

No. 20

Swissair SE-210 Caravelle HB-ICV, accident at Dürrenäsch
(near Zurich/Kloten Airport), Switzerland on 4 September 1963.

Report, dated 10 March 1965, released by the Swiss
Accident Investigation Commission

1. Investigation1.1 History of the flight

Flight SR-306 was a scheduled international flight from Zurich to Rome, with an intermediate stop at Geneva. Dense fog was existing at the time of departure and at 0600 hours the flight was informed that the RVR was 180 m for runway 34 and 60 m for runway 16, and that there was a light northerly wind (1 to 2 kt). At 0604 hours the flight was authorized to taxi to runway 34 behind an accompanying vehicle. At 0605 the crew reported that they will taxi half way down runway 34 to inspect the fog condition and then return to take-off position. This was done, using at times considerable engine power probably in an attempt to disperse the fog. Around 0612 hours the aircraft was back to the threshold of runway 34 and permission to take-off was granted. The flight took off at 0613 hours and started to climb to flight level 150, its cruising altitude. (See Figure 19) Four minutes later witnesses on the ground noticed a whitish trail of smoke on the left side of the aircraft and suddenly a long flame from the left wing-root. Around 0620 hours the aircraft reached an altitude of approximately 2 700 m, it then began to loose height, entered a gentle left turn losing height more rapidly and finally went into a steep dive. Parts of the aircraft became detached and at 0621 hours a "MAYDAY" message was received. At 0622 hours the aircraft crashed into the ground on the outskirts of Dürrenäsch, at an elevation of 559 m, approximately 35 km from Zurich/Kloten Airport.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	6	74	
Non fatal			
None			

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

Damage to property on the ground was considerable and amounted to "almost 100 000 Swiss francs".

1.5 Crew information

The pilot-in-command, age 39, had a valid airline transport pilot's licence and a total of 7 600 flying hours including 380 hours on Caravelles. He was in good health, with an above-average rating; he had had two days rest before the flight.

The co-pilot, age 39, had also a valid airline transport pilot's licence. He had over 6 000 hours of flying with Swissair, more than 380 hours being on Caravelles. He was in good health, his rating upon retraining for Caravelle was average, and he had had three days rest before the accident.

Qualifications of the four cabin attendants were not mentioned in the report.

1.6 Aircraft information

The certificate of airworthiness of the aircraft was valid until 31 December 1964.

The last 250-hour T check had been carried out on 30 August 1963, around 35 flying hours before the accident. The entries in the relevant documents indicated that the prescribed maintenance and servicing had been carried out at the prescribed times. No major defects or deficiencies had occurred, nor had the aircraft been damaged at any time. A "K-check" and a "V-check" were carried out at Zurich and nothing abnormal was found.

At the time of departure the aircraft's gross weight was 44 635 kg and the centre of gravity was 29.8%, both within the permissible limits.

The type of fuel used was not mentioned in the report.

1.7 Meteorological information

The general meteorological conditions were marked by a high-pressure ridge over Central Europe. The rising warm air increased the cloud formation and extensive fog descended in the early morning. Zurich airport was shrouded in dense fog. Above the fog there were 2/8 Sc at 3 000 m and 4/8 to 6/8 Ci at 7 000 to 8 000 m. An observation station 550 metres from the end of the runway 34 reported the following:

<u>at 0550 hours</u>	<u>at 0620 hours</u>
runway visual range: 60 m	300 m
vertical visual range: 90 ft	100 ft

The mobile station at the beginning of runway 34 reported a runway visual range of: 210 m at 0500, 180 m at 0600 and 210 m at 0632 hours.

1.8 Aids to navigation

When taking off on runway 34, two beacons (OZ and Rhein) located respectively at 5.5 km and 11 km from the end of the runway, may be used.

1.9 Communications

Communications were normal until 0616 hours approximately; then, after a silence of about 5 min, the emergency call was sent. This was the last message of the aircraft.

1.10 Aerodrome and ground facilities

Runway 34 is 3 700 m long and lights on the edge of the runway are spaced 30 m.

1.11 Flight recorders

The aircraft was equipped with a Fairchild flight recorder. The tape was damaged during the accident, however, most of it was readable.

In the period from 0608:46 to 0611:55, no interruption in the readings of minor speed increases due to vertical acceleration or changes in direction normally associated with the halting of an aircraft were observed. The speeds during this period were occasionally somewhat greater than normal during taxiing operations. The following average speeds were read out:

	<u>distance</u>	<u>speed</u>
- from parking location to runway No. 34	(1 000 m)	10 kt
- taxiing on runway No. 34	(1 450 m)	13 kt
- taxiing back on runway No. 34	(1 800 m)	18.5 kt

Take-off began at 0612:43, lift-off at 0613:25. Other read out of interest were:

- 0613:45 Changes course to 220 (over outer marker).
- :55 Speed increases somewhat irregularly to 202 kt, altitude increases steadily to 6 500 ft above sea level.
- 0618:31 Speed drops - slowly at first - then increasingly rapidly to 155 kt, altitude increases steadily to 8 600 ft above sea level.
- 0619:52 Speed increases again towards 175 kt (speed unreadable hereafter). Altitude increases steadily to 8 780 ft above level.
- 0620:05 Altitude decreases to 8 600 ft above sea level.
- 0620:43 Vertical acceleration indicates switch-over in electrical current. Altitude decreases more rapidly.
- 0620:50 At 7 900 ft above sea level (altitude unreadable hereafter).
- 0621:04 (Emergency message: MAYDAY - MAYDAY)

Acceleration recordings cease (failure of current)

1.12 Wreckage

Following the crash, fragments of the outer locking ring of the tire of No. 4 wheel, a grounding cable complete with connecting cables, a "blow-off" mark, as well as small quantities of hydraulic oil were found on the threshold of runway 34. The track of the aircraft during the take-off run was visible for a distance of approximately 1 600 m from the runway threshold. The "blow-off" mark was found between the tracks of the two pairs of wheels of the left landing gear. After that point traces of hydraulic oil were found at regular intervals of approximately 140 cm over a distance of around 60 m on the left side of the track. Fragments of the tyre of No. 4 wheel were found between 1 350 m and 1 700 m from the threshold of runway 34.

Along the flight path, over a distance of approximately 12 km, a number of parts of the aircraft were found, originating from the left landing gear shaft, the rear portion of the left wing, the lower surface of the fuselage behind the trailing edge and the tail. In the vicinity of the crash site the number of parts increased steadily. Important components of the brake parachute installation were found 5 km from the accident site, those of the bracing of the tail hull 3 km, the left landing flap 2 km, and the tail gangway 1.7 km from the accident site.

The devastation caused by the accident covered a rectangle approximately 400 m by 230 m. About one third along its longitudinal axis, there was a crater 20 m in diameter and about 6 m deep. Most of the wreckage was found at the crash site; remains of passengers and crew were only found at this location. Approximately 90% of the entire aircraft structure was recovered and identified.

1.13 Fire

Further to the initial in-flight fire, a violent fire, which lasted about 2 1/2 hours, broke out at impact.

1.14 Survival aspects

None.

1.15 Tests and research

The fragments of No. 4 wheel's rim flange which were found on the runway, and fragments of No. 3 wheel rim revealed intergranular fracture structure, which could only be duplicated at temperatures of over 250°C. It also revealed deposits of burned hydraulic oil.

Detailed mechanico-technological, metallographic and X-ray examinations of the wheels' body did not reveal defects or flaws. Tire parts were examined, signs of explosion were found on No. 1, 2 and 4 wheels' tires (left landing gear), whereas no sign of explosion were found on No. 5 to 8 wheels' tires (right landing gear).

Braking tests were conducted both on the test bench and during aircraft taxiing. It was found during the bench tests that when the brake discs became white hot, the wheel flange burst off from the whole circumference of the wheel rim with fragments flying off at high speed. The fracture structure was identical in shape and nature (intergranular) to that found on No. 4 wheel. Following the fracture, hydraulic oil leaking from the fractured leads and the tire padding caught fire.

1.16 Fog dispersal method

The following fog dispersal method was contained in paragraph 10.2.7 of the "Flight Training and Flying Procedures SE-210", Training Manual 1st Edition, published by Swissair in November 1961:

"FOG DISPERSAL-TAKE-OFF"

If ground fog persists with a runway visibility below the normal take-off minimum of 400 m, fog may be temporarily lifted with the following conditions:

- a) Visibility on the runway at least 100 m.
- b) Wind speeds less than 3 kts (no obvious drifting of fog).
- c) Back track on the runway for at least 1,000 m close to runway edge for take-off, rpm 6,000 - 6,500, brakes smoothly applied to avoid acceleration of aircraft.
- d) Stop twice on the way down (1/2 way + 100 m before take-off point), apply 7,000 - 7,500 rpm for 15 sec., reduce power again to 6,000 and start taxiing on.
- e) Assistance of ground van inspecting visibility increase is of utmost value.
- f) Start take-off as quickly as possible. This fog dispersal procedure will provide a tunnel 40 m wide, 25 feet high, visibility 400 - 800 m, effective for 2 - 5 minutes.
- g) Warning: It must be stressed
 - that crosswind will close the tunnel again and
 - that careful use of brakes is necessary to avoid hot brakes on take-off."

This was deleted from the 2nd Edition of the Training Manual published in November 1962. However the method was mentioned during the retraining course followed by the two pilots of the ill-fated aircraft, from November 1962 to February 1963.

2. Analysis and conclusions

2.1 Analysis

It was determined that the wheel flange of No. 4 wheel split while the aircraft was performing a turn in order to position itself in the take-off direction and that the tire exploded as a direct consequence thereof. The condition of the brake discs and tappets, as well as of the brake shoes, indicated that the brake system had become overheated prior to take-off, as a result of prolonged braking. Tests and calculations showed that such overheating could lead to a wheel fracture of this kind.

At least at the beginning of its outboard run down runway 34 the aircraft was taxiing at a relatively high number of revolutions per minute; the return run showed occasional high rpm and was most likely carried out without any intermediate stops. The pilot-in-command most likely did not use the fog dispersal method but tried to improve runway visibility temporarily by increasing engine power without stopping.

It was considered that deliberate braking by the pilot-in-command most probably caused the overheating of the brakes. Whether intentional or accidental braking caused any additional effects, was not ascertained. There were no positive indications of accidental braking due to irregularities or defects in the braking system. However, although overheating of the brakes was found on both landing gears, the possibility of an accidental braking could not be ruled out.

Testimonies revealed a rapid transition, a few minutes after take-off, from a white smoke trail to an extensive fire in the area of the left landing gear shaft. Tests and calculations showed that the wheel rims reached their maximum temperatures only a few minutes after the braking operation. Examination of the wreckage revealed that a primary source of fire existed in the left landing gear shaft in the area of Nos. 3 and 4 wheels, and that No. 3 wheel burned in the air. Traces on the runway showed that hydraulic oil must have leaked from the No. 4 wheel braking system and burned, even at the beginning of the take-off run.

Therefore the outbreak of the fire might have been caused either by the fracture of No. 3 wheel in the air, due to overheating of the brakes, or the spreading of the fire caused by the fracture of No. 4 wheel on the runway.

Evidence of heavy demands on the entire braking system before take-off was found. Statistics proved that No. 4 wheel was one of the wheels bearing an above-average load, however this did not exclude a similar possibility for No. 3 wheel. It is quite possible that the rim of No. 3 wheel only reached its critical temperature during flight. Exactly when No. 3 wheel burst in the air was not determined, but it was not considered as particularly essential.

The fracture of the rim might have damaged fuel lines and the leaking fuel might have become ignited on the overheated brake parts. The neighbouring fuel lines might also have been damaged by the fracture or might have melted due to the fire. The overheating due to the heat from the brakes and the fire also burst Nos. 1 and 2 wheels. This caused further damages which must have led to further spreading of the fire. Subsequently, the fire -- fed by fuel -- spread from the left landing gear shaft to both the outside and inside of the fuselage and also affected the rear of the fuselage and the tail unit.

Another possibility was that the fire which resulted from the fracture of No. 4 wheel on the runway, had not been quite extinguished when the landing gear was retracted. Following lift-off and immediately prior to retraction, the fire might have been fed by hydraulic oil leaking from the wheels or might have become re-ignited after having been temporarily extinguished. Such a fire might first have spread to the tires and then to the wheel rim of No. 3 wheel. Because of the air current prevailing in the landing gear shaft during flight No. 3 wheel must have been especially exposed to the effects of the burning gases from No. 4 wheel which was located just above it. Also the deformation of the rim fragments from No. 3 wheel could hardly be explained without prior effects of burning with localized, concentrated increases in temperature. It therefore appeared more likely that the fracture of No. 3 wheel was a consequence of the fracture of No. 4 wheel (See Figure 20).

The flight appeared normal for the first five minutes following take-off. The increasing loss of speed which occurred after 0618 hours reflected the first obvious effects of the fire on the aircraft's performance. It was assumed that the crew became then fully aware of serious difficulties and tried to identify and correct them. This would explain the radio silence at that time.

The flight recorder data showed that difficulties increased after 0620 hours: the aircraft veered to the left, its altitude decreased rapidly, switch-over operations indicated a malfunctioning of the electrical system. As a result of the fire, different aircraft parts broke off with increasing frequency and the flaps were presumably extended to approximately 20° in an attempt to keep control of the aircraft. Whether the left power plant had been deliberately cut off, or lost due to an interruption in the fuel supply, was not determined. The emergency call at 0621 was sent when the crew realized that their efforts were hopeless and that disaster was inevitable. The final loss of control, which was clearly indicated by the dive, was caused by one or more of the following factors:

- The structural stiffness of the left wing, the rear of the fuselage and the flight control system might have diminished under the influence of the heat and resulted in a considerable deterioration of the aircraft's flying qualities.
- The hydraulic system might have been damaged in such a way as to possibly cause loss of aileron elevator and rudder control.
- The destruction of the rear of the fuselage might have damaged the setting of the elevator unit to such an extent as to make the elevator control ineffective.

The explosions at impact were caused by the mechanical effects of the impact and the subsequent atomization of fuel which created, at least in some areas, an explosive gas mixture.

2.2 Conclusions

Findings

The pilot-in-command and the co-pilot were duly certificated and qualified for the flight.

The aircraft had a valid certificate of airworthiness and had been properly maintained. Its gross weight and center of gravity at the time of departure were within permissible limits.

Extensive fog existed on runway 34 at the time of take-off and the pilot-in-command decided to taxi halfway down the runway to inspect the fog condition and then return to take-off position.

During this process overheating of the brakes occurred, No. 4 wheel's rim flange exploded and hydraulic oil leaks caught fire. When the undercarriage was retracted after take-off, the fire spread in the left gear shaft and No. 3 wheel exploded in turn, probably damaging fuel lines. The fire became intense, different parts of the aircraft broke off and damage to the aircraft's structure finally resulted in a complete loss of control.

Cause or
Probable Cause(s)

The crash was due to the destruction of essential structural parts of the aircraft by a fire caused by overheating of the brakes during the taxiing phase.

3. Recommendations

No recommendations were contained in the report.

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ACCIDENT TO SE-210, CARAVELLE HB-ICV,
OF SWISSAIR, AT DÜRENÄSH, SWITZERLAND.
4 SEPTEMBER 1963

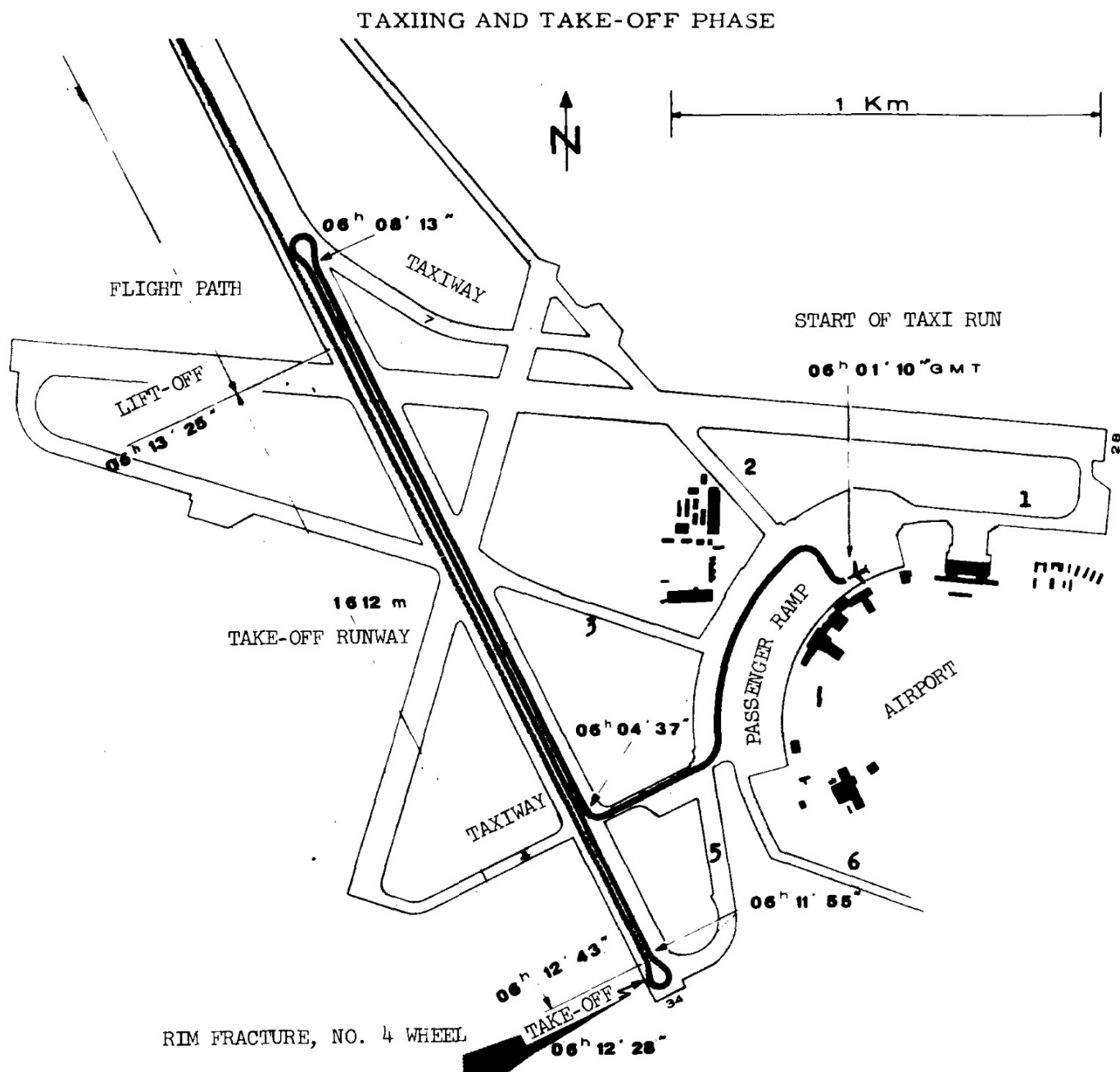


FIGURE 19

ACCIDENT TO SE-210, CARAVELLE HB-ICV,
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PRESUMED PATH OF THE FIRE

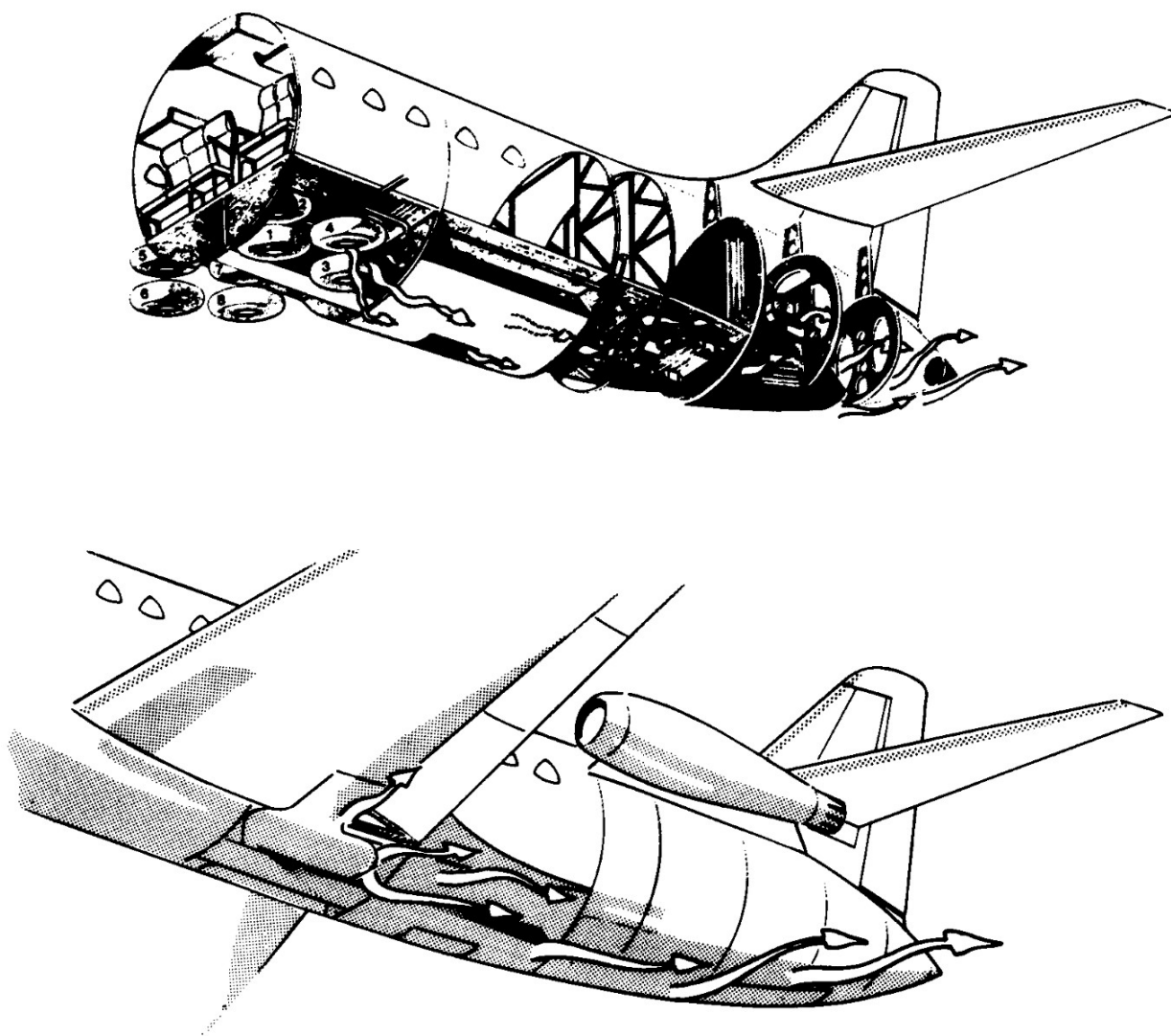


FIGURE 20