

No. 4

Air Ferry Limited, Douglas C-54A (DC-4), G-APYK, accident near Mont Canigou, Pyrénées Orientales, 50 km southwest of Perpignan Airport, France, on 3 June 1967. Report, dated 25 April 1968, released by the French Ministry of Transport. Also published by the United Kingdom as C.A.P. 312

1.- Investigation1.1 History of the flight

The aircraft was on a non-scheduled international flight from Manston, England, to Perpignan, France, via Dover, Lydd, Beachy Head, Chateaudun, Nevers and Clermont-Ferrand. The aircraft was cleared to take-off from Manston at 1731 hours GMT and after flight at lower levels was cleared to FL 70 at 1757 hours: the flight reported its position, normally and regularly, to London Airway until 1812 hours, then to Paris Control until 1947 hours having been cleared to FL 90 approaching the FIR boundary. At 1947 hours it had reached the FIR boundary and was then requested to contact Marseille Control on 126.7 Mc/s. At 1948 hours it established contact with Marseille Control and reported having crossed the FIR boundary at flight level 90 (FL 90) and estimating Clermont-Ferrand at 2003 hours. At 2003 hours it reported over Clermont-Ferrand at FL 90 and was requested to report on frequency 123.9 Mc/s when over Mende.

At 2025 hours the flight reported over Mende at FL 90, estimating abeam Montélimar at 2044 hours. Marseille Control immediately asked for confirmation abeam Martigues for it could not be Montélimar which is practically on the same parallel as Mende. The aircraft then corrected its message to abeam Montpellier at 2044 hours and shortly thereafter, on request, gave its estimated time of arrival (ETA) at Perpignan as 2110 hours. A rough calculation showed that if the aircraft had passed Mende at 2025 hours and if its ETA of 2044 hours abeam Montpellier was confirmed, its ETA of 2110 hours at Perpignan was not possible without a decrease in ground speed of about 18 per cent, unless the pilot had allowed some time for the approach procedure. In view of this Marseille Control requested at 2033 hours confirmation of the 2110 hours ETA at Perpignan. The flight replied with an ETA of 2210 hours then corrected this to 2110 hours. At 2043 hours the aircraft reported abeam Montélimar (instead of Montpellier), and estimating Papa 3, an entry point into Perpignan located at Narbonne, at 2052 hours. This estimate was appropriate but made the ETA of 2110 hours for Perpignan even more difficult to accept.

At 2050 hours the aircraft corrected its ETA over Papa 3 to 2051 hours, confirmed its ETA at Perpignan as 2110 hours and requested authorization to start its descent. Marseille Control cleared the aircraft to descend to FL 70 and asked it to call Perpignan Approach on frequency 120.0 Mc/s. At 2052 hours the aircraft called Perpignan Approach, confirmed its 2110 hours ETA and stated that it was descending to flight level 70. Perpignan Approach then gave the flight the QFE, the QNH and the surface temperature and asked it to call again on passing flight level 70. At 2055 hours the aircraft reported approaching FL 70 descending to FL 50, and five minutes later it reported approaching FL 50. Perpignan Approach acknowledged receipt and asked it if it had the aerodrome in sight. The flight replied "Roger, we'll advise, field in sight." Having apparently understood that the aircraft actually had the runway in sight, Perpignan Approach then instructed it to report

downwind for runway 33 and told it that the wind was calm. At 2104 hours Perpignan Approach asked the aircraft for its flight level and was advised 4 000 ft; the flight also advised it would be "... with you in about five minutes." When asked by the Controller if it had the field in sight the flight replied at 2105 hours "Yankee Kilo negative at this moment." Perpignan Approach then repeated in a questioning tone of voice - "Yankee Kilo, you have not my field in sight?" and received the reply "that is affirmative". The controller misunderstood this remark and told the aircraft to report downwind for runway 33, wind calm. A few seconds later the aircraft asked for QDMs, Perpignan Approach was surprised and asked it to repeat its request. There was no reply to any subsequent calls by Perpignan. It was subsequently found that the aircraft had crashed in the Pyrénées mountains at a place known as "Cirereus" (42°29'30" north 02°21'40" east), 50 km southwest of Perpignan Airport at an elevation of 1160 m. The accident occurred at 2106 hours.

### 1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	5	83	
Non-fatal			
None			

### 1.3 Damage to aircraft

The aircraft was destroyed by impact and fire.

### 1.4 Other damage

A few trees were burnt or destroyed.

### 1.5 Crew information

The pilot-in-command, aged 46, held a valid British airline transport pilot's licence issued on 25 February 1966. He was qualified as pilot-in-command on various types of aircraft including the DC-4. He also held a restricted flight radio telephony operator's licence. He passed his last medical examination on 10 January 1967 and his last DC-4 line check on 18 April 1967 and was considered as conscientious and competent.

He had flown a total of 10 400 hours including 146 hours in the DC-4, of which 27 hours were logged at night. He had flown 5 143 hours as pilot-in-command of which only 241 hours were flown in large aircraft (170 hours in the DC-3 and 71 hours in the DC-4). He had flown 6 hours 30 minutes in February, 32 hours 23 minutes in March, 41 hours 40 minutes in April and 58 hours 38 minutes in May 1967. His last flight prior to the accident was on 31 May 1967.

He had landed at Perpignan 12 times during the years 1958 and 1959, once in 1965 and once on 28 May 1967 when he had made a day landing as pilot-in-command with a holding and descent procedure based on NDB PER and the TVOR.

The co-pilot, aged 61, held a valid commercial pilot's licence issued on 15 April 1966. He was qualified as co-pilot in DC-3, Viking and DC-4 aircraft and his instrument rating was renewed on 3 October 1966 in DC-4. He passed his last medical examination on 5 April 1967.

He was co-pilot in a DC-4 which was involved in an accident at Dublin on 19 September 1961 (emergency landing as a result of the incorrect operation of the fuel system by the crew).

It was difficult to establish his total flight time: however, according to the last available figures, in August 1965, 17 500 hours were claimed including 13 000 hours as pilot-in-command.

He had flown 14 hours 50 minutes in April, 66 hours 35 minutes in May and 6 hours 45 minutes in June 1967, including a total of 41 hours at night during these three months.

After three days of rest, on 29, 30 and 31 May he had flown 6 hours 45 minutes during the evening and night of 1 to 2 June and commenced duty again during the middle of the afternoon of 3 June 1967.

It appeared that he had flown to Perpignan aerodrome on numerous occasions as co-pilot.

Also aboard was a supernumerary pilot, aged 34, who was receiving route training with no specific duties aboard the aircraft. A commercial pilot's licence had been issued on 31 May 1967 but had not yet been delivered to him. He had passed the initial instrument rating flight test on 3 May 1967 and his last medical examination on 13 March 1967. He had flown a total of 1 780 hours including 1 536 hours as pilot-in-command. On 16 and 25 May 1967 he completed a full flight conversion course on the DC-4 (6 hours and 25 minutes of flight time) with the exception of night flying. Up to the day of the accident he had completed 23 hours 35 minutes of flight time as supernumerary pilot in order to gain route experience.

After completing 40 hours of flight time during the last 30 days, he had had 24 hours 35 minutes rest before commencing duty during the middle of the afternoon of 3 June 1967.

Also aboard were two air hostesses, who were fully cognizant of the emergency procedures.

#### 1.6 Aircraft information

The certificate of airworthiness of the aircraft was valid until 11 April 1968. Up to the last flight the aircraft had flown a total of 42 663 hours including 3 930 hours since the last Check 4 and 24 hours since the issue of the last certificate of maintenance issued on 1 June 1967 and valid for 40 days or 220 hours flying.

The weight of the aircraft at take-off from Manston was 30 488 kg and its centre of gravity position at 28 per cent was within the permissible limits. At the time of the accident the weight of the aircraft was 28 288 kg.

### 1.7 Meteorological information

The aerodrome forecast for Perpignan from 1500 hours to 2400 hours was as follows: surface wind: 090°/10 kt; visibility 20 km; cloud: 2/8 Cb 3 300 ft; 2/8 Cu 3 300 ft; 3/8 Ac 10 000 ft; 4/8 Ci 25 000 ft; probability 30%: thunderstorm.

During the flight the following information was passed by the Perpignan Control Tower: AERO of 2100 hours: wind: calm; visibility 25 km; 4/8 Ci 7 500 m; QNH 1025 mb.

The 2100 hour chart showed that in the Perpignan area the weather conditions were good. The cloud amounts, which were generally small, resulted mainly from high cloud of the cirrus type. A few stratocumulus layers resulting from the spreading out of cumulus cloud were observed in places. The visibility exceeded 10 km. The winds were calm or variable and slight.

Radar observations in southern France, including Marignane and Montpellier, gave a nil echo return which seemed to exclude the existence of large cloud masses.

Observations made at Perpignan, Carcassonne and Cap Béar at 2100 hours (6 minutes before the accident) gave:

	Perpignan	Carcassonne	Cap Béar
Wind	calm	180° 6 kt	300° 8 kt
Visibility	25 km	15 km	20 km
Present weather	nil	nil	nil
Cloud	4/8 Ci at 7 500 m	2/8 Sc at 1 000 m	1/8 Ci
QNH	1025 mb		

Various witnesses also confirmed that the weather conditions were good over the area of the accident, the sky was clear but there was no moonlight and the night was dark. Sunset was at about 1945 hours.

The en-route and destination forecasts provided to the crew before departure from Manston were on the whole satisfactory and the small differences which could possibly have been found, in particular regarding the winds at the end of the route, could not explain why the aircraft deviated from the normal route: wind speeds were about 5 kt.

### 1.8 Aids to navigation

The aircraft carried the following equipment:

1 magnetic compass, 1 gyro-magnetic compass, 2 ADF receivers, 2 VOR and 2 ILS.



The following navigation aids were available along the final sections of the route:

Nevers	VOR, NDB
Clermont-Ferrand	VOR, NDB
Mende	NDB
Montpellier	VOR
Carcassonne	NDB
Martigues	VOR
Perpignan	TVOR, NDB, locator, automatic D/F equipment operated by Perpignan Tower.

No abnormality in the functioning of these aids was recorded between 1900 and 2200 hours on 3 June 1967 and in particular no official complaint about the functioning of the aids available at Perpignan were made by any airline. Furthermore, another DC-4 which flew on the same route some 10 minutes before did not report any particular difficulty with these aids.

#### 1.9 Communications

No communication difficulties were experienced until 2052 hours when the aircraft established communications with Perpignan Approach. The quality of the communications with Perpignan was sometimes poor, in particular at about 2100 hours and 2104 hours. This, in addition to the lack of standard phraseology, led to misinterpretation of the pilot's transmission by the controller.

#### 1.10 Aerodrome and ground facilities

Not relevant to this accident.

#### 1.11 Recorders

##### 1.11.1 Flight recorder

The aircraft was equipped with a SADAS flight data recorder recording five parameters: time, magnetic heading, altitude, indicated air speed and vertical acceleration. The readout and analysis were effected without difficulty by the British and French authorities.

The last part of the route starting from the passage over the reporting point prior to reaching the FIR boundary was reconstructed. It showed that at 1932 hours the aircraft was climbing to flight level 90, where it became stabilized at about 1935 hours on a track which was practically due south. Then, some alterations in heading were made until passage over Clermont-Ferrand VOR (CMF) at 2003 hours. Still within airway A 27, the aircraft continued until a short distance from Mende NDB (MEN) when it turned slightly southwest, Mende was passed to the west of the beacon shortly after 2025 hours, and although some two minutes later the aircraft resumed a heading approximately parallel to A 27, its route continued to turn towards the southwest after passing abeam Montpellier at about 2043 hours.

The aircraft passed about 15 km west of the point Papa 3, at about 2051 hours (see Fig. 4-2), when it was leaving flight level 90. At that moment the track made good was about 200° and continued to deviate towards the southwest. Flight level 70 was reached shortly after 2055 hours and the aircraft was approaching flight level 50 at about 2100 hours. The flight path was at this moment headed clearly for Prades, when at 2059 hours the aircraft was less than 30 km west of Perpignan airport, descending to about 5 700 ft and making good a track of about 225°. The aircraft flew over Prades at about 2102 hours and then, some three minutes before the impact, when it was at about 4 400 ft, went into a wide left-hand turn for two minutes, then into a fast right-hand turn of about 90°, immediately followed by a steep left-hand turn during which normal acceleration peaks of as much as 2g were recorded as well as a clear variation in altitude in both senses. The impact occurred shortly after 2106 hours, on a northerly track at an altitude of about 3 800 ft.

#### 1.11.2 Air Traffic Control Radar Recorder

The ACC Nord surveillance radar was equipped with a photographic recorder operating at about one frame every ten seconds. This showed the positions of aircraft returns on the screen together with a clock indicating the times of the frames.

It was possible to identify G-APYK and to reconstruct the route on a time basis. In summary this analysis indicated:

1824 hours	Passage of reporting point Foxtrot Charlie
1851 hours	Over Chartres
1900 hours	Over Chateaudun
1928 hours	Over Nevers, followed by a slow left-hand turn of 360 degrees (holding manoeuvre to obtain separation with a preceding aircraft)
1932 hours	Resumption of southerly heading until 1940 hours when the return was no longer on the screen.

The sections between Foxtrot Charlie and Chartres, also Chateaudun and Nevers were not flown on constant headings and suggested that the navigation was not faultless. However, the times of overflight of the reporting points coincide exactly with those reported by the crew.

#### 1.12 Wreckage

The initial point of impact was situated in the territory of the commune of Py (Pyrénées Orientales) at the place known as 'Al sarrat de las Leignes', 50 km southwest of Perpignan aerodrome and 80 km south of Carcassonne, at an elevation of about 1 160 m (see Fig. 4-3).

Evidence revealed that the aircraft was in a tight left-hand turn, with a bank of about 60° and a recorded speed of 290 km/h when it struck a rock spur with its left wing outboard of No. 1 engine. The entire port wing broke away from the fuselage at the wing root and disintegrated over a sparsely wooded plateau with a slight slope in approximately the direction of the aircraft's heading at the time of impact. The wing wreckage was scattered over about 300 m. The heavier parts such as Nos. 1 and 2 engines and the port undercarriage unit were arrested by trees at the end of the plateau at the point where the slope became steeper (about 45°).

After losing its port wing, the aircraft followed a ballistic trajectory without striking any trees and then crashed into a rock wall which was at an angle of about 60° to the horizontal, 450 m north of the first point of impact and 220 m lower down at a place known as 'Cirereus'.

It was estimated that on final impact the speed of the aircraft was about 330 km/h, that the aircraft was in a nose-down attitude at an angle of dive of about 45° and that it therefore struck the rock wall along the edge of the right bank of the Le Barreau river at practically a right angle. Six or seven seconds elapsed between the first and the final impact.

No evidence of malfunction or failure of the aircraft, its controls and its engines prior to the first impact were found. It appeared that the flaps and undercarriage were retracted at the time of impact. The throttle controls were in the fully open position and No. 1 and 2 propellers were heavily marked along the leading edge indicating that No. 1 and 2 engines were developing considerable power at the time of impact. No conclusion could be drawn on No. 3 and 4 engines. Due to the severity of the impact and the following fire the instrument panel was completely destroyed and only a few navigation equipment were recovered: the two Collins omni bearing selectors, one Collins frequency control unit, the ADF tuning indicator and a distant reading compass. Expert examination of these units revealed only the following: one of the Collins omni bearing selectors was selected on the 280° radial (FROM or TO), the Collins frequency control unit was most probably selected to 113.1 Mc/s (the frequency of the Moulins VOR), the distant reading compass appeared to have been functioning at the time of impact.

Autopsies of the crew were performed and the presence of carbon monoxide was investigated by means of a gas chromatographic technique. Expressed as a percentage saturation of the haemoglobin or the myoglobin with carbon monoxide, the results were as follows:

Pilot-in-command	18.6% (lung)
	19.9% (muscle)
Co-pilot	11% (muscle)
Supernumerary pilot	6.3% (muscle)

The three pilots had been killed by impact prior to the fire which followed the impact.

#### 1.13 Fire

At first impact, the port wing, which separated at the wing root, exploded and the fuel caught fire. Another fire broke out following the final impact. The fire destroyed part of the starboard wing and most of the forward part of the fuselage. All the baggage which was in the holds was completely destroyed by fire.

#### 1.14 Survival aspects

This was a non-survivable accident. Evidence revealed that all occupants of the aircraft had fastened their safety belts. However, they were ejected westwards on to the two banks of the river at almost right angles to the aircraft's heading. Some bodies were found about 175 m away from the wreckage.

### 1.15 Tests and research

Malfunctioning of the heating system was known to have occurred in DC-4 aircraft: the internal heater circuits are such that the static pressure of the clean air is, in principle, higher than the static pressure in the combustion chamber. However, the pressure differential is very slight and only a relatively very small disturbance is sufficient to reverse the flow of burnt gases from the combustion chamber into the warm air circuit. Such disturbances can be caused either by the formation of a crack with a raised edge initiating a turbulent flow or by a back pressure in the exhaust due, for example, to the fouling of the exhaust piping or partial obstruction by a piece of metal detached from the combustion chamber.

The Janitrol heaters (one cockpit heater, two passenger cabin heaters) and their warm air distribution ducts were recovered. The two cabin heaters were not affected by the post-impact fire but they had been slightly deformed in the accident. Their outer casings showed no traces of cracks or oxidation.

The cockpit heater was found at the point of impact of the aircraft's nose, buried under stones and the ashes of various pieces of wreckage, and it had probably been subjected to heating in the fire. Its outer jacket showed only slight oxidation, but it had been heavily deformed by impact. The heater combustion chamber was cut open and fairly marked internal oxidation was found. Folding of the sheet metal had occurred as a result of the impact and numerous fine cracks were detected. A small piece of metal where oxidation had occurred had become detached, revealing a hole resulting in intercommunication between the internal part of the combustion chamber and the annular section serving as a passage for the air to be heated. This hole was situated exactly at the localized hot spot found on all the heaters. Such deterioration could not have been detected during a routine inspection, apart from dismantling and pressure testing as required solely during general overhaul.

The warm air ducting, made of light alloy and lagged with fibre glass, was entirely flattened. When cut open lengthwise, the internal wall of the duct showed numerous black smoke marks. These marks could not have been caused by the fire for the ducting was flattened during the impact before it was subjected to the fire.

The metallurgical examinations of the cockpit heater carried out at the Centre d'Essais des Propulseurs de Saclay, including spectrographic analysis and micrographical examination, revealed oxidation through the whole thickness of the sheet metal of the heater, which could only have taken place over a long period of time, and the presence of lead both inside the heater and in the warm air circuit. These findings tended to prove that there was definite intercommunication between the inner and outer portions of the heater, thereby bringing the burnt gases into contact with the clean air to be heated.

Examination of the internal deposits on the warm air ducting revealed a high content of silicium associated with the presence of sodium, potassium, borium and magnesium coming from the fibre glass surrounding the duct; a clearly defined lead content arising from the fuel; the presence of iron, nickel and chromium, deriving from the action of the heater (therefore prior to the accident); and traces of molybdenum.

Examination of the combustion chambers of the passenger cabin heaters revealed cracks and splits. Micrographical examination of the metal in the vicinity of these cracks showed intergranular corrosion progressively affecting the whole thickness of the sheet metal. These cracks and splits, whether in the middle of the sheet metal or near welds, were the result of slowly developing phenomena, due to oxidation or fatigue.

Examination to determine if the joints of the heater exhaust pipe had deteriorated was inconclusive - these had been extensively damaged by impact and no conclusion could be reached concerning their condition.

The examination of the cockpit heater indicated that the production of carbon monoxide was not attributable to the nozzles recovered from the wreckage but it may have been due to faulty regulation of the fuel flow to the heater or to a defective ignition system - no conclusion could be reached.

Flight tests performed in the United Kingdom with heaters deliberately made defective did not confirm the degree of carbon monoxide contamination deduced from the autopsies.

## 2.- Analysis and Conclusions

### 2.1 Analysis

Reconstruction of the flight path, based on the recording of communications between the aircraft and various ground stations and confirmed by photographic recordings of the ACC Nord surveillance radar and by analysis of the flight data recorder read-out, revealed that the route followed by the aircraft was normal until a short distance before Mende - an elapsed time of almost three hours. Then the aircraft started to deviate from the normal route and at Papa 3 this deviation was as much as 15 km west of that point and increased appreciably by further deflection towards Prades where the aircraft began what might have been an approach and landing procedure.

The scanty evidence obtained from expert examination of the VOR equipment of the aircraft tended to indicate that Perpignan TVOR had not been selected and that the indication for abeam Montpellier was the last VOR radial used by the crew. It was believed that, with the exception of the Mende NDB, for which interference from another station could not be excluded, all other navigational aids were functioning normally and were permitting accurate navigation. The subsequent route followed by the aircraft indicated that the crew did not check accurately their navigation. Also the crew gave an estimated time of arrival at Perpignan 10 minutes later than it should have been, probably because the time allowed for the approach procedure which was included in the original flight plan had not been deducted.

The communications exchanged between Perpignan and the aircraft reveal some misunderstandings and confusion. In respect of the controller this situation probably arose from the poor quality of communications, language, and lack of standard phraseology. However, the controller could have checked the bearing of the aircraft by D/F during any of the transmissions and if he had done so he should have become aware that the aircraft was not in close proximity to the aerodrome.

It was also apparent that the aircraft was descended below the minimum safe altitude, as shown on the flight plan, when it did not have the aerodrome in sight.

It was considered that the weight of evidence suggested an impairment of the powers of judgement of the crew and that this was confirmed by the toxicological evidence relating to the presence of carbon monoxide. The levels of carbon monoxide were far higher than those induced by smoking; also, the co-pilot and supernumerary pilot did not smoke. There was no evidence of fire during flight and the death of the pilots occurred before the post-impact fire; therefore it was concluded that the cockpit atmosphere was contaminated by carbon monoxide.

The level of contamination required to produce a level in the region of 20 per cent in two or three hours in the case of a man at rest at mean sea level is 200 to 250 parts per million. As a result of various factors (altitude, increased rate of breathing) this level may drop to 80 to 100 parts per million at 9 000 ft. A large number of published documents have shown that carbon monoxide levels far lower than 20 per cent can lead to a decrement in performance of higher cerebral functions (as shown by tests, such as simple choice discrimination, arithmetic tests, plural noun underlining and 't' crossing) and can affect the nature of judgements, situational responses and decisions, even at sea level.

Hypoxia associated with flight at an altitude of 9 000 ft considerably reinforces the unfavourable effects of intoxication by carbon monoxide. It has been calculated that at 9 000 ft a pilot with 18 per cent carbon monoxide in the blood would find himself under physiological conditions corresponding to an altitude of approximately 17 000 ft; 11 per cent would correspond to approximately 14 000 ft and 6 per cent to approximately 12 500 ft in an uncontaminated atmosphere. In other words, at least two of the three crew members were flying at a level of hypoxia which has always been considered as dangerous.

It was considered that the only source of carbon monoxide contamination during the flight could be a defective cockpit heater system. Although it was not possible to demonstrate the required level of contamination in test flights, the positive indications of the presence of exhaust gases in the warm air ducting provided sufficient evidence that contamination did in fact exist.

## 2.2 Conclusions

### (a) Findings

Everything was in order as regards the crew who were qualified to carry out the duties entrusted to them in this type of aircraft and on the route in question. Although the pilot-in-command had previously flown to Perpignan, he was flying for the first time on the route via airway A-27 with a reporting point at P3, but the co-pilot had already flown this route on numerous occasions. The pilot-in-command had flown only a small number of hours of flight time in that capacity in heavy aircraft.

The aircraft was certificated, equipped and maintained in accordance with British and international requirements and was operated in accordance with the operating regulations.

The navigational equipment of the aircraft conformed to British and international requirements and permitted normal use of the aids in service both along the route and on the approach to Perpignan. The aircraft documents (manuals, charts, etc.) were complete and up to date.

Examination of the few components of the radio equipment which were recovered did not reveal any evidence which made it possible to determine accurately the conditions under which those components were functioning. An omni bearing selector was, however, found with an indicated radial of 280° FROM (radial abeam Montpellier) and a VOR frequency selector with a probable setting of 112.1 Mc/s.

The aids to navigation in service on the day of the accident functioned correctly and no abnormality was reported either on the ground or in flight. Apart from the usual phenomena affecting the reception of medium frequency aids at night, no interference from foreign stations was reported, except perhaps for the Mende beacon.



The fact that Perpignan VOR was out of operation and the reporting point displaced to Perpignan NDB and also that the Perpignan ILS had been withdrawn from service had been correctly notified by NOTAM by the French authorities, reproduced by the British authorities and brought to the knowledge of the crew.

The communications with the ground proceeded without interruption up to the time of the accident. During the last part of the flight there was some hesitancy about names (Montélimar/Martigues for Montpellier) on the part of the crew and communications between Perpignan Tower and the aircraft clearly gave rise to misunderstandings due both to language difficulties and to the phraseology employed.

The meteorological conditions were favourable along the route as a whole and in the area of the accident and there was satisfactory agreement between the forecasts provided on departure from England and the actual weather situation although some slight errors in the wind directions were made.

The reconstruction of the flight path, from analysis of the transcripts of the recorded communications, the film of Paris ACC radar and in particular the recording of the flight parameters, revealed that after a normal flight the aircraft's track began to deviate to the west after passing near Mende; this deviation increased up to a point 15 km west of Papa 3 where the route was deflected still further towards Prades which was flown over three minutes before impact.

The reconstruction of the final phase of the flight path which was consistent with the evidence of eye witnesses revealed that, after a wide left-hand turn for about two minutes, the aircraft changed heading by 90° to the right, immediately followed by a steep left-hand turn, obviously designed to avoid the mountainside which the pilot had very probably seen on switching on his landing lights at the time he asked Perpignan for a heading (QDM).

The impact occurred, during this turn, shortly after 2106 hours, on a northerly heading, at an elevation of 1 160 m (approximately 3 800 ft) and at a speed of about 290 km/h, according to the flight data recorder. Examination of the wreckage showed that the aircraft was in a clean configuration (undercarriage and flaps retracted), with the engines probably developing a high power. No evidence was found of any mechanical failure before the impact or of any fire in flight and the aircraft did not lose any component in flight before the first impact.

The toxicological examinations of the crew revealed the presence of varying levels of carbon monoxide in the specimens of tissue examined and that the carbon monoxide levels had built up slowly and were sufficient to impair the judgement of the crew.

The only possible source of carbon monoxide contamination during the flight was the cockpit heater system. Examination of the Janitrol heaters, and in particular the heater and one of the warm air ducts of the cockpit, revealed cracks, considerable oxidation and the presence of lead. However, flight tests carried out in England did not produce contamination conditions similar to those revealed by the toxicological examinations. The fact that the nose undercarriage compartment is not sealed means that carbon monoxide could pass into the cockpit if the joints of the exhaust pipe were defective. The positive evidence obtained from examination of the heater and the warm air ducting led the Commission to regard the cockpit heater system as a direct factor in the accident.



(b) Cause or  
Probable cause(s)

The accident occurred following a collision with the mountainside, which resulted directly from a series of errors on the part of the crew (failure to use all the means of radio navigation available in the aircraft, error in dead reckoning, descent starting from a point which had been inadequately identified, failure to observe the safe altitudes fixed on the company's flight plan and, perhaps, mistakes in identification by visual reference to the ground). This irrational conduct of the flight can be explained by the phenomena due to intoxication by carbon monoxide coming from a defective heating system.

Finally, it should be stressed that the misunderstandings which occurred between the aircraft and the Perpignan controller, as a result of language difficulties and in particular the non-existence of any standard phraseology, and also the failure to check the aircraft's magnetic bearing by means of the D/F equipment during the communication at 2055 hours, may have constituted additional aggravating circumstances.

3.- Recommendations

No recommendations were contained in the report.

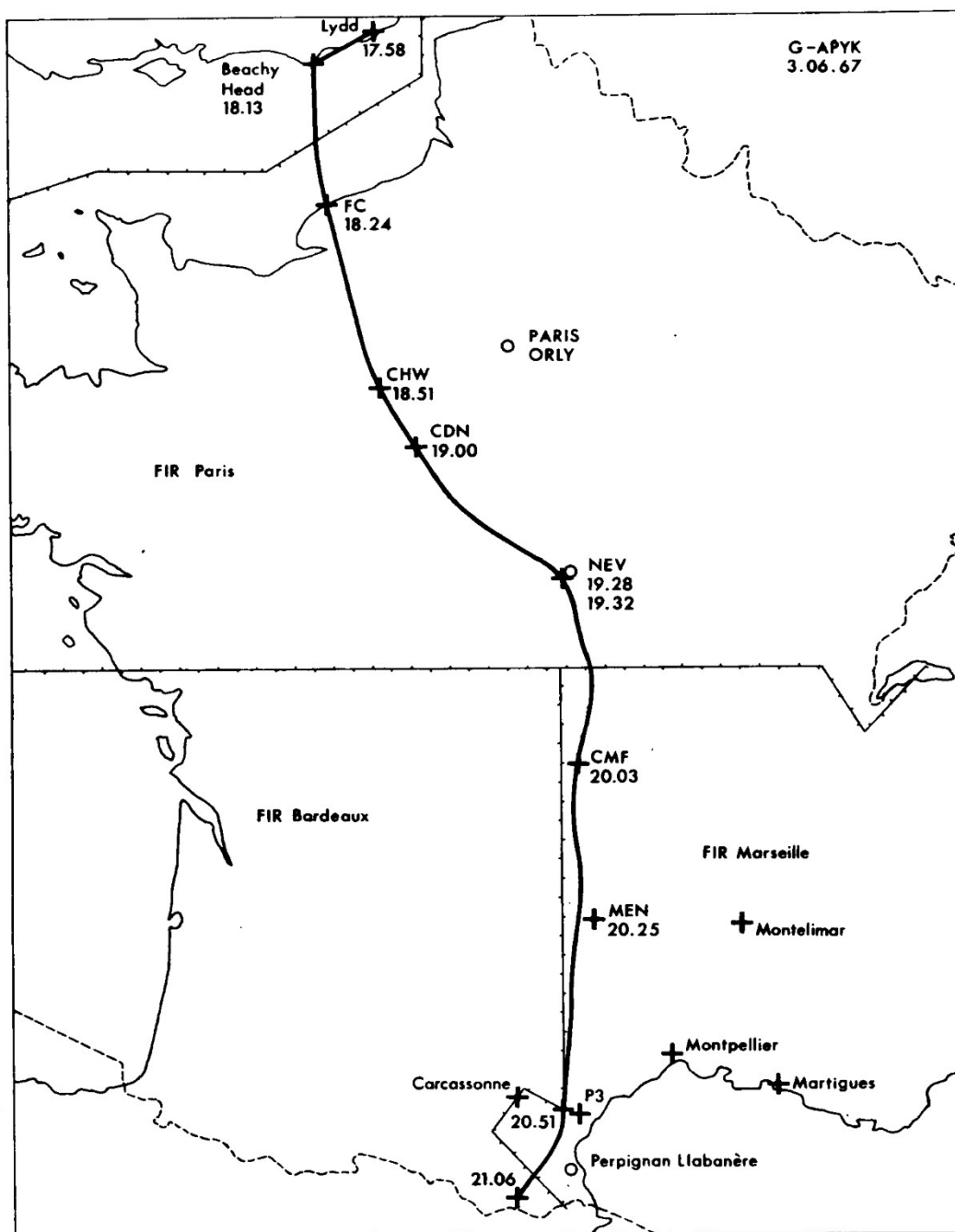


Figure 4-1. Reconstruction of the entire route

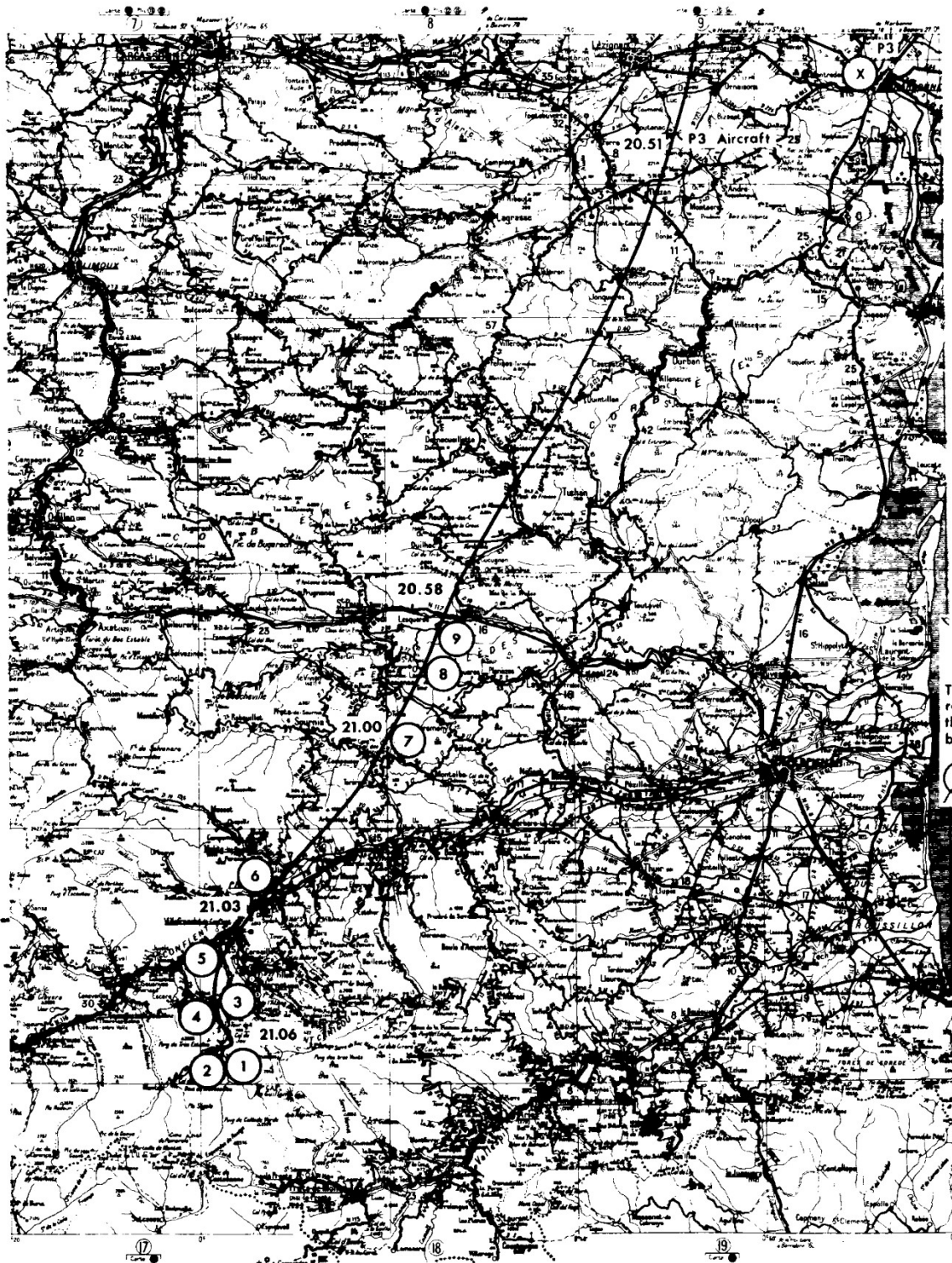


Figure 4-2. Final phase of the flight reconstructed from the read-out of the flight data recording. Circles indicate the witnesses location.

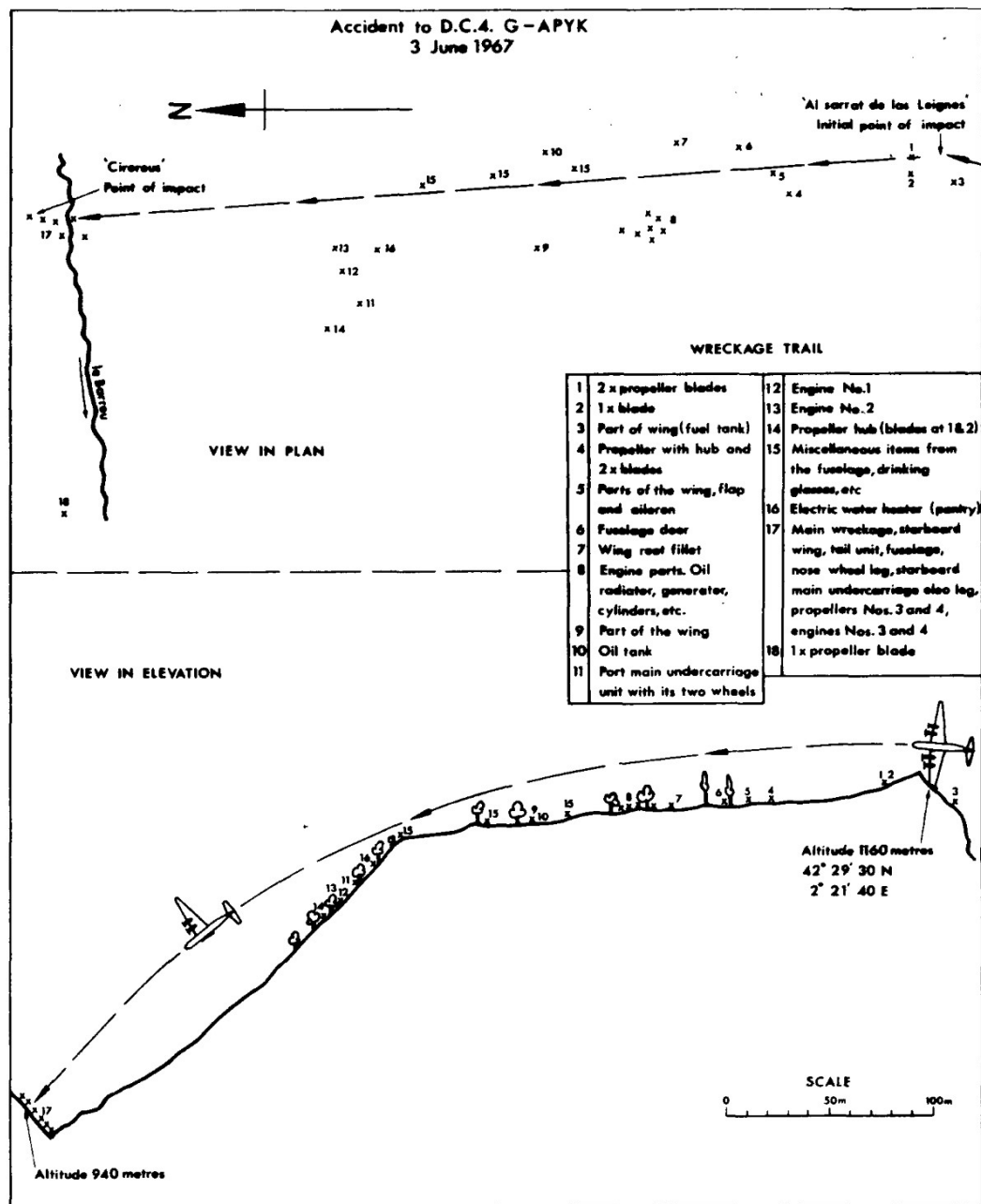


Figure 4-3.

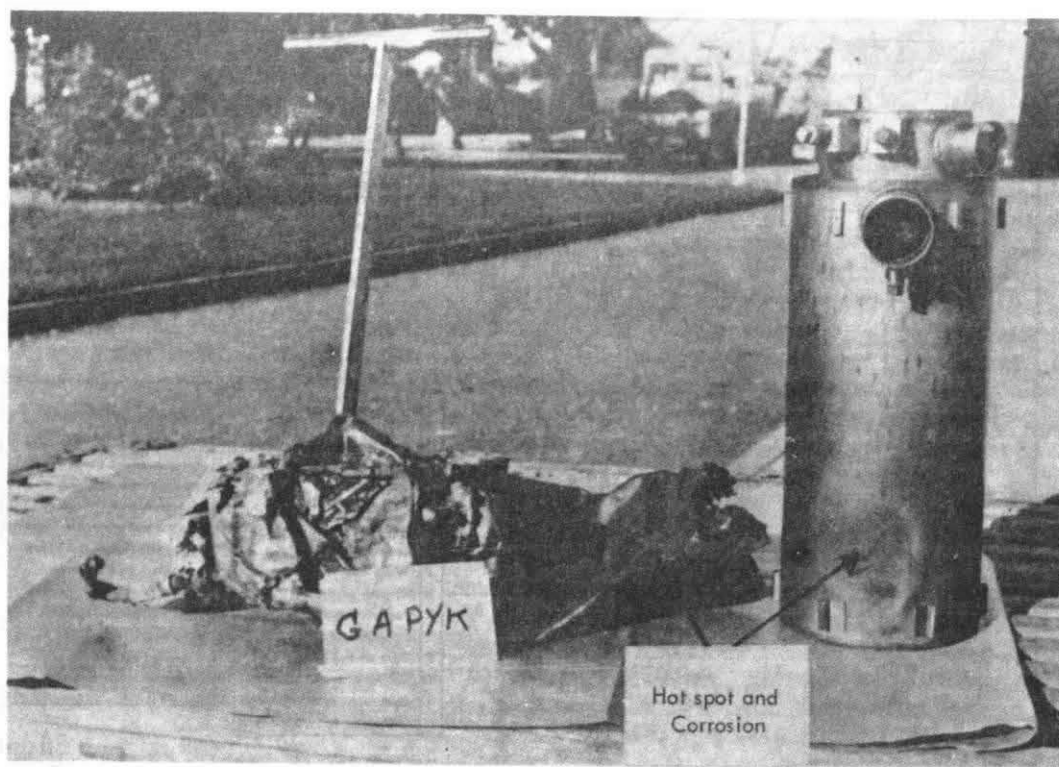


Figure 4-4. The Janitrol Heater