window, resulting in a depressurization. The flight crew conducted an emergency descent and diverted into Philadelphia International Airport (KPHL), Philadelphia, PA. Of the 144 passengers and five crewmembers onboard, one passenger received fatal injuries and eight passengers received minor injuries. The airplane sustained substantial damage. The regularly scheduled domestic passenger flight was operating under 14 *Code of Federal Regulations* Part 121 from LaGuardia Airport (KLGA), Queens, New York, to Dallas Love Field (KDAL), Dallas, Texas.

D. DETAILS OF THE INVESTIGATION

1.0 Airplane Configuration

The airplane was configured with 143 travel-class passenger seats, 2 cockpit flight crew seats, 2 cockpit observer seats, and 2 double retractable flight attendant (F/A) jumpseats. Two aft-facing F/A jumpseats were located in the forward part of the cabin behind the forward lavatory and two forward-facing seats were located in the rear of the cabin ahead of the aft lavatory). There were 6 emergency exits, 4 floor-level Type I (door) exits and 2 overwing Type II (window) exits.

1.1 Emergency Equipment

Figure 1 (next page) shows the location of the emergency equipment on the airplane.

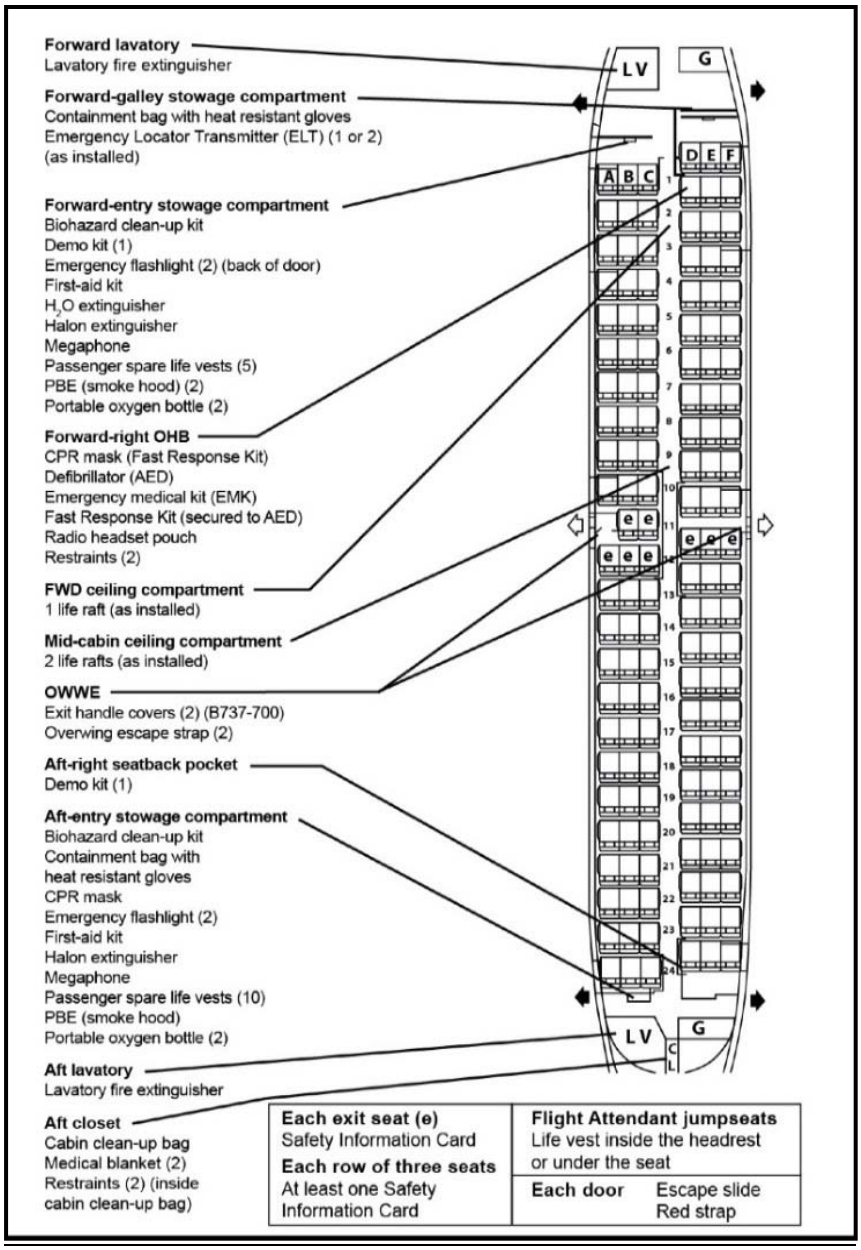

Figure 1 – Emergency equipment stowage locations (from Southwest Airlines Flight Attendant Manual Revision #17-04 effective at the time of the accident).

After the decompression, flight attendants retrieved 2 portable oxygen bottles for use from the from the forward-entry stowage compartment, and 2 portable oxygen bottles for use from the aft-entry stowage compartment. To attend to the injured passenger in row 14 flight attendants retrieved and used the automated external defibrillator (AED) and attached Fast Response Kit (containing tools and supplies needed to use the AED along with personal protective equipment and a CPR mask) from the forward-right overhead bin.[3]

[3] The emergency medical kit was also retrieved from the forward-right overhead bin. According to the Flight Attendant Manual its contents are for use by medical personnel (credentials checked by F/As) and

1.2 Supplemental Oxygen

To provide oxygen to passengers in the event of a depressurization event, a supplemental oxygen system was located in the passenger service unit (PSU)[4] above each triple seat set[5] on the airplane (a total of 48 on the airplane). The supplemental oxygen system consisted of a chemical oxygen generator, a lanyard-based activation system, a distribution manifold with flexible mask supply tubing, and 4 masks.[6] The four masks were designed to deploy from PSU when the stowage compartment door opened – either automatically upon cabin altitude reaching 14,000 feet, or manually by the flight crew using a guarded switch on a cockpit overhead panel. Oxygen generation at a PSU began after one passenger pulled a mask toward his/her face, tensioning the lanyard connected to the firing pin release cable. Once the firing pin was released, oxygen flowed through the tubing into a reservoir bag attached to the mask and was available to the passenger. A flow indicator on the tubing coupler near the PSU was designed to turn green indicating that oxygen was flowing to a mask.[7] To aid in maintenance, a heat-sensitive indicator strip on the oxygen generator turned to black after the generator had been activated (all 48 of the generators in each of the 24 rows on the accident airplane were found to have been activated).

Flight attendant and passenger interviews indicated that the tubing for some masks detached at the coupler near the PSU. Documentation of the passenger masks after the accident indicated that of the 48 total systems, 13 were found with one or more masks detached.[8]

1.3 Passenger Seats and Cabin Window

Row 14 consisted of 6 passenger seats in two triple seat sets (ABC and DEF). Seat 14A was located next to the cabin sidewall with a window on the left side of the airplane (photograph 1). The 14 ABC triple seat was manufactured by B/E Aerospace, P/N 87517501 MFG date 11/98. The seat cushion was manufactured by Franklin Product Inc. P/N 44BM1490 MFG date 14MAR2016.

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a list of contents outside the kit can help determine whether access to kit is needed. It was found under seat 14C with the red seal still intact indicating it had not been used.

[4] In addition to the supplemental oxygen system, a PSU contains individual controls for reading lights, airflow, flight attendant call buttons, PA speaker, and information placards.

[5] Masks are also located in service units in the lavatories and over the flight attendant jumpseats.

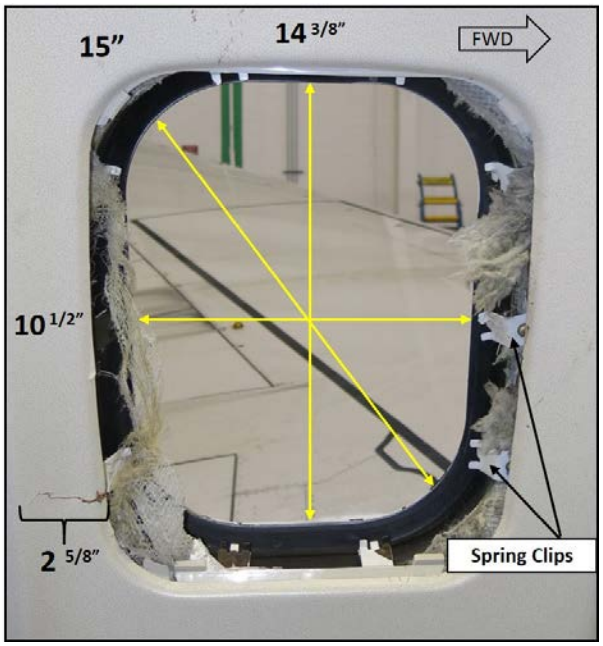
[6] There was one extra mask per PSU over each 3-seat set in a row. According to 14 CFR Part 25.1447, the number of oxygen masks needs to exceed the number of seats by 10 percent.

[7] The flow indicator was described along with a photograph in the company's flight attendant manual revision #17-04 dated 11/17/2017, under section 3.8.0 Emergency Oxygen System (Revised: 04/28/2016).

[8] Eleven systems were found with 1 mask detached. The system above row 12 ABC was found with 3 masks detached and the system above row 16 ABC was found with 2 masks detached.

Photograph 1 – Row 14 ABC triple seat set showing seat 14A adjacent to broken window.

The exterior cabin window measured 10 1/2 inches horizontally, and 14 3/8 inches vertically, and 15 inches diagonally (photograph 2). The interior sidewall had a fracture in the lower left aft corner measuring 2 5/8 inches. Ten spring clips surrounded the window frame. Figure 2 shows the components of the window assembly including the outer pane, middle pane, rubber seal, and spring clip.



Photograph 2 – Row 14 window measurements.

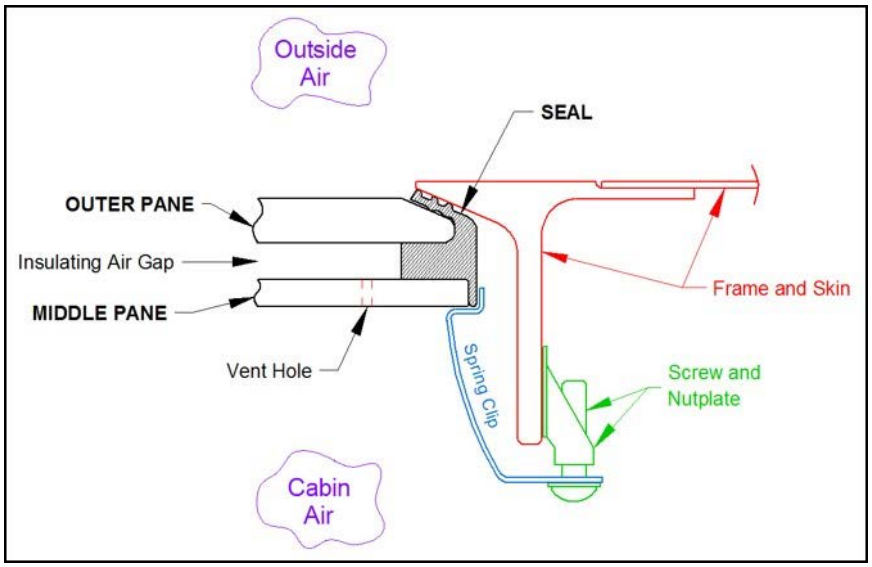


Figure 2 – Window diagram.

2.0 Flight Attendants

Flight 1380 was operated with 3 F/As. Table 1 provides the position, assigned jumpseat location, and dates of initial and last recurrent training for each F/A.

F/A Position	Assigned Jumpseat Location	Initial New Hire Month	Last Recurrent Training Month
A	Forward Entry Door (Outboard seat)	May 2016	September 2017
B	Aft Left Galley Door (Inboard seat)	March 2018	N/A
C	Forward Galley Door (Inboard seat)	September 2010	October 2017

Table 1 - Flight attendant position, location and training dates.

3.0 Accident Summary

When the decompression occurred F/A A was in the forward lavatory, F/A C was in the cabin getting drink orders near row 5, and F/A B was in the aft galley preparing for the inflight service. F/A A and C immediately went to the forward jumpseat and sat down. They fastened their four-point restraints and put on the oxygen masks that had deployed from above their jumpseat. F/A B heard a loud noise and noticed the airplane started shaking but did not notice the oxygen masks had deployed until alerted by a company employee who was seated on the aft jumpseat. Once he pointed out the oxygen masks she put one on and asked him to retrieve a portable oxygen bottle (POB) from the stowage location in front of the jumpseat. F/A A recalled not having contact with the flight deck, and because of the pressure in her ears, she could barely hear anything, the cabin was loud and windy.

All of the passenger oxygen masks deployed in the cabin. After putting his mask on, passenger 8D noticed a woman with a child was struggling to get their oxygen masks on, so he got up and went to help them. He helped get the child's mask on and then noticed the tubing was not attached to the passenger service unit, so he reattached the tubing and went back to his seat.

All three F/As donned POBs and moved into the cabin to check on the passengers. F/A A noted that the tubing from some of the passengers' masks had come free and some were wearing it only over their mouths (rather than over the nose and mouth). She checked to ensure each passenger was receiving oxygen, in some cases allowing a passenger to breathe from her POB while she ensured they had an operational mask. On the left side of the airplane there was a mother with a lap child. F/A A placed her oxygen mask on the child to check that the baby was getting enough oxygen and then she showed the mother how to hold the mask from above her seat to the child's face.

F/A C also walked aft and when she reached row 14, noticed that passenger 14A was still restrained in her seat by her lapbelt, however the passenger's upper torso, arms and head had been pulled outside the airplane through the window. F/A C grabbed onto the passenger and tried to bring them back into the airplane with assistance from F/A A. Two male passengers (8D and 13D) helped and were eventually able to get the passenger back into the airplane. One of the men and a nurse (passenger 11C) started CPR while F/A A went to retrieve the AED and F/A C went to the back of the airplane and called the pilots to alert them to the passenger's condition and request additional medical assistance from qualified passengers.

F/A B was unaware of the window breach but could see the other F/As and passengers attending to a passenger in row 14. She also noted that two other passengers from row 14 had come back to the aft galley. She heard the interphone chime and answered the phone but couldn't hear anything because it was very loud. She did not recall hearing any announcements from the flight crew about being at a safe altitude to breathe but they did make a public announcement (P/A) that they would be landing in Philadelphia. One of the passengers from row 14 sat in the aft jumpseat with the SWA company employee for landing and F/A B sat on the floor with passengers holding her down. F/A A stated she did not have time to sit in her jumpseat for landing so she sat on the aisle floor near row 4 or 5 and passengers held her down. F/A C sat on the floor near the jumpseat in the aft galley for landing. All three F/As shouted the commands "heads down, stay down" during the landing. Passengers 8D and 11C stayed with the injured passenger and continued CPR compressions until after touchdown. Emergency response personnel then boarded the airplane and transported the injured passenger to the hospital.

4.0 Flight Attendant Training and Guidance

4.1 Flight Attendant Training

F/As were trained at Southwest Airlines University (SWAU) by SWAU instructors. The initial new hire training program was conducted in Dallas, TX.[9] It covered a variety of topics including company orientation, regulatory compliance, normal procedures, and emergency procedures. Most of the instruction was instructor-led discussion augmented by hands-on scenario-based training using simulator devices and equipment. F/As also had courseware and references available on their electronic flight bags (EFBs) that included study modules for "homework." After successful completion of training F/As were required to complete 5 hours of supervised initial operating experience in revenue flights. F/As received an annual 8-hour recurrent training course at one of the 10 crew bases. The course was supplemented by about 8-10 hours of computer-based training required to be completed in advance. Newly-hired F/As were required to go through recurrent training about 4-6 months after completing initial training.

The Southwest Airlines *Inflight Initial Learners Guide*, dated March 1, 2018, contained 68 pages addressing multiple training topics. This guide was provided to flight attendants undergoing initial training. The module on inflight emergencies addressed turbulence, decompression, fire, and effective CRM skills to use when dealing with emergencies. The decompression section addressed causes of depressurization and its effects on people. It pointed to relevant sections in the Flight Attendant Manual (FAM), and contained videos addressing oxygen mask deployment and operation, the portable oxygen bottle, flight deck oxygen, and a news report about Southwest Airlines flight 812 (a depressurization event).

According to SWA training personnel, during initial training F/As learn the P/A to make to passengers during an event requiring use of the passenger oxygen masks. They also are provided decompression scenarios and an opportunity to participate in (or observe) simulated mask deployments, methods to assess system operation/flow, use of the POB, and methods to manually deploy masks from the PSU.

According to the senior manager for inflight training (senior manager), F/As were instructed to take the following steps in a decompression event: 1) secure themselves in a jumpseat or passenger seat[10]; 2) take oxygen; 3) turn the lights to bright; 4) make the decompression P/A and attempt to contact the pilots. Once the situation was stable they could use the POB or go mask-to-mask to check on passengers and check the lavatory.

[9] The duration of the initial training course ranged from between 3 and 5 weeks depending on when a particular flight attendant was hired and trained (F/A A successfully completed a 5-week initial training, F/A B successfully completed a 4-week initial training, and F/A C successfully completed a 3-week and 3-day initial training).

[10] The senior manager stated later in the interview taking oxygen as the first step followed by securing themselves; a senior instructor interviewed stated that the first thing FAs need to do in a decompression event is take oxygen and then secure themselves.

The senior manager stated that time management strategies were addressed in first aid and security training which emphasized the need to delegate duties and responsibilities among the crew. F/As also received training in Risk Resource Management Human Factors (a module co-facilitated by a pilot and a F/A) and reviewed ways to maintain situational awareness using the "ABCD" method (Assess – assess the situation; Balance – knowing and using their resources; Communication – communication between flight deck and cabin crew; Debrief – discuss the situation and response afterward). The ABCD method was intended as a way to work through any given situation on the airplane whether it was a medical event or another type of emergency.

The senior manager stated that the only time F/As would not be seated in their jumpseat during landing would be in a situation where either one of the crew was providing first aid (the other two would be in their jumpseats), the jumpseat was broken or there was a hole in the fuselage near the jumpseat (in which case the F/A would be secured in a cabin seat closest to their primary exit), or a F/A was incapacitated and not able to perform required duties. The senior manager stated that "flight attendants need to be on their jumpseat because the safest, most secure place for them is to be secured in their jumpseat because they have to potentially be able to evacuate that aircraft." The senior manager answered "no" when asked, "if you have no additional seats for passengers, would you ever find it okay to reseat a passenger on a jumpseat in place of a working flight attendant on that flight?"

4.2 Flight Attendant Manual

Southwest Airlines provided a copy of the F/A manual (dated 11/17/2017, Revision 17-04) that was current at the time of the accident.

Within the Aircraft topic, section 3.8.0 titled "Emergency Oxygen System" described the locations, function, and function of the passenger supplemental oxygen system in the cabin.

Within the Equipment topic, section 1.4.13 titled "Portable Oxygen Bottle (POB)" described the preflight check procedures and inflight operation of the POB for decompression and first-aid situations. The section stated that on the B737-700 airplane 2 POB's were located in the forward-entry stowage compartment and 2 POB's were located in the aft-entry stowage compartment. The manual noted that, when fully-pressurized, the POB would provide at least 60 minutes of use.

Within the Emergency topic, section 2.4.2 titled "Decompression" stated the following:

> "Slow or sudden loss of cabin pressure can result from a failure in the pressurization system, a leaking door or window, or structural failure. Decompression may be gradual and unnoticed in the cabin, or it may be sudden and loud, accompanied by a drop in temperature, rushing air, and fogging. … At the equivalent of 14,000 feet, oxygen masks in the cabin and

> entry areas deploy automatically; they can also be deployed by the Pilots. The Pilots will put the aircraft into an emergency descent immediately. This will affect the ability to stand upright and walk. Prompt administration of oxygen prevents hypoxia. This is the essential first step in any decompression. Once Flight Attendants have administered oxygen to themselves, other issues can be dealt with in order of importance."

Section 2.4.2 also outlined procedures to be followed in the event of an emergency decompression event. These included the following steps: "1. Take oxygen from the nearest mask immediately. 2. Secure yourself." Step 3 was to be accomplished by the flight attendant nearest the forward control panel after the aircraft reached a safe walking attitude, and it included: a) turning the cabin lights to bright; and b) making a PA explaining the use of oxygen, "Ladies and gentlemen, pull down on the mask in front of you. Place the mask over your nose and mouth and breathe normally. The bag may not inflate. You **are** (emphasis in original) receiving oxygen. Fasten seatbelts and positively no smoking." Step 4 outlined FAs working mask-to-mask through the aisle to assist passengers in the cabin, donning the nearest portable oxygen bottle, and checking the lavatories.

Within the Emergency topic, section 3.1.0 titled "Takeoff and Landing" stated that "prior to **every** (emphasis in original) takeoff and landing, Flight Attendants must assume the brace position and conduct a silent 30-second review. The chapter further contains information detailing the brace positions established for the aft-facing and forward-facing jumpseats that includes "shoulder harness and seatbelt are securely fastened…"

Within the First Aid topic, section 2.2.0 titled "First Aid During Landing" stated that "In a life-threatening medical situation during a routine landing, a Flight Attendant may be called on to administer first aid. The Flight Attendant might not be able to occupy the assigned jumpseat. An able-bodied assistant (ABA) would need to be briefed and seated near the exit, time permitting, on operation of the Flight Attendant's assigned exit… In the event of a planned emergency landing: The Flight Attendant must occupy the jumpseat."

Within the topic titled Your Flight Beginning to End, section 6.5.0 titled "Prior to Landing" stated that F/A A was responsible for ensuring that F/As B and C were seated on their respective jumpseats; F/A C was responsible for ensuring that F/A A was seated on the forward jumpseat; and all F/As were to "assume the brace position on the jumpseat and conduct a silent 30-second review."

5.0 Injuries to Persons

5.1 Injury Classifications

Injuries	Flight Crew	Cabin Crew	Passengers	Other	Total
Fatal	0	0	1	0	**1**
Serious	0	0	0	0	**0**
Minor	0	0	8	0	**8**
None	2	3	135	0	**140**
Total	**2**	**3**	**144**	**0**	**149**

Table 3 – NTSB injury classifications.

5.2 Description of Injuries

The City of Philadelphia Medical Examiner's Office performed an autopsy on the fatally injured passenger. The cause of death of the 43-year-old female passenger was determined to be "blunt force trauma of the head, neck, and torso." Passenger 14A's injuries included a disarticulation of the spine at C6-C7 and T5-T6 (with associated spinal cord contusions), subdural hemorrhage, subarachnoid hemorrhage, bilateral orbital roof fractures, multiple left sided rib fractures, and multiple abrasions and contusions of the face, neck, chest, back, and extremities.

Peter Wentz
Survival Factors Investigator

E. LIST OF ATTACHMENTS

Attachment 1: Flight Attendant and Passenger Interviews
Attachment 2: SWAU Training Staff Interviews