AIG/44A/72

DENMARK

DIRECTORATE OF CIVIL AVIATION

AIRCRAFT ACCIDENT REPORT

I/S MAERSK AIR

FOKKER F27 MK 500 OY-APB

Rønne Airport

27. december 1969

Report of the inquiry into the accident to a Fokker F.27, OY-APB, at Rønne airport on the 27th December 1969.

All times in this report are GMT.

Aircraft type:	Fokker F.27 Mark 500.
Registration:	OY-APB.
Owner/Operator:	Maersk Air.
Crew:	Captain Gerrit Burger - injured Co-pilot Captain Leif Troest Jespersen - injured.
Passengers: (Pupils)	First officer Poul Erik Frimor - injured First officer Finn Vejen Bjerre - injured.
Place of accident:	Approx. 460 metres west of runway 29, Rønne airport.EKRN.
Date and time:	27th. Dec. 1969 at 15.55.

Information of the accident.

Information of the accident was received by the duty crew of the accident investigation section of the Directorate of Civil Aviation at approx. 16.00.

An accident investigation team arrived at Rønne airport at 20.35. The team consisted of representatives from the Directorate of Civil Aviation and from Maersk Air. Special tests and research were undertaken by the Dutch aviation authorities, Rolls Royce Limited and Dowty Rotol Limited among others.

Summary.

Immediately after having made an approach with a simulated engine failure a new take-off was made. When the aircraft had accelerated to a speed slightly above V_2 a failure of the other engine was simulated.

When the aircraft was at a height of 120' above the runway it began to tilt, first to the left and then to the right, simultaneously as it lost height.

The loss of height continued until the aircraft crashed in the stony beach about 460 metres west of the end of the runway.

During the "ground run" on the beach the aircraft fuselage broke up completely.

The four people aboard came out of the aircraft via a hole in the fuselage and had been injured in varying degree.

1.1. History of the flight.

As part of the transition training of the company pilots Maersk Air had scheduled training flights on the Fokker F.27 MK 500 for the afternoon of Saturday 27th. December 1969.

Captain Burger of the Fokker company had been put at the disposal of Maersk Air as instructor for this purpose and Captain Jespersen, First officers Frimor and Bjerre were to be pupils alternately. The flight was a final brush-up preparatory to the examination by the civil aviation authorities and was to include take-offs and landings, both on one engine and two engines, in darkness.

The four pilots met at Hanger C, Copenhagen airport, Kastrup, at 14.00. Frimor and Bjerre having already obtained all relevant meteorological information from the weather office.

Rønne airport was chosen for training as the weather here was the most favourable, i.e. 4 km visibility and 4/8 at 600', 8/8 at 1000'.

During the pre-flight briefing the instructor mentioned that the training would include single engine take-offs and landings.

V_1 and V_2 were given as 85 kt. and 90 kt. respectively and flap retraction speed and final take-off climb speed as 105 kt. and 110 kt.

A more detailed briefing of the flying to be carried out was to be given during the flight itself.

Captain Jespersen was the first pupil to fly and he seated himself in the left pilot seat, the instructor sat in the right pilot seat.

First officer Frimor sat in the jumpseat, in between and to the rear of the two pilot seats.

Engine start was at 14.50 and take-off from runway 22, EKCH was at 15.00. The take-off was made on both engines but with the fuel trim reduced to 50 % in order to simulate a heavy aircraft. Captain Jespersen stated that the aircraft was indeed "heavy" to get into the air. After becoming airborne the fuel trim was re-adjusted to 730° TGT. This alteration immediately resulted in an increased rate of climb.

The flight to Rønne was at FL 70 via Kastrup VOR and Ugglarp.

Heavy icing was seen on the front windshield while en route to Rønne and caused the pupil to ask the instructor to put the windshield heater on "high" while the pupil himself inspected the leading edge of the wings with the help of the wing inspection light. Ice was seen on the leading edges but the instructor did not think that it was thick enough at the time for an effective de-icing.

Two normal touch and go landings on runway 29 using the ILS were made after arrival at Rønne. The pupil had both engines at his disposal with the fuel trim reduced to 65 % during these landings according to the instructor.

The third approach and landing was to take place with a simulated engine failure on the right engine. The maximum height during these three circuits was 2000'.

After the second "touch and go" the aircraft was cleared to 2000'. The instructor briefed the pupil on the single engine approach that was about to be carried out while the aircraft was inbound to ROE, including the fact that after landing it was intended to take-off again immediately using both engines, but that an engine failure would be simulated again when the speed had built up to between V_1 and V_2. During this briefing the characteristic noise connected with heavy icing was heard whereupon the instructor again checked the leading edges but was still of the opinion that the quantity of ice was insufficient for de-icing to be effective.

At a time when the aircraft was just about to pass over, or had just passed over the NDB, the instructor reduced the power of the right engine to a torque pressure of about 50 psi - equal to zero thrust.

After passing the NDB a procedure turn was completed and then the glide path was intercepted inbound at 1500' with 16½° flaps set and gear down. On the glide path, at the instructor's request the speed was held at 115-120 kt., 10-15 kt. more than normal, because of the ice on the wings.

According to the instructor the fuel trim was still set at 65 % during this approach.

Flaps were set at 26½° at 250-300' and finally when the pupil was sure that he would be able to land, at 40°. The aircraft then made a normal landing.

After touch down the instructor selected $16\frac{1}{2}^{\circ}$ flaps, re-trimmed the aircraft and asked for take-off to be made at 85 kt.

The pupil applied power to both engines, released the throttles at V_1, pulled the aircraft into the air and ordered "gear up".

The gear came up as the instructor cut the left engine. The pupil established a climb of 9° on the flight director but as the speed reached 97 kt., and he wished to hold V_2 until 400' was reached, he pulled backwards slightly on the control column.

The speed began to drop and at one point the instructor called out "watch your speed". However, according to the pilots, the speed dropped to 88-89 kt. and the aircraft began to roll to the left. At this time the height was about 100'. The pupil counteracted the left roll with the ailerons but the aircraft continued past the horizontal into a roll to the right. According to the pupil's statement this happened a couple of times during which he counteracted the rolls with large movements of the ailerons. He thinks that the speed was about 90 kt. and he stated that he was unable to control the aircraft.

Neither of the pilots noticed the vertical speed indicator but at a time which the pupil estimated was when the aircraft began to lose height as he was able to see the trees or the ground at the end of the runway, the instructor took over the piloting of the aircraft by taking hold of the control column and applied full power to the left engine.

However, the aircraft continued to sink in spite of the fact that the speed was still 90 kt. A shock was felt in the aircraft when it hit some bushes and the ground about 270 metres west of the end of the runway on the slope down to the sea.

The instructor realized that it would not be possible to regain control of the aircraft even before the left engine had managed to develope full power. He therefore pulled both throttles back and the aircraft then crashed onto the stony beach at the edge of the water at the bottom of the slope.

During the "ground run" the aircraft broke into several sections before coming to rest in about $1\frac{1}{2}$-2 metres of water about 90 metres from the first point of contact.

First officer Bjerre was in the forward cargo compartment immediately to the rear of the cockpit and during the collision he was thrown down and knocked unconscious.

Captains Burger and Jespersen and first officer Frimor were injured to some extent but retained consciousness and when they had released themselves quickly found a hole in the front part of the fuselage and got out. Shortly afterwards Mr. Bjerre regained consciousness and was partly able to help himself out of the aircraft and onto land.

1.2. Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Non-fatal	2	2	-
None	-	-	

1.3. Damage to aircraft.

The aircraft was totally destroyed.

1.4. Other damage.

None.

1.5. Crew information.

1.5.1. Captain Gerrit Burger was born on 11th April 1913 in Amsterdam, Holland. An Airline Transport Pilot's Licence had been issued to him on 6th June 1947, had been renewed in July 1969 and was valid until 1st. Jan. 1970. The licence permitted him to pilot multi-engined aircraft not exceeding 2000 kg. and to pilot multi-engined aircraft exceeding 2000 kg. of the Fokker F.27 type.

The Danish Directorate of Civil Aviation had endorsed this licence in a letter dated Dec. 12th. 1969 permitting him to pilot Danish registered aircraft until Jan. 10th. 1970.

The captain's career as a pilot began before the second world war. He was employed in KLM in 1945 and was pensioned off on Dec. 31st. 1968.

He was afterwards employed by Fokker as a flight instructor and as early as Nov. 1968 was re-trained on to Fokker F.27 aircraft. This included 13 hours training flying. In 1969 he flew for 14 days as co-pilot with N.L.M. - Dutch Airlines Limited - in order to obtain practice.

For the last two years before leaving KLM he flew DC8 and then DC7 aircraft. He had an accumulated flight time of about 22,000 hours, of which about 400 were on Fokker F.27.

The flight time on Fokker F.27 was obtained in connection with his job as instructor in the transition training of pilots in Djakarta (5 pilots), Tripoli (10 pilots), Sardinia (9 pilots), and Amsterdam (4 pilots).

Captain Burger flew F.27-500 aircraft for the first time in Denmark. He had not received any special instruction or flight training in connection with the transition to F.27-500. He had acquired knowledge of the differences between the -500 series and the types he had flown earlier by his own efforts.

1.5.1.1. Duty and rest periods.

Captain Bürger had been off duty for 70 hours before beginning work at 14.00 on Dec. 27th.

Since starting flying duties at Maersk Air as instrúctor on 2.12.1969 he had flown 34:40 hours.

1.5.1.2. Significant medical history and medical checks.

Captain Bürger was medically examined in connection with licence renewal on July 28th. 69. There were no remarks.

1.5.2. Captain Leif Troest Jespersen was born on 1st March 1937. An Airline Transport Pilot's Licence had been issued to him on 17th. Feb. 1967 and was renewed on 6th. April 1969. It was valid until 30th. March 1970.

Captain Jespersen learned to fly in the Danish Air Force and served here between 1959-1965. He was then employed by Falck's Air Service until the second half of 1969 when this company was amalgamated with Maersk Air.

Among the aircraft types that he had flown were the Heron and the Hawker HS 748. This last type had been flown since Nov. 1967 and he had hereby accumulated 717.25 hours on the type.

Captain Jespersen's total hours were 3,878 of which 6.15 hours were gained on training flights on the Fokker F.27.

1.5.2.1. Duty and rest periods.

Captain Jespersen had been off duty for 67 hours prior to beginning work at 14.00 on Dec. 27th.

He had flown 99 hours 20 min. in the previous 90 days and 47 hours 45 min. in the previous 30 days.

1.5.2.2. Significant medical history and medical checks.

Captain Jespersen was medically examined in connection with licence renewal on Sept. 2nd. 1969. There were no remarks.

1.5.3. The passengers, first officers Frimor and Bjerre were born on the 7th. July 1937 and the 9th. Sept. 1938 respectively.

First officer Frimor was issued with Airline Transport Pilot's Licence No. 7120 on 19th. Feb. 1969. This was renewed on the 10th. July 1969 and was valid until Jan. 27th. 1970.

His last medical examination was on 7th. July 1969 and there were no remarks.

First officer Frimor had flown NORD 262 and other types. His total flying hours were 3,552 of which 7.15 were gained on training flights on the Fokker F.27.

First officer Bjerre was issued with Airline Transport Pilot's Licence No. 7091 on 27th. Jan. 1969. This was renewed on 22nd. Oct. 1969 and was valid until 9th. May 1970.

His last medical examination was on 17th. Oct. 1969 and there were no remarks.

First officer Bjerre had flown DH 114 and NORD 262 and other types. His total flying hours were 3,949 of which 7.00 were gained on training flights on the Fokker F.27.

Both pilots had been off duty for the previous 67 hours.

1.6. Aircraft information.

1.6.1. Airframe.

The aircraft, Fokker F.27 MK 500 serial No. 10426, was built at "N.V.KONINKLIJKE NEDERLANDSE VLIEGTUIGENFABRIEK FOKKER" in Holland on Dec. 17th. 1969. The aircraft was registered as OY-APB in accordance with certificate of registration No. 2304 issued on 16th. Dec. 1969.

The aircraft was owned by Maersk Air, Copenhagen airport, Dragør.

Certificate of airworthiness No. 1017, issued on 18th. Dec. 1969 was valid until 18th. Dec. 1970.

The aircraft was equipped as a 52 passenger version. A B-check was made on the aircraft on the 26th. Dec. 1969 at 20.00 hours and an A-check on 27th. Dec. 1969 at 14.00 hours.

The aircraft had flown 32 hours 08 minutes since new.

1.6.2. Engine and propellers.

Both engines were Rolls Royce Dart 532-7 turbo-prop. made by Rolls Royce Ltd.

Position	1	2
Serial No.	14289	14305
Manufactured	June 1969	August 1969
Installed in OY-APB	Nov.11th.1969	Nov.10th.1969
Hours since new	32.08	32.08

Both propellers were R 193/4-30-4/61 type and were manufactured by Dowty Rotol Ltd.

Position	1	2
Serial No.	DRG/224/69	DRG/226/69
Manufactured	Sept.27th.1969	Oct.2nd.1969
Fitted on engine	Nov.11th.1969	Nov.11th.1969
Hours since new	32.08	32.08

1.6.3. Weight and balance.

No special weight and balance calculation had been made for this flight. A standard weight and balance calculation had been made however for the use in connection with training flights carried out on the company's 3 Fokker F 27 aircraft.

A basic O.W.E., based on an average of the weight of the three aircraft, was included in the calculations. The calculation also assumed that 4 passengers were on board, one of which was in the cockpit in addition to the two pilots.

During the flight on the 27th. however, only two passengers, of which the one was in the cockpit, were on board.

An investigation has been carried out of the weight and balance condition on the basis of the actual circumstances known to have prevailed during the flight of OY-APB.

The total traffic load consisting of the 2 passengers mentioned and 500 kg. of ballast was 655 kg. Furthermore, 3962 kg. of fuel and 284 kg. of water methanol were on board.

On this basis ramp weight is calculated to have been 17302 kg, the maximum being 20,510 kg. Maximum take-off weight was 20,410 kg.

The centre of gravity is calculated to have been at 28,7 % MAC at the time of take-off. As the forward and aft limits at the weight mentioned are 25,3 % and 38 % MAC respectively the centre of gravity therefore was within the permissible limits at take-off from Kastrup.

The maximum landing weight is 18,600 kg. so naturally this weight can not have been exceeded during the landing at Rønne.

The flight time from take-off EKCH until the time of the accident was 55 minutes and according to the fuel totalizers engine I had consumed 837 lb. and engine II 769 lb., a total of 1606 lb. equaling 730 kg. which by and large agrees with the calculated consumption for the flight.

Assuming that the fuel totalizers were correct the total weight at the time of the accident was 16,572 kg.

Assuming that first officer Bjerre was standing immediately behind the jumpseat the centre of gravity at the time of the accident was 26 % MAC. This is also within the permitted limits for this weight, the limits being 24,1 % and 38 % MAC respectively.

As the weight of OY-APB differs only by 14 kg. from the fleet average weight it is regarded as being of no importance to the values mentioned above.

The amount of ice noticed on the aircraft had such an insignificant weight that it is not regarded as having had any influence on the position of the centre of gravity.

As regards the 500 kg. ballast in the aft cargo compartment neither captain had any definite knowledge of the quantity or the position of this.

1.7. Meteorological conditions.

The VMC forecast valid for the Copenhagen FIR and the Bornholm area for the period 1200-1800 issued at 1115:

Forecast:	High pressure over Poland with a ridge of high pressure over southern Scandinavia.
Weather:	Overcast and misty. Widespread fog or fog banks over the southern and western regions. Risk of supercooled drizzle locally.
Visibility:	3000-6000 metres, in and by fog areas 300-3000 metres.

Clouds:	6-8/8 st/sc 500/1000 ft. by fog areas 5-7/8 st 300/500 ft. in fog vert. vis 100/300 ft.
Freezing level:	On or near the surface.
Icing:	Light to moderate.
Turbulence:	None or light.
Surface wind:	Between SE and SW 5/15 kt.
Upper wind:	S to SW 10/15 kt.

TAF valid 1200-2100 and the other scandinavian TAFs were given to first officers Frimor and Bjerre in document form at the 13.46 briefing.

EKRN

Wind	170 10 kt.
Visibility	4 km.
Clouds	4/8 st 600 ft. 7/8 sc 1000 ft.

TAF valid 1500-2400 given verbally at the briefing:

EKCH

Wind	variable 08 kt.
Visibility	5 km.
Clouds	5/8 st 800 ft, 8/8 sc 1000 ft.

Tempo, Visibility 2 km, clouds 6/8 st 400 ft.

EKRN

Wind	180 10 kt.
Visibility	4 km.
Clouds	4/8 st 600 ft, 8/8 sc 1000 ft.

The actual weather for EKRN was as follows:

1355 Wind 210 08 kt, visibility 5 km, clouds 8/8 st 1000 ft temp. -02 dp. -03 qnh 1031.

1455 Wind 220 10 kt, visibility 5 km, clouds 8/8 st 1000 ft, temp. -03 dp. -04 qnh 1031.

1555 Wind 220 10 kt, visibility 5 km, clouds 8/8 st 1000 ft, temp. -03, dp. -04 qnh 1031.

1655 Wind 200 10 kt, visibility 5 km, clouds 8/8 st 700 ft, temp. -03, dp. -04 qnh 1030.

Over central and southern Skåne supercooled drizzle was observed and a SIGMET was sent from Malmø valid 1740-2130, mod. severe ice rep. in SW part of ESMM FIR and forecast local in whole FIR, cloud top 3000 ft, intensity no change, stationary.

From the Rønne area a pilot report was received at 1805 from a DC9 which reported moderate icing below 2000' at Rønne. A SIGMET was not issued for EKCH FIR.

During the period 1548-1819, i.e. roughly the same period as OY-APB training flights in Rønne, an SAS DC9 was also engaged in flying training. The captain of the DC9 noticed that the cloud base was about 600' and the tops about 3000', the temperature was about $-2^{\circ}C$ to $-5^{\circ}C$.

During the flight anti-ice was used on all systems. After landing it was found that 3-4 cm of ice had built up underneath the wing. The cause of this was given as the comparatively long time in the clouds and conditions connected with the DC9 wing at low speeds.

The captain of SK 247/48, a Convair 440, which landed in Rønne at 1705 and left again at 1731, stated that the cloud base had been observed to be 6-700' with the tops at 3000'. While flying in clouds, light icing had been noticed, but as the aircraft had only been in cloud for a short time, ice had not been a problem.

The crew of SK 245/46, a DC9, which landed in Rønne at 1414 and left again at 1443, did not notice any ice in connection with the flight to or from Rønne.

Sunset was at 14.31.

1.8. Aids to navigation.

1.8.1. Aircraft.

The aircraft was equipped with 2 Collins DF 203 ADF sets, both of which were in order.

It was stated that both sets were tuned to RØNNE beacon, 334 kc. As the ADF sets were seen to have been tuned to 352 and 336 kc. respectively according to readings taken in the cockpit, it must be presumed that the tuning was displaced as the pilots left the cockpit.

2 Collins 618 M/A VHF sets, both of which were in order. COM I was found tuned to 122.75 MC, the frequency for Copenhagen airport's Aerodrome Traffic Information Service. COM II was found tuned to 122.30 MC, the frequency for RØNNE tower.

NAV I and NAV II were both tuned to 110.30 MC, the ILS for runway 29.

The MARKER beacon switch was found in "LOW" position.

1.8.2. Ground.

The following ground based navigation aids were used during the training flights at RØNNE:

Rønne NDB, identification ROE 334 kc, positioned 1.1. NM from the end of runway 29. This was in operation and functioning normally.

ILS Outer Marker, 75 MC, positioned 3.7 NM from runway 29. This was in operation and functioning normally.

The approaches were carried out in accordance with Jeppesen Approach Chart for Rønne airport.

1.9. Communications.

A recording was made of the communication on 122.3 MC between OY-APB and RØNNE tower.

The communications were normal and routine. A copy is given in Appendix A.

1.10. Aerodrome and ground facilities.

1.10.1. Runway 29.

Runway 29 (T.H.294^{o}) in Rønne airport is 2060 metres long and 45 metres wide. The height of the threshold is 51 feet and the slope is -1.0. The full length of the runway was usuable. The surface was dry with ice in patches and the braking action measured by "Messfix" friction meter, just before flying began, was 0,40, 0,55, 0,50.

On the morning of the 26th. Dec. the runway was covered by a compact layer of ice. It was therefore treated with both Isopropanol and Urea as well as gravel.

The runway is equipped with high intensity runway lights and a high intensity approach light system.

It was dark at the time of the accident and the runway lights were on at 100 %. The approach lights were on at 30 %.

1.10.2. Rescue equipment.

Rønne airport had 2 foam-equipped fire tenders with 4 carbon dioxide and 2 powder extinguishers.

A life boat with an outboard engine was also available. This was on a trailer by a slipway leading down to the sea about 600 metres east of the threshold to runway 11.

1.11. Flight recorder.

The aircraft was equipped with a type F-532B United Control Flight Data Recorder. This registers gravity loadings, magnetic headings, indicated airspeed and pressure altitude on a stainless steel tape using the speed of the advancing tape as a time base.

Apart from some minor damage by water the Flight Data Recorder was recovered intact from the wreckage and the undamaged steel tape could be read without difficulty.

In order to analyse the values registered, the steel tape was photographed and enlarged until it was 25 times bigger so that a reading of the tape could be made at intervals of 1.2 seconds. By using a calibrating microscope and the graphs calculated by the United Control Data Division for the sensor in question, the recording for the final two minutes of flight was read and the result reproduced graphically. The aircraft IAS below 100 kt. during the last phase of the flight was outside the range of usability of the recorder and the readings had therefore to be estimated from the manufacturer's calibration graphs. The values thus found were later (see below) verified by measurements on the recorder.

As mentioned, the recorder had received minor damage from water, but after being dried out for a fairly long period in a heated locker it was connected to a test bench and checked. The results were compared with the manufacturer's calibration table and showed no differences except for an altitude deviation of approximately 100'. The deviation found can be presumed to have been caused by the force of the water pressure in the air intake of the recorder during the crash, and can explain the irrelevant marks on the final part of the altitude trace.

As regards the above mentioned speeds of less than 100 kts., a calibration of IAS at 0, 70, 85, and 98 kts. agreed very closely with the values used.

On this basis it must be presumed probable that the recorder was functioning properly immediately prior to the crash and that the values read off are correct within the tolerances allowed.

See Appendix B.

1.12. Wreckage and the site of the accident.

1.12.1. OY-APB crashed on the beach at the water's edge on a course of approximately 290°M in an area immediately to the west of RØNNE airport at a position 5504N 1444E and came to rest 540 metres from the end of the runway about 120 metres south of the runway centre line. See Appendix C.

The coast line is roughly parallel with the extended centre line of runway 29 for about 300 metres and at a distance of about 100 metres away from it.

The foreshore consists of large and small pebbles as well as some very large stones of up to several tons in weight. From the foreshore a relatively steep slope leads up to the airport level 16-17 metres above.

On the eastern part of the above mentioned stretch of coastline it was noticed that branches had been lopped off some bushes and small trees which were situated on the upper edge of the slope about 270 metres from the place where the aircraft came to rest. The fresh breaks in the branches made an angle of 3-4° with the horizontal plane and lined up with the accident site. The bush furthest away from the accident site was topped off at a height equivalent to 1 meter above the level of the airport.

Furthermore, a 6 meter long furrow was observed in the snow on the upper edge of the slope and was measured to be in the direction of 275° M.

It must be taken for granted that APB caused this furrow in the snow and tore the branches off the trees and bushes at the same time.

About 90 metres from APB's tail section, in the direction from which the aircraft approached, there was a very large ice-covered stone in the water. There were scratch marks in the ice and traces of blue paint on the stone.

As the colour of the paint matched that found on the aircraft, it can be established that APB hit the stone and struck the earth at the latest at this point.

At a distance of 12 and 24 metres from the stone respectively, the torn off propellers of the aircraft were seen in the water. A large piece of the aircraft structure was also seen in the water about 40 metres from the stone.

In the region between this large piece of the aircraft structure and the main portion of the aircraft a large quantity of smaller pieces of wreckage could be seen in the water. All the pieces of wreckage seen were in the water. The aircraft was lying in about 1½ metres of water.

Following an external examination of the aircraft it was decided to pull it up onto land. A winch placed at the top of the slope pulled the individual pieces on to the foreshore where further examination was carried out. As it was feared that rough seas would cause further damage should a storm occur, the aircraft was winched from the foreshore up onto the airport area.

1.12.2. The forward section of the fuselage had broken from the remainder just in the front of the wing root and lay capsized in the water with the bottom turned towards land, attached only by wires and bunches of cables.

From a point about 3 metres aft of the nose the bottom of the fuselage had been ripped up and ribs and plating were partly torn off between the two longitudinal crashbeams. The forward sections of the crashbeams, although deformed, were intact, but the rear sections had been torn off. The structure to which the aircraft floor is attached was deformed, but the floor itself was still in place although not intact. The bottom skin and the structure between the torn bottom section and the closed nose-wheel doors were intact but had been pressed inwards to some extent.

On the right side of the fuselage, two holes, approximately 1 x 1/2 metres, made by the right propeller, were seen. One hole was immediately above the front cabin window, the other was a little higher and a little further forward. It must be presumed that the rotation forces in the propeller, after this had parted from the engine, had caused it to fly over the fuselage and that in doing so, two propeller blades had penetrated the fuselage.

The rear section of the fuselage was split longitudinally between the two crashbeams. The tail section and the left side were broken off immediately behind the wing section in one piece, and the right side, from the rearmost emergency exit and foreward to just in front of the rear edge of the wing, was folded out under the wing in another piece. The remaining section of the fuselage below the central section of the wing was completely broken up and smashed. The bottom fuselage structure in the aft section of the aircraft was similar to the forward section in that it had been ripped up and partly torn off as far as the area just in front of the tail bumper, which was still intact on the structure, apparently without having been in contact with the ground during the impact.

During the salvaging it was found that of the 26 double seats in the aircraft, 4 in the left aft fuselage section were attached to the floor tracks. In the right rear section 4 double seats were still attached to the floor tracks and 2 were missing. In the forward section of the fuselage the 4 forward double seats on each side were attached to the floor tracks. The remaining 5 double seats on the left side and the 3 on the right side in the area below the centre section of the wing were all badly damaged. While the seats in the forward section of the fuselage were intact, the remaining seats were all damaged to some degree. The tail section including the fin and stabilizer was undamaged.

The outer three metres of the left wing were bent upwards and the outer three metres of the right wing were broken off completely.

Apart from dents and the impressions of torn off sheeting skin on the bottom, the engine gondolas, the engines themselves and the undercarriage were intact. An examination of all three undercarriage legs showed that these were in the "UP" and locked position. It was further found that the flaps were extended as far as the $16\frac{1}{2}^{\circ}$ mark. When the flap spindles were checked it was seen that these also were in a position equivalent to $16\frac{1}{2}^{\circ}$ flap extension. No defects were found during the examination of the aircraft control system.

1.12.3. The following positions of the instruments and switches in the cockpit were noted after the accident:

Autopilot	manual	
Altimeter L.H.	1031 mb	
Altimeter R.H.	1031 mb	
Fuel quantity		
left tank	3600 lb.	used 837 lb.
right tank	3700 lb.	used 768 lb.
Landing lights		
L.H.	OFF	
R.H.	ON	
Taxi light	ON	
Water methanol switches		
L.H.	OFF	
R.H.	OFF	
Fuel filter heater		
L.H.	ON	
R.H.	ON	
Pitot heater	ON	
Windshield de-icer	High	
Propeller and engine de-ice		
Main cycling switch	SLOW	
L.H. switch	ON	
R.H. switch	ON	
Pneumatic de-icer	OFF	

1.12.4. During the salvaging of the aircraft 20 sacks were found on the bottom of the sea. Some of the sacks contained 25 kg of small pebbles. As the sacks were of the same type and contained the same material as is used by MAERSK AIR for ballast, it can be assumed that they had been put in OY-APB as ballast.

1.12.5. It was noticed that ice had formed on the leading edge of the wings, fin and tailplane. The wings, tail section and fuselage were also covered by a layer of ice.

The ice on the wings and leading edges of the tail was measured on the morning of Dec. 28th. As the air temperature was a little below freezing point it can be assumed that the ice itself had not changed appreciably. The ice on the leading edge of the wings had a width of about 75 mm. and was about 25 mm. thick. The ice on the tail had a width of about 60 mm. and a thickness of 15 mm.

In order to examine and determine the type and origin of the ice, 5 samples were taken from the leading edges of the wings, from the tail and nose sections and from the top of the fuselage. It is possible that some of the ice could have come from sea water picked up during the "ground run" on the beach or possibly accumulated during the night.

The samples were kept in a deep-freezer but unfortunately, technical difficulties with this caused the destruction of all the samples and except for establishing that water from the Baltic sea was present in all samples, further tests were not possible.

1.12.6. A preliminary examination of the engines revealed that extensive damage had been caused to the nose cowling and spinner extension of them both and that the engines themselves had been severely corroded, particularly the magnesium parts. Both propellers had also been torn off. The front part of the housing covering the reduction gear on the right engine had been torn off and several components, mainly those which had been mounted on the lower section of the engines, had been deformed or torn off.

The fuel trim actuators were found in positions corresponding to a fuel trim of 52.8 % for the left engine and 52.7 % for the right engine.

Both propellers were found and each had all 4 blades in place in the hubs. All the blades were severely deformed and signs of damage were seen inside the propeller hubs.

The engines were sent to Rolls Royce, Glasgow. The fuel control units and fuel pumps to Lucas Gas Turbine Equipment Ltd. and the propellers and propeller control units to Dowty Rotol Ltd., Gloucester, for detailed examination under the supervision of ARB.

1.12.7. The examinations at Rolls Royce showed that the rotors of both engines were immovable due to distortion caused by impact. Furthermore, it was shown that the fractures in the propeller axles resulted from torsional shear, leading them to believe that the engines had been producing power at the time of collision. The conclusion was that no damage or defects had been found which could be thought to have been present prior to the accident.

1.12.8. The examination of the fuel control unit and the fuel pump from the right engine showed that these were intact and a trial on the test bench gave satisfactory results. The same was the case with the fuel pump from the left engine but a check of the fuel control unit from the left engine was not possible owing to the severe corrosion. Dismantling of the unit however gave no indication that it had not functioned correctly.

1.12.9. An examination of both propellers at Dowty Rotol showed as regards the left propeller:

- that the 4 blades were bent backwards towards the propeller's pressure side,
- that they were twisted in a way that was characteristic of a propeller in fine pitch at the time of collision,
- that the other damage to the propeller was characteristic of a propeller that had been windmilling at the time of collision,
- that even though the contacts in the propeller hub were heavily corroded and the mechanism of which the contacts were part was destroyed in the accident, nothing was found to indicate that it did not function normally,
- that the propeller pitch lock unit including flight fine pitch stop and cruise pitch stop appears to have operated normally,
- that the damage to blade nos. 1, 3, and 4 eyebolt sleeves and the ball-bearings of blade no. 2 indicate that the blade angle at the time of collision was 20° which is

equivalent to the flight fine pitch stop,

- that neither visual examination nor bench tests indicate any hydraulic, mechanical or electrical defect of the propeller prior to the collision with the ground.

As regards the right propeller the examination showed:

- that blades no. 2 and 3 were bent forwards towards the suction side of the propeller, while blades 1 and 4 were bent backwards towards the propeller's pressure side,
- that traces of green paint were found on blade nr. 3,
- that all blades were twisted in a way that was characteristic of a propeller in fine pitch at the time of collision,
- that the other damage to the propeller was characteristic of a propeller that had been windmilling at the time of collision,
- that even though the contacts in the propeller hub were heavily corroded and the mechanism of which the contacts were part was destroyed in the accident, nothing was found to indicate that it did not function normally,
- that the propeller pitch lock unit including flight fine pitch stop and cruise pitch stop appears to have operated normally,
- that the damage to blade nos. 3 and 4 eyebolt sleeve indicate that the blade angle at the time of collision was 20° which is equivalent to the flight fine pitch stop,
- that neither visual examination nor bench tests indicate any hydraulic, mechanical or electrical defect of the propeller prior to the collision with the ground.

The traces of paint on blade no. 3 of the right propeller match the paint on the holes of the exposed fuselage mentioned in 1.12.2. It can therefore be established that blade no. 3 caused one of the holes in the fuselage. The bending forward of blade no. 3 towards the suction side of the propeller was probably caused after it had been torn off the engine. This is suggested by other indications and damage. The forward bending can have taken place as the blade penetrated the fuselage. If this is correct, then it was blade no. 2 which made the other hole and in doing so was bent forward. Blade no. 3 has then caused the hole over the window and blade no. 2 the hole a little higher and further forward.

The propeller control units were examined both visually and on a testbench. No indications were found that these were not operating normally prior to the accident.

1.12.10. The examination of the accessory gearboxes and accessory gearbox drive shafts revealed nothing to indicate that they had not functioned normally up to the time of the accident.

1.12.11. The technical examinations have not established any defects or damage which can be considered to have occurred prior to the collision with the ground.

1.13. Fire.

No fire occurred.

1.14. Survival aspects.

As regards the passengers, both were in the cockpit area or immediately aft of this.

The passenger cabin aft of the leading edge of the wing was heavily damaged and any passengers in this area would probably have received severe, possibly fatal, injuries. Any survivors would have had the possibility of escaping through the main door or the emergency exit in the left side of the fuselage. Both these exits were above water.

The forward part of the fuselage was intact but tipped over onto it's left side thereby blocking the freight door in the left side. This left only the right cockpit window and the holes in the fuselage for escape.

First officer Frimor released himself from the jumpseat at once in spite of the difficulty caused by the aircraft being tilted. He saw that Bjerre was lying unconscious in the cargo compartment and he immediately went aft into the cabin to look for the emergency exits but had to give up when the water became too deep. On the way back he grabbed some life vests for himself and the other 3 pilots.

Burger left the cockpit first and was followed by Jespersen. When they reached the cargo compartment they noticed a hole in the fuselage through which they both crawled.

Just before the landing Frimor had switched on the landing light when he saw a suggestion of the ground ahead. This stayed on after the aircraft had come to rest and thereby illuminated the area in front of and around the aircraft. The pilots could see the coast and big stones sticking up out of the water and they realized that the aircraft was on the bottom of the sea.

In the meantime, Frimor had returned to the cargo compartment where he thrust the life vests out to the pilots and then attempted to get the unconscious Bjerre out through the hole. He did not succeed in this however until Bjerre regained consciousness and was able to help himself. He was then carried ashore by Bürger and Frimor.

Jespersen had by then jumped into the water and waded ashore on his way to the airport for help.

1.14.2. The traffic controller was in the tower and had watched the event taking place. He alerted the airport rescue service and Falck-Zonen - a large Danish private rescue organization -, Rønne, as soon as he saw the aircraft disappear behind the slope. It was 15.55 at that time. The traffic controller had mistakenly formed the impression in the darkness that the aircraft had descended in the direction of the extended centre line of the runway and he directed the airport's 2 rescue vehicles and the available squad of 3 men to an area on the coast a little north of the centre line of runway 29.

It was not attempted to launch the boat that was available.

A duty crew of 6 men is available for rescue duties etc. during normal flight operations at Rønne airport. This crew is reduced to 3 when training flights only are taking place.

Due to the darkness, the narrow roads where passage was difficult because of snow, and the difficulties of surveying the terrain, the aircraft was not found until 16.08, i.e. 13 minutes after the accident and about the same time that Jespersen reached the airport office.

The first rescue vehicles from Rønne arrived at this time also. This was Falck-Zonen with an ambulance and frogmen. The stretch of coast by the airport extending both east and west is difficult of access because of high, steep slopes leading directly on to the beach. The slopes themselves are covered in several places by a thick growth of bushes, mostly blackthorn. Furthermore, the beach itself is impassable for vehicles because of the large stones.

In addition, on this particular day the slope was very slippery with snow and it took nearly 10 minutes to get Bjerre up to the ambulance, partly because he had injured his back.

From the airport there is only one road down to the beach. This is the road close to which the lifeboat and slipway mentioned in 1.10.2 are placed.

Had this been an aircraft filled or nearly filled with passengers which had crashed in the circumstances described, and with a water temperature of around $0^{\circ}C$, it will be fairly obvious that the possibility of saving those passengers who had survived the crash itself, would have been very limited.

Similarly, the survival aspects would have been very doubtful had the accident occurred under the same circumstances but further out in the sea, when the available sea rescue equipment is considered.

1.14.3. Both pilot seats in the cockpit were equipped with seat belts and shoulder straps. Neither of the pilots were using the shoulder straps. The question of whether or not to use the shoulder straps had in fact, just been discussed between the pilots and agreement reached that they were inconvenient during training flights.

1.15. Tests and research.

None.

1.16. Additional data.

None.

2. Analysis and Conclusions.

2.1. Analysis.

2.1.1. According to 1.12.9 the propeller blade angles were 20° at the time of the accident, corresponding to both propellers being at the flight fine pitch stop. Furthermore, the damage to the propellers indicated that they had been windmilling at that time.

This information is contrary to the result of the engine examinations given in 1.12.7 which, on the basis of the fractures in the propeller axle, suggest that engine power was being produced at the time of the accident.

The former conclusions are thought to be correct as they are largely based on demonstrated facts. In this connection it can be mentioned that Captain Burger has stated that he pulled the throttles back to idle after the aircraft struck the ground.

As the propellers are equipped with an auto-feather system it would have been expected that one or both would have been in the feathered position had an engine flame-out occurred. As stated above, this was not the case and it can therefore be established that the engines were in "idle" at the time of the accident.

As mentioned in paragraph 2.1.2, the speed was approximately 94 kt. IAS in the final seconds immediately preceding the crash. At 90 kts. TAS (ISA conditions) and 15,000 r.p.m. the blade angle will be 27°. It is not known how much the r.p.m. of the left engine had increased and therefore which blade angle had been attained, before the throttle was again retarded, but as regards the right engine it must be presumed that this had achieved 15,000 r.p.m. and therefore a blade angle of 27°:

It will take about 2.6 seconds for the blade angle to move from 27° to the flight fine pitch stop (20°) if the throttle is retarded rapidly.

On this basis it can be established that Captain Bürger retarded the throttles at least 2.6 seconds before impact. At an estimated ground speed of about 90 kt. or 46 metres/second this means that the captain had abandoned all hope of remaining airborne at the latest 120 metres before the impact and at a height of at least 40 feet.

2.1.2. The sequence of events of the take-off, from the moment the aircraft was lifted off the runway until it hit the water, reconstructed from the Flight Recorder read-out, shows that the pilot lifted the aircraft off the runway about 800 metres before reaching the end of the runway at 85 kt. IAS.

A steady climb of about 400 f.p.m. on a heading of about 292-293°, was then established. 6 or 7 seconds later the IAS had increased to 98 kt., which was the highest speed reached during this last part of the flight. The height was then about 45 feet. At this time a heading change of 6° to the left began and the speed began to decrease. This was immediately followed by the climb changing to a slight descent. It must be presumed that it was at this time, or just before, that the power of the left engine was reduced.

About 11 seconds after lift-off the height was 60 ft. above the runway, the speed had fallen to 92 kt. IAS, while the course had altered slightly to the right. The aircraft then began to climb at a rate of about 800 f.p.m. on a steady heading of 285°. When the aircraft was 120 ft. above runway level over the end of the runway the speed had further reduced to 87-88 kt. IAS. The climb stopped at this time and a relatively rapid heading change of 6° to the left began.

19 seconds after lift-off the IAS was 85 kt. and the aircraft again began to lose height and simultaneously alter course slowly to the right. The path of descent was then fairly constant at 1000 f.p.m. until the aircraft hit the water 29 seconds after lift-off.

The IAS of 85 kt. was steady for the first 2-3 seconds and then it began to increase. 4½ seconds prior to the impact with the water at an IAS of 90 kt. a relatively violent change of heading, totalling 13° to the left, was begun.

As stated in 1.12.1, the bushes on the slope were lopped off at an angle of 3-4° for a length of 20 metres. When the contours of the terrain and the direction of the aircraft are considered, it can be established that it was the right wing and possibly the propeller which produced the furrows and lopped off the branches. The aircraft glided down towards the sea at an angle of almost 7°. This indicates that the right wing had lifted and the aircraft had been in a roll to the left when it hit the bushes. It is not known whether or not the roll was a consequence of the aircraft having hit the bushes and the slope.

During the remainder of the flight the IAS increased further to 94 kt. and stayed there for about 3 seconds then fell to 92 kt. just before the aircraft collided with the water.

A graph of the total energy as calculated from the speed and height shows a steady increase to begin with which reached a maximum about 8 seconds after lift-off. This coincides largely with the reduction of power on the left engine. Following a slight fall a fresh increase begins and reaches a maximum 16-17 seconds after lift-off. This slight rise can be explained by the instructor having retarded the throttle more than is required to obtain zero thrust (approx. 40 p.s.i.) and adjusting it correctly a few moments later. Captain Jespersen mentions indeed that at one time the instructor gave a little power on the left engine.

After the 16-17th. second the graph shows a steady fall until the 23rd. second where a slight increase is shown which again decreases during the last 3 seconds prior to the collision with the water, this time more steeply than previously.

This final rise and fall can be explained by the fact that the instructor first opened the throttle of the left engine and then retarded both throttles as mentioned in 1.1.

Whether the changes of heading were the result of yaw, roll or a combination of both cannot be decided by the read-outs from the flight recorder, but eyewitnesses on the ground who saw the aircraft when it was over the far end of the runway, have stated that the aircraft first dropped the left wing and then the right one at the same time as a loss of height was initiated.

2.1.3. It was in the nature of things that the instructor took over the flight controls following the initial roll i.e. at the earliest 10 seconds before the collision with the water. Whether or not he actually took over control of the aircraft will be discussed later.

Captain Jespersen was of the opinion that Burger did not take over until the aircraft had begun to lose height and did not open the throttles until just before the aircraft hit the bushes. Burger himself thought that he took over when Jespersen had apparently lost control of the aircraft and that he immediately opened the throttle on the left engine, which actually agrees with Jespersen's explanation.

The fact that the speed increased during the descent is in itself no proof that more power has been applied, but when the graph of the aircraft's total energy is studied, it seems that, as previously mentioned, the left engine begins to produce power between 5 and 6 seconds prior to the collision with the water.

This implies that Bürger must have taken over and increased the power between 10 and 6 seconds before the collision, equivalent to an altitude between 160 ft. and 100 ft. AMSL.

If the engine acceleration time is taken into consideration it was probably closer to 10 seconds rather than 6 seconds before the collision with the water that the throttle of the left engine was advanced.

Captain Burger has stated that after he had opened the throttle of the left engine, he heard the increased engine noise but did not feel an effect which necessitated equalizing the asymmetrical position of the rudder pedals. However, it must be accepted that as the aircraft accelerated rather energetically, as shown by the rise in the graph of the total energy of the aircraft, the left engine had begun to develop power but lost it again after 1-2 seconds.

Referring to 2.1.1. it can be seen that the throttles were retarded at least 2.6 seconds before the collision with the water and on the basis of the acceleration and total energy graph it must be presumed that this was about 4 seconds before the collision.

As previously mentioned, the complete sequence of events from lift-off to collision took 29 seconds but no real problems arose or were acknowledged until the 16th. or 17th. second, even though problems could have been expected as early as the 12th. or 13th. second when the speed dropped below 90 kt. The instructor was watching the speed and in fact called out *"watch your speed"*.

2.1.4. As mentioned elsewhere, the instructor took hold of the flight controls at a time when Jespersen had lost control of the aircraft. Jespersen regarded this as meaning that the instructor had taken control of the aircraft. However, it didn't mean that Jespersen took his hands and feet away from the flight controls.

Burger has explained that Jespersen had control of the aircraft as it was far too late for him to take over and that he had not called out that he had control. He only had his hands and feet on the controls in order to follow the movements.

With this background in mind it cannot be decided who actually had control of the aircraft although, as a matter of principle, it must be said that Jespersen had control as no order had been given that the instructor had taken over control.

The instructor's explanation that it was too late to take over cannot be accepted as it must be the instructor's responsibility to conduct the training with relation to the circumstances prevailing i.e. the characteristics of the aircraft concerned, the qualifications of the pupil, airport conditions, flight altitude, weather, lighting etc., so that the instructor retains a margin in which action can be taken should he feel that the safety of the aircraft is compromised - the smaller the margin, the greater the vigilance required from the instructor. It must be said that if Burger was of the opinion that it was too late to take over control, then he had delayed too long. The fact that he called out *"watch your speed"* indicated that he was aware of the risk that had arisen and by following developments closely could have intervened in time in one way or another.

A correct reaction would have been for the instructor to open up the "dead" engine again as soon as he saw the speed decrease below V_2. This opinion should be viewed in the light of the fact that he had particularly invited Jespersen to maintain an approach speed higher than normal during the approach that had just been completed. This showed that he thought that the ice had a certain significance and it would have been natural to use this precaution for the take-off procedure as well.

Jespersen on his side took the instructor's operation of the controls as a sign that he had assumed control in spite of the fact that he had not given any orders.

Jespersen felt that he couldn't hold the aircraft and when the instructor took over, thought *"now he's got it, now it'll be allright"*.

Captain Jespersen had a total of almost 4,000 flight hours, of which a great number were as pilot in command. The flight on which he was engaged was a final brush-up as pilot in command preparatory to the official rating check.

Jespersen could have brought the "dead" engine in again if he had identified the situation as dangerous.

It would, however, have been most unusual for a pupil to have done this as it would amount to terminating the manoeuvre because the pupil didn't think that the situation was developing satisfactorily. This of course would normally have been frowned on by the instructor as it would signify the lack of a pupil's traditional respect for an instructor and the confidence that he will be able to cope with any situation.

In any case, it is beyond all doubt that the responsibility for the safety of the aircraft during flight rests with the instructor.

In the light of the above it must be concluded that the situation can actually have been that each pilot thought that the other was flying and so left the aircraft to fly itself during the final phase.

In addition, it must also be concluded that the unfortunate development of the situation could have been terminated if either of the pilots had brought in the left engine as soon as the aircraft went out of control.

2.1.5. Captain Bürger had chosen 85 kt. and 90 kt. respectively as V_1 and V_2.

As regards V_1, this was within the permissible limits considering the available runway length and therefore of no significance for the occurrence.

According to the F.27 Flight Manual (III-65) V_2 should however have been 93 kt. (SL $-3^{\circ}C$ and 16.5° flaps, dry, no slope, 100 % fuel trim) at take-off weight from EKCH.

The value for the actual weight at the time of the accident was 91 kt.

This figures are for a "clean" aircraft and cannot be regarded as applicable in this case as the aircraft in question had a build-up of ice on the leading edges of the wing, the tail-plane and the fin.

V_2 shall be at least 1.2 V_s or 1.1 V_{mc}. With a build-up of ice as mentioned above, the values of V_s and V_{mc} will be invariably increase, which in turn will influence V_2 min.

As previously stated, Burger suggested that a somewhat higher approach speed be used because of the ice. Obviously, the V_2 speed should have been adjusted in the same way.

2.1.6. As mentioned in 1.12.5, ice formation was observed on the leading edges of the wings, stabilizers and fin. The amount of ice found on the morning of the 28th. may be considered to have been approximately the same as was present on the 27th. when the accident occurred, in view of the prevailing circumstances.

The ice build-up began during the flight to Bornholm at FL 70 and its existence had been noted.

Burger's justification for not de-icing before a sufficiently thick layer had built up is in accordance with normal practice. When the de-icing is started there should be a sufficiently thick layer of ice so that it can crack and break away from the rubber de-icing boots.

At which speed the ice has built up and whether most of it was accumulated during the approach before the last landing is not known but there is one definite fact; that the thickness of the ice on the leading edge of the wing after the accident was measured to be 25 mm. (approx. 1 inch), and as the F.27 Flight Manual (II A-12) states: "*Ice accretion to the leading edge thicker than 1 inch should be avoided*", it can be established that the layer which had built up when the aircraft crashed, in any case, was thick enough to ensure that an effective de-icing could have been performed.

One of the factors leading Burger to believe that there was no significant ice build-up on the aircraft was the fact that only normal power settings were used during the approaches. This comparison cannot be applied to the last approach as this was performed on one engine and at a higher speed than normal.

Finally, it should be stated that Captain Burger has not previously flown Fokker aircraft in areas where ice accretion occurs. The flights in Denmark, therefore, were his first experience of icing on F.27 aircraft.

2.1.7. The instructor has explained that he adjusted the fuel trim to 100 % during the last part of the flight, but as is evident from 1.12.6, the fuel trim was found in a position equivalent to 52.8 % and 52.7 % respectively for the left and right engine. With reference to the circumstances it can be taken for granted that the fuel trim was in the above mentioned positions when the aircraft collided with the water.

The basis for simulating a heavy aircraft by reducing the fuel trim is given in the Fokker report, H 27-526, of Jan.25th.

1968. In the summary of this report it is stated: "*In this report take-off data is given with the reduced trim settings in order to simulate at a low weight airplane performance with a large weight for training purposes.*
Note: This report is being supplied for information purposes only. The liability connected with the use of this information shall rest exclusively with the operator."

The actual procedure of simulating a heavy aircraft by reducing the engine power available results in reduced acceleration and thereby use of more runway and a smaller climb gradient, but does not result in any attitude or control changes at a given speed except that the asymmetric situation will not be so pronounced.

An evaluation of the practical value of this procedure on the basis of the above mentioned will not be attempted at this time.

It should be mentioned that neither the pilots nor Maersk Air itself, knew of the existence of this report at the time of the accident.

2.1.8. It is evident from page III 65 of the F-27 Flight Manual that the net climb gradient on one engine ($-3^{\circ}C$, S.L. 36,572 lb.) will be 2.8 % and the gross gradient will be 2.8 % + 0.8 % = 3.6 % based on "guaranteed power" = 96 % of "Nominal Power" which is 1910 b.h.p. so "guaranteed power" will be 1830 b.h.p.

Rolls Royce state that 50 % fuel trim will cause a loss of 295 b.h.p. (ISA). On this assumption the actual engine power will be 1615 b.h.p. or 215 b.h.p. below the values given in the Flight Manual. With 85 % propeller efficiency and taking the reduction in jet thrust into consideration it is estimated that the total reduction in engine power will be 200 h.p.

A loss of 200 h.p. in the circumstances prevailing will cause a decrease in the climb gradient of about 2.0 %. Considering the 52.7 % fuel trim that was actually selected, the gross climb gradient should then be about 1.75 %.

It is evident from the Fokker report H 27-526 that the gross climb gradient based on guaranteed power is about 2.0 % when using 52.7 % fuel trim (ISA). At nominal power the gradient has been calculated to be 2.6 %.

It should be mentioned that it was not possible to read this gradient of 2.0 % directly from the graphs. This result was not obtained until the curves on the graph were extended. Based on a weight of 36,572 lb. and ISA it will only be possible to trim down to about 65 % fuel trim and still stay within the bounds of the existing graph.

It should be noted that a difference of 0,85 % arises in the calculation of the gross climb gradient depending upon whether the F.27 Flight Manual or the Fokker report H 27-526 is used as the basis of calculation.

It should also be mentioned that Rolls Royce Dart engines are adjusted to maximum effect at ISA conditions and although the effect will fall only negligibly from ISA to $-3^{\circ}C$ air temperature, it will make the difference mentioned slightly less.

From the above it can be gathered that even an average pilot should have been able to maintain a positive climb of 1-2 % following the throttling back of the left engine provided that the aircraft was "clean".

Whether it was at all possible to maintain a climb with the amount of ice that was on the aircraft cannot be determined, but it has in any case probably been marginal. There would also have been a further deterioration in performance in connection with the roll and yaw.

A climb equivalent to a gradient of approx.9 % was maintained however, from about the 11th. to the 16th. second after lift-off.

In order to establish a climb which was consistent with a speed of 90 kt. Jespersen was obliged to pull back a little more on the control column as his speed at the time was rather more than 90 kt. This can have been excessive and can perhaps explain why the airspeed dropped so rapidly.

2.1.9. As stated in 1.12.3 the fuel filter heater switches were found in the "ON" position.

On page I-6 of the Flight Manual it is stated: "*The fuel heater switches must be set to OFF during take-off, final approach and landing*".

These fuel heater switches were used while the aircraft was flying around RØNNE airport and the instructor asserted that they had been switched OFF.

The switches are situated on an overhead panel on the right side. This panel also holds 15 other switches of the same type plus a number of dimming rheostats, all of which, except for the fuel switches, were positioned as was to be expected.

Even if the possibility of the fuel heater switches having been moved during the evacuation cannot be excluded, it is remarkable that only the fuel heater switches, and both of them, had been moved.

The hot air valve had been torn off the left engine during the accident. The valve was found in the "open" position and on the basis of the damage caused, the construction and method of operation, it must be considered probable that the valve was in the "open" position when the damage was caused. This confirms therefore the "ON" position of the fuel filter heater switches.

All the performance calculations in 2.1.8 have been made on the assumption that the fuel filter heaters have been "OFF".

However, should this in fact not have been the case, the engine power would have been 8 % less than calculated. The stated climb gradients will then have been about 1.3 % less. In which case the last vestige of climb ability can very well have been lost.

2.1.10. From 1.12.3 it is seen that the engine de-ice switches were "ON" and "SLOW".

Regarding engine ice protection the F.27 Flight Manual states:

"Depending on the indicated outside air temperature the following sequences must be selected:

SLOW - at I.O.A.T. below minus 6°C.

FAST - at I.O.A.T. between minus 6°C and plus 10°C.

Note: *It is important that the correct cycling sequence is selected as selection of a wrong cycling speed will not give adequate protection".*

The minus 6°C I.O.A.T. mentioned equals a true temperature of approximately minus 10°C. As the ambient air temperature at the altitude at which the aircraft was flying was not minus 10°C or below, the cycling switch should have been selected "FAST".

Even if the possibility of the cycling switch having been moved during the evacuation of the cockpit cannot be excluded, then, using the same reasoning as given in 2.1.9, it must be accepted that the system has been operated in the "SLOW" cycle. There has therefore been a risk of a build-up of ice on the propellers and a consequent loss of efficiency.

However, in view of the apparently normal performance of the aircraft during the flight preceding the reduction of power on the left engine, it must be regarded as extremely doubtful that a build-up of ice had in fact taken place on either of the propellers.

The same argument can also be used to exclude a theory that a possible malfunction in one of the cycling switches can have resulted in ice on one of the propellers.

2.1.11. After the aircraft had reached a height of 52 metres and the speed had fallen to 87-88 kt. the aircraft began to roll to the left. Jespersen was able to right the aircraft again by using large movements of the controls but only to have it continue over into a roll to the right. That is to say, the recovery attempts were characterized by large control movements and slow reactions.

In the F.27 Flight Training Syllabus it is stated:

"When approaching the stall, large aileron movement may be necessary to maintain lateral control. However, ailerons remain effective even in the fully stalled condition".

The "power off" stalling speed with 16.5° flap is about 77 kt., and the "power on" stalling speed is somewhat lower. In connection with the fact that ice had built up on the leading edge of the wings in a rather irregular pattern, it must be taken for granted that the stalling speed has increased, perhaps as much as up to 85-90 kt.

The fact that the flight recorder shows that the aircraft was airborne at 85 kt. indicates that the "power on" stall speed on two engines was 85 kt. or lower.

In any case, it seems that the manoeuvre which the aircraft performed can be identified as the result of a stalled, or near stalled, condition. This is supported by the circumstance that the aircraft rolled to the left initially, that is, a left wing stall with "power off" on that wing which would cause it to stall at a higher speed than the right wing which was in a "power on" condition.

It should be mentioned that neither of the pilots noticed the characteristic buffeting in the aircraft in connection with the stall but first officer Bjerre, standing at the back of the jump-seat, could feel the aircraft shake. Finally, the stall characteristics of the aircraft could well have been altered by the ice on the wings.

2.1.12. The question as to whether the wind over the slope could have influenced the flight has been raised. As this wind of 220/10 kt.

was relatively weak and fairly constant and as the distance from the slope to the place where the difficulties began is quite large, it is considered that the effect of the wind over the slope has not been of any significance.

2.2. Conclusions.

2.2.1. Findings.

1. The crew were properly licenced.
2. Nothing has been found to indicate that the pilots were physically or psychically unfit to fly on that particular day.
3. Captain Burger had not received any special instruction or flight training in connection with his transition to F.27 500.
4. The pilots were not using the shoulder harness provided.
5. The aircraft certificate of airworthiness was valid.
6. The centre of gravity was within the permissible limits. A special weight and balance calculation had not been made for this flight but a standard calculation assuming 4 passengers was used for all training flights.
7. No malfunctions or damage were found which can be considered likely to have existed prior to the accident.
8. A possibility of light to moderate icing and risk of supercooled drizzle were forecast. The actual weather in RØNNE was in accordance with the forecasts.
9. Approximately 25 m/m iceformation was found on the wings and it is considered that the same amount has been present at the time of the accident.
10. An approach in darkness with a simulated engine failure on the right engine was conducted with a "touch and go". The ensuing take-off was made on both engines whereafter failure of the left engine was simulated.
11. Command in the cockpit was poor. This resulted in uncertainty as to which pilot was actually flying the aircraft during the final phase of the flight.
12. The V_2 chosen was not in accordance with the speed given in the F.27 Flight Manual for the actual aircraft configuration.
13. The fuel trim was adjusted to 52.8 % and 52.7 % respectively for the left and right engine.

14. Propeller and engine de-icing were selected to "SLOW" sequences in spite of that the O.A.T. were requiring "FAST" sequences.
15. Fuel heaters were selected "ON" in spite of that fuel heaters "OFF" are incorporated in the Approach Checklist.
16. In the configuration used the aircraft has had only a very marginal climb ability - if any at all.
17. Following the simulated failure of the left engine the aircraft at one time had a rate of climb of abt. 800 ft/min. which is equivalent to a climbgradient of approximately 9 %.
18. Both throttles were reduced to idle at least 2.6 seconds before the aircraft crashed.
19. The instructor did not intervene in time in the piloting of the aircraft.

2.2.2. Probable cause.

During take-off followed by a simulated engine failure the aircraft was brought into a situation which permitted only a limited climb ability, if any. In order to reduce the speed, the pupil attempted such a rate of climb that the airspeed fell below that desired, causing the aircraft to stall or at least to be in a condition approaching the stall. The reason why the stall developed into an accident was that the instructor did not identify the situation as dangerous quickly enough and initiate the action necessary.

3. Preventative measures and recommendations.

3.1. Partly on the basis of the experiences gained in connection with the accident to OY-APB, RØNNE airport has aquired a rubber boat of the pontoon type - a Zephyr 504 M - which is equipped with a 40 h.p. outboard engine. Because of its low weight the boat can be carried down the slope and across the beach if necessary.

Three 24-passenger rubber life rafts have also been obtained Stripped of their emergency equipment these weigh about 70 kg. each. The inflatable rubber boat is able to carry the 3 life rafts as well as 4 men and it is thus possible to have an assistant available for each life raft.

As the rafts are sent regularly to the manufacturer for inspection there will be certain periods when only two rafts are available.

While these rafts therefore will always be sufficient to carry 48 people and in most cases up to 72 people, they will not have the capacity to carry all possible survivors of larger aircraft.

An increase in the number of life rafts could be arranged without large financial expenditure but this would then lead to a requirement for increased boat capacity and a possible increase in the manpower available.

As it can hardly be expected that survivors in the water or in an aircraft floating on the water will be able to distribute themselves equally among the rescue craft available it would seem necessary to have a certain excess capacity of space available, in whatever form this may be.

It is recommended that the question of aircraft capacity versus the capacity of the water-borne rescue craft should be given general consideration.

3.2. As mentioned in 1.14.2 only two tracks down to the beach are available and these are positioned 600 metres south east and 200 metres south respectively of the threshold to runway 11.

Neither of these tracks will be of any use to rescue vehicles in the event of an accident unless the accident takes place in the immediate vicinity of the tracks.

It is suggested that additional tracks be provided from the airport level down to the beach. The area on the extended centre line at least should be equipped with this means of access as it must be presumed that the risk of an accident on the beach or in the water will be greatest at this point.

3.3. At a chief pilot meeting held in the directorate of civil aviation on Feb. 19th. 1970 during which the circumstances pertaining to OY-APB's accident were discussed, the question was raised as to whether the existing training regulations were still relevant and whether they could continue to be used for modern aircraft.

Because of this the directorate initiated the appointment of a working group consisting of representatives from aviation organizations and the directorate with the object of revising the training regulations.

The initial discussion of the working group was held on Dec. 1st. 1970 and the final report can probably be expected some time during 1972.

3.4. The 2 pilots did not use shoulder harness during the flight.

Experience shows that a flight crew's use of shoulder harness can prevent injury and loss of life in the event of an accident.

A flight crew's possibility of avoiding injury or loss of consciousness in connection with accidents is of importance in maintaining freedom of movement and therefore for survival. This is of vital importance to the passengers' chances of survival and it is therefore recommended that it be considered whether the use of shoulder harness should be made mandatory for flight crews during take-off and landing when passengers are carried.

3.5. It is recommended that clear agreement between any two pilots at the controls should be reached as to who has control and how/when control is to be transferred.

3.6. It is recommended that a load sheet should be required to be filed for <u>every</u> flight or series of flights. If required this can be based on convenient standard assumptions provided that accurate corrections can be and are made should any of the assumptions change. This would also ensure that the captain was conversant with the ballast/balance conditions.

Directorate of Civil Aviation, april 1972.

APPENDIX A

Transcript of communication on 122,3 Mc/3 between Rønne Tower, OY-APB and Scandinavian/BT on December 27th 1969.

opb	rønne twr oscar yankee alpha papa bravo good afternoon
twr	good afternoon ascar papa bravo
opb	rønne papa bravo descending to flight level three zero presently out of four five approach to your beacon and our intentions is to night fly for about two hours
twr	roger papa bravo cleared inbound at two thousand feet for an ils approach to two niner the wind is two six zero and eight knots visibility five kilometers in mist eight octars at eight hundred feet qnh one zero three one transition level two zero
opb	roger down to two thousand roger o.i your weather altimeter setting one zero three one call you two thousand beacon outbound
twr	papa bravo roger
twr	papa bravo request your flight level now
opb	papa bravo is down leaving three zero
twr	thank you
sk/bt	rønne skandinavian bravo tango we are descending throurh seven zero to five zero we request the an ils approach pull up and a right circuit to two niner
twr	roger skandinavian bravo tango you are cleared down flight level three zero wind is two six zero and eight knots runway two niner visibility five kilometer in mist eight octars at eight hundred feet qnh one zero three one transition level two zero
sk/bt	skandinavian bravo tango roger cleared level three zero altimeter one zero three zero
twr	one zero three one
sk/bt	one zero three one roger
opb	papa bravo the beacon outbound
sk/bt	rønne skandinavian bravo tango now coming down to level three zero
twr	oscar papa bravo roger report on final two niner leavin- one five zero zero feet on the glide path
opb	roger report on final leaving one five zero zero feet on the glide path
twr	skandinavian bravo tango roger maintain three zero in the holding

sk/bt skandinavian bravo tango maintaining three zero
twr oscar papa bravo what is your position and altitude
opb .... fifteen hundred turning inbound
twr roger
sk/bt rønne bravo tango your ils is transmitting a wrong call sign
twr ja it is correct well I thought everybody knew it already but call sign is romeo sierra ta romeo sierra echo it will be changed after newyear
sk/bt roger
opb ...... bravo on glide path fifteen hundred leaving
twr papa bravo roger and skandinavian bravo tango cleared down two thousand feet cleared for an ils approach two niner report leaving two thousand feet
sk/bt roger cleared for an ils we are leaving three zero for two thousand ?feet? one zero three one will check leaving two thousand ?fifteen? hundred inbound on glide path
twr .... roger oscar papa bravo what are your intentions
opb we make.an touch and go back to the beacon
twr roger continue approach to two niner report passing the outer marker wind two six zero ten knots
opb roger
twr you're cleared touch and go two niner two six zero ten knots and climb on two seven zero degress to two thousand feet
opb ....two seven zero two thousand
twr yeah and you past the beacon
twr skandinavian bravo tango position and altitude
sk/bt ?leaving? fifteen hundred on the glide path
twr roger
twr oscar bravo papa when reaching two thousand feet you are cleared back to the beacon for a new ils report passing one five zero zero feet climbing
opb roger when reaching two thousand we are cleared back to the beacon two thousand ?understand? we will report out of fifteen hundred
twr -
opb oscar papa bravo fifteen hundred
twr roger and report passing the beacon outbound again
opb roger
twr bravo tango wind two seven zero and eight knots you are cleared touch and go two niner then a right hand circuit at one thousand feet or below

sk/bt we will make a pull up and stay below clouds for a visual right cicuit

twr roger

opb .... rønne beacon outbound

twr roger you're outbound roger and report the procedure turn completed

opb roger

sk/bt rønne skandinavian bravo tango it's not possible to make a visual circuit we are now fifteen hundred feet heading southbound two one zero

twr roger bravo tango then climb to flight level three zero southbound then cleared back to the beacon

sk/bt (sk/bt og twr samtidig).... cleared to climb to flight level three zero southbound and then back to the beacon

twr -

sk/bt skandinavian bravo tango we are maintaining three zero we are heading back to the beacon for an ils approach

twr bravo tango roger

opb papa bravo procedure turn inbound

twr roger papa bravo report passing the outer marker and what are your intentions this time

opb just touch touch and go

twr roger

twr bravo tango cleared down two thousand feet and cleared for ils approach report beacon outbound

sk/bt skandinavian bravo tango we check inbound øh beacon outbound and we'll check on the two thousand feet

twr -

opb ..... bravo outer marker

twr papa bravo roger and the wind two seven zero and six knots cleared touch and go two niner then climb on two seven zero degres initialy one thousand feet

opb roger oscar papa brav......one tousand papa bravo

twr -

twr bravo tango what is your position and altitude

sk/bt bravo tango we are now turning inbound at fifteen hundred

sk/bt we'll make a full stop landing

twr roger report the outer marker

sk/bt roger i'll check outer marker

twr	oscar papa bravo cleared up to when passing one five zero zero feet you are cleared back to the beacon climbing to two thousand for a new ils approach report beacon outbound
opb	roger at fifteen hundred feet we are cleared to two thousand
twr	-
opb	we are at fifteen hundred
twr	papa bravo roger
sk/bt	rønne skandinavian bravo tango leaving fifteen hundred on the glide path for full stop landing
twr	you are cleared to land two niner wind is two six zero six knots
sk/bt	roger cleared to land two niner
twr	-
twr	bravo tango when will you be ready again for take off
sk/bt	two three minutes
twr	roger you are cleared back track take off position
sk/bt	roger cleared to back track
opb	bravo beacon outbound
twr	roger report procedure turn completed
opb	roger
opb	bravo procedure turn completed
twr	roger continue approach report the outer marker
opb	roger
sk/bt	skandinavian bravo tango is ready
twr	roger bravo tango you are cleared for take off two niner and for an ils approach
sk/bt	roger cleared take off two niner and cleared ils approach two niner
twr	-
opb	papa bravo outer marker
twr	roger continue approach papa bravo the wind is two three zero and ten knots
opb	roger
twr	papa bravo wind two two zero eight knots cleared touch and go two niner then climb straight ahead initialy one thousand feet
opb	?climb? straight ahead initialy two thousand feet
twr	one thousand
opb	one thousand
twr	-
twr	bravo tango report passing abeam the vor east bound
sk/bt	roger will check abeam the vor eastbound and bravo tango now maintaining two thousand

twr -

twr bravo tango cleared holding overhead rønne flight level three zero

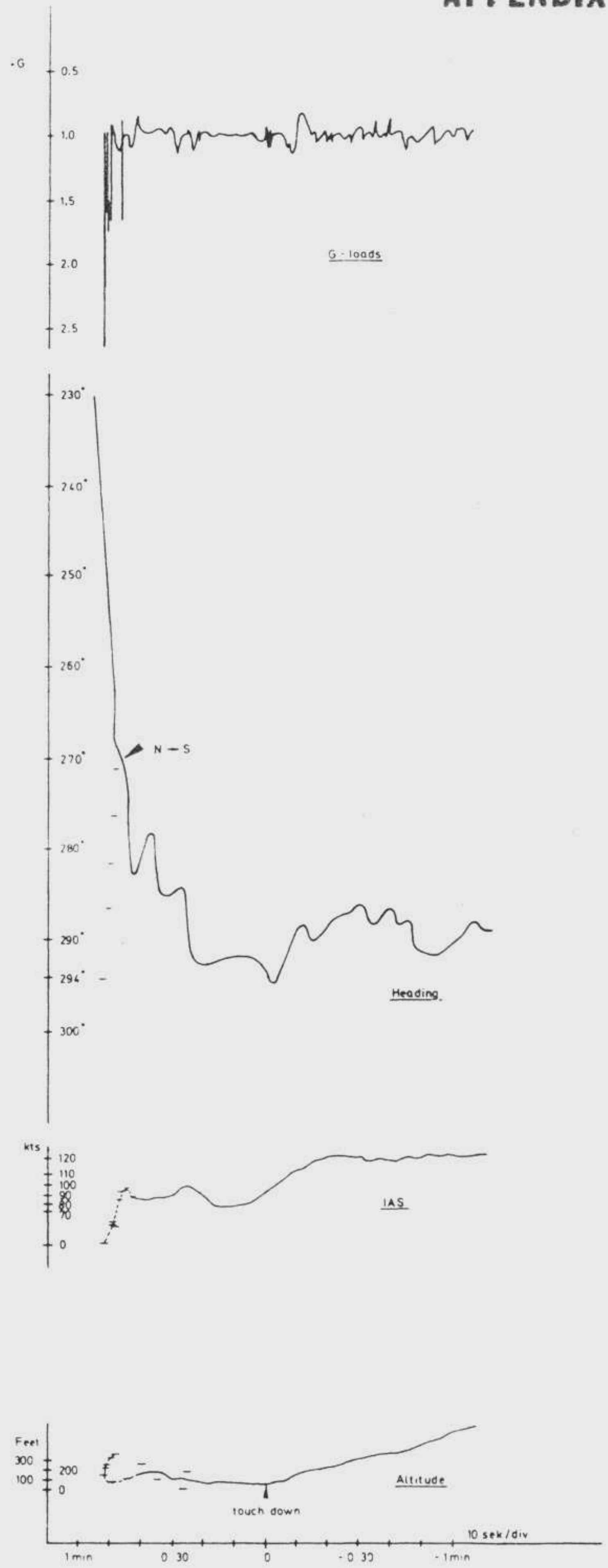
sk/bt skandinavian bravo tango understand take up holding in flight level three zero

twr affirmative we have had a crash here

sk/bt skandinavian bravo tango is now main ?taining?? flight level? three zero

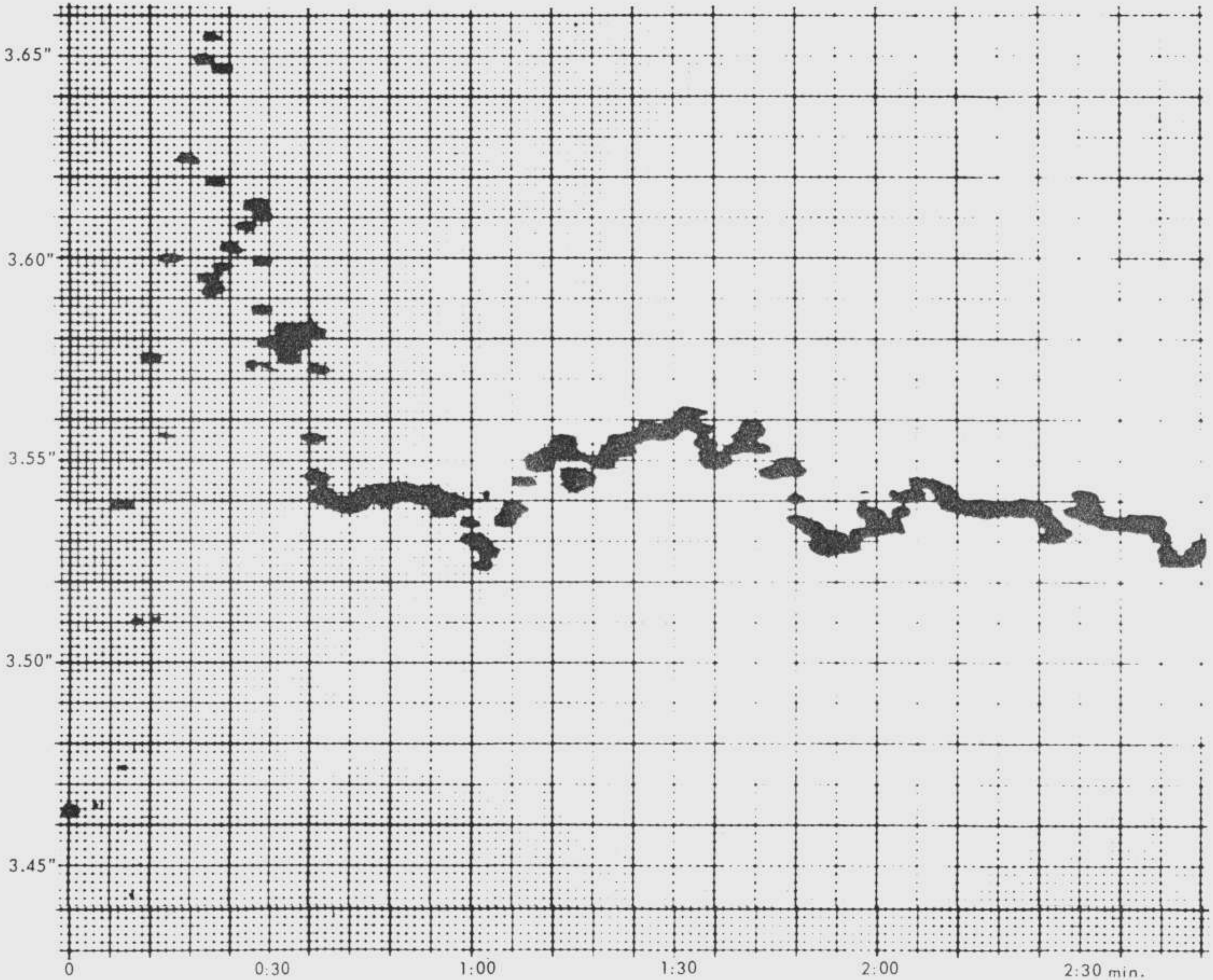
twr roger

APPENDIX B



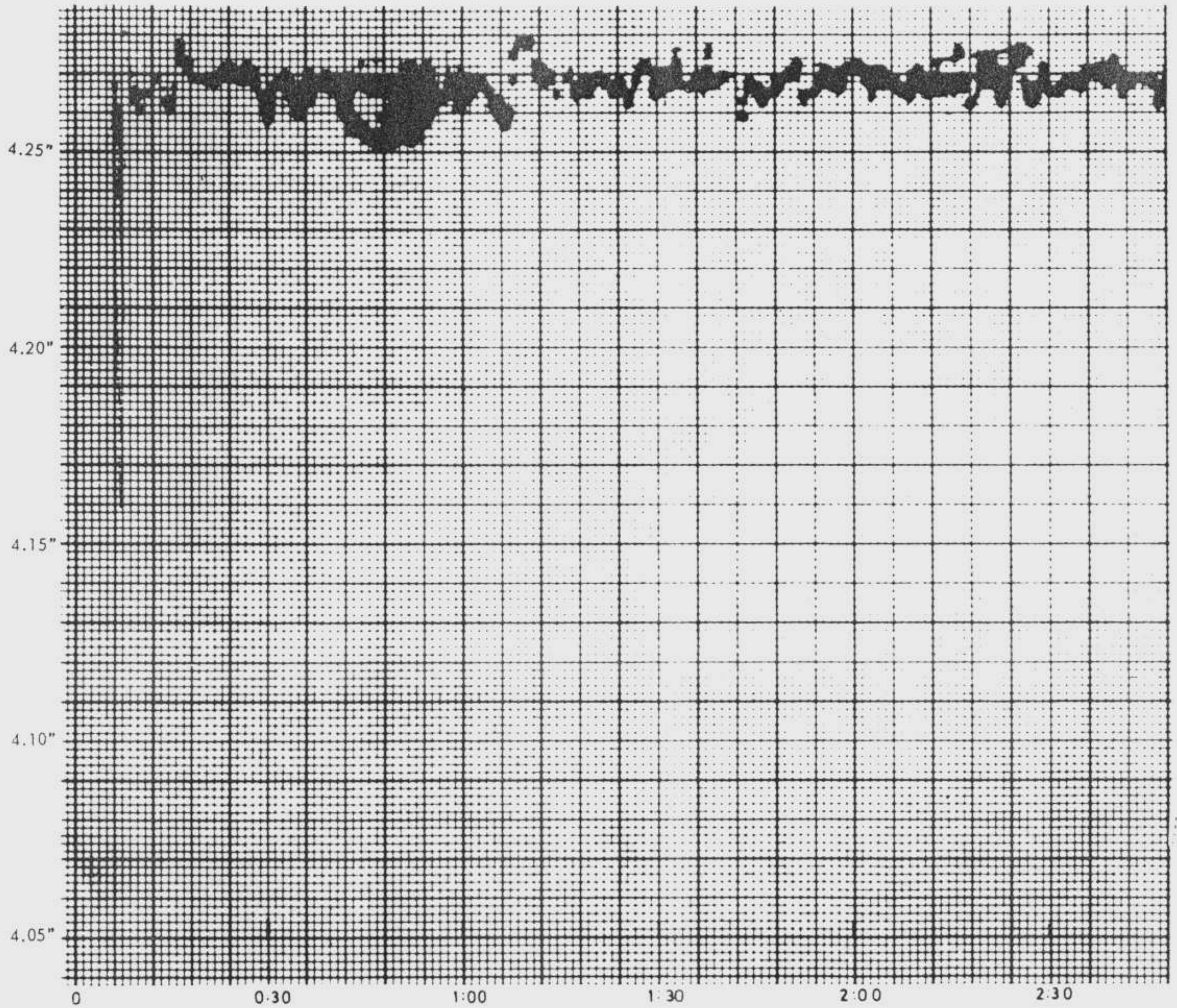
+G
0.5
1.0
1.5
2.0
2.5
G - loads
230°
240°
250°
260°
270°
N — S
280°
290°
294°
300°
Heading
kts
120
110
100
90
80
70
0
IAS
Feet
300
100
200
0
Altitude
touch down
10 sek/div
1 min
0 30
0
- 0 30
- 1 min

OY-APB
Flight Data Recorder
Sensor P/N 100435



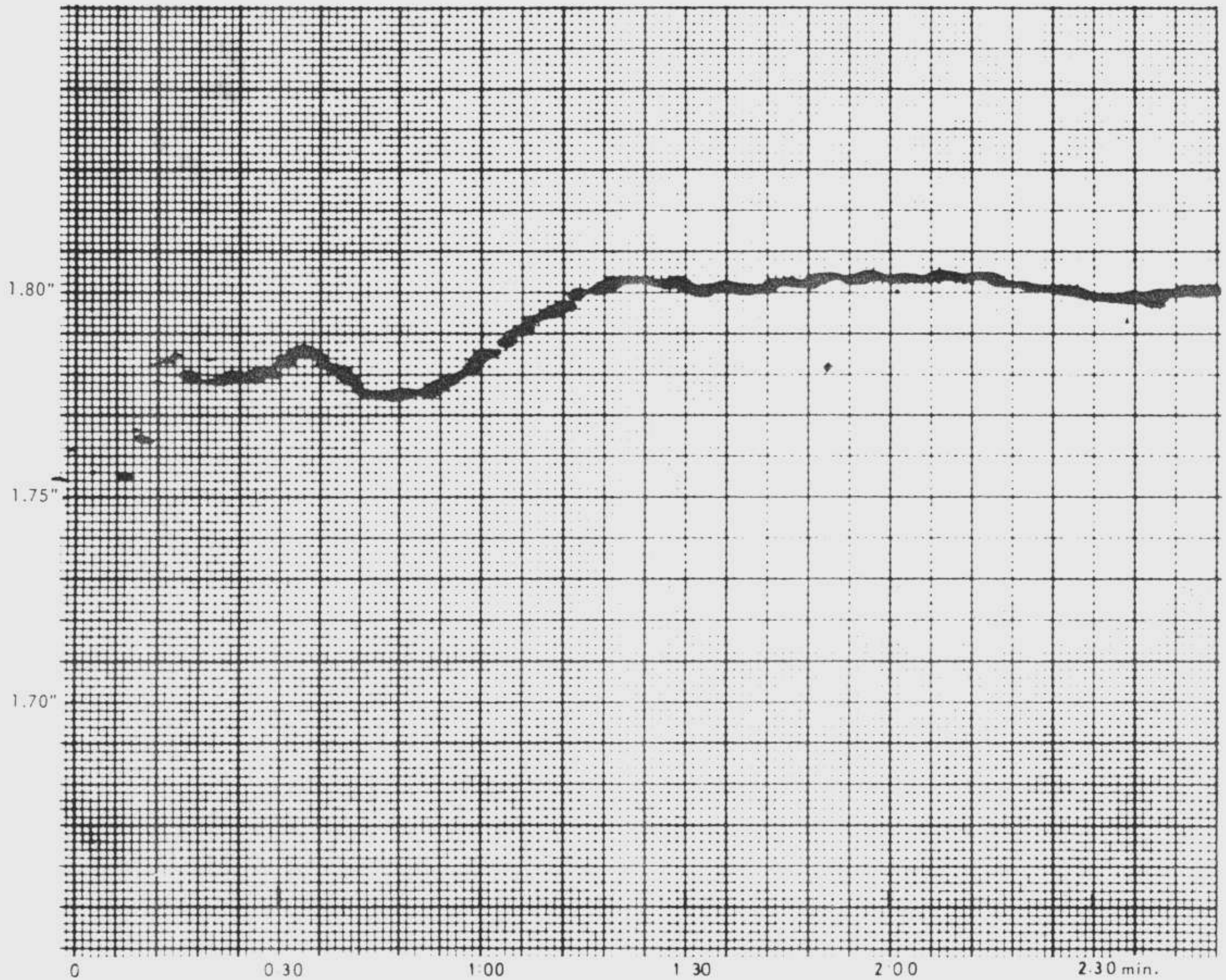
Heading Record
25 times enlarged

OY-APB
Flight Data Recorder
Sensor P/N 100435

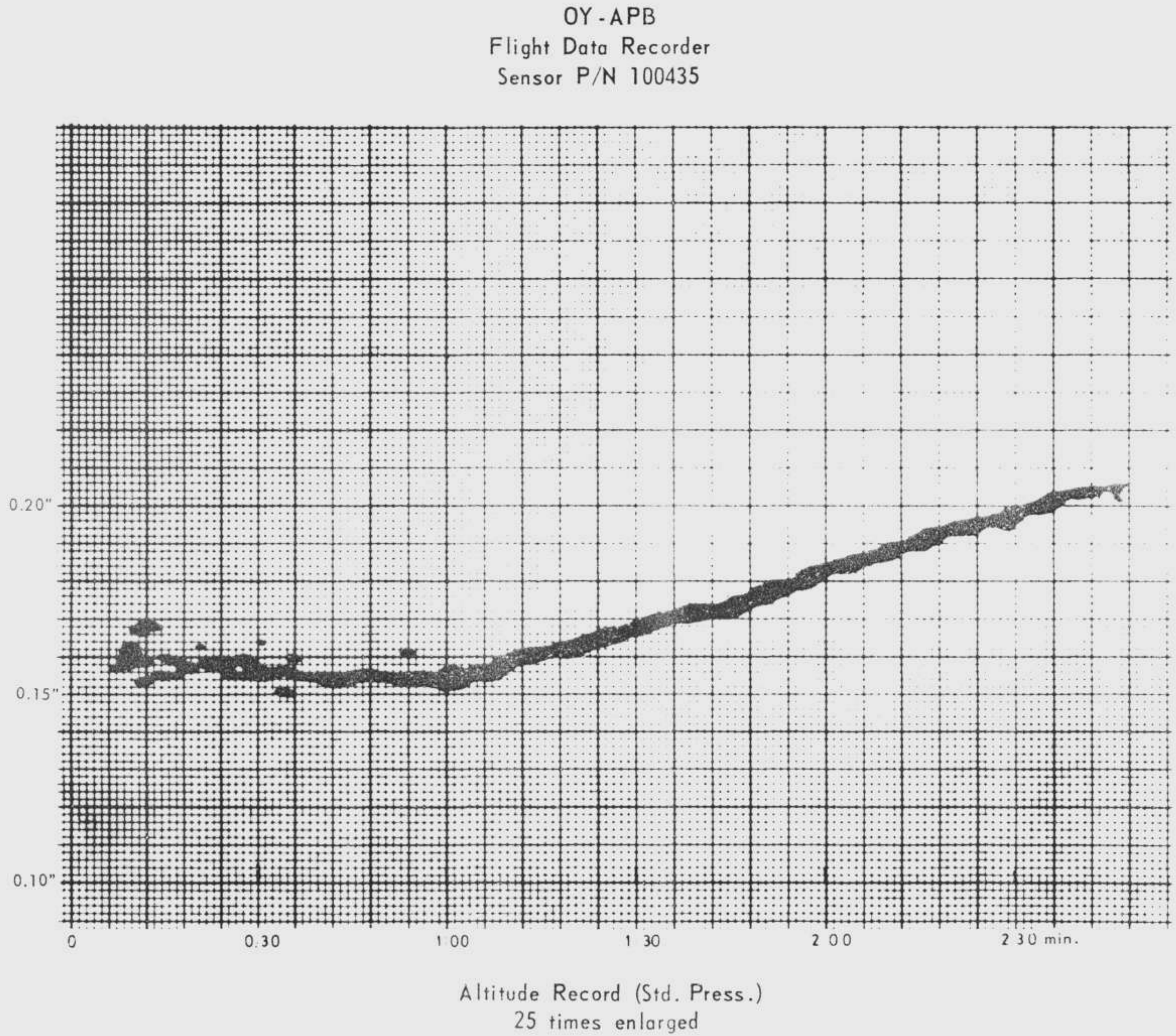


G-load Record
25 times enlarged

OY-APB
Flight Data Recorder
Sensor P/N 100435

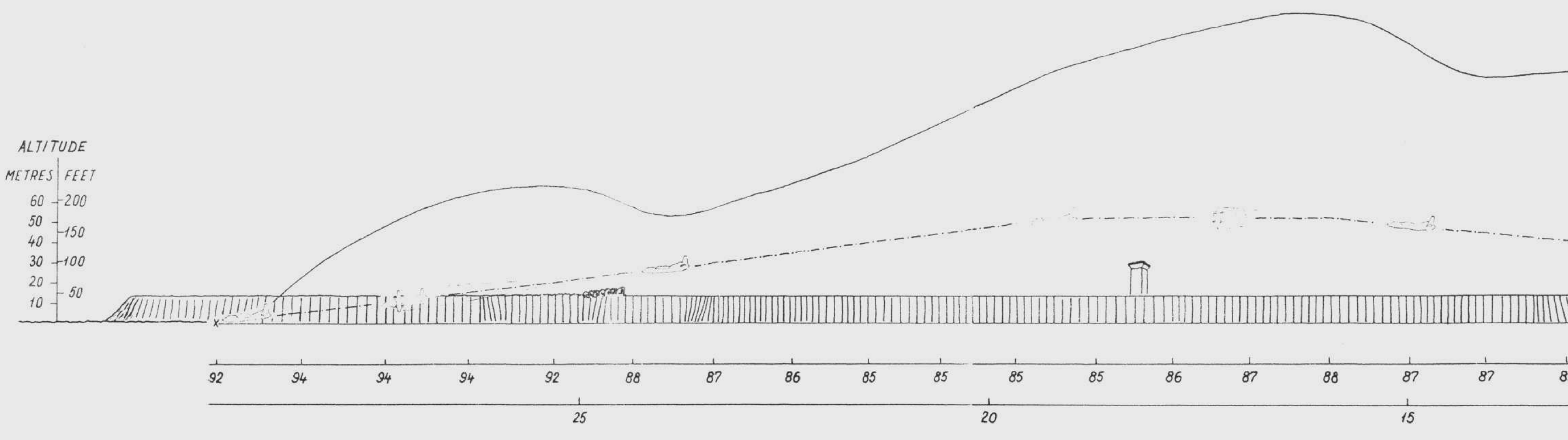


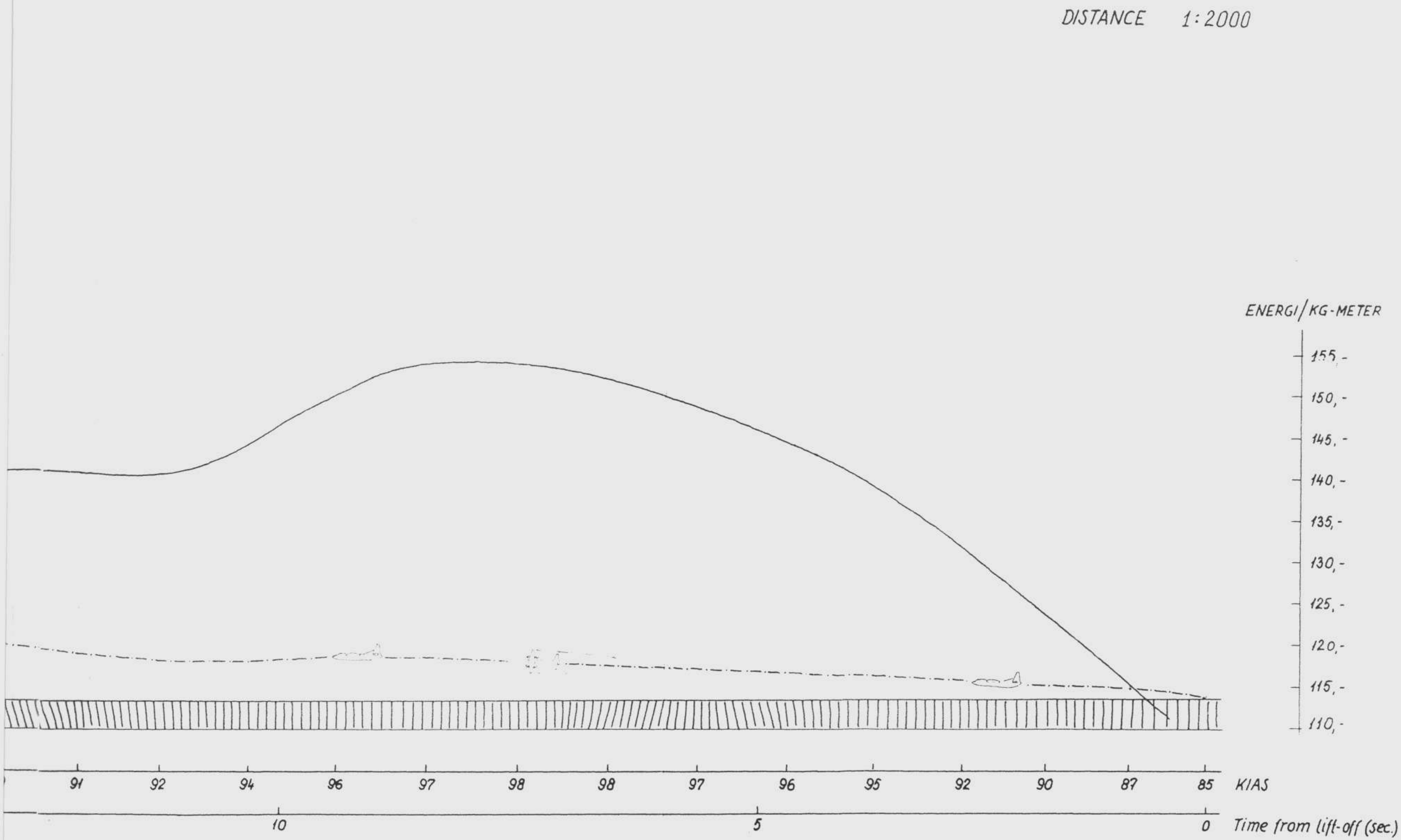
Speed Record
25 times enlarged


OY-APB
Flight Data Recorder
Sensor P/N 100435
0.20"
0.15"
0.10"
0
0.30
1.00
1.30
2.00
2.30 min.
Altitude Record (Std. Press.)
25 times enlarged

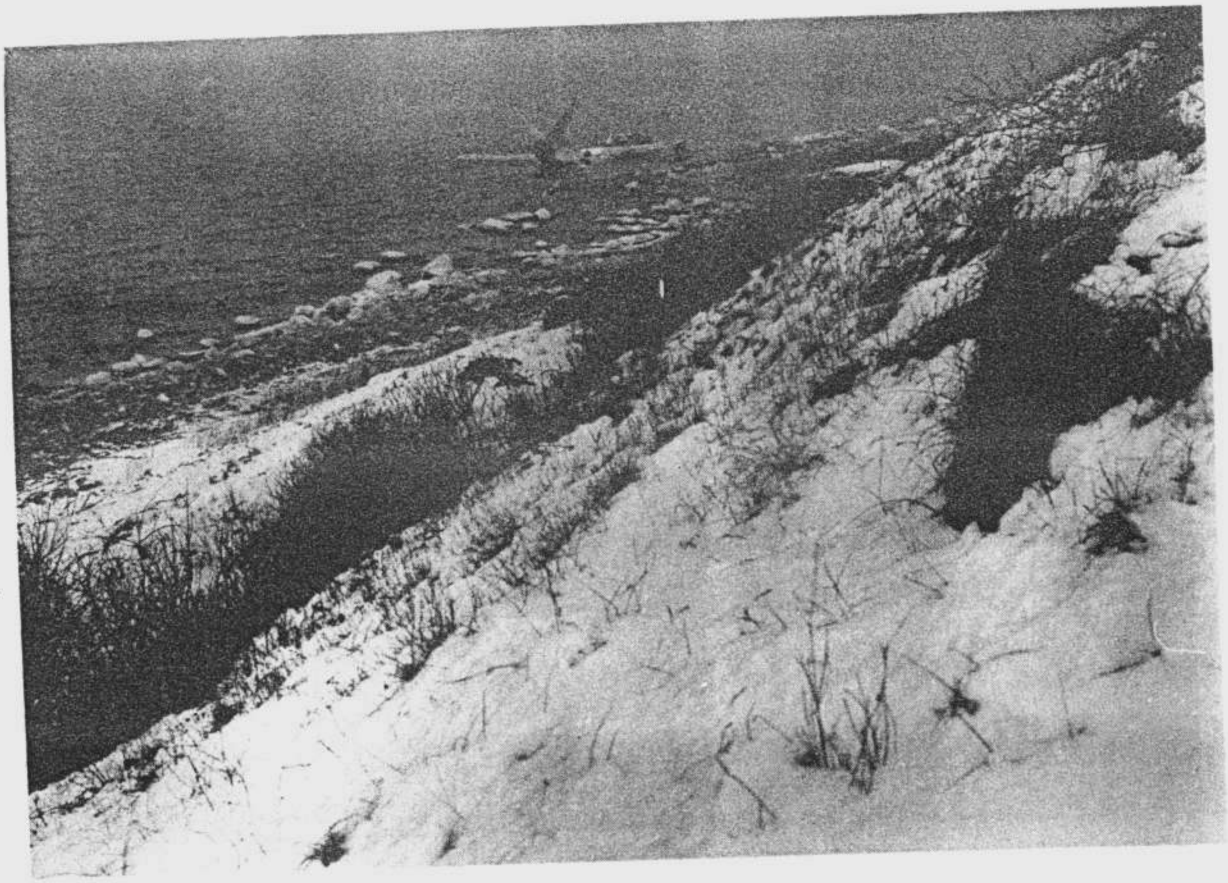
MAERSK AIR FOKKER F-27 ACCIDENT
RØNNE AIRPORT DECEMBER 27, 1969.

Flight Path according to Flightrecorder readout.




DISTANCE 1:2000
ENERGI/KG-METER
155,-
150,-
145,-
140,-
135,-
130,-
125,-
120,-
115,-
110,-
91 92 94 96 97 98 98 97 96 95 92 90 87 85 KIAS
10 5 0 Time from lift-off (sec.)

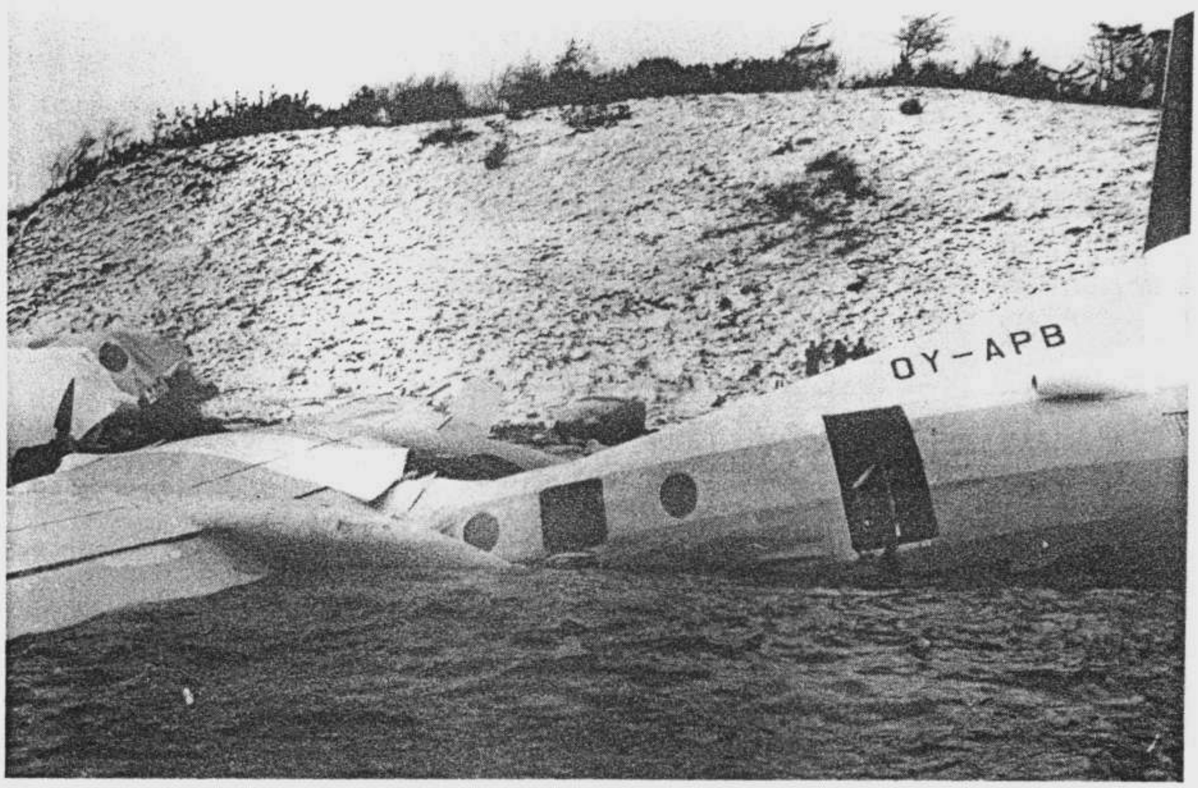
APPENDIX-C



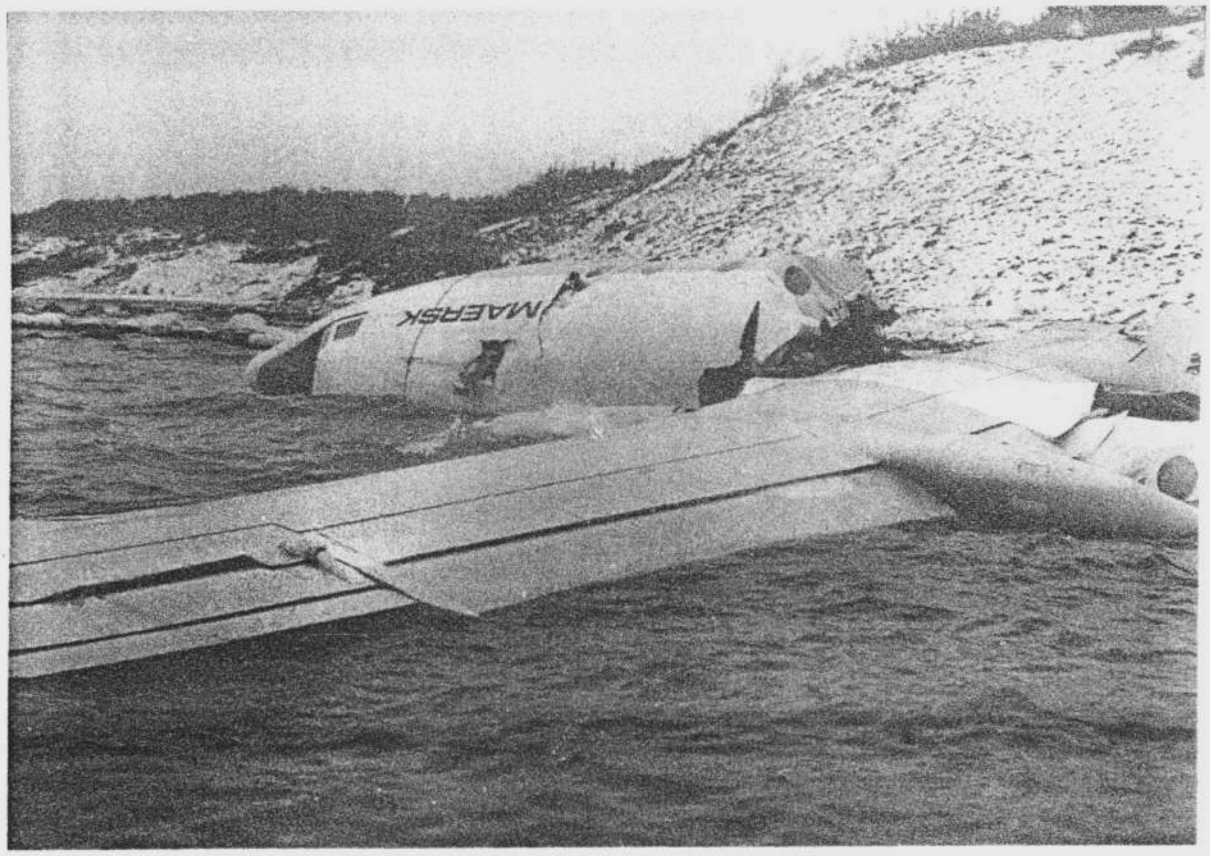
1. Accident site seen from east.

2. The aircraft wreck seen from southeast.

3. Notice the inverted position of the front fuselage and the torn up bottom structure.



4. The aircraft wreck seen from the sea.



5. Notice the two holes caused by the R/H propeller
in the inverted portion of the front fuselage.

6. Notice ice build-up on the leading edges of stabilizer and fin.

7. Front portion of the fuselage after being winched up on to the airport. Notice the torn up condition of the bottom structure between the crash beams. The crew escaped through the hole in the bottom.

8. The left side of the aft fuselage.

9. The right side of the fuselage broken off between the two crash beams.

10. The lower side of the aft portion of the fuselage showing the undamaged tail bumper and the damage to the bottom structure.

11. Crash area seen from glide path to runway 11.