SA-NONE

FILE NO. B-0001

AIRCRAFT ACCIDENT REPORT

SCANDINAVIAN AIRLINES SYSTEM
McDONNELL - DOUGLAS DC-8-62, LN-MOO
(NORWEGIAN REGISTRY)
IN SANTA MONICA BAY
NEAR LOS ANGELES, CALIFORNIA

JANUARY 13, 1969

Adopted: JULY 1, 1970

NATIONAL TRANSPORTATION SAFETY BOARD
Bureau of Aviation Safety
Washington, D. C. 20591

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Report Number: NTSB-AAR-70-14

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SYNOPSIS

A Scandinavian Airlines System, Douglas DC-8-62, LN-MOO, of Norwegian Registry, crashed in Santa Monica Bay, approximately 6 nautical miles west of the Los Angeles International Airport, Los Angeles, California, at approximately 1921 P.s.t., January 13, 1969. The aircraft was operating as Flight SK-933 from Seattle, Washington, to Los Angeles, California, following a flight from Copenhagen, Denmark. A scheduled crew change occurred at Seattle for the flight to Los Angeles.

The accident occurred in the waters of Santa Monica Bay while the crew was attempting an instrument approach to Runway 07R at Los Angeles International Airport. Of the 45 persons aboard the aircraft, 3 pesengers and 1 cabin attendant drowned; 9 passengers and 2 cabin attendants are missing and presumed dead; 11 passengers and 6 crewmembers including the captain, the second pilot, and the systems operator, were injured in varying degrees; and 13 passengers escaped without reported injury. The aircraft was destroyed by impact. The fuselage broke into three pieces, two of which sank in approximately 350 feet of water. The third section including the wings, the forward cabin and the cockpit, floated for about 20 hours before being towed into shallow water where it sank. This section was later recovered and removed from the water.

The weather at Los Angeles International Airport wae generally: 1,700 feet broken, 3,500 feet overcast; visibility 4 miles in light rain and fog; wind 060° at 10 knots; and the altimeter setting was 29.87 inches of mercury. The weather in the accident area was reported to be similar.

The Board determines that the probable cause of this accident was the lack of crew coordination and the inadequate monitoring of the aircraft position in space during a critical phase of an instrument approach which

resulted in an unplanned descent into the water. Contributing to this unplanned descent was an apparent unsafe landing gear condition induced by the design of the landing gear indicator lights, and the omission of the minimum crossing altitude at an approach fix depicted on the approach chart.

As a result of the investigation the Board developed recommendations concerning DC-8 failed indicator bulbs, altimeter setting procedures, and approach plate legends.

1. INVESTIGATION

1.1 History of the Flight

A Scandinavian Airlines System, Douglas DC-8-62, LN-MOO of Norwegian Registry, crashed in Santa Monica Bay, approximately 6 nautical miles vest of Los Angeles International Airport, Loa Angeles, California, at approximately 1921 P.s.t., January 13, 1969. The aircraft was operating as Flight SK-933 in regularly scheduled international passenger service from Copenhagen, Denmark, to Lor Angelee, California, with an en route stop and scheduled crew change at Seattle, Washington.

Of the 45 persons aboard the aircraft at the time of the accident, 4 drowned, 11 are missing and presumed dead, 17 were injured, and 13 reported no injuries. The survivors included the captain, the second pilot, and the systems operator.

The aircraft was destroyed by impact. The fuselage broke into three pieces, two of which sank in approximately 350 feet of water. The third section including the wings, the forward cabin, and the cockpit floated ror a considerable time after the accident. This portion of the aircraft vas towed into shallow water and sank approximately 20 hours after the accident. Pais portion was later recovered and removed from the water.

The captain of the flight into Seattle reported a routine flight which terminated with an ILS approach to Seattle. Be used the autopilot coupler down to approximately 200 to 300 feet above the grounh and, at that point, he disconnected the coupler and completed the approach manually. There were *only* three maintenance discrepancies on the aircraft an4 they were entered in the aircraft log. These discrepancies were: (1) inoperative fast-slow airspeed function on the captain's attitude director indicator; (2) low oil quantity on the No. 1 engine; and (3) some inoperative lights in e lavatory.

The crew that was involved in the accident had flown a trip into Seattle from Copenhagen on January 11, 1969, and had approximately 48 hours' rest prior to going on duty on January 13, 1969.

The SAS Los Angeles office, under the operation control of Stockholm, Sweden, dispatched SK-933 from Seattle to Los Angeles. The two dispatchers involved in this dispatching were properly certificated by the appropriate regulatory agencies.

The first dispatche. came on duty at 1000 P.s.t. [1/], January 13, 1969. He received a personal weather briefing from the Weather Bureau office at Los Angeles International Airport and reviewed the Service "A" teletype

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1/ All times in this report will be Pacific standard time, unless otherwise designated. The 24-hour clock will be utilized.

report before he prepared the flight plan data for SK-933. At about 1010, he picked up the 0000Z 300 millibar (MB), Tropopause Chart, the significant weather chart, and the latest available forecasts for Seattle, Los Angeles, and alternate airports.

Using this weather information, the dispatcher prepared the flight plan information for SK-933 from Seattle to Los Angeles with Las Vegas, Nevada, as the planned alternate. He calculated that the average wind correction angle would be /9° and the average speed correction value would be -50 knots. Eo temperature deviation from standard txisted and no temperature correction was applied to the flight plan.

This information, together with the fuel requirements for the flight and an extra amount of fuel because of anticipated approach delays at Los Angeles, was forwarded to the ,Seattle station agent. The dispatcher planned a computer-stored flight plan cruising at Flight Level 330 (FL330), with an estimated time en route of 2 hours and 16 minutes. The fuel required for %he flight was 22,700 kilograms (kilos) 2/ and he suggested the aircraft be loaded with 25,000 kilos of fuel to allow for possible delay in the Los Angeles area. The dispatch data, together wlth the forecast weather at Los Angeles, was forwarded with a dispatch release at 1135. The Los Angeles forecast was: 3,000 feet overcast, visibility 5 miles in haze and smoke, occasional 1,500 feet broken, visibility 2 miles in rain and fog.

At 1330, the dispatcher sent a message for the captain of SK-933 which stated tr-t pilots had reported a solid overcast from 17,000 feet down to 9,000 feet, wlth rime icing from Bakersfield to Los Angeles.

The crew arrived at the Seattle/Tacoma Airport approximately 1 hour before the scheduled departure time. They were provided with the dispatch release, the weather folder, the load sheet, and the flight plan. The captain accepted the flight plan and dispatch release.

The crew completed their preflight checks with no discrepancies noted. This check included the stall warning system, autopilot system, flight controls, trim systems, and the altimeters. The previously mentioned write-ups were noted to be in the aircraft logbook.

when the refueling had been completed, the aircraft required deicing due to snow on the wings. The deicing procedure was accomplished and the systems operator verified the deicing procedure from the cabin.

After deicing was completed, the engines were started with no discrepancies noted. The pressure altimeters were set and cross-checked, and the radio altimeters set below zero for the takeoff so that the warning

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2/ 1 kilogram = 2.2046 pounds.

lights would not come on. No differences were noted between the pressure altimeter readings at this time, and they reflected the field elevation at Seattle,

The flight departed from Runway 16 at Seattle at 1546, 1 hour and 11 minutes behind schedule. The captain was occupying the left seat and the second pilot was in the right seat. The second pilot was flying the aircraft and the captain handled the communications and other duties normally assigned to the second pilot.

Following the takeoff, the flight was given radar vectors for the climb to FL310. When the aircraft climbed through 18,000 feet, the barometric altimeters were reset to 29.92 and a difference of approximately 20 feet between the altimeters was noted. The radio altimeters were set at their highest reading of 2,500 feet during the climbout. The flight was later cleared to FL330 and cruised at that altitude until entering the holding pattern at Bakersfield, California.

The autopilot was used in the climb, with the airspeed hold function used to maintain the climb attitude. None of the crew recalled any malfunction or any difficulty with the autopilot at any time during the flight.

At 1700, the second dispatcher came on duty. He was briefed on the local weather, the possibility of delay due to the approaches at Los Angeles being made on Runway 07R, and the extra holding fuel aboard SK-933. The second dispatcher assumed responsibility for the duty between 1715 and 1720.

The second dispatcher checked the weather and determined that the Los Angeles weather was suitable for the arrival of SK-933, but the nearest alternate, Ontario, California, was below minimums. The weather at Las Vegas, the planned alternate, was satisfactory.

The flightcrew contacted the Los Angeles Air Route Traffic Control Center (LAX ARTCC) and, at 1732, they were cleared to hold at the Bakersfield Very High Frequency Omnidirectional Radio Range Tactical Air Navigation Station (VORTAC) at FL330.

At 1747, the dispatcher was notified that SK-933 was holding at Bakersfield. At 1831, he received a radio call from SK-933 requesting the minimum fuel required to divert from Los Angeles to Las Vegas. He advised the crew that a diversion to Las Vegas would require 7,400 kilos of fuel, assuming a climbout from a missed approach.

Upon receipt of the 7,400-kilo fuel requirement, the captain and the systems operator calculated that they could hold about 1 additional hour before they would have to divert to Las Vegas. At this time, they had between 10,500 and 11,500 kilos of fuel remaining.

At 1839, the flight was cleared to FL180 and was holding at Fillmore. The flight was provided with an altimeter setting of 29.86, and the crew said that this setting was applied to both altimeters and the instruments were cross-checked, with no significant discrepancies noted.

At 1902, the ENR ARTCC controller issued the following clearance: "Scandinavian 933 is cleared to Los Angeles Airport via direct Fillmore, Fillmore 158 radial, to intercept and proceed via the back course ILS, cross Fillmore one one thousand cross the Ventura 100 radial at and maintain 5,000 over." The captain of SK-933 replied: ". . . cleared to Los Angeles Airport, 158 radial to the back course of the ILS, leave Fillmore at one one thousand, and 100 radial at 5,000."

The controller replied, "Ventura 100 radial, that's Westlake Intersection at and maintain five thousand," and the captain responded, "Westlake, uh, five thousand?"

The controller replied, "Roger, the Westlake Intersection is formed by the Fillmore 158 and the Ventura 100," and the captain acknowledged with "Roger."

The Westlake Intersection was not depicted on the radio facilities charts available to the crew nor on any printed radio charts, since it was a newly designated intersection.

SAS crews were not authorized to execute a back course ILS at Los Angeles, and the crew did not have an approach plate depicting this particular approach. The pilots decided to conduct a VOR approach to Runway 07R and reviewed the procedures for this approach.

While the flight was descending, the controller requested the crew to reduce their airspeed to 160 knots. The flaps were extended to reduce to this speed. This segment of the flight was flown with the autopilot engaged. The vertical speed wheel of the autopilot was used to control the descent, and the altitude preselect was used in the manual mode as a reminder of the altitude to which the flight had been cleared. The altitude preselect warning light came on as the aircraft approached preselected altitudes.

The captain described the night as black and featureless, with no ground reference. None of the flightcrew recalled seeing any ground lights during the approach.

At 1907, when the crew was requested to slow to 160 knots, the approach checklist was being performed. The flight deck crew did not agree as to how far the checklist had progressed; however, there was agreement that it was stopped for a period of time at the item relating to the radio altimeter.

The captain stopped the checklist at that point because the aircraft was above the highest altitude that would be registered by the radio altimeter, and he wanted to check the operation of this system as the aircraft descended through the 2,500-foot gate. 3/

At 1911, the flight was vectored to a heading of 180° and cleared to descend to and maintain 3,000 feet. The captain first tuned the Los Angeles VOR frequency on the No. 1 navigational receiver and then returned it to the ILS frequency. The second pilot tuned the Los Angeles VOR on the No. 2 receiver. These settings remained on the receivers until the accident. The flight director was set up by the second pilot in "radio automatic" and the selector switch set to No. 2. The inbound heading of 071° was set on the heading selector.

At 1914:10, the arrival controller issued the following clearance: "Scandinavian 935 turn left heading 080, intercept the back course, cleared back course Runway 7 right approach, and your position is, . . . 18 miles from Trout 4/." The captain replied; "OK right (sic) to zero eight zero."

At 1917, the controller transmitted, "Cardinal six seven Tango now four miles from Trout." Six seven Tango (67T) was a Cessna 177 aircraft conducting a back course ILS approach to Runway 07R.

At 1917:55, the controller requested, "Scandinavian niner three three reduce to 153 knots if able." The flight acknowledged this request.

At 1919:05, the captain called, "Approach, 933, how much longer do you want us to maintain 3,000." The controller replied, ". . . you've been cleared for the approach Scandinavian 933."

At that time, the second pilot believed that the flight was 11 or 12 DME miles from the VOR, while the captain thought it was 14 miles. The second pilot immediately disconnected the autopilot and ordered the landing gear extended.

The captain put the landing gear handle in the down position and the second pilot: ordered completion of the landing checklist; however, no action was taken in this respect because of radio traffic and cockpit activities. After ordering the gear extended, the second pilot then initiated a descent to his minimum altitude of 576 feet m.s.l. He planned his descent to be about 1,000 f.p.m., and he did not recall any "abnormal"

3/ 2,500 feet is the highest altitude (above the surface) displayed on the radio altimeter. The system operates above this height; however, the pointer remains masked from view.

4/ Trout Intereection is 4.7 nautical miles, 248" from the approach end of Runway 07R at Los Angeles. This is also the intersection of the ILS localizer and the 194° radial of the Santa Monica VOR.

sink rate. His primary flight reference instrument was the attitude indicator, with cross-checks on the vertical speed indicator, the airspeed indicator, and the altimeter.

After tie landing gear had been selected down, the nose landing gear safe light aid not illuminate, but the main landing gear safe lights were lighted. The nose landing gear unsafe light was not illuminated.

At 1919:25, the controller asked, "Cessna six aeven *Tango*, . . . what is your altitude now?" 67T replied, ". . . one thousand five hundred," and the controller replied, "Roger do you have the airport in sight yet?" 67T answered, ". . . negative."

At 1919:35, the controller asked, "Scandinavian nine three three reduce to minimum speed, what will that be?", end the captair. replied ". . . that will be one two six."

The controller directed "Okay, reduce to that. at this time if you will."

During the next 55 seconds, the controller informed the crew of 67T that they were at Trout and asked if they could increase their speed from their reported 110 hots. The pilot replied that he could not increase his speed.

During this period, all of the communications with 67T and SK-933 were being carried out on the same frequency and could have been heard by both crews. The captain of *SK-933* stated that he was not concerned about the traffic ahead of his flight.

It was necessary to have full flaps extended to operate at a speed of 126 knots; however, the flaps were not extended at this time because the nose gear was showing an unsafe indication and, if the gear were unsafe and the flaps extended beyond 26°, the landing gear warning horn would blow and could not be silenced without retracting the flaps.

The landing gear was recycled. at least one time by the captain and still showed an unsafe condition *on* the nose gear. The second pilot believed that the flaps were extended to full down, and he attempted to reduce speed to 126 hots after the gear was recycled. The captain, however, did not extend full flaps until after the system5 operator verified the nose gear was down an3 locked.

The captain asked the systems operator to check the circuit breakers on the landing gear lights and to check visually the nose gear down locks. The systems operator checked the circuit breakers from memory and then took off his headset, leaned forward between the pilots to check the gear

lights, got the flight manual out and rechecked the circuit breakers. While he was leaning forward between the pilots to check the gear lights, he heard the captain advise the controller that they were having gear trouble and, if it was not resolved by the time they reached minimums, they would pull up and divert to Las Vegas. Tnis transmission, at 1920:42, was the last received from the flight.

After checking the lights, the systems operator went to the rear of the cockpit, removed the cover plate from the peephole, verified the down and locked position of the nose gear, and called this information to the pilots. He attempted to replace the cover plate but gave this up and was just starting to etand up when the aircraft struck the water.

The captain stated that at 7 DME miles, the altitude wae about 1,200 feet m.s.l., and he was satisfied with what he saw on the Plight instruments. h e lowest epeed he recalls vas 130 h o t s after full flaps were extended.

The second pilot extended the landing lights at about 1,500 feet. He remembered passing through 1,000 feet and, at about the same time, heard the systems operator call out that the gear was down and locked. He did not recall the rate of descent at that time and did not believe his speed had been reduced to 126 knots.

The next thing the second pilot recalled was seeing the drum of the altimeter nearing "0". He did not recall the position of the 100-foot Indicator. At this time, he attempted to pull up by applying back pressure on the wheel and adding power. Before he was able to complete these actions, the aircraft struck the vater.

h e captain described the impact as being similar to landing in a flying boat.

The accident occurred at latitude 33°55'14" N. and longitude 118°31'58" W., approximately 6 miles west of the Los Angeles International Airport. The average depth of the water in the wreckage area was 350 feet. The accident occurred during the hours of darkness at approximately 1921:30 P.s.t. (0321:30 G.m.t., January 14, 1969).

The approach was conducted in instrument flight conditions in clouds and rain. No icing was noted during the descent and approach, and all the deicing equipment was in use throughout the approach, wlth no indication of a malfunction. The crew did not notice any significant turbulence during the approach.

Bone of the crew felt any unusual sink rate, buffeting, yawing of the aircraft, any unusual flight control inputs, or trim changes during the approach. With. the exception of momentary flashing of a heading difference

light, none of the crew recalls *any* warning lights appearing in the cockpit. This includes the low altitude warning light associated with the radio altimeters. There were no indications of *any* engine flameout and none of the crew, except the second pilot, had any warning prior to the accident. At the time of the impact, the captain was looking at the VHF navigational receiver tuning head, with his feet on the floor and his arms on the armrests.

After the aircraft came to a stop, there was water in the cockpit about waist deep. After obtaining flashlights and lifejackets, the crew proceeded into the cabin and supervised the evacuation of the passengers and cabin attendants.

Because this mishap occurred in international waters, the accident inquiry was governed by the provisions of Annex 13 to the Convention on International Civil Aviation, Second Edition, March 1966, as amended. At the request of the Norwegian Government (State of Registry), the National Transportation Safety Board undertook the inquiry on behalf of the U. S. Government.

The inquiry was conducted by a team of aircraft accident investigators from the Board's Washington Office which included specialists in Operations, Structures, Powerplants, Witnesses, Aircraft Systems, Air Traffic Control, Weather, and Flight Data Recorder. The Maintenance Recorda phase of the inquiry was conducted by the Norwegian Government.

Organizations that participated *in* the inquiry included: The Norwegian Directorate of Civil Aviation; the Federal Aviation Administration, Scandinavian Airlines System; International Federation of Air Line Pilots Association; Air Line Pilots Association International; McDonnell-Douglas Corporation; and the Professional Air Traffic Controllers Organization.

In addition to the field phase of the inquiry, Scandinavian Airlines System conducted, at the request of the Board, simulator taste in an effort to reproduce the latter portion of the flight. The results of these tests were reported to the Board and are discussed in the report. A public hearing was not conducted as a part of this inquiry.

1.2 Injuries to Persons

Injuries	*crew*	Passengers	Other
Fatal	3*	12**	0
Nonfatal	6	11	0
None	0	13	

* 2 missing and presumed dead
** 9 missing and presumed dead

Post-mortem examinations of the recovered bodies reported moderate to minimal traumatic injuries, none of which was considered serious enough to have caused death. Death was due to drowning in these cases.

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

None.

1.5 Crew Information

(a) Flight Crewmembers

Captain Kenneth Davies, *aged* 50, was initially employed by SAS on February 1, 1948. He held CAA Certificate No. D-562, reissued November 29, 1968, and valid until May 28, 1969. His latest medical check was dated November 25, 1968. In addition *to* the DC-8, Captain Davies had flown Sandringham, E-3, SA-2, E-6, DC-7, and CV-990 aircraft for SAS.

According to the SAS records, Captain Davies had a total flight time of 11,135 hours with SAS. Of this time, 900 hours were in the DC-8. The captain had flown 95 hours *in* the previous 90 days, 46 hours in the previous *30* days, and 11 hours in the prwious 3 *days.* His total flight time in the 24-hour period preceding the accident was approximately 3 hours. Be had more than 24 hours available for rest nince his previous flight into Seattle on January 11, 1969.

Captain Davies received his last route check November 3, 1968, his last proficiency check November 7, 1968, in a simulator, his last emergency training January 7, 1969, and his last water ditching training August 28, 1968. His last recorded flight into Los Angeles was June 7, 1968. A review of the grade sheets for his recent simulator and aircraft checks revealed no discrepancies or derogatory remarks.

Prior to his employment by SAS, Captain Davies was a Squadron Leader pilot in the Royal Air Force Coastal Command. He had held a British "B" license No. 15416, issued August 8, 1947.

Captain Davies received his E-8 rating on April 5, 1966, and completed his DC-8 training May 3, 1966.

Second Pilot Hans Ingvar Hansson, aged 40, was employed by SAS, August 5, 1957. He held CAA Certificate No. D-453, which had been reissued December 1, 1968, and was valid until May 31, 1969. In addition to the DC-8, he had flown CV-440 and DC-7 aircraft while employed by SAS.

According to the SAS records, Second Pilot Hansson had flown 5,814 hours for SAS, which included 973 hours in the DC-8. He had flown 143 hours in the preceding 90 days, 53 hours in the preceding 30 days, and 11 hours in the 3 days preceding the date of the accident. On the day of the accident, he had flown approximately 3 hours.

Second Pilot Hansson had more than 24 hours available for rest before the scheduled departure from Seattle. His last medical certificate was dated November 11, 1968.

Second Pilot Hansson took his last route check July 29, 1968, and his last proficiency check September 13, 1968, in the DC-8 simulator. His last emergency training was received October 29, 1968, and his last water ditching training was August 20, 1968. His last reported flight into Los Angeles was January 1, 1969.

A review of available training records of aircraft flights and simulator flights revealed no significant discrepancies in Mr. Hansson's training. He completed his DC8 training May 2, 1968.

Systems Operator Ake Ingvar Andersson, aged 32, was employed by SAS May 23, 1966. He held CAA Certificates E-1842 and MF-275 as pilot and flight engineer, respectively. His certificates were reissued February 28, 1968, and were valid until May 28, 1969. All of the flight time he had accumulated with SAS ms in the DC-8 aircraft.

According to SAS records, Systems Operator Andersson had flown 985 hours total time with SAS. He had logged 122 hours in the preceding 90 days, 48.5 hours in the preceding 30 days, and 11 hours in the preceding 3 days. His total flying time in the 24 hours preceding the accident was approximately 3 hours. Mr. Andersson had more than 24 hours available for rest prior to the scheduled. departure from Seattle.

Mr. Andersson had completed his DC-8 training on February 5, 1967. His last route check was September 30, 1968, his last proficiency check was November 6, 1968, and his last trip into Los Angeles was December 2, 1968. His Last medical examination was completed January 30, 1968.

A review of his training records revealed no significant discrepancies. He completed his last emergency training November 27, 1968, end his last water ditching training August 17, 1968.

(b) Other Crewmembers

SAS records indicate that the cabin crew was certificated and had received their emergency training as indicated below:

Name	Certificate		Emergency Training	Water Mtching
	Reissued	Valid To		
Lenshoj, Henning	5/2/68	5/2/70	12/6/68	8/17/68
Roosand, Arne	2/28/67	3/4/69	11/20/68	9/18/68
Olesen, Peter	5/4/60	3/30/70	1/2/69	9/20/68
Larsson, Britt Marie	8/1/68	2/10/70	12/27/68	7/4/68
Gothberg, Susanne Ingeborg	8/1/68	2/10/70	12/27/68	7/4/68
Jenninge, Ann-Charlotte	3/22/68	2/21/70	1/7/69	8/8/68

1.6 Aircraft Information

(a) Airworthiness and Maintenance

Douglas E-8-62, registration letter LN-MOO, serial No. 45822, was owned by Det Norske Luftfartselskap (Norwegian Airlines), and operated by Scandinavian Airlines Systems (SAS). LN-MOO was manufactured in 1967 according to the Export Ceriificate of Airworthiness No. E-76612 WE-AEDO-48. A Certificate of Airworthiness was issued on June 23, 1967, by the Mrectorate of Civil Aviation and was valid at the time of the accident.

LN-MOO was overhauled *at* SAS Maintenance Base, Copenhagen, on April 3, 1968. Total time on the aircraft at that time was 3,425 hours.

A periodic check was completed January 7, 1969, and the total time on the aircraft at that time was 6,948 hours.

A termination check was completed on the aircraft on January 12, 1969, and an *en* route check was accomplished at Seattle on January 13, 1969, approximately 4 hours before the accident occurred.

The powerplants Installed on the aircraft were four Pratt & Whitney JT3D-3B turbo fans. They were Installed as follows:

Engine S/N	Position	Total Time	Time Since Overhaul
669277	No. 1	4,967 hours	New Engine
645354	No. 2	5,129 hours	New Engine
645411	No. 3	5,428 hours	New Engine
645412	No. 4	5,342 hours	New Engine

A review of SAS Maintenance Records Indicated that all overhaul and inspections of the major assemblies of LE-MOO had been accomplished in a timely manner; hwever, the No. 1 generator, S/N 457, was overtime for change. The minimum requirement list showed that three operable generators were necessary for dispatch.

(b) Weight and Balance.

The load sheet form prepared by the SAS Seattle station agent for this flight was reviewed. The form shared the aircraft's basic weight to be 65,531 kilos. The load sheet showed that the operating weight of the aircraft was 89,754 kilos, with a maximum allowable takeoff weight of 112,750 kilos and a maximum allowable landing weight of 108,800 kilos. The calculated takeoff weight was 95,068 kilos, and the weight at the time of the accident was approximately 77,668 kilos.

The center of gravity limits for this flight were, expressed in percentage of mean aerodynamic chard (MAC), 18.2 percent forward and 32.3 percent aft. The aircraft was calculated to have been within these limits, both at takeoff and at the time of the accident.

(c) Fuel

The aircraft was serviced with aviation kerosene at Seattle prior to its departure. The total. amount of fuel on board at the time of engine start was approximately 25,000 kilos. It was estimated that 13,000 kilos of fuel would be required for the flight; however, due to headwinds and traffic delays, approximately 17,400 kilos were consumed. Approximately 7,600 kilos remained on board at the time of the accident.

1.7 Meteorological Information.

The 1900 surface weather chart prepared by the National Meteorological Center showed a cold front oriented north-south over the Pacific Ocean near longitude 122° W. An extensive area of low clouds, rain, and fog preceded the front over the southern California coastal area.

The prevailing weather at the Los Angelea International Airport was in part as follars: ceiling measured 1,700 feet broken, 3,500 feet overcast; visibility 4 miles in light rain and fog; temperature 55° F.; dew point 52° F.; winds 060° at 10 knots; and altimeter setting 29.87 inches Hg.

At 1900, Santa Monica reported scattered clouds at 900 feet, ceiling measured 1,500 feet overcast, visibility 2½ miles in light rain and fog. Point Mugu Naval Air Station reported scattered clouds at 600 feet, estimated ceiling 2,000 feet overcast, with visibility 2½ miles in moderate rain *and* fog.

The San Nicolas Island 1600 winds-aloft observation was as follows for altitudes up to 4,000 feet m.s.l.:

Surface	130° true	10 knots
1,000 feet	145° true	18 knots
2,000 feet	160° true	23 knots
3,000 feet	170° true	25 knots
4,000 feet	195° true	23 knots

The San Nicolas Island 1600 radiosonde ascent shared the freezing level near 10,500 feet m.s.l.

The Weather Bureau Aviation Terminal forecast for Los Angeles, which was valid from 1500 to 0300, was as follows for the period from 1500 to 0000: ceiling 3,000 feet overcast, visibility 2 miles, light rain, occasionally 1,500 feet overcast, visibility 2 miles, moderate rain, fog, wind 100° at 10 knots and gusty.

AIRMET BRAVO 6, which was issued at 1730, valid 1730 to 2200, predicted extensive areas of overcast, stratus west of the coastal mountains, with ceilings and visibilities less than 1,000 feet *and* 2 miles, and icing in clouds above 8,000 feet.

The Weather Bureau at Seattle *did* not provide a weather briefing to either the Plightcrew or the dispatcher; however, it provided the following documentation: significant weather prognostic chart valid at 1600, 200-millibar and tropopause prognostic chart valid at 1600, 300-millibar prognostic chart valid at 1600, 12-hour Terminal Forecast for Los Angeles, San Francisco, and Seattle valid from 0900 to 2100 and 0900 to 0900, respectively, *and* the 1200 sequence reports received on circuit 8034 and relays from 8035.

The accident occurred at night in *rain,* with en overcast *sky.* The moon had not risen.

1.8 Aids to Navigation

The Los Angeles International Airport was equipped with a tower; Flight Service Station; Instrument Landing System; VOR; Radar with ASR, PAR, and ASDE; VASI for Runway 07R; and Sequence Flasher for Runways 25L and R.

The ILS approach for Runway 07R was a back course procedure and no glide slope information was available for the approach. The PAR radar was not available for approaches being made toward the east.

The runways and taxiways were equipped with MI-L-822 lighting.

A comparison of the VOR approach plate available to the SAS flightcrew and the VOR approach plate, published by the U. S. Coast and Geodetic Survey (C&GS) for the approach to Runway 07 left and right at Los Angeles International Airport, showed that the approaches depicted on the two charts were eesentially the same. One difference was the lack of any reference to a minimum altitude at the Del Rey Intersection 5/ on the chart used by the SAS flightcrew. The C&GS charts, dated November 7, 1968, shoved a minimum altitude of 1,300 feet at the Del Rey Intersection.

The captain's navigation radio receiver was recovered and found tuned to a frequency of 109.9 MHz, the frequency of the ILS localizer to Runway 07R.

The first officer's navigation receiver was recovered and was found tuned to 113.6 MHz, the frequency of the Los Angeles VORTAC.

All aids to navigation at the Los Angeles International Airport were flight checked vlthin 4½ hours following the accident and all equipment was found to be operating vlthin the required tolerances.

1.9 Communications

Communications were maintained between the aircraft and ground stations in a routine manner throughout the flight.

1.10 Aerodrome and Ground Facilities

The aircraft did not reach the airport and the facilities were not involved. The airport elevation was 125 feet msl.

5/ The Del Rey Intersection was the intersection of the 251° radial of the Los Angeles VORTAC and the 203° radial of the Santa Monica VOR or at 5 DME miles from the Los Angeles VORTAC on the inbound radial. This intersection is a transition approach fix for the VOR approaches to Runways 07 left and right at the Los Angeles International Airport.

1.11 Flight Recorderr

The aircraft was equipped with a Fairchild Model 5424 flight recorder. This recorder was installed in the overhead of the aft left side of tho pressurized cabin at the production break of the fuselage. The fuselage failed at the production break and the tape recorder was separated from the aircraft. The recorder was recovered from the ocean floor by the Lockheed Submersible "Deep Quest." The recorder was intact and the recording medium was undamaged.

The flight data record contained traces representing all the required data including indicated altitude, airspeed, and heading. The "g" trace and binaries were also recorded.

The altitude trace of the flight recorder was compared to the assigned altitude at the time SK-933 was crossing Fillmore. The flight recorder trace was steady at the assigned altitude of 11,000 feet. 6/ When the aircraft was at an assigned altitude of 3,000 feet, the flight recorder trace was varying between 3,100 feet and 3,300 feet.

The airspeed trace was checked at the time the aircraft was assigned a speed of 150 knots, and the flight recorder record showed 150 knots. The indicated airspeed increased as the aircraft descended and then undulated slowly between a high of 164 knots and a low of 140 knots until the aircraft started its final descent from 3,050 feet.

The altitude trace showed that the aircraft started a descent from 3,050 feet, 1:58 minutes prior to impact. The aircraft descended to 2,200 feet in 26 seconds; leveled for 16 seconds; then descended to sea level in 1:16 minutes. Two seconds prior to impact, a positive "g" loading was recorded and the altitude trace started to flatten out.

The airspeed during the final descent was oscillating between 140 knots and 168 knots. Twenty seconds before impact the airspeed was 140 knots and increased to 155 knots at impact.

1.12 Wreckage

The impact forces broke the fuselage into three major sections:

(1) An 85-foot section, with the wings attached, from the nose back to approximately the trailing edge of the wings. This section remained afloat following the accident and was towed to a point off Malibu Beach, California, where it subsequently sank. This portion of the aircraft was recovered and transported

6/ All altitudes are above mean sea level (m.s.l.) unless otherwise stated.

to the Long Beach Terminal Island Naval Shipyard where it was examined and documented. The flight instruments and all of the navigational radios were recovered in this section;

(2) A center section of fuselage, approximately 42 feet long from the trailing edge of the wing back to the production break just forward of the rear pressure bulkhead; and

(3) The tail cone containing the entire horizontal and vertical surfaces.

The nose landing gear, the main landing gear, and all four engines separated from the aircraft at impact. The components in (2) and (3) above were not recovered.

A partial listing of instrument readings and settings were as follows:

(1) From the captain's panel of the cockpit: the airspeed indicator pointer was at 192 knots with the "bug" 7/ set at 154 knots; the barometric altimeter indicating 29,120 feet with 29.84 inches Hg and 1011 millibars set in the instrument; the radio altimeter indicator with the pointer retracted behind the mask, the flag sharing, and the bug set at 2,450 feet; the Horizontal Situation Indicator with the No. 1 DME reading 017 nautical miles, the No. 2 DME reading 006 nautical miles, the shutters closed on both DME indicators, an indicated heading of 080°, the course pointer on 259°, the heading select bug on 075°, and the "From" indication showing on the indicator.

(2) From the copilot's panel: the airspeed indicator pointer was at 210 knots and the bug was at 147 knots; the barometric altimeter was indicating 9,310 feet with 29.92 Hg and 1013 millibars set in the instrument; the radio altimeter pointer was retracted behind the mask, the flag exposed, and the bug set between 178 and 180 feet; the Horizontal Situation Indicator showed the No. 1 DME indicating 017 nautical miles, the No. 2 DME reading 006 nautical miles, and the shutters were closed on both DME's.

(3) From the flight engineer's panel, the fuel quantity indicators read:

Auxillary No. 1	1,300 kilograms
Auxillary No. 4	825 kilograms
Forward Auxillary	0
Center Auxillary	125 kilograms

7/ Bug -- A manually operated reference indicator or reminder.

Main No. 1	1,000 kilograms
Main No. 2	950 kilograms
Main No. 3	1,920 kilograms
Main No. 4	1,425 kilograms
Total Fuel Quantity sharing	7,545 kilograms

The following recovered lamps or bulbs were tested, using a meter for continuity through the filament of each:

Light	No. of Bulbs	Filament Condition
Captain's Altitude Preselect	1 bulb	Good
Second Pilot's Altitude Preselect	1 bulb	Good
Captain's Flight Director MDA	1 bulb	Good
Second Pilot's Flight Director MDA	1 bulb	Good
Captain's Navigational Warning Annunciator Radio Altimeter (Bowtie)	3 bulbs	Good
Second Pilot's Navigational Warning Annunciator Radio Altimeter (Bowtie)	3 bulbs	Good
Captain's Radio Altimeter Indicator	2 bulbs	1 Good, 1 Open
Second Pllot's Radio Altimeter Indicator	2 bulbs	Good
Nose Gear Safe Indicator (Green Light)	2 bulbs	1 Good, 1 Open

(The Noose Gear Safe Indicator bulb with the good filament was found with loose wire connections at the socket.)

The center section of the fuselage, measuring approximately 42 feet, was observed on the ocean floor. It was collapsed laterally with the structure twisted end mangled. This portion oank in 325 feet of water, approximately 120 feet north of the tail section.

The complete tail section, from the production break aft, sank in 355 feet of water.

All four engines were observed on the ocean bottom in the wreckage area. Generally, the wreckage was orientated along on a true bearing of 060° and. covered an area 1,250 by 800 feet.

The portions of wreckage which remained underwater were visually examined 'by investigators aboard the Lockheed Submersible "Deep Quest," but were not recovered.

1.13 Fire

Fire d.d not occur.

1.14 Survival Aspects

The passenger cabin was arranged for 20 first-class passengers and 126 tourists, with five rows of double seats on each side of a center aisle in the first-class section and 21 rows of triple seats on each side in the tourist cabin. The rows were numbered consecutively, 1 through 5, in the first-class cabin and 6 through 27 (excluding No. 13) in the tourist cabin. The cabin divider had a curtain across the aisle. Between the passenger cabin and the cockpit on the right side were the forward galley and two lavatories. On the left side opposite the galley were two rows of double-seat units for crewmembers and, across from the lavatories, was the forward passenger entry door. A folding double seat was located et the entry, Overwing window exits were at both ends of rows 7 and 9 in the tourist cabin. Aft of the tourist cabin was a galley on the right side opposite the aft cabin entry door, where another folding double seat was located. There were three lavatories toward the tail.

The SAS crew in the cockpit consisted of: captain in the left seat, second pilot (copilot) in the right seat, and systems operator (flight engineer) at the engineer'r panel. Tho cabin crew consisted of an air purser, two air stewards, end three air hostessea. All 36 passengers were seated throughout the tourist cabin. No one was seated in row 6, but three survivors were in row 7. A survivor from row 24 said that one male passenger had been seated behind him. At the time of the accident, one steward was standing below and between No. I and No. 2 liferaft compart-ments near the forward entry door. At impact, the No. 1 liferaft fell on him. One hostess was standing in the forward galley and the purser was moving forward through the unoccupied first-class cabin. He noticed the proximity of the water and jumped into a seat to the left side of the aisle. He was the only occupant of the first-class cabin. Two hostesses and one steward who were toward the rear of the aft cabin did not survive.

The captain reported that initial impact was tail-down and did not seem to be too hard in the cockpit. Deceleration seemed to be rapid and the cockpit flooded with water to about one-third depth.

The major break of the aircraft was at the trailing edge of the wing et approximately seat row 16. Some pieces of the center aisle floor and keel back to row 26 remained with this forward portion of the aircraft. The aft section of the cabin, which broke off and sank rapidly, was observed to be collapsed and twisted. It was noted that approximately 30 feet of the keel of this aft section had been torn frcm the fuselage and remained with the portion that floated. The forward portion of the aircraft, which remained afloat for about 20 hours, did so with the forward galley service door sill above water level and the cabin floor 'backto seat row 16 above the water level..

The six crewmember survivors were in the forward portion of the plane. Eighteen passenger survivors were from the forward section of the tourist cabin that remained afloat, and six of the survivors were from the aft cabin section. Passenger survivors reported only one impact which they likened to a very hard landing. The impact was followed by rapid deceleration that was described by one passenger as being similar to thrusting a shovel into sand. Quantities of water were forced up through the floor of the cabin of the aircraft, and the center aisle between rows 2 and 11 was disrupted to the extent that portions were missing completely, leaving openings down to the baggage compartment. This condition made evacuation difficult.

The surviving crewmembers, assisted by a nonrevenue captain and air hostess, evacuated passengers from the cabin onto wings and into liferafts to await rescue. Survivors estimated that the time from impact until rescue was 45 minutes to 1 hour.

After two rafts had been loaded with survivors, the rafts were tied together and were paddled away from the left wing, passing in front of the nose of the aircraft. The second liferaft in tandem was blown back against the jagged metal at the nose of the aircraft where it was punctured. This raft collapsed with "startling epeed," spilling the people back into the water.

When other survivors attempted to launch another liferaft from the forward edge of the right wing near the No. 3 engine pylon, this liferaft was also punctured by jagged metal and collapsed with an "unexpected suddenness."

Four bodies (three passengers and one air hostess) were recovered and examined by pathologists, and the cause of death was found to be drowning. The injuries to the passengers indicated that they had been seated, with their seatbelts fastened, at the time of impact.

An emination of the seats contained in the recovered section of the fuselage showed that:

> The two double-seat units opposite the forward galley remained in place; in the first-class cabin, only the first three rows of double-seat units on the right side (?. C&D, 2 C&D, and 3 C&D) remained in position; the 1 A&B seat unit from the left side was in its approximate proper position, but broken loose from the fuselage wall; the floating portion of the tourist cabin contained triple-seat units numbered 6 through 15, without a No. 13; of these units, row 6 left side and row 15 left side were the only ones missing; all other seat units in this section remained in place.

Miscellaneous items mentioned by the survivors included:

1. The "FASTEN SEATBELT" sign was on but the "NO SMOKING" sign had not yet been turned on.

2. The emergency cabin lights operated, although they did not remain lighted very long.

3. A suggestion was made that liferaft covers should have a ball handle and/or luminous paint to facilitate finding the lanyard for the inflation of the liferaft. In the darkness out on the wing, the liferaft had to be turned over several times to find the cover release pull string.

4. Flashlights were at a premium and it was suggested that one should be located beside each exit.

5. Several survivors reported that the lights on their lifejackets did not work. Some of these survivors, however, did not get into the water. Other survivors, who did get into the water, did not pull the tab to remove the plugs so that water could activate the battery.

6. Some of the survivors stated that the standard seatbelts had extra long, free ends, and this delayed their release. They said this was caused by having to interpret what the problem was during a moment of panic, as well as requiring both hands to release the belt.

1.15 Tests and Research

SAS conducted flight and simulator tests utilizing the flight recorder readout, the sequence described by the cockpit crewmembers, and a recording of the Los Angeles Approach Control tape.

Different crews have flown these sequences, and the systems operator involved in the accident has participated in these tests.

The results obtained confirmed that the recorded data can be simulated almost exactly within the appropriate time schedule.

1.16 Other Information

Captain Kenneth Davies, on being admitted to the UCLA Hospital, requested that blood specimens be taken from the Flightcrew. This was done for Captain Davies, First Officer Ingvar Hansson, and Purser Lenshoj. The specimens were subsequently tested for blood-alcohol levels. The results of these tests indicated that no ethyl alcohol was present in any of the specimens.

The UCLA Hospital records indicated that the captain gave a history of a previous medical workup for possible diabetes. During the captain's hospitalization following the accident, special diabetic studies were done. The results of these studies were found to be clinically insignificant and the diagnosis of diabetes was not made.

A review of the captain's medical history revealed that indications of possible diabetes had been discovered during a regular physical examination in April 1967. A glucose tolerance test completed on April 20, 1967, shoved a response indicative of diabetes. A diagnosis of diabetes wat made and the captain was declared medically unfit for flight duty. He was instructed to lose weight and was placed on oral diabenese, an anti-diabetic medication.

By August 1967, the captais lost 22 pounds and the diabenese medication was stopped. A repeat glucose tolerance test was completed on September 19, 1967, and the results of this test were normal.

In October 1967, the captain appealed to the State Director of Health of Norway for medical recertification. During the appeal, an in-hospital examination and a reevaluation of all medical documentation was Completed. This resulted in a decision that the captain had reverted to a prediabetic condition and was medically qualified for flight duties. A medical certificate was issued, followed by two more medical certifications, one prior to and one after the accident.

SAS Pilot Procedures

The SAS Aeroplane Flight Manual DC-8, Series 60, indicated that the pilot must plan and perform all instrument approaches with the highest degree of precision in order to effect a smooth, safe approach and landing.

To guide crewmembers in their tasks, the manual provided detailed instructions regarding the duties of the pilot flying the aircraft (1/P), and the pilot who assists him (2/P). The 1/P was responsible for the operation of the throttles, but the landing flaps and landing gear were to be actuated by the 2/P on command of the 1/P. The 2/P had a "very important duty" to inform the 1/P cf "abnormal" deviations from the approach procedures, altitude, rate of descent, etc. During a manual approach, the 1/P was instructed "to concentrate on instrument flying and to not look out of the aircraft." The 2/P was dirscted to divide his attention between the flight instruments and looking outside the aircraft "when visual guidance was expected."

Particular attention was to be paid to the radio altimeter and a warning given if, at any time, terrain clearance of less than 200 feet was indicated and the approach lights were not visible. In this accident, the second pilot was functioning as the 1/P and the captain was responsible for the duties of the 2/P.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

It became apparent, early in the investigation, that the causal factors of this accident lay in the operational area. The aircraft was capable of performing the flight and no significant malfunction of the aircraft or its systems can be held in causal relationship to the accident. The weight and balance were within limits throughout the flight. The weather, in the terminal area, was adequately forecast and reported, The crewwereproperly certificated and were qualified to perform their duties in accordance with the existing regulations applicable to this operbtion.

The accident was the result of a series of events that in and of themselves would not have caused the accident, but in combination caused a breakdown in the cross-check6 and cockpit discipline required for a safe air carrier operation.

The first difference from a normal flight appeared when the crew was advised that their flight plan would be longer than normal due to the forecast 50-knot reduction in ground speed caused by the winds aloft that would be encountered en route. They were also advised at that time that there was a possibility of traffic delays in the Los Angeles area because of the weather and the direction of landing.

After the crew had prepared themselves and the aircraft for departure, they were advised that an additional delay would be necessary while the aircraft was deiced. This operation took nearly an hour and resulted in a departure 1:11 hours after the scheduled time.

It is apparent that the crew m s concerned about the progress of the flight as they were cruising toward Los Angeles. The second pilot performed a ground speed check and determined that their actual headwind component was 110 knots rather than the 50 knots forecast for the trip. At this time, the crew had determined that the aircraft was cruising at the predicted airspeed dictated by the original power settings. Aside from the malfunction of the Doppler circuit breaker, there was no known discrepancy with the aircraft. Their average predicted ground speed for this flight was approximately 362 knots. By reducing this speed 50 knots, the time of flight was extended from 2:08 hours to approximately 2:25 hours. This added time also increased their fuel consumption and left them with less fuel available for holding at Los Angeles before they would have to divert to their alternate, Las Vegas, Nevada. For example, the extra fuel burned would have allowed approximately 20 minutes additional holding at 24,000 feet or 30 minutes at 18,000 feet, using the fuel flaws calculated to have been used by this crew.

The next delay was the extended holding period at Bakersfield and Fillmore. These two holding periods totaled 1:30 hours.

During this period, the captain demonstrated Concern regarding the fuel reserve when he requested the systems operator to contact the dispatcher and ask for the amount of fuel that would be required to divert to Las Veges. At this time, the captain had available in the cockpit the information and data neceseary to determine this figure. The workload in the cockpit, in a holding pattern, was not such as to preclude the calculation of these figures by the systems operator.

The first visible error on the part of a crewmember was the improper setting of the second pilot's altimeter. While holding at 18,000 feet, the crew was given a new altimeter setting but the second pilot did not change the setting in his instrument. This later resulted in an approximate 60-foot difference between his altimeter and the captain's. This difference was never noted by the crew.

The fact that the second pilot did not reset his altimeter was understandable because he was holding at 18,000 feet, the transition altitude used by aircrews to reset the altimeter. Aircrews use a standard setting of 29.92 inches above 18,000 feet and the latest reported setting below that altitude. However, once the aircraft descended below 18,000 feet, the pilot was required to reset his altimeter to agree with the value provided by the ground station. Under these conditions, the second pilot's instrument would have indicated an altitude approximately 60 feet higher than the altitude the captain's instrument indicated.

The next significant event was the clearance issued to the crew at 1902. This clearance authorized the flight to proceed to the Los Angeles Airport via a back course ILS and to intercept the ILS via the 158° radial of the Fillmore VORTAC to cross the 100° radial of the Ventura VORTAC. This clearance was in a standard form using proper terminology. The captain's readback was incorrect. When the controller repeated part of the clearance to clarify the incorrect readback, he mentioned the Westlake Intersection. This intersection was newly established and was not depicted on the area chart used by the flightcrew; however, it had been properly described to the crew.

At the time, the captain should have informed the controller that he could not comply with the clearance as issued and should have requested a clearance for an approach he was authorized to use. Instead, the captain end the second pilot decided to conduct a VOR approach and accordingly prepared themselves for that approach. The approaches are similar in profile and serve the same runway. The crew could not provide the Board with any explanation for this action.

This was the first time either of the pilots had ever been requested to perform an instrument approach and landing on Runway 07 at Los Angeles. They were therefore not as familiar with the approach pattern, altitudes, and headings as they would have been had the approach been to Runway 25.

During the performance of the approach checklist, the crew was requested to reduce their airspeed to 160 knots. It was necessary to interrupt the checklist and extend the landing flaps to reduce to this airspeed. Then, because the aircraft was above the minimum displayed altitude of the radio altimeter, 2,500 feet above the ground, the captain stopped the checklist so that he could verify the operation of the radio altimeter. However, the next two items on tne checklist were to be performed by the systems operator on his panel and he accomplished them. The following item on the checklist was to be the extension of the landing gear.

At 1911, the flight was cleared to descend to and maintain 3,000 feet and was given a vector to intercept the back course ILS. Both pilots tuned in the Los Angeles VOR and then the captain tuned the ILS frequency on his navigational receiver. He apparently intended to keep a running cross-check on the aircraft's position through the use of this information.

At 1914:10, the controller issued the clearance: "Scandinavian 933 turn left heading 080, Intercept the back course, cleared back course Runway 7 right approach, and your position is, . . . 18 miles from Trout." The captain's reply was "OK right (sic) to zero eight zero." This was the second time the captain had improperly read back a clearance. This clearance was also given in standard terminology. This was also the captain's second clear chance to advise the controller that he was not authorized to conduct aback course ILS and request a VOR approach.

As the flight continued at 3,000 feet and 160 knots, the crew should have heard the controller advise the light aircraft ahead of them that he was 4 miles from the Trout Intersection at 1917. One minute later, the controller requested that SK-933 reduce its airspeed to 150 knots and the Captain acknowledged this request. This should have indicated to the crew of SK-933 that they were overtaking the traffic ahead of them.

At 1919:05, 4:55 minutes after having been cleared for the approach, the captain called the controller and asked how much longer the controller wanted them to maintain 3,000 feet. The controller responded by advising the crew that they had been cleared for the approach.

The Board believes that the various events that had occurred to delay the flight as discussed above, were having a cumulative adverse effect upon the crew of this aircraft. This effect was reflected in the various minor errors they were making. Air carrier crews are, by the nature of their work, very conscious of time and schedules. When delays begin to appear, they can have an influence on a pilot's conduct of his duties and lead to decisions and actions that he would not normally make or take. The decisions by the SAS crew were not in and of themcelvee dangerous, but

they do appear to be directed toward short-cutting the system to prevent any further delays in getting the aircraft to Los Angeles. The crew must have been continuously aware of the fact that they were conducting an approach other than the one for whish they had been cleared. For this reason, there may have been some apprehension on their part that the controller would detect their deviation from the ILS approach and call them about it.

In this mental environment, the crew began their preparation for the approach when the second pilot disconnected the autopiiot and ordered the landing gear extended. At this point, the aircraft was approximately 10 or 11 miles from the VOR station. The minimum descent altitude for this approach was 576 feet, which left the second pilot with a requirement of losing 2,424 feet in 10 miles or 4 minutes of flying tine at 150 knots. Under these conditions, a rate of descent of 600 to 700 feet per minute would have been adequate to complete the approach. The descent rate of 1,000 feet a minute, which the second pilot intended to make good, was a reasonable rate of descent and would have created no difficulty had he maintained it down to the minimum descent altitude.

Having started the descent, the pilot's attention was distracted almost immediately by the failure of the nose landing gear safe light to illuminate and the actions of the captain and the systems operator as they attempted to resolve the problem. It is apparent that he was not concentrating, on the approach because, instead of the 1,000 feet per minute he planned, the actual rate of descent was about 1,960 feet per minute for 26 seconds, 0 feet per second for 16 seconds, and an average of 1,720 feet per minute to impact. In addition, a review of the airspeed and heading traces indicates that, during this period of time, the aircraft was not being flown with the precision expected of a professional pilot, conducting an instrument approach at night, under instrument flight conditions.

The captain's attempts to ensure that the landing rear was eafe distracted the second pilot from his primary task of flying the aircraft. Furthermore, the captain's cycling of the landing gear and his inaction with respect to extending the landing flaps, made speed control and altitude control difficult. When the captain finally positioned the flaps to the full down position, he did not inform the second pilot that he had done so. The crew's problems were compounded when the controller asked them to reduce their speed to 126 knots. This request must have re-enforced the crew's apprehension about the possibility of a missed approach. This was a distinct possibility because of the landing gear problem. The captain had stated, in his last radio contact with the controller, that if they didn't solve the problem by the time they reached minimums, they would execute a missed approach. All of the crewmembers must have known that a missed approach meant an automatic diversion to their alternate of Las Vegas because they did not have enough fuel remaining to stay in the Los Angeles

area while they attenpted to solve the landing gear problem. .They were aware of the traffic and the existing delays and should have realized that there was no alternative tu a diversion.

The captain was precluded from accomplishing his primary task of monitoring the approach by his activities in connection with the failure of the nose gear safe light to illuminate. During this period of time, the prescribed cross-checks and cockpit discipline broke down significantly. The captain undertook actions which were the responsibility of the second pilot; did not carry' out instructions piven by the second pilot; and did not keep the second pilot'advised of the action that he was taking about which the second pilot should have been informed. Consequently, the second pilot's attention was diverted from his primary task of monitoring the flight instruments and flying the sircraft, since he had to look at the flap handle and indicator to determine the flap position. He also had to look at the landing gear handle and the warning lights to determine the position and status of the landing gear. He was attempting to slow the aircraft down to 126 knots while the aircraft was not properly configured to operate at that airspeed. This led to the erratic flying which was depicted on the flight recorder trace.

As a result of the circumstances summarized above, neither pilot was monitoring the position of the aircraft and neither knew the altitude of the aircraft during the descent, with two exceptions. Both pilots recalled seeing an altitude indication when the aircraft was about 1,000 feet above the water. The only other altitude recalled by either pilot was the second pilot's recollection of seeing the altimeter approaching "zero" feet.

The approach chart used by the crew played a part in the accident sequence. Had the approach chart depicted the minimum altitude at the Del Rey Intersection, one or both of the pilots should have been alerted to verify the altitude in the vicinity of 1,000 feet. This was 300 feet below the minimum altitude for that point. Had the crew intended to descend to that altitude rather than minimums, they would have had an opportunity to level the aircraft out and stabilize their flight condition while they continued to analyze their landing gear problem.

The uninjured survivors, injured survivors, and the fatalities were almost evenly divided among the occupants of the aircraft. This condition resulted from the varying impact forces that occurred along the fuselage as it broke into the three segments. This progressive breakup of the aircraft was instrumental in absorbing the impact loadings in a "staging" manner and allowed this accident to be classified as survivable.

By attempting to pullup, the second officer succeeded in rotating the sircraft to a noseup attitude, but there was insufficient time to arrest the rate of descent before the aircraft struck the water in a

tail-low attitude. This contact caused the fuselage to fail first at the production break which is just forward of the aft pressure bulkhead. The loading forces were in an upward direction when related to the keel beam at this point. There was also a twisting or rotational force that was caused by the left wingtip contacting the water immediately after the initial contact. The mass of the aircraft, forward of the trailing edge of the wing, was being accelerated in a downward direction as related to the keel beam, thus causing the circumferential failure of the fuselage just aft of the trailing edge of the wing. This downward loading, combined with twisting moments, resulted in tearing out a 30-foot section of the keel beam from the fuselage aft of the trailing edge of the wing. The removal of this keel beam structure destroyed the "tubular" integrity of the aft portion of the fuselage and allowed the twisting and collapsing of that segment of the cabin to occur. The collapsing of the structure was probably a factor in causing most of the fatalities by trapping the occupants in the rapidly sinking section.

Survivors described the impact with terms ranging from "seeming to be not too hard" to "a tremendous blow." The flight recorder, which records the vertical acceleration loads at the center of gravity of the aircraft, registered only a +1.5 "g". This load factor is considered extremely light for the event that took place and supports an analysis of progressive atsorption of the forces placed on the aircraft. Additional support for this conclusion was the pathological observation that the Injuries on the four bodies that were recovered should not have precluded escape from the aircraft, and the deaths were the results of drowning.

Marks on the three recovered passenger bodies indicated that their seatbelts were used. These three passengers were among those seated in the last 10 rows of seats. Nine of the nonsurviving passengers were known to have been seated in the aft cabin. The unexpected impact, the severe twisting and collapsing of this section of the fuselage, the panic a8 the cabin rapidly filled with water, and the delay caused by needing two hands to disconnect the extra long free end of the seatbelt were considered to be among the reasons that nine passengers failed to survive.

The three nonsurviving crewmembers were known to have been standing in the rear of the aft cabin in the proximity of the aftermost break in the fuselage. This portion of the fuselage is believed to have sustained the highest impact loading, but the air hostess who was in this group had not suffered serious physical injury and her death was attributed to drowning. It is probable that the cabin crewmembers in this group sustained blows that caused unconsciousness.

Three nonsurviving passengers were known to have been seated in the last three rows of seats in the section of the fuselage that remained afloat. These passengers may have left the aircraft toward the tail and fallen into the water. All but one of the Seats they occupied at the time of impact remained intact and in place.

The survivors reported several problems associated with the evacuation of the aircraft. Most of these problems can be associated with the panic conditions that exist in an emergency, and no amount of planning or training will specifically encompass all of the contingencies that can occur. A major problem that could have affected survivability following this accident was the reported rapid collapse of the liferafts when they were punctured by the jagged wreckage. These collapses were reported to have been so rapid that there was a question in the minds of crewmembers familiar with the liferafts as to whether they were actually of the double tube construction.

Inspection established that the liferafts did have the double tube constructioc; however, both tubes were punctured by the sharp, jagged metal almost simultaneously. This condition can occur anytime the liferafts are subjected to wind or wave action, pushing the liferafts against jagged metal. Special care must be exercised to prevent this from occurring. Training of crewmembers to launch the liferafts downwind and away from such hazards, whenever possible, would alleviate this problem to some degree. It would be desirable to compartmentalize the tubes and connect them with one-way flow valves, thereby enhancing the liferaft's overall reliability.

The Board believes that the pilot intended to descend to his minimum altitude as soon as possible and then fly level to the missed-approach point, rather than the type of approach path depicted on the VOA approach plate.

It was noted that SAS did have back course ILS approach procedures for other airports and the crew was qualified to perform them. However, when an approved approach is being used at any airport, the pilot must adhere to that approach, or inform the controlling sgency of his decision not to comply and request another type of clearance.

The fail-safe concept of having two separate bulbs in the light indicators for the DC-8 landing gear proved to be inadequata. The opaque cover shield of the light unit was illuminated by one bulb and the absence or failure of a bulb vas not apparent until the second bulb failed,

The failure of the good bulb precipitated the actions of the captain and systems operator in their attempts to analyze and correct the lack of a "SAFE" indication on the nose landing gear. These actions diverted the second pilot's attention from his primary task of flying the aircraft and, also, resulted in the breakdown of crew coordination and the lack of utilization of the checklists.

As has been observed in other accidents, the MDA lights associated with the radio altimeters did not alert the pilots that the aircraft had descended below the preselected altitude. Even though the captain's MDA light would have been illuminated at 2,450 feet, soon after the descent

from 3,000 feet was initiated, and the second pilot's MDA light would have illuminated at approximately 180 feet, neither of the pilots recalled seeing these lights. Pilots are conditioned by seeing the MDA light every time the aircraft approaches for a landing and the light has lost its warning value. A second problem was the size and location of the MDA light which was inadequate to draw the pilot's attention when it illuminated. As a result of these factors, combined with the confusion in the cockpit, neither pilot was warned by the illumination of the MDA lights.

The Board believes that this accident was caused by a series of distractions and aggravations that were cumulative in nature. These distractions, i.e., the delayed departure from Seattle, the headwinds twice as strong as forecast, extended holding patterns dictated by the unusual traffic pattern for the Los Angeles area, tne clearance to an intersection that was not depicted on the chart being used by the crew, receipt of a clearance that the pilot could not comply with, decision to make an approach other than the one issued, and failure to get a "SAFE" indication on extension of the landing gear, were sufficient to disrupt seriously the discipline and established procedural patterns of the crew.

The actions of the captain and the systems operator, while trying to diagnose the reason for not getting a "SAFE" indication on the nose landing gear, demonstrate a lack of knowledge of the landing gear system and its associated warning systems. The training of flightcrews has become increasingly difficult as aircraft become more complex. Because of the complications of system design, only a basic knowledge of the various systems, and the more probable failure situations, are taught to flightcrews during their ground school training.

During the investigation, the possibility that a portion of the pitot static system in the aircraft could have Seen providing erroneous information to the altimeters was considered. The flight recorder was, in this Installation, a completely separate system. However, comparison of the fiight recorder record to the reported altitudes and the recorded airspeeds to the performance characteristics of the aircraft, indicated that the aircraft's position in space and the information recorded on the flight recorder were essentially the same.

2.2 Conclusions

(a) Findings

1. The crewmembers held valid certificates issued by their respective countries.

2. The aircraft was operationally capable of performing its mission.

3. Terminal weather conditiocs had been adequately forecast and the flight was properly dispatched.

4. The flight had been cleared for, and the captain had accepted, a buck course ILS approach.

5. SAS procedures did not authorize a back course ILS approach at the Los Angeles International Airport. No approach plate for this approach was aboard the aircraft,

6. The crew planned and was executing a VOR approach without notifying the controlling authority.

7. The altitude restriction of 1,300 feet at the Del Rey Intersectisn was omitted from the SAS VOR approach chart being used by the crew.

8. The second pilot was flying the aircraft and the captain was performing the functions of a copilct and handling the communications.

9. The crew did not recognize the clearance to commence the final. approach descent and remained at 3,000 feet 4:55 minutes longer than required.

10. Following initiation of the final descent, the second pilot ordered the landing gear extended and ccmpletion of the checklist.

11. Upon extension of the landing gear, the unsafe lights were extinguished; however, the nose gear safe light did not illuminate.

12. Tho captain and systems operator attempted to diagnose and correct the apparent discrepancy.

13. There were no altitude cross-checks while the captain was engaged in ascertaining the condition of the nose lending gear.

14. The second pilot heard the controller's request to slow to 126 knots and was attempting to comply.

15. The systems operator visually determined that the nose gear was down an3. locked and informed the pilots.

16. The second pilot saw the altimeter approaching "0" feet and attempted to "pullup."

17. The flight recorder and the reported altitudes coincided at 3,000 feet and "0" feet.

18. The actions of the captain and systems operator distracted the second pilot's attention from his primary job of flying the aircraft end monitoring its position in space.

19. The design of the landing gear Indicator lights was not "fail-safe."

20. The recognized procedures for checks and balances between crewmembers were not followed during this approach.

21. There was no adequate altitude warning system required in air carrier aircraft.

(b) Probable Cause

The Board determines that the probabie cause of this accident was the lack of crew coordination and the inadequate monitoring of the aircraft position in space during a critical phase of an instrument approach which resulted in an unplanned descent into the water. Contributing to this unplanned descent was an apparent unsafe landing gear condition induced by the design of the landing gear indicator lights, and the omission of the minimum crossing altitude at an approach fix depicted on the approach chart.

3. RECOMMENDATIONS

On January 12, 1970, the Board recommended that the FAA take corrective action to ensure detection by flighterews of failed indicator bulbs in the DC-8 landing gear position indicators. On May 22, 1970, the FAA reported that tney had investigated the suspected deficiencies end, in their opinion, the reassessment of the DC-8 landing gear indicator system showed that the system performed its function; had an adequate backup system; and was in conformance with all other pertinent Federal Aviation Regulations. It was their opinion that the landing gear indicator system provided the required reliability and aircraft operational safety. They did, however, recommend that all airlines which did not have a specific check of the indicator bulbs include such a check in their "Before Start" and "Before Landing" checklists. This latter action is one means frequently used to compensate for improvements thut should have been made in the design of a safety feature.

The Board believes that earlier detection and adequate corrective action are needed in cases of this kind. The FAA action was pertinent to the Board's recommendation, but both FAA and the aviation industry should seek long-term corrective actions to eliminate problems of this nature.

The Board stresses the fact that it is the responsibility of the manufacturer and the operator to be alert to identify and correct problems of this nature before they become an accident causal factor. In this case, the aircraft manufacturer and the airline operator have been responsive to the problem. After the accident. McDonnell-Douglas designed alternate landing gear indicator covers that will provide positive indications to flightcrews when one light bulb is inoperative. SAS has installed covers on the landing gear indicators in their DC-8's that perform the same function.

The operational use of this improved design in all DC-8 aircraft would result in an enhancement of safety, complementing the action taken by the FAA.

Two other areas are worthy of consideration from the standpoint of accident prevention. These areas have not been the subject of formalized correspondence between the Safety Board and the FAA but are discussed in the paragraphs which follow.

There was one ancillary procedural service that was provided for the flight that was of questionable merit. This was the act of clearing the aircraft to the transition altitude of 18,000 feet and holding it there for 23 minutes. At the time the flight was cleared to 18,000 feet, it was given the then current altimeter setting of 29.86. The captain reset his altimeter; however, the second pilot, who was manipulating the controls, left his altimeter set at 29.92.

Although the lowest usable flight level varied with the barometric pressure, the existing Federal Aviation Regulations required that the transition from "flight levels" to thousands of feet should have occurred at 18,000 feet or higher. In this case, the actual altitude at which this change should have occurred was 18,500 feet.

The details of transition altitudes are considered pertinent to the controllers for the provision of appropriate altitude separation between those aircraft using 29.92 and those at lower altitudes using the local altimeter setting, It is also considered appropriate that the pilots utilize 18,000 feet as a fixed transition point. Likewise, it is recognized that there are times when the utilization of this altitude is required rather than face system delays at other points.

The Board recommends that when use of the transition altitude is required or opted, the controllers again give the current altimeter setting as the aircraft is cleared to descend below 18,000 feet. This procedure should obviate any possible chance of overlooking or forgetting to set the altimeters properly.

The C&GS approach chart for an LOC(BD)RWY 7R, dated 12 December 1968, for the Los Angeles International Airport carried the notation "ASR/PAR" in the plan view portion although PAR service was not available for this runway. The PAR listing is carried on all approach charts issued by the C&GS for an airport whenever that type of an approach is available for at least one runway. It is conceivable that this listing on a chart in this particular manner could be confusing and be interpreted to mean that the PAR served the runway whose approach procedure was depicted thereon.

The Board recommends that, if the PAR listing is to be carried on all approach charts for the facility where it is installed, the number of the runway(s) served by that PAR be added to the legend.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

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/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

July 1, 1970