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SPECIAL STUDY

PASSENGER SURVIVAL IN TURBOJET DITCHINGS

(A CRITICAL CASE REVIEW)

Adopted: April 5, 1972

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591
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16. Abstract

This study examines the condition and circumstances which determined the outcome of the ditching of a DC-9 aircraft in regard to the survival and nonsurvival of the occupants. It was found that the passengers were prepared inadequately for the ditching due to a combination of factors including insufficient preparation time, inadequate briefings, insufficient training and the lack of proper crew coordination. It was estimated that decelerative forces were in the order of 8 to 12 g's, causing unrestrained occupants to be thrown forward, inducing seat failures and spinal injuries. The cause of seats, seatbelt, and galley equipment failures were analyzed.

It was estimated that the aircraft remained afloat for 5 to 6 minutes. The fact that a liferaft inflated inside the aircraft was attributed to impingement of the raft package by the galley structure, forcing the crewmembers out of the aircraft. Leadership of the crew while awaiting rescue and an inflated emergency escape slide minimized further loss of life. Recommendations were advanced dealing with increased training for crewmembers, better passenger communication techniques, increased strength requirements for seats, seatbelts, and galley equipment and the development of slide raft combinations and lifevest design. Twenty references are included.

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FOREWORD

The ditching of a DC-9 turbojet aircraft on May 2, 1970, in the Carribean Sea resulted in an extensive investigation into the facts, conditions and circumstances relating to this accident and the survival of 40 of the 63 occupants.

A public hearing was held on July 7 through 10, 1970, in connection with this accident. The National Transportation Safety Board issued an official report (Ref. 1) on March 31, 1971, in which the possibility of additional deficiencies in survival procedures and equipment was indicated, and that these possibilities were being studied by the Board.

This study is the result of the Board's effort in that area. The details of its contents were obtained through personal interviews, statements of passengers and crew, and through information contained in 22 questionnaires received from the 35 surviving passengers (Ref. 2, 3). The report was prepared by the Human Factors Branch of the Bureau of Aviation Safety. The study is directed toward those factors directly influencing the survival of the occupants and their escape from the aircraft. It is anticipated that consideration of the conclusions and implementation of the recommendations will contribute materially to increased occupant protection in civil aviation.

To avoid misunderstanding, the Board wishes to stress that the inadequacies revealed in this study should be considered as symptoms of the present state of the art of occupant protection rather than as criticism of the individuals concerned.

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PASSENGER SURVIVAL IN TURBOJET DITCHINGS

(A CRITICAL CASE REVIEW)

I INTRODUCTION

An Overseas National Airways (ONA) DC-9, operating as a scheduled passenger flight from John F. Kennedy International Airport, New York, to the island of St. Maarten, West Indies, ditched at sea approximately 30 miles east-northeast of St. Croix, Virgin Islands on May 2, 1970, during daylight hours. There were 57 passengers and a crew of six aboard the aircraft.

The flight was being operated as Antilliaanse Luchtvaart Maatschappij (ALM) Flight 980 under the terms of a lease agreement between two companies: ONA, which furnished the DC-9 aircraft and a flightcrew; and ALM, which furnished the cabin crew.

The flight was forced to terminate in the Carribean Sea because of fuel exhaustion. While there were five liferafts aboard the aircraft, none were launched successfully. Forty persons were rescued from the sea by helicopters, but the remaining 22 passengers and one stewardess did not survive. (Ref. 1)

II SCOPE

The purpose of this study is to examine in detail the conditions and circumstances which determined the outcome of the ditching as it affected the survival of passengers and crew; to identify those pre-conditioning factors which led to the loss of 23 lives; and to formulate conclusions and recommendations concerning modification of equipment and procedures in order to provide increased occupant protection in air carrier operations.

For clarity of presentation and discussion, this report is divided into four sections. Section A identifies the preconditioning factors relating to the passengers, the cabin crew, the cockpit crew and the aircraft equipment. Section B relates the salient facts about the ditching and evacuation. Section C analyzes the interaction of the related factors and their outcome. Section D lists the conclusions reached and the recommendations developed from this study.

III SECTION A PRECONDITIONING FACTORS

1. *Passenger Preconditioning*

There were 57 passengers aboard the aircraft: 29 adult male passengers, 26 adult female passengers and two preteen children. Although seat assignments were given in New York, several of the passengers had changed location when boarding and while in flight. One male passenger, who made a practice of sitting at an overwing exit if a seat was available at that location, chose to sit in seat 13E next to the right aft overwing exit. He made a mental note of the procedure needed to open this exit in the event of an emergency. The passengers were distributed fairly evenly throughout the cabin.

(a) Experience

Most of passengers had flown before. The passenger composition was not typical; there were more female passengers than is usual in normal air carrier passenger operations. It may be assumed, however, that the passengers were familiar with the general cabin procedures, lay-out and exit locations, and had heard frequently the standard passenger briefing, demonstration of the oxygen mask operation and the location of the emergency exits.

(b) Passenger Briefing

Upon departure from New York, the purser gave the customary salutation, the en route flight time, and service information. Then he stated:

> "As a government regulation, we have to request you to read the safety instructions which you will find in the seat pocket in front of you.
>
> "We also have to draw your attention to the red exit signs in the front, in the rear and over the wings. Please do not smoke until the NO SMOKING sign is switched off, put the back of your seat in a vertical position and fasten your seatbelts. "In a few moments, we will demonstrate (for) you the use of a lifevest and oxygen mask."

Following this, the cabin crew demonstrated the operation of the oxygen mask and the donning method of the lifevests.

The availability and location of the rafts in the aircraft was not mentioned during the briefing. However, the safety instructions provided in pamphlet form presented in both written and pictorial form, the necessary information to locate and use the rafts, as well as information for emergency protection and egress. The safety instruction pamphlet also stated that the captain would instruct the passengers to brace for ditching just before landing.

(c) Preditching Briefing

Some time after a missed approach was executed at St. Maarten, the purser, upon orders from the captain, used the public address system in the cabin to inform the passengers that the aircraft was low on fuel and that, as a precautionary measure, they should put on their lifevests.

No mention was made of the operation of the emergency exits, the location of the liferafts, nor was an attempt made to brief individual able-bodied male passengers about these functions.

2. *Cabin Crew Preconditioning*

The cabin crew consisted of a purser, a steward and a stewardess. This crew was employed by ALM. At the time of the accident, the purser had been employed for approximately 6 years as a cabin attendant, including 3 years as a purser. The steward and stewardess had been employees of the company for approximately 1 year.

(a) Training

The cabin crew received initial training immediately following employment by the company, including general emergency procedures and ditching duties. Despite this, no one in this crew had ever removed a raft from storage, lifted a raft package or practiced with a raft under simulated ditching conditions (wet ditching drill).

In accordance with ALM company policy, recurrent training was given once a year. Specific DC-9 training was also received by this crew in August of 1969. ALM does not carry liferafts on their DC-9; and ALM equipment and procedures are somewhat different from those used by ONA. Because of these differences, ALM requested additional training for their cabin personnel when the original leasing agreement went into effect. This training was accomplished in January 1970 by an ONA instructor, who presented an 8-hour course at ALM's home base (Curacao, W.I.), which covered the differences existing in the equipment carried by ONA and their procedures for use. One such difference involved the prepositioning of the liferaft stored in the coat closet. Since ONA does not have tiedown facilities in their DC-9, their procedure is to leave the liferaft in its storage area as

opposed to the ALM procedure which requires prepositioning of the raft near the galley exit or, in case no rafts are carried, to preposition the evacuation slides. The cabin crew was instructed, during their "differences" training, not to preposition this raft. This instruction was countermanded later by an ALM written instruction that directed cabin crews to preposition the raft prior to ditching.

General ALM procedures were to be used by the flight attendants since no DC-9 Flight Attendant manuals were distributed to the ALM cabin crew by ONA. These procedures called for a briefing in two phases to the passengers in case of ditching. The procedure also called for a warning from the cockpit crew to take emergency stations and a call for safety positions (brace for impact) when impact was imminent.

(b) Preflight Instructions

The cabin crew and the cockpit crew did not conduct a joint review of emergency procedures during the preflight phase at New York. Although this was not customary as far as the ONA crew was concerned, the ALM cabin crew customarily performed such a procedure, when directed, under supervision of the captain or the purser. During the preflight check, the captain discovered that the public address system was inoperative from the cockpit, but he failed to relay this information to the cabin crew, and they were unaware of this fact throughout the flight; however, the public address system in the cabin was functioning properly.

(c) Preditching Instructions to Cabin Crew

Some confusion existed as to the phraseology used by the captain in giving instructions to the purser when it became apparent that the aircraft might have to be ditched. Testimony of the three flight deck crewmembers (Ref. 2) indicates that the captain told the purser that a fuel problem existed and to prepare the passengers for a possible ditching.

The purser testified that he was called to the cockpit twice and that after the second call the navigator told him that they were "running out of gas." The captain also told him that he might have to ditch the aircraft as they were low on fuel. When no one told him anything further, the purser asked the captain whether he should inform the passengers. The copilot or the navigator then told the captain: "I believe we have to inform the passengers." The captain then said, "Go ahead, Spencer, inform the passengers."

The time that these instructions were given was estimated by crew and passengers as 5 to 7 minutes before the actual ditching occurred.

3. *Cockpit Crew Preconditioning*

The cockpit crew consisted of the captain, a first officer and a navigator. The captain was employed by ONA in 1967; the first officer, 1970; the navigator, 1966.

(a) Training

The captain and first officer had received recurrent DC-9 training, including evacuation and ditching procedures, within the last year. This training consisted of an 8-hour course in the description, location and use of all emergency provisions aboard the aircraft. Opportunity was provided to observe or participate in the handling of such equipment. However, ditching drills under simulated circumstances (wet drills) were not provided. The navigator had not received DC-9 training but had received a DC-8 recurrency class within the last year. Prepositioning of the liferafts is taught for the DC-8 aircraft.

The general operation of this flight was governed by the procedures described in the DC-9 Flight Manual. The emergency procedures section of this manual specifies that the captain – "gives signal when touchdown is imminent by turning on NO SMOKING - SEATBELT signs; uses P. A. system, if operative." Chapter four of ONA's Operations Manual instructs under Aircraft Ditching Procedures that – "two minutes before ditching, or at 1,000 feet, one of the pilots will announce over the public address system, "standby for ditching," and prior to touchdown, the command, "brace for impact," will be given. The aircraft's emergency checklist did not include any reference to the subject of crew or passenger warning before impact.

The necessity for briefing of the crew by the captain is prominently mentioned in both the DC-9 Flight Manual and the Operations Manual.

(b) Preditching Actions

When the cockpit crew realized the inevitability of the ditching, less than 10 minutes was left to review the emergency procedures for such an event. As previously mentioned, the captain called the purser to tell him that they were low on fuel and to inform the passengers. He also sent the navigator aft to help out in the cabin. The first officer ran through the emergency checklist by memory and the captain flashed the NO SMOKING - SEAT BELT sign just prior to impact.

4. *Equipment Preconditioning*

The DC-9 was configured as a single-class, 105-passenger capacity aircraft. Passenger seating was arranged in 21 rows of one double-seat unit on the left side of the cabin and one triple-seat unit on the right side. All seats were forward facing and stressed to meet the minimum requirements of 14 CFR 25.561. Cabin attendant seats were provided in the forward and aft part of the cabin. The forward seat was located next to the main entry door on the cockpit bulkhead and was a double aft-facing jumpseat. The aft seat was a double forward-facing jumpseat on the cabin pressure bulkhead.

(a) Lifevests

There were 122 lifevests aboard the aircraft. Individual lifevests were located in a pocket fastened to the seat-pan under each passenger seat. The pockets were held closed by a strap-and-snap fastener which had to be pulled down to open. The lifevests were packaged in a sealed, transparent plastic container. A pull-tab was provided to tear the sealed package to remove the vest. Additional vests were located at each crew station and 10-spare vests were in the forward coat closet. Twenty-five lifevests were recovered and inspected. About one-half of these had permanent attachments of the retention straps to the front fittings and the others required the user to fasten the straps to the front D-ring fittings. All vests had locator lights. About one-third of the lights had a manually operated switch for operation and the remainder were water- activated lights requiring manual removal of a plug from the power package.

(b) Rafts

Five 25-man liferafts were aboard the aircraft. One raft was stowed in the coat closet opposite the forward galley area. Four rafts were stored in individual compartments in the overhead rack; they were located just aft of the overwing exits in two compartments on each side of the cabin. The raft packages, weighing about 125 pounds each, were restrained in the compartment by two quick disconnect straps. The raft package is a cloth bag with two carrying handles on each side. Package dimensions differ depending on the storage requirements and may be cylindrical, rectangular or square shaped. The raft package in the forward coat closet in this case was a cylindrical package approximately 4 feet long and 18 inches in diameter. The overhead packages were retangular and approximately 4 feet by 2 feet by 1 foot. A lanyard inside the package provided for both tiedown of the raft and actuation of the inflation bottle.

(c) Seatbelts

All passenger seats were equipped with seatbelts of the fabric-to-metal type. The locking mechanism for this type seatbelt requires the fabric of one end of the belt to be inserted and pulled through a metal buckle. The spring-loaded serrated cam of the buckle is designed to prevent the fabric from slipping unless the cam is lifted.

(d) Galleys

A standard galley was located in the forward cabin. The galley consisted of 3 units, two containing ovens and a third for storage. All ovens, bins and carriers were provided with a locking mechanism designed to withstand the minimum crash-load requirements of 14 CFR 25.561.

IV SECTION B
DITCHING AND EVACUATION

1. *Preparation for Ditching*

It was estimated that 5 to 7 minutes were available from the time the purser was told of a possible need to ditch until impact with the water. The passengers were occupied, during this time, in overcoming difficulties obtaining and donning lifevests. Passengers experienced difficulty opening the strap-snap button device holding the lifevest storage pocket closed, and several passengers had to get on their hands and knees before they could open the lifevest pocket. One passenger ripped the strap off. Several passengers were unsuccessful in obtaining their own vest and required help from other passengers or from cabin crewmembers. Passengers also experienced difficulty opening the plastic covers for the lifevests. One passenger used his pocket knife to open the plastic cover. Several passengers reported confusion in fastening and adjusting their lifevests.

The purser, steward and stewardess initially helped passengers with their vests. When the navigator entered the cabin, the purser went to help the navigator who was having considerable difficulty in removing the liferaft from the coat closet and moving it to the galley area. These two men subsequently spent the remaining time trying to locate the raft's lanyard inside the raft package. While the raft was being moved, the steward secured the galley and unfastened the girt bar of the galley door slide, in accordance with ditching instructions laid down by ALM. The stewardess' time was spent in helping passengers don and adjust their lifevests. Just before impact, she was observed to be standing, and helping two passengers put on their vests.

Several passengers took pillows down from the overhead rack and assumed different crash positions despite the lack of guidance from the crew. Still others looked out the windows and assumed that the aircraft was making an overwater approach to the runway. At least five passengers neglected or forgot to refasten their seatbelts after the lifevests were donned.

2. *The Ditching*

The majority of the passengers had no warning of the impending impact although many sensed the emergency situation. Several survivors reported that the lights went out or blinked just before impact. One survivor assumed a braced position when she heard the engines flame out. The deceleration was generally described as severe to violent. The direction of the deceleration was described as predominantly longitudinal by the passengers seated forward of the wing centerline and forward and upward by those seated in the rear of the aircraft. Five passengers known to have been unrestrained at impact were thrown out of their seats; four of those survived. At least seven passengers were also thrown from their seats despite having their belts fastened; of these seven, four survived. Definite seat failures were reported by two survivors and possible failures by others. Although the breakover feature of the seatbacks is often confused for seat failures in aircraft accidents, descriptions of damage by survivors and the nonsurvival of the occupants of the first three rows on the left of the cabin afford a high probability that these rows were affected by failure. Two survivors reported being thrown to the vicinity of the left forward cabin bulkhead near seats 1A & B, and they stated that other passengers were also deposited in that area.

The captain and the first officer were restrained by seatbelts and shoulder harnesses. The inertia reel of both seats functioned properly after a small amount of forward travel of the shoulder harness. The crew in the cabin, however, was without restraint at impact. Although the captain attempted to signal the impending impact by switching the NO SMOKING - SEATBELT sign off and on, which is supposed to activate the chimes in the cabin, no chimes were heard by the cabin crew or any of the surviving passengers. The navigator who was still trying to locate the raft's lanyard, happened to look out of the galley door window, and seeing the surface of the sea nearby, shouted a warning to sit down. The steward sat down on the raft pack-

age, facing aft, and the purser and navigator occupied the aft facing jump seat adjacent to the cockpit door, but they did not have time to fasten their seatbelts. The contents of the galley (drawers, bins and equipment), were spilled on the floor during impact.

3. *Evacuation & Survival*

When the aircraft came to a stop, it floated in a level attitude. The water level was at the doorsill when the steward opened the galley door with some difficulty. The purser attempted to open the main cabin door but was unsuccessful due to airframe distortion in the area of the upper door frame. The three crewmembers then diverted their attention to the liferaft and attempted to move the package to the galley door, but they were unsuccessful. The first officer also came into the galley area, but, before he could lend a hand, the raft suddenly inflated and trapped his foot. The navigator and the steward attempted to puncture the inflating raft but they did not have a suitable tool. They then exited through the galley door. The first officer did not remember how he released his foot from the raft.

The passenger seated at the right aft overwing exit immediately opened this exit and exited with his wife. Except for two passengers who exited by means of the galley door, and the two found in the cabin by the captain when he opened the left overwing exits from the outside, all other survivors exited through the right aft overwing exit.

The first officer left the aircraft by means of the galley door. The captain, hearing the inflation of the raft, after physically aiding the first officer through the jammed cockpit door, exited through the left sliding sindow in the cockpit. The captain made his way to the overwing exits and, after some difficulty, opened both and aided two passengers out of the aircraft.

After watching the aircraft sink, the captain made his way to the main body of survivors and started to collect survivors. Meanwhile, the navigator had found and inflated an evacuation slide from one of the aircraft's doors which served as a rallying point to everyone. All survivors mentioned the presence of the yellow flotation device which caused most of them to make their way towards it. Other flotation devices used were a small diameter tire, a trunk, suitcases and seat cushions. Some passengers, however, especially those who were unable to swim, relied on their lifevests and made no attempts to reach the slide.

V SECTION C
ANALYSIS

The aircraft went through the ditching maneuver without significant structural compromise to the occupiable areas and without transfer of lethal accelerative forces to properly restrained occupants. This section contains an analysis to show why 23 occupants did not survive the accident, and to what extent the circumstances and occurrences during ditching and the post-impact activities were contributory factors to the survival of 40 occupants and the nonsurvival of the remaining occupants.

1. *Preparations for Ditching*

There was inadequate time for the cabin crew and the passengers to prepare for the ditching. During the estimated 5 to 7 minutes following notification of a possible ditching and impact with the water, the passengers were occupied, for the most part, with overcoming difficulties of obtaining and donning lifevests. Most, if not all passengers stood while donning their lifevests while the three cabin crewmembers concentrated their efforts in aiding the passengers with their vests and moving a liferaft from the coat closet to the galley. There was no briefing of the passengers about brace positions, use of pillows, removal of dangerous personal effects, location of exits or location and movement of rafts. Passengers were not relocated or reminded to refasten their seatbelts.

The deficient cabin management was not entirely the result of the lack of time, however.

There are several conditioning circumstances which, in combination, reduced the effectiveness of the ditching preparation.

(a) Passenger Preparation

The most notable circumstance was the manner in which the pretakeoff safety instructions required by 14 CFR 121.571 (Briefing passengers before takeoff) were presented to the passengers. These instructions requested the passengers to perform certain tasks: read the safety instructions; locate the exit signs; do not smoke; put the seatback in a vertical position; and fasten seatbelts. (The verbatim text may be found in Section III.1.(b)). It is noted that the instructions consisted of the items as listed in section 121.571, but that the oral briefing which that section requires on these items is absent. Although it is recognized that safety instructions cannot be all inclusive and that instructions in lengthy detail are not feasible in passenger operations, there is no reason to be apologetic about being required to remind passengers of these safety requirements to the point of such brevity. Nor should the announcement be worded in such a manner that it leaves the initiative for compliance with the instructions to the passenger. In the same vein, the provisions of section 121.573 ("Briefing passengers: extended overwater operations") require that passengers be briefed on the location and operation of the lifevests as well as the liferafts. Although the lifevests were demonstrated, their location was not mentioned nor were the liferafts mentioned in this briefing. Because of the manner and method of presention of these safety instructions, it is doubtful that the passengers retained any appreciable amount of the information which the announcement attempted to convey.

It is recognized that many foreign operators adopt the regulations and requirements of the Federal Aviation Regulations (FAR) out of operational necessity and because of their inclusiveness from a standpoint of practical passenger safety. It must be pointed out, however, that these regulations are designed as a minimum standard to which U. S. carriers are expected to conform; each carrier must devise procedures to anplify these minimum requirements. To include only the bare minimum of information is not considered in the best interest of passenger safety.

The preditching announcement consisted of a request to don lifevests, but it was presented to the passengers as a precautionary measure because the purser did not receive adequate instruction from the flight deck crew. If the purser had realized the inevitability of the ditching, undoubtedly he would have proceeded with the entire prescribed procedure for ditching. This would have prepared the passengers in relation to the location of rafts what to do with them, how to use the available exits and how to protect themselves during the water impact. Many passenger statements revealed that the announcement was indeed taken as a precautionary measure and that further instruction was expected. The most important single factor in occupant survival during ditchings is proper preparation and control of the passengers by the crew. This is borne out by accident investigations made by the Civil Aeronautics Board and the National Transportation Safety Board, and by a Civil Aeronautics Board special study. (Ref. 4, 5, 6, 7). It appears that close crew coordination and detailed crew guidelines are the main ingredients necessary to successful completion of this task. The problems experienced by the passengers with the location, storage method, packaging and donning of the lifevests, despite two demonstrations, reinforces the fact that adequate guidelines in the form of briefing outlines were missing. This contributed to a great extent to the time limitation experienced in the preparation of the passengers.

(b) Training

Both the ONA crew and the ALM crew had received the standard initial training in emergency procedures which included ditching procedures. This training was reinforced each year through scheduled recurrent training sessions. The training consisted of classroom discussions of emergency equipment aboard the aircraft, its location and use as well as a review of procedures to be followed in the event of an accident.

It was noted that, in accordance with ALM company policy, the cabin crew was required to review emergency procedures and equipment locations under supervision of the captain or the purser. The value of such training lies in the fact that each member is required to review periodically his procedures, which promotes a learning cycle while it constantly reminds the recipient of his safety tasks. Perhaps because of the unusual flying circumstances, a foreign flight-crew's being away from their domicile without supervision, the cabin crew did not jointly review their procedures at any time after the beginning of these flights. Nor was the procedure followed regarding the prepositioning of the liferafts which was taught in the training course given by ONA; this procedure had, in fact, been countermanded by ALM; consequently the purser used valuable time in removing the raft from the closet, positioning it in the galley area and trying to locate the lanyard..

Although the lack of a public address system was a factor, the delay of the flight deck crew in accepting the inevitability of the ditching and the lack of proper coordination with the cabin crew were the critical circumstances in this situation. When the impending ditching became obvious, the purser was called to the cockpit and informed of the low fuel state. Yet, the information given to the purser was not instructional; it allowed him to interpret the outcome of the low fuel state without adequate guidance, and it afforded him insufficient time to perform his task adequately. Not only did the information fail to emphasize the reality of the ditching, but also it allowed the purser to use his own judgment as to what extent the passengers should be informed. In retrospect, the element of crew coordination could have been exercised better by the captain through more efficient utilization of the navigator. If the navigator had been sent to the cabin earlier, with more definite instructions than the captain's remark to go see if he could help out – (Ref. 2), the captain could have extended his command responsibility into the cabin despite the lack of intercom capabilities. This would have relieved the purser from a decision-making process for which he was inadequately prepared.

As previously pointed out, survivability in emergency landings, all other factors being equal, is primarily dependent on the proper preparation of the occupants for that landing and knowledgeable, well-trained crewmembers who make authorative decisions and maintain discipline, both before the emergency and after it, during the evacuation and while awaiting rescue. These are points to be stressed in the training of crewmembers.

(c) Crew Composition

Not only was the cabin crew employed by a different company than the flight deck crew, they were of different nationalities. Although there was no language barrier, procedures taught in training were different possibly because of different needs, philosophies and operating conditions of the two companies. A certain amount of standardization is established in training among U. S. air carriers, due to the requirements of the FAR's. Similar standardization may not be expected, however, between U. S. air carriers and foreign operators because of the existence of different regulations and safety philosophies. An outstanding example is the method of signaling impending impact as a procedure at ALM as opposed to ONA's procedure. The only method recognized by ALM is that the captain will give the commands: "Emergency Stations" and "Safety Positions," meaning that the cabin crew and passengers should take their emergency positions and brace for impact, respectively. Despite conflicting information in the handbooks, the generally accepted ONA procedure was to sound the chimes by activating the NO SMOKING - FASTEN SEATBELT sign several times. Since the cabin crew was not familiar with this method, it could not have conveyed the intended meaning to them even if they had heard chimes and seen the signs.

The lack of positive instructions from the captain caused at least five survivors and one stewardess to be without seatbelt restraint at the time of impact. It is reasonable to assume that

some of the nonsurviving passengers were similarly affected.

2. *The Ditching*

(a) Aircraft Dynamics

The direction of the inertial resultant of body acceleration was forward and down with a slight lateral vector to the left for those occupants seated forward of the aircraft's center of gravity and forward and up for those seated aft of the center of gravity. Although the magnitude of deceleration cannot be calculated accurately because of such unknown factors as stopping distance, structural collapse and uniformity of deceleration, an estimate may be made based on the probability that seat failures occurred and the facts that passengers were thrown forward for a considerable distance and typical crash force-induced injuries were incurred.

Assuming a uniform deceleration from 100 m.p.h. to zero without structural compromise to the fuselage, a stopping distance of 50 feet will produce a mean g level of 6.8 g's over a time span of 0.68 seconds. Since this computed mean value represents a rectangular crash pulse, however, and the actual crash pulse would be triangular in shape, the peak g value would be in the order of 13.5g's or about twice as large over the same time span.

Considering that most seats apparently remained attached to the floor structure, the forces which were generated must have been lower than, but approaching the ultimate seat design strength of, 9 g's forward, 1.5 g's sideward, 2 g's upward and 4.5 g's downward multiplied by a safety factor. It is estimated, therefore, that the magnitude of the deceleration may have been in the order of 8 to 12 g's applied over a time period of 0.5 to 1.0 seconds and that the aircraft came to a stop in 50 to 80 feet. The value for this stopping distance must be assumed to be the distance that the aircraft traveled after its fuselage became immersed in the water. It is not necessarily the total distance that the aircraft was in contact with the water.

(b) Occupant Dynamics

The pilot and copilot had fastened their shoulder harnesses prior to impact and both inertia reels locked after a few inches of travel of the straps. (The inertia reels are usually set for 2½ g's or approximately 80 feet per second/second, measured by means of the rate of travel of the straps due to upper torso displacement.) The cabin crew and the navigator were without restraint at impact.

It is of interest to note the absence of injury incurred by the cockpit crew and the three aft-facing crew in the cabin as opposed to the variety of injuries sustained by the majority of the passengers. Both pilots had maximum restraint available in the form of seatbelt and locked shoulder harness which prevented the upper body from rotating forward during the deceleration. The aft-facing, seated cabin crew had a form of maximum body support from cabin structure. As a result, the decelerative forces were distributed uniformly across the upper body. Conversely, the passengers, restrained by a seatbelt only, were subjected to violent forward displacement of the upper torso at impact allowing the head to come into contact with the seat in front and the chest to come into contact with the thighs and knees. Additionally, flexure of the spinal column during this movement resulted in spinal injuries which constituted the predominant type of injury to the survivors of this accident.

When comparing the currently used restraint systems in transport aircraft with the type of support afforded the three rearward facing crewmembers, it appears that aft-facing occupants have a better chance of impact survival since the decelerative loads are more uniformly distributed over the body.

Considerable research has been done over the last 25 years on the subject of forward- versus rearward-facing seating in aircraft. The consensus has been that adequately stressed rearward-facing seats offer a form of maximum body support with a minimum of objectionable restraint in air carrier operation. Economic considerations and passenger acceptance have been

the major drawbacks in considering the implementation of this safety concept. The injury pattern noted in this accident, however, offers further proof of the protective qualities of this full body support concept. (Ref. 8, 9, 10, 11.)

As reported earlier, the stewardess and at least five passengers were unrestrained at impact and were thrown varying distances forward. Several survivors commented in questionnaires and interviews on their observation of a pile of people and seats in the forward section of the aircraft near the left cabin bulkhead at seats 1A&B. Estimates ranged from four to 15. Two survivors recalled being thrown forward and having to push away other passengers in order to extract themselves from this pile. At least seven passengers were thrown from their seats despite having their belts fastened.

It is fairly certain that disabling injuries were sustained by a number of the fatalities due to their being thrown forward or being hit by other unrestrained passengers. More than half (12) of the fatalities were located in the first six rows of seats in the aircraft, and seven of these were seated on the left side of the cabin.

(c) Equipment Failures

Passenger Seats

It is believed that the first three double seats on the left side of the cabin failed. These failures probably were caused by a combination of overloads caused by the crash forces, by other passengers being thrown forward, and by the compromising of the floor structure due to hydrokinetic forces when the bottom of the aircraft gave way upon water impact. Failure of the fuselage bottom was observed by one of the crew when the aircraft sank, and the fact that baggage and aircraft equipment were released from the various baggage holds would indicate such failure. (This also may have been the cause of the jamming of the forward main entrance door and the cockpit access door.)

One of the major requirements for impact survival of occupants is that they remain restrained and, in so doing, closely participate in the deceleration of the environment. Seat failure negates the effect of the seatbelt and allows the occupant to come into forcible contact with environmental structure. Accident investigations have shown that such failures have been directly responsible for occupant injuries and fatalities in otherwise survivable impacts (Ref. 8, 19). Since tolerance of the human body to crash-induced deceleration with optimum restraint exceeds the minimum strength requirements of present day aircraft seats by a factor of "5" in a longitudinal direction (Ref. 15), it seems only reasonable that seat tiedown requirements should be based on criteria other than those listed for emergency landing conditions in 14 CFR 25.561. Since the forward- facing passenger is restrained only by a seatbelt in air carrier operations, human tolerance limits to this type of restraint appear to be the more suitable criteria. The literature on this subject shows that an average of 15 to 20 g's can be tolerated without debilitating injury (Ref. 12, 13, 10, 16).

Seatbelts

Seven instances of seatbelt failures were reported in this accident. Failure of seatbelts to restrain passengers has been reported in accidents and incidents on several other occasions. These occurrences invariably were associated with the so-called fabric-to-metal locking mechanism, where one half of the belt is inserted underneath a spring-loaded lever attached to the other belt half. Serrations on an off-center cam of this lever press into the fabric, providing the locking capability. Tension applied to the belt loop will tend to rotate the cam which in turn presses the serrations deeper into the fabric because of their eccentricity.

It has been found that a variety of conditions may allow slippage of this type of safety belt. The primary cause of slippage is attributed to the wear of the serrations due to repeated use of the belt, which tends to round the edges of the serrations. Secondly, the spring tension of the lever is an important aspect of the proper operation of the buckle. The condition of the webbing material is a third consideration. It may become soiled with repeated handling and hard with age. Apart from these mechanical

deficiencies, improper use of the belt, inadvertent lifting of the lever by the user, as well as the magnitude of the onset rate of the applied force, may well be additional factors in these belt failures.

The demonstrated inadequacy of this type of locking mechanism as opposed to the reliability of the metal-to-metal buckle raises serious doubt as to its suitability in aircraft due to the potential lack of crashworthiness inherent in the design.

Galleys

The contents of the forward-facing galley unit were spilled on the floor at impact, despite the fact that the steward had secured the bins, ovens, and coffee maker in preparation for the ditching. The failure of the locks of the galley to retain these items has been observed in many survivable accidents (Ref. 20). It is believed that rapid, oscillating accelerations occur during a crash which unlock galley security devices and that the items contained in these devices are then ejected by additional accelerations.

Although the locations of galleys differ in various aircraft models, their position in most aircraft is invariably associated with an emergency exit. Spillage of large items such as bins, drawers and ovens can seriously impede movement through the area during emergency evacuation situations. In this accident, equipment not only obstructed the exit passage, but also hampered ready deployment of the liferaft package.

3. *Postditching Aspects*

(a) Evaucation Time

When the aircraft came to a stop, the first officer was instructed to go to the cabin. He found the cockpit door jammed, however, and returned to open his side window. Again, the captain told him to go to the cabin and physically helped him through the partially opened door. When the captain turned to retrieve his lifevest from his seat, he heard the raft inflate in the galley area. The interval between the time the first officer left his seat and inflation of the raft is estimated to have been less than 1 minute.

The captain exited through his side window after donning his lifevest and swam to the left wing. One minute is estimated for this activity. He tried to open the forward overwing exit which was blocked by a seat back. He then opened the rear overwing exit and helped one passenger out of the aircraft. He moved the seat back obstructing the forward exit and aided another passenger out of the aircraft. Two to 3 minutes is estimated for this sequence of events.

Since the captain did not observe anyone else in the aircraft when he removed the two passengers, the other survivors therefore must have exited the aircraft within this time span of 2 to 3 minutes. The captain then swam away with the two passengers and when he turned around, he saw the aircraft sink. Estimating another minute to help the two passengers and swim a short distance, it is estimated that the aircraft remained afloat for not more than 5 or 6 minutes.

(b) Evacuation Pattern

Thirty-one passengers probably evacuated through the aft right overwing exit which was opened by the passenger sitting next to it. It was fortunate that this passenger made it a practice to sit next to an exit and that he was mentally prepared for action in case of an emergency. The single large opening created by the removal of the exit window became a focal point which attracted immediate attention in the subdued lighting of the cabin. It demonstrates the value of having knowledgeable persons seated at these strategic positions in case of emergencies. The importance of properly briefed and informed passengers cannot be overstated since this was the only emergency exit opened from within the cabin (with the exception of the galley door which was not visible from the passenger compartment), despite the fact that passengers were seated next to the two overwing exits on the left side of the aircraft.

The galley service door was utilized by the navigator, copilot, purser, steward and at least two passengers. This exit was probably blocked by inflation of the liferaft within 1 minute after

this door was opened, and probably remained unuseable throughout the time the aircraft was afloat. The right aft overwing exit remained the only immediately available exit until the captain opened the exits on the left side. The two additional passengers, aided by the captain, egressed by this means after the remainder of the survivors had evacuated.

(c) Crew Actions

The navigator and the two cabin attendants found it impossible to launch the liferaft package. They tried individually and collectively to move the raft but found it jammed in some manner. Despite the weight of the raft package, it seems unlikely that the bins from the galley would impede movement of the raft. The only reasonable explanation is that the galley structure was displaced during the impact and impinged on the raft container and possibly on the inflation lanyard.

It was noted that all three of the crewmembers concentrated on the raft in the galley despite the fact that the emergency stations of the navigator and the steward were the overwing exits. Four additional liferafts were available in storage compartments in the overhead racks at these locations. It seems only human nature to be preoccupied with the equipment closest at hand under the pressures of the emergency situation. Additionally, the navigator was unfamiliar with the DC-9, having had no specific training on this type of aircraft, and the steward was not accustomed to flying in aircraft with liferafts aboard, since ALM does not carry them as part of their DC-9 equipment. If these two crewmembers had covered their respective emergency stations after the aircraft came to a stop, the survival situation might have been improved considerably.

Training deficiencies must be cited for the confusion that took place in the galley area, and also as the reason that the navigator and both cabin attendants concentrated on the one item of survival equipment immediately available. It was noted that evacuation drills were not conducted as a part of the training given to the crewmembers, nor was an opportunity provided to go through an entire wet ditching drill wherein crewmembers could handle the equipment under the actual environmental conditions for which it was designed. The importance of such training is recognized by the military in that flying personnel of the United States Air Force and United States Navy are required to go through a wet-ditching drill once every year. Schools are provided by the Air Force, Navy and Coast Guard for this purpose. Such drills are made as realistic as conditions permit. Survival schools are also provided where training is given in great detail. Some of the major air carriers also maintain facilities to train their personnel in these emergency procedures. The value of this training lies in the fact that personnel not only learn the importance of covering their assigned stations, but that they recognize their role in the overall survival process, as well as the role the other crewmembers play. Concurrently, such training provides personal knowledge and familiarity with the equipment with which they must work. Since accidents of this type are fortunately very infrequent, it is considered all the more desirable and necessary to afford frequent drills in order to maintain crewmember proficiency. It can not be overstated that crew training and leadership are very significant factors in the survival of occupants during emergencies. References 5 and 6 contain excellent examples of the final outcome of ditchings when these qualities are involved.

(d) Equipment

Two important factors combined to minimize the loss of lives after the aircraft was evacuated: (1) the leadership exhibited by the crewmembers in rounding up many of the survivors; and (2) the deployment of the evacuation slide which served as a rallying point to them. Several survivors, especially those who were unable to swim, made no attempt to reach the slide, however, and drifted considerable distances. If the slide had not been available, dispersion of survivors is likely to have been much greater. Such dispersion not only would slow the rescue operation, but also would

decrease the chances of locating all survivors. In light of the above, some form of large flotation device is considered vital in increasing survival chances and the ALM instruction to detach the slide before ditching is a commendable procedure in this regard.

The slide-raft combination, which is under development, would have afforded at least one raft if it had been installed in this aircraft. In part, the value of this device stems from a measure of automation that would be introduced into the heretofore manual operation of preparing, launching and boarding of survival equipment. The cumbersome and time-consuming methods and operation of survival gear have not kept pace with the increasingly automated environment in which it is used. Because modern aircraft have larger fuselage openings when exits are removed and lower sill clearances than the older reciprocating equipment, the possibility exists that modern aircraft have a decreased flotation time. Therefore, it seems imperative that newer automated equipment be introduced on an accelerated basis to decrease the time necessary for evacuation of the aircraft and the boarding of the liferafts.

Problems with the lifevests were many. Initially, there were difficulties with obtaining and donning the vests. In the water, passengers could not find the controls for vest inflation and experienced difficulties in adjusting the straps. It was clear that the operation of this flotation device was not understood by many passengers despite two recent demonstrations. This would indicate that either the briefings were inadequate or the vest operation is too complicated. Almost all survivors complained about the restrictive feeling of the inflated tubes around their necks and cheeks. They stated that this tended to restrict proper breathing. In spite of this condition, most survivors also stated that the position of the vest at the head gave them an insecure feeling because they felt their head would slip out of the rings, thereby removing their only means of flotation. As is the case with liferafts, lifevest design, as currently used in air carrier operation, has not changed significantly during the last few decades. Renewed efforts in simplified operation and increased comfort of life vests are needed.

VI SECTION D
CONCLUSIONS AND RECOMMENDATIONS

The outcome of this ditching was determined largely by faulty judgment on the part of the cockpit crew, inadequate training of the entire crew, and functional failure of equipment. Additional lives could have been saved in this accident; the controllable factors influencing survival as well as non-survival are contained in the following conclusions:

1. *CONCLUSIONS*

1. The pretakeoff briefing, which is required to acquaint passengers with the emergency provisions of the aircraft, was inordinately short, a statement of facts rather than a briefing, and it left the initiation of action to the passengers.
2. The preditching briefing was incomplete in that the passengers were not informed about the various emergency provisions on the aircraft. This was as a direct result of the failure of the cockpit crew to inform the cabin crew adequately about the urgency of the situation.
3. The briefing outline regarding the lifevests was inadequate: despite two recent demonstrations, the passengers were unfamiliar with the location, the storage method and the packaging of the lifevests, and considerable difficulty was experienced in donning the lifevests. This reduced the effective use of the available time for passenger preparation.
4. The entire crew had received standard training; despite this fact, the cockpit crew exhibited inadequate knowledge of the critical actions necessary in the

preparation for a water landing, and did not exert its command responsibility. The cabin crew exhibited less than efficient management in the cabin preparation as a result of dissimilar training and experience.

5. Unfamiliarity of the entire crew with each other and the use of dissimilar safety procedures and methods resulted in conflicting actions.
6. The aircraft went through the ditching dequence without significant structural compromise to the occupiable areas. The forces generated were estimated to have been in the order 8 to 12 g's applied over a time period of 0.5 to 1.0 seconds.
7. Analysis of the dynamics of occupants indicates that the high proportion of fatalities in this accident was due to disabling injuries which were caused by a combination of unrestrained passenger's being thrown forward, by failures of seats, and by slippage of a number of seat belts.
8. Adequately stressed aft-facing seats probably would have greatly diminished the injuries sustained in this accident by virtue of the increased body support offered through such an arrangement.
9. The forces generated during the water impact approached the 9 g design strength of the seats and were a factor in their failure. Since impact tolerance of the human body, when restrained by a seatbelt only, has been established on the order of 15 to 20 g's, the failure of seats at the 9 g value exposes occupants to serious and unnecessary injuries.
10. At least seven instances were reported wherein the seatbelt failed to restrain its user. Slippage of the "fabric-to-metal" belt has been found in other accidents and this condition is indicated in this accident. The demonstrated inadequacy of the locking device raises serious doubt as to its suitability as a restraining device.
11. The contents of the galley were spilled during the deceleration of the aircraft which blocked ready access to the raft package as well as the emergency exit at that location. Spillage of drawers and bins has been observed in many other accidents, indicating that the locking devices on these items are unreliable.
12. Through analysis of the movements of the captain, it is estimated that the aircraft floated for approximately 5 to 6 minutes after landing on the water and that most survivors had evacuated the aircraft within 2 to 3 minutes.
13. The value of seating knowledgeable persons next to emergency exits was demonstrated when a passenger, who made it a practice to prepare himself for any eventuality, promptly opened the aft overwing emergency exit. This opening served as a focal point for other passengers and allowed at least 31 persons to evacuate the cabin through this exit.
14. The navigator and the two male cabin crewmembers were unable to move the life raft package after the aircraft came to a stop. Weight of the package is not considered a likely factor to explain this difficulty. The only other plausible explanation is that the galley structure shifted during impact and impinged on the raft container, thus retaining it in its original position.
15. The navigator and the steward should have proceeded to the overwing exit area and directed passenger evacuation after the aircarft came to a stop. Inadequacy of training is cited for their failure to do so in that no evacuation drills were given as part of their training, and neither of them was intimately familiar with the survival equipment

because wet ditching drills had not been a part of their training curriculum.

16. Additional lives could possibly have been saved if crew leadership had been exhibited within the aircraft to the degree such leadership was shown while the survivors were awaiting rescue.
17. The loss of all liferafts on board the aircraft probably affected the survival of several passengers. If the evacuation slide had not been deployed and used as a rallying point, additional lives might have been lost because of dispersion of the survivors.
18. If a slide-raft combination had been installed in this aircraft, at least one raft might have been available without the necessity to deal with the cumbersome and time-consuming method of launching and boarding the raft. The slide-raft combination offers a measure of automation which should facilitate the tasks of the cabin attendants.
19. Lifevests were found to be restrictive around the neck and gave the passengers a low level of confidence regarding retention. In addition to the difficulties in donning the vests, the passengers had considerable problems finding inflation and adjustment controls.

RECOMMENDATIONS

Several recommendations resulting from the investigation of the ditching of ONA Flight 980 have already been made to the Federal Aviation Administration. These recommendations and the FAA's responses were included in the Safety Board's Accident report released on June 15, 1971. A more recent status report concerning these recommendations was provided by the FAA in a letter dated June 29, 1971, a copy of which is included in this report as Appendix 3.

A number of new recommendations are made as a result of this special study. The first recommendation pertains to cabin galleys. The Safety Board has been monitoring FAA's efforts to solve the problem of security of galley parts under crash conditions. Following the ONA accident, the FAA initiated a project to survey and analyze the extent and nature of the problem. It is the Board's understanding that as a result of this project, the FAA is planning to issue an NPRM to modify FAR Part 25 to require a fail-safe primary locking system or a secondary locking system for subunits of the galley structure. However, such a regulation, under Part 25, would not apply retroactively to aircraft already certificated by the FAA.

Recommendation one below reflects the Board's belief that the galley unit security problem should be corrected on currently certificated aircraft as soon as possible.

Recommendations two, three, and four are repetitions of recommendations previously made in the Board's accident report. This has been done to emphasize the Board's continued concern in these areas of safety.

As a result of the conclusions reached in this study, the Safety Board recommends that the Federal Aviation Administration:

1. Expand and accelerate its investigation of the failure mode of galley drawers, bins, ovens, etc., with a view towards elimination of such failures in current aircraft, as well as in future aircraft.
2. Reexamine the applicable Technical Standard Order governing the design and manufacture of lifevests with a view towards development of more comfortable, standardized, and less complicated lifevests for use in air carrier aircraft.
3. Expedite the development of the slide-raft combination and require installation of this device on all U. S. air carrier aircraft at an early date.
4. At its earliest opportunity, act upon a recommendation made previously by the Board regarding the metal-to-fabric seatbelts, to eliminate their use in aircraft of U. S. registry in favor of the

metal-to-metal type of seatbelts with a standardized actuating device.

5. Amend FAR Part 129, "Operations of Foreign Air Carriers," to include the safety provisions of Subpart T of Part 121 governing the briefing of passengers, or include these provisions in the operations specifications issued to foreign air carriers by the Administrator and require that approved wording for such briefings be included in the appropriate flight/operations manuals of the applicable crewmembers.

6. Collaborate with the Air Transport Association in the development of more effective methods for conveying safety information to passengers. Research should be conducted in the application of communication techniques, behavioral sciences, and optimum learning situations. The recent advances in audio-visual techniques should also be explored.

7. The FAA establish requirements for intercarrier crew compositions to assure that adequate training and standardization of emergency procedures have been accomplished in all facets of the operation.

8. The FAA expedite its reevaluation of FAR Part 25.561 regarding design strength requirements for aircraft seats and other cabin equipment. The Board regrets that the FAA did not incorporate the increased strength requirements proposed in NPRM 69-33 into the Federal Aviation Regulations. The Board is of the opinion that new materials and design techniques in the aerospace industry, combined with the known tolerance limits of the human body to decelerative forces and the recurring failure of furnishings in aircraft accidents justifies an increase in these strength values.

9. Require periodic crew training in evacuation and wet ditching drills.

10. The Air Transport Association collaborate with foreign carriers, through the International Air Transport Association, in the standardization of methods for conveying safety information to passengers.

11. All air carriers make a critical review of their crew training practices and materials with a view toward expanding their training in the areas of crash survival and crew leadership and ensuring adequate retention of such knowledge.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

April 5, 1972

TABLE OF INJURIES

Occupant and degree of Injury	Head	Upper torso	Lower torso	Upper extremities	Lower extremities	Spinal	Remarks
Pilot, none	–	–	–	–	–	–	Seatbelt and shoulder-harness
Copilot, none	–	–	–	–	–	–	Seatbelt and shoulder-harness
Navigator, minor	–	–	–	–	chipped patella	–	Aft-facing, no restraint
Purser, none	–	–	–	–	–	–	Aft-facing, no restraint
Steward, none	–	–	–	–	–	–	Aft-facing, no restraint
Stewardess, fatal	Unknown injury detail						Standing in aisle, no restraint
1 A fatal	Unknown injury detail						
1 B fatal	Unknown injury detail						
1 C serious	–	–	–	–	–	anterior compression fracture T-12 & L-1	Thrown free into galley area, Seatbelt fastened
1 E serious	–	–	muscle strain lower back; seatbelt bruise	–	bruises	fractures transverse processes L-2 & L-3 left	
2 A fatal	Unknown injury detail						
2 B fatal	Unknown injury detail						
2 C fatal	Unknown injury detail						

TABLE OF INJURIES

Occupant and degree of Injury	Head	Upper torso	Lower torso	Upper extremities	Lower extremities	Spinal	Remarks
2 E fatal	Unknown injury detail						
3 A fatal	Unknown injury detail						
4 A serious	concussion; contusions	fractures 7th & 8th rib left	bruises	contusion right hand	muscle strain left leg and foot	–	Thrown to row 1 No seatbelt
4 B minor	–	chest pains: neck bruises	lumbosacral sprain seatbelt bruise	ecchymosis & hemetoma both arms	bruises	–	
4 E serious	–	hairline fracture of rib; muscle strain chest	–	–	–	unspecified spinal injury	
5 A fatal	Unknown injury detail						
5 B fatal	Unknown injury detail						
5 D minor	–	–	seatbelt bruises	–	–	–	
5 E minor	–	–	seatbelt bruises	–	bruised knee	–	Struck submerged wing when exiting
6 B serious	unknown	fractured ribs	unknown	unknown	unknown	unknown	Thrown to row 1 Seatbelt fastened
6 C fatal	Unknown injury detail						Child
6 D fatal	Unknown injury detail						
6 E fatal	Unknown injury detail						Child

TABLE OF INJURIES

Occupant and degree of Injury	Head	Upper torso	Lower torso	Upper extremities	Lower extremities	Spinal	Remarks
7 A minor	–	–	muscle strain sacro-lumbar region; seatbelt bruise	–	–	–	
7 D serious	–	–	–	–	–	narrowing disk L-4/5	
7 E minor	–	–	–	–	–	minimal narrowing disk L-5/S-1	
8 A serious	lacerations	fracture left clavicle	unknown	unknown	unknown	unknown	Thrown free Seatbelt fastened
8 B fatal	Unknown injury detail						
8 D	Unknown injury detail						
8 E	Unknown injury detail						
9 C minor	–	muscle strain neck & shoulders	muscle strain	laceration & bruises	lacerations	–	
9 E fatal	Unknown injury detail						Thrown free Seatbelt fastened
10 A serious	–	–	–	–	–	anterior compression fracture L-1 (cord injury)	Thrown free No Seatbelt
10 B serious	concussion; eye injury	bruises	contusions lower back	–	–	–	Thrown free Seatbelt fastened
10 D fatal	Unknown injury detail						Was seen alive inside aircraft
10 E serious	–	multiple bruises fractures 8th 9th, 10th rib right side	& contusions	lacerations left hand	–	–	Possibly thrown free Seatbelt loosely fastened

TABLE OF INJURIES

Occupant and degree of Injury	Head	Upper torso	Lower torso	Upper extremities	Lower extremities	Spinal	Remarks
11 C serious	–	fractures 8th 9th, 10th rib right side	–	–	–	anterior compression fracture L-3	
11 E none	–	–	–	–	–	–	
12 A serious	–	–	–	avulsion fracture right greater tuberosity	–	anterior compression fracture T-12	Thrown free Seatbelt fastened
12 B serious	–	–	–	–	–	–	Severe pulmonary edema
13 A serious	–	–	–	–	–	disrupted disk C-7/8	
13 B fatal	Unknown injury detail						
13 C minor	–	–	muscle strain lower back; seatbelt bruise	bruises and lacerations		–	Thrown free No seatbelt
13 E serious	concussion; broken tooth	fracture 6th, 7th rib, left	seatbelt bruise	bruises and lacerations		–	
14 A minor	laceration right eye; bruises	–	–	muscle strain right arm bruises and lacerations		–	Thrown free No seatbelt
14 B fatal	concussion; contusions & hematomas of scalp; multiple contusions & abrasions face; avulsed lip; broken incisor left upper	–	–	abrasions and contusions left lower arm and hand	–	–	Dead on arrival Cause of death: asphyxia due to drowning; Thrown free No seatbelt

TABLE OF INJURIES

Occupant and degree of Injury	Head	Upper torso	Lower torso	Upper extremities	Lower extremities	Spinal	Remarks
14 C none	–	–	–	–	–	–	
14 D serious	–	–	–	–	–	fracture dislocation L-1 & L-2	
14 E fatal	Unknown injury detail						Thrown free Seatbelt fastened
15 A	Unknown injury detail						
15 B fatal	Unknown injury detail						
15 A serious	concussion	depressed fracture of sternum; fracture 2nd rib right and 2nd & 3rd rib left.	–	–	–	anterior compression fracture T-4	Thrown free No seatbelt

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

APPENDIX II

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

C
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Y

29 JUN 1971

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D.C. 20590

Dear Mr. Chairman:

As you know, the Federal Aviation Administration pursues a continuing program effort to reassess in light of service experience and revise as necessary the various safety criteria for civil aircraft. In this regard, we have reviewed the advance copy of Report NTSB-AAR-71-8 pertaining to the 2 May 1970 accident near St. Croix, Virgin Islands, involving the Overseas National Airways, Inc., DC-9, which you submitted to this office with your letter of 7 June 1971. Since a number of the recommendations contained in the report are encompassed within the existing program, we have reviewed the recommendations with respect to the program objectives and the background information contained in the report.

Letters cited in Appendices E through I of the report summarize views of the Federal Aviation Administration on your various recommendations as of the latter part of 1970. Since that time, further action has been taken as indicated below.

An air carrier operations bulletin was issued 20 October 1970 directing operations inspectors to ascertain that all air carriers under their jurisdictions have incorporated in each ditching checklist a "warn passengers" item appropriate with the intent expressed in your recommendation.

A regulatory project regarding public address systems for airplanes operated under Federal Aviation Regulations Part 121 has been established.

The field investigation of lifevest stowage provisions has been completed on numerous typical air carrier aircraft currently in service. The results of the investigation are being used in our current work on survival equipment standards.

A study has been underway regarding seat belts, with particular emphasis on the problems of buckle fastening as mentioned in your report and letters. The objective is a revision of the Technical Standard Order for seat belts as appropriate in light of service difficulties and advances in technology.

The information you provided on safety belt deficiencies in the Capitol Airways DC-8 accident and the Champion Citabria acrobatic airplane have been included in the analysis. In regard to the DC-9 ditching, other than the statement on page 7 that at least five passengers did not have their seat belts fastened at impact, we find little mention of seat belts in Report AAR-71-8. As our 21 October 1970 letter indicated, any additional information you may have on metal-to-fabric buckled belts would be very useful.

Reassessment of life rafts, life preservers, and individual flotation devices has been initiated with the objective of upgrading Technical Standard Orders in light of more recent advances in technology. In addition, considerable work has been accomplished on standards for the new combined inflatable emergency evacuation slide-life rafts.

Guidelines for approval of these slide/rafts have been developed and manufacturers are pursuing designs for existing airplanes. The door-mounted slide/rafts should overcome a number of problems normally encountered during the launching of conventional life rafts. This work is being directed toward in-service airplanes as well as airplanes of new design.

Sincerely,

/s/J. H. Shaffer
Administrator

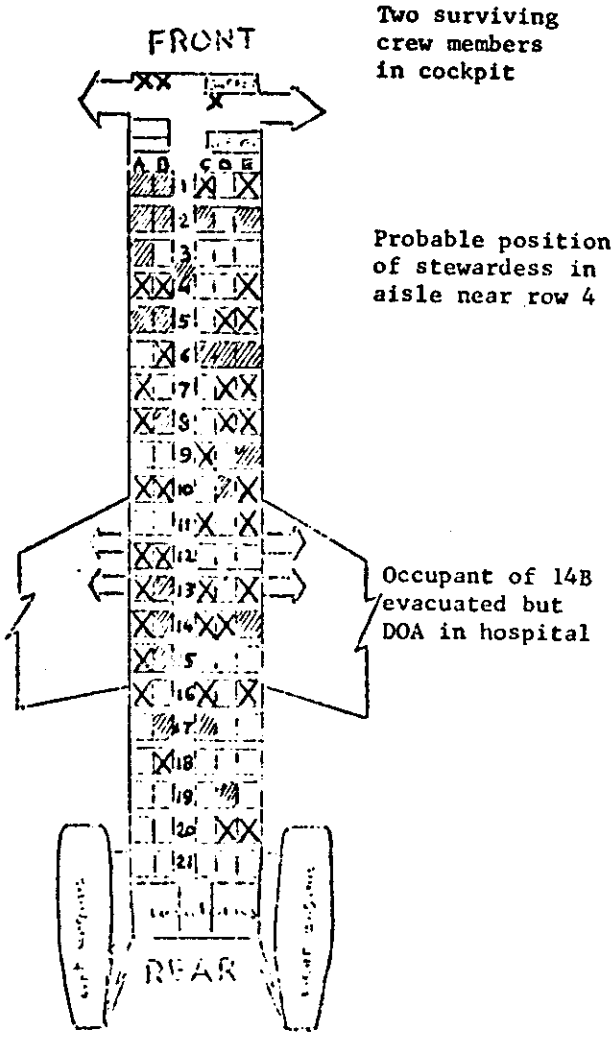
APPENDIX III

LEGEND:

⇨ -- EXIT

⊠ -- SURVIVOR

▨ -- FATALITY



DC-9 SEATING DIAGRAM

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