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Medical Examiner Report of a Boeing 727-95 Aircraft Accident

This is a report on a Boeing 727-95 that crashed on landing. The aircraft, which was designed for a 91-passenger capacity, was carrying 81 passengers and 7 crew members. Of these, 51 survived (including 5 crew members), and 37 died (including 2 crew members).

Evacuation of survivors and deceased, as well as control of the disaster area, was accomplished by flight crew members, by local fire department, public safety department, health department, and civilian defense personnel, and by bystanders in the immediate vicinity. Identification of the deceased was coordinated by the Office of the Medical Examiner of St. Thomas with the assistance of members of the Office of the New York Medical Examiner[2] and members of the Federal Bureau of Investigation.

Observations and suggestions incorporated in this report were made by the Human Factors Group[3] and some of the survivors. It is hoped that these observations and suggestions may serve, in the immediate future, as a means for increasing the safety factor and possibly preventing the occurrence of some of the hindrances to egress from crash-landed aircraft.

Report

Landing

On 27 April 1976, at approximately 3:10 p.m., a Boeing 727-95 crashed while making a scheduled landing approach and an aborted go-round attempt on Runway 09 at the Harry S Truman Airport in St. Thomas, U.S. Virgin Islands, on a clear, dry, and sunny day. The aircraft crashed 1000 ft (305 m) beyond the runway at approximately centerline. It came to rest, fragmented into three major segments (Fig. 1), against a gas station and a one-story factory building and was consumed almost entirely by fire which ignited before the aircraft came to rest. Dense smoke and flames extended from the ceiling and right side of the galley to the aft portion of the aircraft. This added to the darkness within the aircraft, making it more difficult for survivors to locate emergency exits. The forward entry

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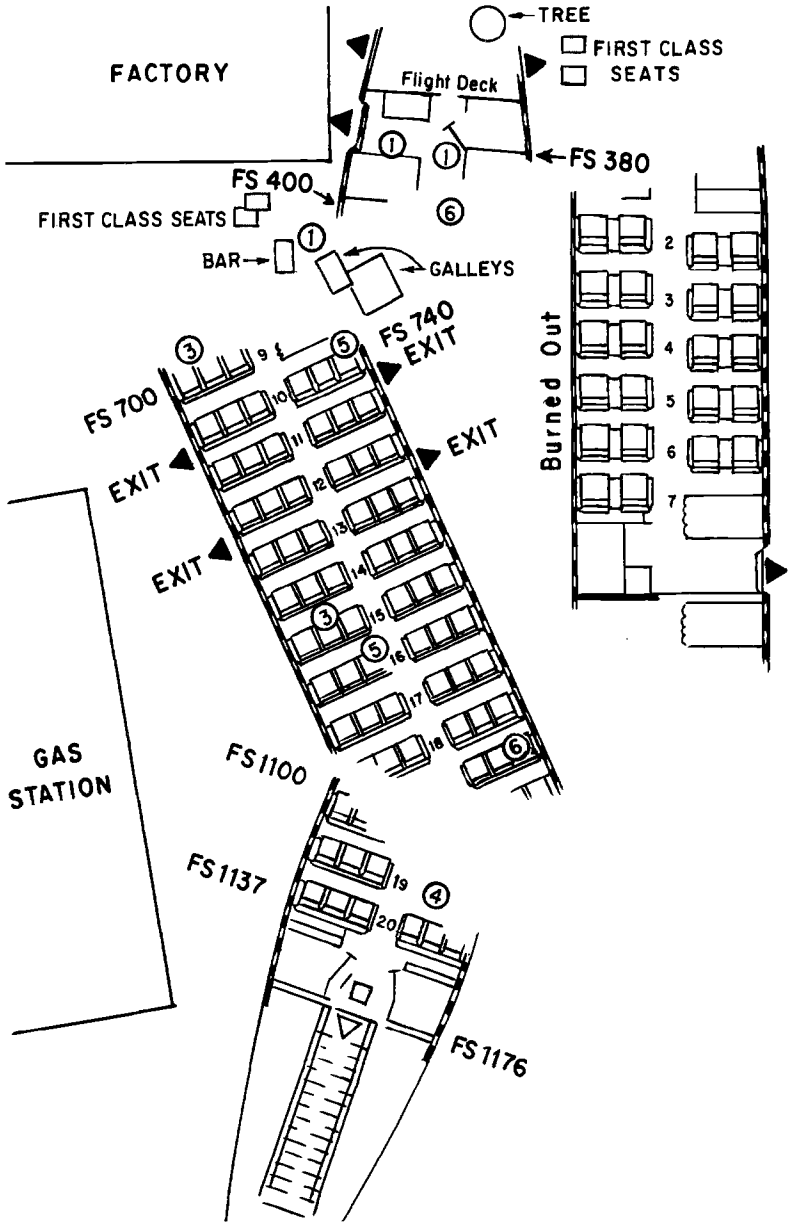

FIG. 1—*Diagram of aircraft after the accident. The encircled figures represent the number of deceased recovered from the respective areas. FS380 indicates fuselage section 380 in. (965 cm) from the nose of the aircraft, FS400 is the fuselage section 400 in. (1016 cm) from the nose of the aircraft, and so forth.*

door was unopened. The aft door was damaged and in no way could be opened as a means of escape, since the exit and stairway rested on the ground. The cockpit-cabin door was jammed.

The final impact was felt on the right side of the center section. One unbelted passenger was projected five rows forward from her seat, over the heads of the other passengers. One other unbelted passenger was thrown forward into the over-wing exit area.

There was a 3-man flight crew in the flight compartment; 9 passengers (3 adult males, 5 adult females and 1 child) and 2 flight attendants in the first class cabin; and 72 passengers (26 adult males, 41 adult females, 2 children, and 3 infants) and 2 flight attendants in the coach cabin.

Survivors

Three flight crew members, who were locked in the cockpit because of the jammed cockpit door, exited from the aircraft through the right cockpit window, which they dislodged. They sustained minor injuries. Two of the passengers, seated by the left over-wing exits, opened the respective window emergency exits quickly and easily. Other survivors, unable to gain access to emergency exits because of darkness and poorly defined exit markings, exited through breaks in the fuselage. The mass attempt to exit from the crashed aircraft was hampered by the funnel effect on approach to the emergency exit windows.

Evacuation of survivors (passenger-estimated at 1½ min), was accomplished by passenger assistance of each other, two flight attendants, and local persons in the immediate area. Survivors were taken to the local hospital (Knud Hansen Memorial) for treatment. Four of the survivors were transferred to the Burn Center in San Juan, Puerto Rico. One injured rescue worker (who was not an occupant of the aircraft) sustained multiple cuts and contusions and was taken to the local hospital for treatment. Table 1 summarizes the number and extent of injuries.

TABLE 1—*Summary of injuries.*

	Crew			
Injuries	Cockpit	Cabin	Passenger	Other
Fatal	0	2	35	0
Serious	0	2	17	1
Minor	3	0	26	0
None	0	0	3	0

Deceased

As the deceased were removed from the wreckage, each body was tagged with a number (in sequence of removal), a symbol for location in the wreckage, and date and time of removal. The bodies were transported to a secured area and then taken by vehicle to the hospital morgue freezer. At the morgue, articles of clothing, jewelry, and other items found on the bodies were packaged and tagged with the respective number corresponding to the body. X-rays of the skull and other areas of identifying significance were taken of each body. The bodies of the deceased were examined for

(1) identification by means of odontology, fingerprints, and personal effects (by family);
(2) percentage and degree of body burns;
(3) signs of smoke inhalation;
(4) signs of trauma (fractures, lacerations, abrasions);
(5) percentage of carbon monoxide saturation in the blood;
(6) blood hemoglobin levels in g/100 ml;
(7) blood cyanide levels in μg/ml; and
(8) gravidity (in child-bearing ages).[4]

[4]Specifically investigated because of questions raised for insurance purposes (one or more victims).

The majority of the deceased were recovered from the aft portion of the wreckage (Fig. 2 and Table 2); however, whether this was because of an attempted mass exodus to the rear or some other reason could not be determined.

To expedite rapid, positive identification of the deceased, one of two forensic odontologists from the New York Medical Examiner's Office communicated, by telephone, with the families of all persons on the passenger list who had not been found or identified. The names of the respective family dentists were thus obtained and the dental records acquired.

Meanwhile, a second forensic odontologist examined the mouths and skull X-rays of the deceased and recorded each dentition. Comparisons were then made matching sex, stature, estimated age, X-rays, and dental records. This procedure resulted in positive identification of 31 bodies.

Of the remaining 6 bodies, 1 adult male (ejected from the aircraft but not disfigured) was identified on sight by friends and family; the identification of 1 adult by fingerprints and personal effects found on the body was confirmed by his wife; and the identification of 1 child and 3 infants by dentition-age-exclusion was verified by parents or other relatives.

Five of the 37 bodies had corroborative identification by fingerprints taken and matched by personnel from the Federal Bureau of Investigation.

Nine passengers and 1 flight attendant seated in the first class cabin, and 26 passengers and 1 flight attendant seated in the coach cabin, died in the aircraft crash. One of the deceased, a 34-year-old male seated in 7A, was ejected from the aircraft still affixed to his seat. This victim died of skull fractures and intracranial hemorrhage. His body was well away from the flames and not burned at all.

Four deceased persons had less than 20% of the body surface involved with third-degree burns (see Table 2):

1. A 51-year-old male, seated in 19C, died from an occipital skull fracture with intracranial hemorrhage. The tracheal mucosa was charred, suggestive of smoke inhalation. The blood carbon monoxide level was equivocal (19% saturation) relative to toxic effects. The blood cyanide level was insignificant. Third-degree burns involved 13% of the body surface (head charred to bone).
2. A 50-year-old female, seated in 3F, died from asphyxia. The tracheal mucosa was charred. The blood carbon monoxide level was 40.3% saturation. The blood cyanide level was insignificant. Third-degree burns involved 11% of the body surface. There was a well-healed abdominal cicatrix and surgical absence of the uterus, both Fallopian tubes, and both ovaries.
3. A 45-year-old male, seated in 20F, also died from asphyxia. The tracheal mucosa was charred. The blood carbon monoxide level was 26.0% saturation. The blood cyanide level was insignificant. Third-degree burns involved 8% of the body surface. The head and face were charred to bone.
4. A 7-month-old infant, seated in 20C, died from asphyxia. The tracheal mucosa was charred. The blood carbon monoxide level was 38.3% saturation. The blood cyanide level was insignificant. Third-degree burns involved 4% of the body surface. The forehead was charred to bone.

Two deceased persons had third-degree burns involving 20 to 30% of the body surface:

1. A 41-year-old female, seated in 4A, died from asphyxia. The tracheal mucosa was charred. The blood carbon monoxide level was 39.0% saturation. The blood cyanide level was insignificant. Third-degree burns involved 26% of the body surface.
2. A 3-year-old male infant, seated in 20E, died from burns. The tracheal mucosa was charred, but the blood carbon monoxide and cyanide levels were insignificant (Table 2). Third-degree burns involved 28% of the body surface. The head and face were charred to bone.

Of the remaining 30 victims, 19 incurred fractures in various locations of the body. The

fractures of 6 of these victims were attributed to the severe degree of heat, and 2 were considered equivocal.

Eight deceased persons had blood carbon monoxide levels of 40.3% saturation or above, and all died from asphyxia and burns:

1. A 50-year-old female, seated in 3F, who was described previously.
2. A 29-year-old female, seated in 2A, was recovered on the floor in the forward section of the wreckage, in the first class cabin, near the cockpit door. There was white foam in the nares and mouth, and gray foam in the trachea and primary bronchi. The tracheal mucosa was charred. There were third-degree burns involving 94% of the body surface. The blood carbon monoxide level was 45.9% saturation. The blood cyanide level was 0.40 μg/ml. Other postmortem findings were marred by the degree of burn. The cause of death was asphyxia, resulting from aspiration of the foam used to extinguish the blaze, and smoke inhalation.
3. A 36-year-old male, seated in 2B, had 46% of the body surface involved with third-degree burns. The tracheal mucosa was charred. The blood carbon monoxide level was 45.8% saturation. The blood cyanide level was insignificant.
4. A 13-year-old male child, seated in 2F, had 40% of the body surface involved with third-degree burns. The tracheal mucosa was charred. The blood carbon monoxide level was 44.6% saturation. The blood cyanide level was insignificant.
5. A 66-year-old female, seated in 19A, had 100% of the body surface involved with third-degree burns. There were multiple limb fractures and luxations. The abdominal organs were eviscerated. The uterus and ovaries were atrophic. The tracheal mucosa was charred. The blood carbon monoxide level was 42.6% saturation. The blood cyanide level was 1.75 μg/ml. The limb fractures and luxations, as well as the evisceration, were attributed to the excessive degree of heat.
6. A 25-year-old female, seated in 20C, had 54% of the body surface involved with third-degree burns. The tracheal mucosa was charred. The blood carbon monoxide level was 45.6% saturation. The blood cyanide level was insignificant.
7. A 25-year-old female, seated in 20D, had 54% of the body surface involved with third-degree burns. The tracheal mucosa was charred. There were multiple limb fractures and luxations. The blood carbon monoxide level was 44.2% saturation. The blood cyanide level was 7.3 μg/ml. The limb fractures and luxations were attributed to the excessive degree of heat.
8. A 47-year-old female, seated in 16B, had 100% of the body surface involved with third-degree burns. The tracheal mucosa was charred. The blood carbon monoxide level was 56.0% saturation. The blood cyanide level was insignificant.

Five of the deceased persons had blood cyanide levels ranging from 1.33 to 7.3 μg/ml. These bodies were all recovered from the aft section of the wreckage (Table 3). All but one incurred multiple limb fractures and luxations attributed to the excessive degree of heat.

1. A 51-year-old female, seated in 16A/B, had 94% of the body surface involved with third-degree burns. There were multiple limb fractures and luxations. The tracheal mucosa was charred. The blood carbon monoxide level was 38.2% saturation. The blood cyanide level was 3.55 μg/ml (considered to be lethal).
2. A 27-year-old female, seated in 20B, had 59% of the body surface involved with third-degree burns. There were multiple limb fractures and luxations. The tracheal mucosa was charred. The blood carbon monoxide level was 39.3% saturation. The blood cyanide level was 1.37 μg/ml.
3. A 25-year-old female, seated in 20D, had 54% of the body surface involved with third-degree burns. There were multiple limb fractures and luxations. The tracheal mucosa was charred. The blood carbon monoxide level was 44.2% saturation. The blood cyanide level was 7.3 μg/ml (considered lethal).
4. A 35-year-old female, seated in 18E, had 36% of the body surface involved with third-

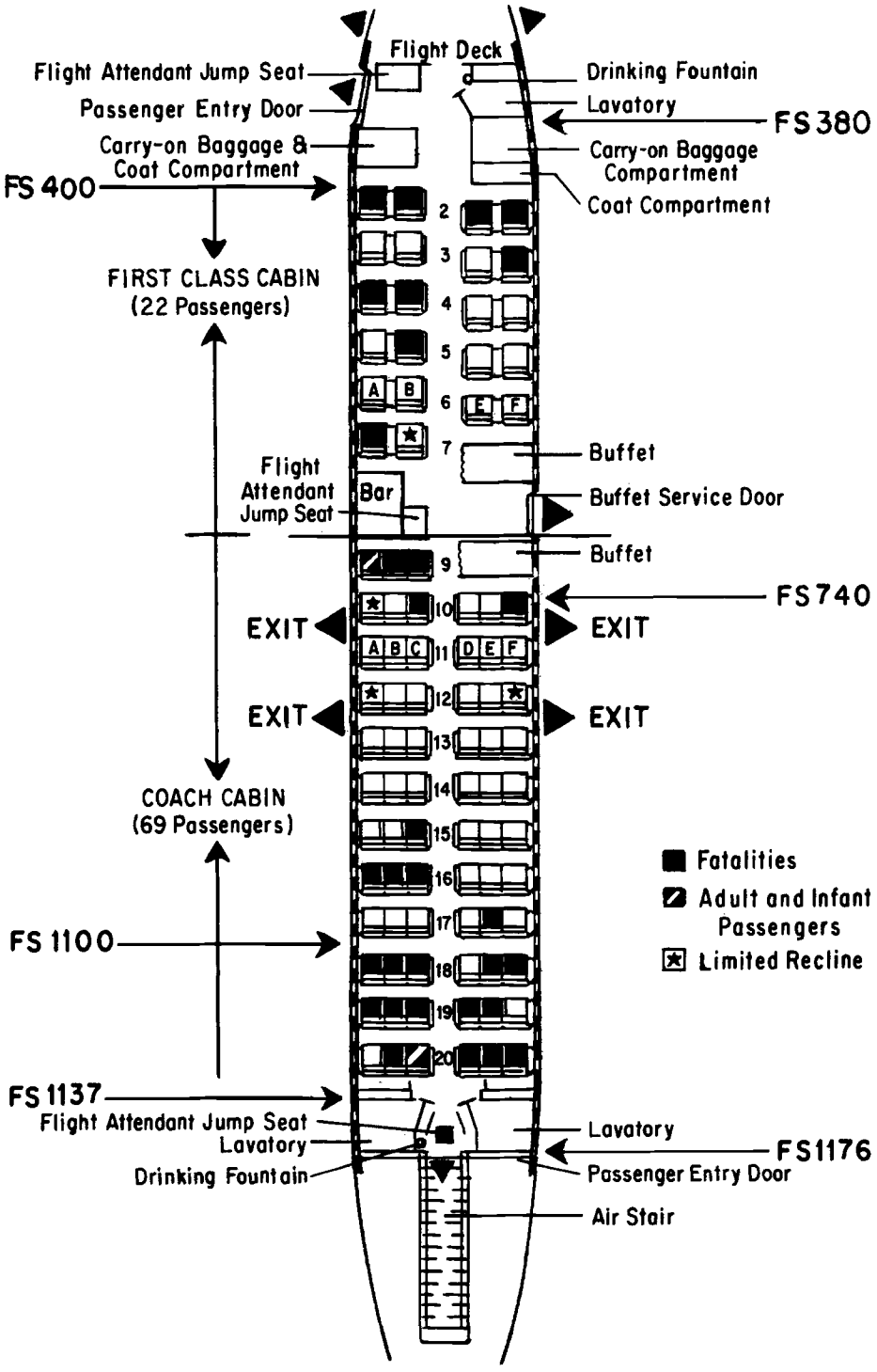

FIG. 2—*Diagram of the interior of the aircraft with fatalities indicated.*

TABLE 2—*Detailed listing of injuries.*[a]

Seat	Victim	Location When Found	Trauma Factor	Smoke Inhalation	Third-Degree Burns, %	Hemoglobin, g/100 ml	Carbon Monoxide, % Saturation	Cyanide, μg/ml
Jump seat	36	forward	Fx 1,2	+	84	15.6	29.0	0.12
2A	5	forward	none	+	94	15.5	45.9	0.04
2B	12	forward	none	+	46	2.4	45.8	0.06
2E	14	forward	Fx 1,3?	+	65	13.2	34.2	0.41
2F	8	center	none	+	40	8.3	44.6	0.08
3F	15	forward	lacerations	+	11	4.3	40.3	0.03
4A	7	center	none	+	26	5.6	39.0	0.08
4B	33	forward	none	±	78	5.3	12.7	0.05
5B	35	aft	none	+	100	13.4	33.5	0.10
7A	1	outside	Fx 4,5	...	...	16.7	1.9	0.03
9A	34	aft	amputation, 1	±	100	11.1	none	0.03
9A	3	center	luxation	...	100	none	none	none
9B	27	forward	none	...	80	1.3	none	none
10C	29	aft	none	+	57	21.1	8.3	0.09
10F	26	aft	Fx 1,2,3,4,5	+	100	10.1	10.6	0.10
15C	16	aft	none	+	100	1.4	33.0	0.03
16A/C	18	aft	none	+	70	16.3	28.4	0.12
16B	21	aft	none	+	100	7.1	56.0	0.08
16C/A	19	aft	Fx 1	+	56	12.0	21.9	0.08
17E	20	aft	Fx 5	±	36	3.9	8.3	0.03
18A/B	31	aft	Fx 1,3[b]	+	94	16.9	38.2	3.55
18B/A	2	center	Fx 3[b]	+	100	18.7	15.8	0.16
18C	25	aft	Fx 1[b]	+	72	13.2	26.3	0.10
18E	11	aft	none	+	36	7.8	20.0	1.33
18F	17	aft	Fx 1,3,5	+	38	10.8	25.4	0.07
19A	28	aft	Fx 1,3,4[b]	±	100	14.8	42.6	1.75
19B	30	aft	Fx 4	+	30	13.8	26.7	0.15
19C	10	aft	Fx 5	+	13	14.2	19.0	0.06
19D	37	outside	Fx 4?	...	88	none	none	none
19E	4	center	Fx 5	+	58	4.3	23.9	0.05
20B	6	aft	Fx 1[b]	+	48	15.9	39.3	1.37
20C	22	aft	none	+	4	10.9	38.3	0.76
20C	24	aft	Fx 3,4	+	54	3.5	45.6	0.03
20D	13	aft	Fx 2,4	+	54	19.1	44.2	7.3
20E	9	aft	none	+	28	0.4	none	0.06
20F	23	center	lacerations 1,3	+	8	11.2	26.0	0.06
Jump seat	32[c]	aft	Fx 1,2,3,4,5	...	...	...	...	...

[a] FX = fracture; 1 = right arm; 2 = right leg; 3 = left arm; 4 = left leg; 5 = skull; + = positive; ± = equivocal. The toxicology tests (hemoglobin, carbon monoxide, and cyanide) were performed by Delbert J. Lancefield, Ph.D., Chief, Forensic Toxicology Research Unit, Aviation Toxicology Laboratory, A.A.C.-114B, Civil Aeromedical Institute, Oklahoma City, Okla.

[b] Injuries resulted from excessive heat.

[c] Victim charred.

TABLE 3—*Blood cyanide content as related to recovery site.*

	Recovery Site			
Cyanide Level, μg/ml	Aft	Forward	Center	Outside
0.03 to 0.10	13	2	4	1
0.11 to 0.41	2	3	1	...
0.76	1	...	...	...
1.33 to 7.3	5	...	...	...

degree burns. The tracheal mucosa was charred. The blood carbon monoxide level was 20.0% saturation. The blood cyanide level was 1.33 μg/ml. The victim was gravid, estimated at first trimester. Whether or not one can consider the blood carbon monoxide and cyanide levels lethal considering the physiological state of the victim remains unresolved, as arguments can be present both ways.

5. A 66-year-old female, seated in 19A, had postmortem findings as previously described.

These elevated blood cyanide levels, supposedly attributed to the burning of plastic fabrics (or possibly other sources within the aircraft), leave unanswered many questions such as lethal range, nature of the source, relativity to the degree of heat, and even possible relationship to the location of the heat or blaze within the aircraft. These questions have yet to be resolved.

Wreckage

Despite the brightness of daylight on the exterior, survivors described the interior of the aircraft as totally darkened because of restricted light source and progressively increasing dense smoke. This darkness added to the panic of the crisis since there were no means of light or luminescence to indicate a source of exit. As one notes that most of the deceased were recovered from the aft portion of the wreckage (21 of 37 bodies), one may wonder if any significance could be attached to these observations:

Did these passengers shy back from the flames forward of the aircraft? Did these passengers pile up as a result of the sudden arrest of the aircraft? Did these passengers turn to what they recalled as being an aft exit, which in reality could not be opened because it was flush with the ground? These questions remain unanswered but are thought-provoking.

For the purposes of evaluation and localization, the aircraft is divided into three sections: nose (flight compartment to FS400[5] left and FS380 right), center (FS700 left to FS1100 left and FS740 right to FS1100 right), and aft (FS1100 to tail).

The section corresponding to FS400 to FS740 was totally burned out. The right section FS740 to FS870 (near Row 14, Fig. 2) was consumed by fire with the exception of the aft wing-attach frame. The left center section FS720 to FS1100 was not consumed by fire, but the remainder of the seats on the left were totally consumed. The left forward and aft over-wing exits had been removed. The entire aft section had been consumed by fire. The left over-wing emergency exits served their purposes well, as described by survivors exiting from the burning aircraft. However, the obstacles created by the seats adjoining these emergency exits were also described by these survivors.

The aft exit door mechanism was intact, but the door and stairway were immobilized by the ground beneath.

[5]FS400 indicates fuselage section 400 in. (1016 cm) from the nose of the aircraft; FS380 is the fuselage section 380 in. (965 cm) from the nose of the aircraft, and so forth.

The flight compartment seats were intact and securely fastened to the support structure. Restraint systems remained fastened to the seats. The flight engineer panel was burned through, and the aft side had fallen to the right of the engineer's seat. All instrumentation wiring and the circuit breaker panel were down. The windshield and side windows were intact with right and left cockpit windows open. The instrument panel and control console were intact. The aft cockpit bulkhead was consumed by fire. All gear at the bottom of the bulkhead was in position. The cockpit door sill was buckled in an upward, angular position.

All the combustible interior furnishings in the forward cabin of the passenger compartment were consumed by flames. The forward left-hand entry door with attached escape slide was closed and intact. The opening handle was in the "closed" position, and the door was wedged shut from the exterior by debris belonging to the adjacent building. The entire lavatory was consumed by fire. Multiple seat parts were found on the ground outside, to the left of the fuselage. Passenger seat belts were attached to the respective seat structures, but the seat legs were separated from the frame. Buffets A and B as well as the interior contents were intact except for displacement. The bar was partially consumed by fire. The entire right side of the mid-cabin was destroyed by fire except for the aft wing-attach frame (FS740 to FS870). Three rows of triple seats, on the left side of the mid-cabin, were essentially intact. The balance of the left side was totally consumed down to the steel seat-leg attachments. Seat tracks and track fittings were in place and structurally sound. The entire aft cabin was destroyed.

Discussion

There were several striking observations to be noted:

1. There was total darkness on the interior of the aircraft despite the daylight and apart from the additional dense smoke. To correct such a situation, several survivors and members of the Human Factors Group proposed that fluorescent markers, battery-operated strobe lights or blinker systems, or fluorescent paint be used to totally outline all available emergency exits. If a battery system is used, it should come on automatically, synchronized with cutting off the engines and electrical systems of the aircraft.

2. Crash landings in aircraft such as the Boeing 727-95 are more than likely to be "belly landings," thereby rendering the aft exit and stairway of this model, which would be flush with the ground, completely useless. It would seem more practical to have the aft exit located on the side, as in the 747.

3. The passageway is relatively narrow at the emergency exits. It was suggested by survivors and others that these areas should clear at least two seat widths (50 by 64 in. or about 1.3 by 1.6 m, the average dimensions of the exit area in a 747). The doorways should be located on the side, aft and forward, and should measure 42 by 76 in. (1.1 by 1.9 m) (the average dimensions of a doorway in a 747) instead of the actual measurement (34 by 72 in. or 0.9 by 1.8 m). These minor difference in measurements could be the distinction, in an emergency, between accommodation and obstruction to passengers with handicaps (limb casts or braces, or possible limb deformity).

4. The format used in the pictorial cards describing emergency procedures should be more explicit. The diagrams showing the location of emergency exits should be marked in red or orange "emergency" color, as it should be in actuality in the aircraft. The movement of the levers and latches should have arrows and directions distinctly marked with "emergency" colors, similar to that which should be used on the actual levers and latches within the aircraft.

5. The format used in giving verbal instructions and demonstrations on what to do in the event of an emergency should vary constantly. This would assure the flight attendants that all passengers are looking and listening and avoid the reaction to rote dissertation, "Yeah, I know all about it. Who wants to think about that anyhow?"

6. Passengers, on occasion, particularly in times of panic, are inept as to the mechanics of closing and opening seat belts. Demonstration of these procedures should be included in the emergency, pre-flight demonstration.

7. The seats near the emergency exits should be particularly assigned to sturdy, healthy, and strong individuals. The aisle seats in these areas should be occupied by flight attendants.

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