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FOREWORD

Accident investigation is recognized today as one of the fundamental elements of improved safety and accident prevention. Nearly every accident contains evidence which, if correctly identified and assessed, will allow the cause to be ascertained so that corrective action can be undertaken to prevent further accidents from similar causes. Thus, the ultimate object of accident investigation and reporting, which is to permit the comparison of many accident reports and to observe what cause factors tend to recur, can be accomplished. These factors can then be clearly identified and brought to the attention of the responsible authorities.

The Accident Investigation Division of the Air Navigation Committee of ICAO at its first session in 1946 recommended that States forward copies of reports of aircraft accident investigations and inquiries, and aeronautical publications and documents relating to research and development work in the field of aircraft accident investigation, to ICAO in order that the Secretariat might appraise the information gained and disseminate the knowledge to Contracting States.

The world-wide collection by ICAO of accident reports and aeronautical publications and documents relating to research and development work in the field of aircraft accident investigation, and publication of the material in condensed form, assists States and aeronautical organizations in research work in this field. By stimulating and maintaining continuity of interest in this problem the dissemination to individuals actively engaged in aviation of information on the actual circumstances leading up to the accidents and of recommendations for accident prevention also contributes to the reduction of accidents.

The first summary of accident reports and safety material received from States was issued in October 1946 (List No. 1 Doc 2177, AIG/56) under the title of "Consolidated List of publications and documents relating to Aircraft Accident Investigation Reports and Procédures, Practices, Research and Development Work in the field of Aircraft Accident Investigation received by the ICAO Secretariat from Contracting States". This was followed by further summaries at regular intervals, the last report being issued on 31 July 1950 (List No. 12, Doc 7026, AIG/513). These summary reports were found to be of considerable technical interest to States, and in view of the large number of requests for copies, it was decided, early in 1951, to revise the method of publication and to produce the material in the future in the form of an information circular entitled "Aircraft Accident Digest".

The first Digest was issued in 1951 under the present title and with the new method of presentation. Since then, the usefulness of the series has continued to elicit favourable comment from the aeronautical world. It is hoped that States will co-operate to the fullest extent permitted by their national laws in the submission of material for inclusion in future issues of this Digest. It is recognized that investigations take a diversity of forms under the variety of constitutional and juridical systems that exist throughout the membership of ICAO and that, for this reason, accident investigation presents one of the most difficult problems of standardization in international civil aviation. At the same time it is a most fruitful source of material for the attainment of the objectives of the Chicago Convention.

The usefulness of such a publication as this is directly proportional to the thoroughness with which accidents are investigated, the frankness and impartiality of the findings, and the readiness with which they are disclosed and authorized to be published. It is in this way only that this most fertile field for international co-operation can be effectively exploited. The measure of interest that this publication has aroused, and the vital information it imparts amply demonstrate the possibilities of ultimate achievement when every accident is investigated with the greatest thoroughness and the findings disclosed with complete frankness.

Restriction upon reproduction in the Digest seriously impairs, of course, the usefulness of any reports, as it is only by comparison between the circumstances that occasioned the accident and the circumstances of other operations that potentially hazardous circumstances can be foreseen and avoided. Names of persons involved may, however, be omitted without detracting from the value of the report.

Follow-up action and other supplementary information or comments on an Accident Report by the State of Registry or State of Occurrence provide useful material for inclusion in the Digest.

Whenever possible, photos and diagrams have been obtained for illustration purposes in order to give a clearer overall picture of the crash area, an idea of the probable flight paths of aircraft, the location of witnesses to the crash, and in general to make the reports more interesting to the reader.

Part II of this issue dealing with Aircraft Accident Statistics has been based on material derived from the Air Transport Reporting Forms G submitted by States and other sources. (For further review of material included refer to the Introduction, page 252.)

Part III consists of an article by the Assistant Director of Meteorological Services, Federation of Rhodesia and Nyasaland, entitled "Hazards of Landing and Take-off in the Vicinity of Advancing Thunderstorms". This is a further discussion of the meteorological aspects of the U.A.T., DC-6B, accident at Salisbury, Southern Rhodesia in December 1958 as presented in Summary No. 55 in this Digest. The similarity of this accident to one (reported in ICAO Digest No. 8) which occurred in Kano, Nigeria in June 1956 indicates the need for a full appreciation of this hazard by all pilots operating in the tropics.

Part IV is the most recent list of laws and regulations available relating to aircraft accident investigation, incorporating all amendments received by ICAO up to 31 December 1959.

The Material for this Digest has been obtained from various sources, is printed for information only and does not necessarily reflect the views of the International Civil Aviation Organization.

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COMMENTS ON ACCIDENT SUMMARIES, CLASSIFICATION TABLES AND SUMMARY OF REPORTED ACCIDENT CAUSES - 1958

Ninety-four reports on aircraft accidents occurring during 1958 have been received by ICAO from twenty Contracting States. The form of the original reports has ranged from a brief statement of the facts to a comprehensive account of the investigation. Selection of forty-three accident reports for inclusion, in summary form, in this Digest has been made on the following basis:

1) World-wide interest in the accident, due to either
    a) Major disaster aspect which had resulted in wide publicity, or
    b) Special nature of accident and possibility of remedial action;
2) Suitability of the original report for preparation of a summary;
3) Interest as an example of good accident investigation practice.

Thirteen reports carried over from 1957 have been inserted at the beginning of Part I. These do not appear in Tables A and B; they have, however, been classified in accordance with pages 16 - 20 of the Third Edition of the Manual of Aircraft Accident Investigation, and the classification appears at the end of each of the summaries concerned.

Summaries of certain known accidents in the category 1(a) would have been included in this Digest if the reports had been available in time for publication. In order to present a more comprehensive picture, a list is included, at the end of Part I, of all the accidents falling in category 1(a) known to have occurred during 1958, in addition to those which have been summarized.

The classifications in Tables A and B follow closely the suggestions contained in the Third Edition of the ICAO Manual of Aircraft Accident Investigation. They have, however, been based on accident reports which have been founded on a variety of reporting and analyzing techniques. Less than half of the total number of accidents investigated by States are released for general publication or sent to ICAO, and of these a selection, as described above, has been made. No effort has been made in this publication to classify according to the type of operation being conducted, for instance, whether public transport (scheduled or non-scheduled), commercial, business, or training; and no differentiation is made between accidents occurring on domestic and on international flights. However, a notation on the type of operation being conducted, where known, is included in Table A. While the tables may serve a useful purpose in indicating the cause trends, the figures are not significant for statistical purposes and readers are warned not to place too much reliance on the trends indicated without comparison with other figures, such as those published by national administrations.

Although considerable care has been taken in drawing up Tables A and B to ensure that the classification conforms with the findings of the reports from States, the very brevity of the tables might give a wrong impression in some instances. The reader is, therefore, always invited to refer to the summary in the Digest and if necessary the report from which it is derived.

Two items arising from the accidents summarized are worthy of note.

1) The occurrence of 3 accidents resulting from collision in the air between civil and military aircraft in visual meteorological conditions (Summaries Nos. 27, 31 and 50).

2) Four accidents due to the aircraft stalling during training manoeuvres (Summaries Nos. 1 4, 34 and 38), two of which occurred during 1957 and two during 1958.

The accidents in the first category focus attention on Air Traffic Control procedures and the limitations of collision avoidance by means of the "see and be seen" principle. Those in the second category emphasize the need for the careful screening of flying training programmes in order to ensure that emergency procedures are practised in circumstances which will permit recovery from any abnormal situations that might arise.

The ICAO Manual of Accident Investigation (Doc 6920-AN/855), which was first published in 1949, has recently been completely revised and the Third Edition is now available in English, French and Spanish. The Manual is designed to facilitate the proper training of investigators, without which many of the lessons that can be learned from the misfortune of accidents may be lost. In addition to the promotion of a higher technical standard of accident investigation, the Manual provides for a standard form of classification and reporting which will facilitate comparison of accident data and the international application of remedial measures arising from accident investigation.

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TABLE A1- ACCIDENT CLASSIFICATION - 1958 (based on phase of operation)

Phase of Operation	No.	Type of Accident	No.	Description	ICAO Ref.	Type** of Operation	Page*
Take-off (28.6%) *	12	Collision - objects - fence	2	Ice on wings impaired aerodynamic efficiency of aircraft, had detrimental effect on acceleration and increased required unstick speed	AR/565	NS	63
				Inattention to flight instruments in conditions of reduced visibility	AR/586	S	196
		Emergency condition - forced landing	2	Failure of mechanic to secure properly the right wing leading edge section and unit separated in flight	AR/533	S	75
				False fire warning during climb out followed by immediate feathering of propeller	AR/585	S	192
		Gear retracted	1	Improper technique of captain caused unintentional retraction of landing gear prior to V_1 speed	AR/550	S	100
		Loss of control	2	The captain prematurely lifted the aircraft before attaining V_2 speed	AR/540	NS	103
				Loss of airspeed and height due to a sudden squall accompanying the onset of a storm	AR/587	S	240
		Emergency condition - engine failed, take-off	3	Failed to maintain altitude due to undue pre-occupation with an engine fire following take-off	AR/556	S	104
				Abnormal flight procedures following mechanical defect in the port engine	AR/531	NS	165
				Incorrect handling of controls	REP/GEN/8	S	246
		Collision - ground	1	Did not properly observe and interpret flight instruments and permitted the aircraft to descend to the ground	AR/570	S	135
		Collision - rising terrain	1	Aircraft did not climb out in accordance with previously approved procedures	AR/573	S	154
	19	Collision - ground	2	Continued VFR into unfavourable weather	REP/GEN/1	NS	62
				Undetermined	REP/GEN/8	S	179
		Collision - rising terrain	7	Navigational error	AR/595	C	79
				First officer tuned the radio compass on the wrong beacon	AR/562	NS	83
				Deviated from authorised track for instrument flight at too low an altitude to clear mountains	AR/579	S	118
				Flew VFR into unfavourable weather	REP/GEN/1	NS	133
				Manoeuvring at low height in mountainous terrain, using ground side of a hill	AR/571	NS	162
				Faulty conduct of the flight	AR/582	NS	229
				May have entered cloud where severe icing occurred	AR/606	S	238

* Percentages are based on the total number of 1958 accidents summarized in this Digest - i.e. 42 (excluding helicopters)

** S = Scheduled NS = Non-scheduled TR = Training T = Test C = Commercial M = Military

TABLE A:- ACCIDENT CLASSIFICATION - 1958 (based on phase of operation) (Continued)

Phase of Operation	No.	Type of Accident	No.	Description	ICAO Ref.	Type** of Operation	Page
En route (45.2%) *		Loss of control	2	Elevator mechanism became jammed due to extraneous object entering the control mechanism	AR/598	T	109
				Aircraft was allowed to lose height and flying speed	AR/580	NS	202
		Collision - aircraft - both airborne	3	High rate of near head-on closure at high altitude	AR/534	S & M	121
				Failure of military pilot to exercise proper and adequate vigilance to see and avoid other traffic	AR/557	S & M	139
				Accident was attributed to an "Act of God"	AR/581	S & M	215
		Stall	1	Unintentional entry into a spin at too low an altitude to recover	AR/569	TR	167
		Collision - water	1	Pilot failed to maintain control of aircraft at a safe altitude during marginal visual flight conditions	AR/590	S	189
		Emergency conditions - forced landing	2	Water in the fuel system	REP/GEN/1	NS	200
				Undetermined	AR/574	S	235
		Collision - objects - trees	1	Premature descent	AR/566	S	212
Landing (26.2%) *	11	Collision - ground	3	The captain did not check altitude during night landing by visual means	AR/542	S	93
				The captain misread the altimeter by 10 000 ft	AR/567	NS	129
				Improper procedure during an authorized instrument flight	REP/GEN/8	S	211
		Collision - water	1	The aircraft ran out of fuel and loss of control followed	AR/583	S	228
		Stall	1	The aircraft stalled during a steep turn	AR/578	S	113
		Heavy landing	1	The hard landing caused the failure or collapse of the right main gear "V" strut support	AR/547	S	150
		Loss of control	2	Trainee failed to maintain minimum control speed - instructor failed to take control in time to prevent critical loss of altitude	AR/584	TR	155
				The accident was due to downdrafts	REP/GEN/8	S	161
		Collision - aircraft - both airborne	1	Both pilots failed to maintain adequate look-out during approach to land	REP/GEN/1	NS	170
		Undetermined	1	It is possible that the pilot misinterpreted the reading of his altimeter	AR/563	S	171
		Undershoot	1	Failed to abandon approach when a visibility of 1/8 mile was reported	AR/568	S	180

* Percentages are based on the total number of 1958 accidents summarized in this Digest - i.e. 42 (excluding helicopters)

** S = Scheduled NS = Non-scheduled TR = Training T = Test C = Commercial M = Military

TABLE B:- ACCIDENT CLASSIFICATION - 1958 (based on accident causes)

Causal Factor	No.	Description	No.
Pilot (57.1%) ★	24	- continued VFR into unfavourable weather	1
		- improper supervision - flight	3
		- inadvertent gear retraction	1
		- failed to attain adequate flying speed	1
		- improper in-flight planning	1
		- improper IFR operation	9
		- failed to observe aircraft	2
		- levelled off too high	1
		- inattentive, fuel supply	1
		- continued IFR below minima	1
		- misjudged distance	1
		- failed to maintain flying speed	1
		- misuse, engine controls	1
Other personnel (9.5%)	4	- inadequate maintenance	2
		- co-pilot	1
		- improper operation, ground facilities	1
Powerplant (4.8%)	2	- mechanical defect	1
		- fuel system	1
Airframe (2.4%)	1	- flight control system	1
Equipment and accessories (2.4%)	1	- stall warning device	1
Weather (14.3%)	6	- icing conditions	2
		- winds aloft and icing	1
		- fog (ice) - collision with uncharted terrain	1
		- downdrafts	1
		- thunderstorm	1
Miscellaneous (2.4%)	1	- an "Act of God"	1
Undetermined (7.1%)	3	-	3

★ the percentages are based on the total number of 1958 accidents classified (42)

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PART I

No. 1

Indian Airlines Corporation, Douglas DC-3, VT-CFB, crashed 10 miles north of Safdarjung Airport, New Delhi, India, on 13 March 1957. Report released by the Office of the Director General of Civil Aviation, India.

Circumstances

VT-CFB took off from Safdarjung Airport at approximately 0832 hours Indian Standard Time on a training flight. At 0839 it reported as being 20 miles north of Safdarjung Airport and at 5 000 ft. There was no further radiotelephony contact with the aircraft. At approximately 0915 hours it crashed 10 miles north of Safdarjung Airport and was destroyed by impact and fire. Both occupants were killed as were three inmates of a hut in the labour colony where the crash occurred.

Investigation and Evidence

This was the first of a series of approximately eight flights to train a captain as a flying instructor.

The instructor's total flying experience exceeded 12 000 hours including almost 5 000 hours (4 381 in command) in DC-3 aircraft. The "trainee" had a total of 5 874 hours to his credit, including over 5 000 hours (1 434 in command) in DC-3 aircraft.

No proper load sheet was prepared for this flight and in the absence of such a document the laden weight of the aircraft was estimated at approximately 24 380 lbs at the time of take-off.

2 550 lbs of ballast were stated to have been put on board the aircraft. The absolute accuracy of this figure is accepted with some hesitation as the loading of ballast was done under the supervision of a chief loader whose evidence was not entirely convincing. Evidence as to the effective lashing of the ballast was conflicting. Considering that thirteen ballast bags were recovered from the front section of the burned out wreckage without any rope suitable for tying down and also that the instructor on the first flight that morning stated that the ballast placed between the seats was not lashed and ballast in the front and rear luggage compartments was covered by network only, it was accepted that the ballast on board was not lashed.

So far as the actual distribution of the load was concerned, it was reasonable to assume that the centre of gravity of the aircraft was within permissible limits at the time of take-off as the DC-3 type of aircraft permits a wide latitude in loading and also the instructor who used this aircraft on a training flight just prior to the subject flight did not report anything abnormal in the trim of the aircraft.

Results of the Inspection of the Wreckage

It was concluded that the aircraft hit the ground in a straight steep dive; there was no structural failure of the aircraft while in the air, nor was there any fire in flight. All control surfaces were functioning when the aircraft hit the ground.

On examination of the engines no evidence was found of internal failure and there were no signs of inadequate lubrication. Both engines were developing power at the time of impact.

The Instructor's Course

On the subject of training instructors the chief pilot of Indian Airlines Corporation stated, "Broadly speaking, the complete syllabus for the pilot-in-command checks is gone through with special accent on the speed and manoeuvre limitations. With particular reference to the first period since this seems to be relevant, the manoeuvres include change of speeds, change of heights, turns and stalls. I have no first-hand knowledge what was intended to be done on this flight as this subject was not referred to me, but during the first flight the manoeuvres referred to above are normally undertaken. The exercise of approaching to stall is generally done twice - once with full flaps and undercarriage retracted and then with flaps and undercarriage extended and normally in this order. From the time period and considering that the aircraft was airborne at approximately 0832 hours and presuming that the crash occurred approximately between 0915 and 0920 hours, he could have reached this stage of demonstration of stall because the trainee was quite capable of doing these initial exercises quickly."

The chief pilot believed, however, that during all these exercises the instructor would normally be in the right-hand seat and the only time he would occupy the left-hand seat "would be either if the aircraft is not behaving as it should or when the aircraft is tending to go out of control." No height for these exercises has been specified, but "it is normal practice for these exercises to be done at about 4 000 ft above ground level and never below 3 000 ft in any case. This is done for two reasons - one to have a good safety margin and the other to be out of approach and circuit height."

A previous trainee trained by the subject instructor stated - "..For the first flight I occupied the left-hand seat and he asked me to do various exercises... The next session, I occupied the right-hand seat and most of the exercises that I carried out the previous day were carried out from the right-hand seat... the approaches to stall were done by myself from the right-hand seat with power on, power off, gear down, gear up, flaps down, flaps up. The exercise was approaching to the stalling point up to the aircraft shuddering and buffeting and just before the nose of the aircraft dropped, the corrective action was carried out. He also acted as a pupil and approached to stall from the left-hand seat and expected me to find out if there was any defect in technique. He emphasized that all these exercises are always to be carried out above 6 000 ft, above ground level and these exercises were conducted above 6 000 ft."

Reconstruction of the Flight of VT-CFB

After taking off with the instructor in the left-hand seat, the aircraft proceeded to an area about 20 miles to the north of the airport. Some exercises were commenced at a height of 5 000 ft above mean sea level.

The very nature of this instructor's course required the pilot under training to take corrective action in case of a faulty manoeuvre. During one of these manoeuvres, which included an approach to stall, the aircraft entered a spin. It would appear that this spin was entered inadvertently as intentional spins are prohibited in DC-3 type aircraft. Corrective action was taken and although partial recovery had been effected, the height available was insufficient for the aircraft to recover from the ensuing dive when it hit the ground.

The circumstances of this accident closely resemble another which occurred in the U.S.A. in 1951.* During the investigation of that accident it was established that the DC-3 aircraft has normal stall characteristics with ample warning of the approaching stall being given before control is lost. The stall is, however, more abrupt and occurs with less warning when the flaps and undercarriage are retracted. In this configuration the aircraft has a tendency to fall off on one wing.

The following data were obtained from the wind tunnel studies made by the

* ... this aircraft was estimated to be at a height of 3 200 ft above the terrain when it stalled and entered into a spin.
ICAO Note:- See also Summaries No. 4, 34 and 38 in this Digest.

National Advisory Council for Aeronautics, using a DC-3 model and analyzing the aircraft's aerodynamic characteristics: "While the tests gave evidence that spin recovery is normal, an altitude loss of approximately 3 000 ft can be excepted prior to a full recovery. Such altitude loss would be particularly true in the event a power-on spin was experienced. The spin would be steep with the nose down about 55 degrees from the horizontal, and the rate of descent would be about 10 500 ft per minute..."

Once VT-CFB entered a spin, it behaved in the classic manner and reproduced all the manoeuvres described in the N.A.C.A. study. No minimum height for these exercises has been laid down. A figure of 4 000 ft above msl corresponds to 3 300 ft above the ground at the accident site. If this was the height at which the aircraft stalled and entered into a spin, then it did not permit a sufficient margin of safety. A minimum altitude of 7 000 ft to 8 000 ft above ground appears desirable.

An additional complication in this case seems to be a probability. The unlashed ballast although it would have retained its position in normal flight, could have shifted after the aircraft became uncontrolled in a spin. It is difficult to calculate the exact effect of this displaced ballast on the aircraft, but one fact can be stated with certainty and that is that it was not a helping factor in the recovery from the spin and might have added to the minimum height that was necessary for the recovery.

Probable Cause.

The accident was attributed to loss of control of the aircraft as a result of a spin, inadvertently entered into at a height too low for recovery.

Recommendations

1. A minimum height, which permits adequate margin of safety for recovery, should be specified for training exercises in DC-3 type aircraft during which there is even a remote possibility of the aircraft entering a spin.

2. A public transport aircraft shall not fly unless written loading instructions have been given by the operator to the person superintending the loading of the aircraft instructing him how the load is to be distributed and secured.

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ICAO Ref: AR/564

Training
En route
Stall

No. 2

Aviación y Comercio, S.A., Bristol 170, EC-ADI, crashed near Barajas Airport, Madrid, Spain, on 9 May 1957. Report released by the Directorate General of Civil Aviation, Spain.

Circumstances

The aircraft was on a scheduled passenger transport flight from Santiago de Compostela to Madrid, carrying 32 passengers and 5 crew. As requested, the flight passed downwind to align itself for landing on the assigned runway No. 23 during which manoeuvre the control tower gave it the green light for landing. The aircraft went by at an altitude of about 300 metres, banking slightly to the left in order to see the light signal more easily. At 1904 hours it saw the green light, compensated for its left bank and, banking to the right, started a right spin which continued to the ground. The aircraft hit the ground with the front part of the fuselage, the right wing and the right engine propeller and caught fire. Although the airport fire fighting services reached the aircraft 6 minutes after the accident and promptly went into action, it was impossible to extinguish the fire completely for more than an hour. Its effects, however, were reduced to such an extent that the crew and passengers could have been saved had they not all died as a consequence of the violent impact.

Investigation and Evidence

The pilot had held a licence since 16 January 1952 and had a total of 5 478 hours flight time. The co-pilot had 427 hours to his credit.

The aircraft's flight time since the last 1 750-hour overhaul was 1 098 hours 35 minutes, and since the last 300-hour check, 13 hours 5 minutes. Total flying time for engine No. 1 was 5 179 hours 10 minutes and for engine No. 2, 7 568 hours 25 minutes. Since the last 850-hour overhaul engine No. 1 had flown 96 hours 55 minutes and engine No. 2, 2 158 hours 10 minutes.

The maximum authorized take-off weight for this type of aircraft was 19 145 kilogrammes; according to the load sheet, the gross weight on departure from Santiago de Compostela was 17 537 kilogrammes.

As proved by both the Tower logs and the Barajas Communications Officer's log, the aircraft EC-ADI, arriving from Santiago de Compostela on flight AO-111, was, at 18 hours Z, given landing, runway, wind, QNH and QFE instructions on the long-range direction-finder frequency (owing to airborne VHF failure), and was advised by radio telegraphy that the QGP (clearance to land) would be given by means of light signals from the Tower.

The aircraft received and acknowledged the Tower instructions as is clearly proved by the long-range direction-finder log and by the Radio Operator's log which was recovered from the wreckage.

In view of the fire and the disturbance of the aircraft for the purpose of extracting victims, it was impossible to undertake a complete examination of the control mechanisms and levers or to decide on the condition of the engines at the time of the accident.

Examination of the wrecked control mechanisms failed to disclose any fracture, deformation or jamming prior to the accident as their characteristics proved that this occurred on impact.

Two blades were left on the right engine propeller; the other two were broken off and buried in the ground almost in a feathered position. Examination of the propeller pitch control gear as well as the fracture in the socket of the two blades buried in the ground would appear to indicate that this propeller was not in a feathered position, and this coincides with the (operational) position of the switches of this particular engine.

The position of the flaps at the time of the accident would appear to indicate extension during the first portion of the flight track, judging by the fractured right flap and by the position in which it came to rest after the right wing was bent back.

It appeared that the aircraft went into a stall. The crash against the ground in a right turn coincides with the stalling manoeuvre set out in the "Manual of Instructions to Pilots".

Although an experienced pilot is unlikely to allow his aircraft to stall while the engines are operating at normal cruising revolutions, there is no doubt that this may occur when there is a series of coinciding circumstances.

Failure of the right engine might cause the stall in an aircraft flying at a high angle of attack, especially during a right turn. Although no conclusive proof exists that the engine was running, the information available leads one to believe that it was, and there is consequently but little likelihood that engine failure was the actual cause of the accident.

It seems more probable that the aircraft was flying at a high angle of attack (owing to the fact that the pilot was looking through the window) and that the right turn coincided with a tail wind gust which, with the aggravating circumstances that the pilot's right foot was on the rudder control, caused the stall.

It is believed that the aircraft may have been operating at speed limit, since the pilot had to concentrate his attention on the tower and the signal was not immediately forthcoming, as can be appreciated by the distance covered from the time when the pilot, looking towards the runways, was able to see the terminal building façade at a tangent.

On the other hand, the possibility remains that the aircraft was operated by the co-pilot who had very little experience on this type of aircraft.

Probable Cause

The accident was due to personnel errors.

1) The failure of radiotelephony compelled the pilot to concentrate on the green light during the approach manoeuvre.

2) The pilot's attention was so distracted that he operated close to the speed limit. Although such a distraction is infrequent, statistics show that it may occur after 5 000, 7 000 and even after 13 000 flying hours.

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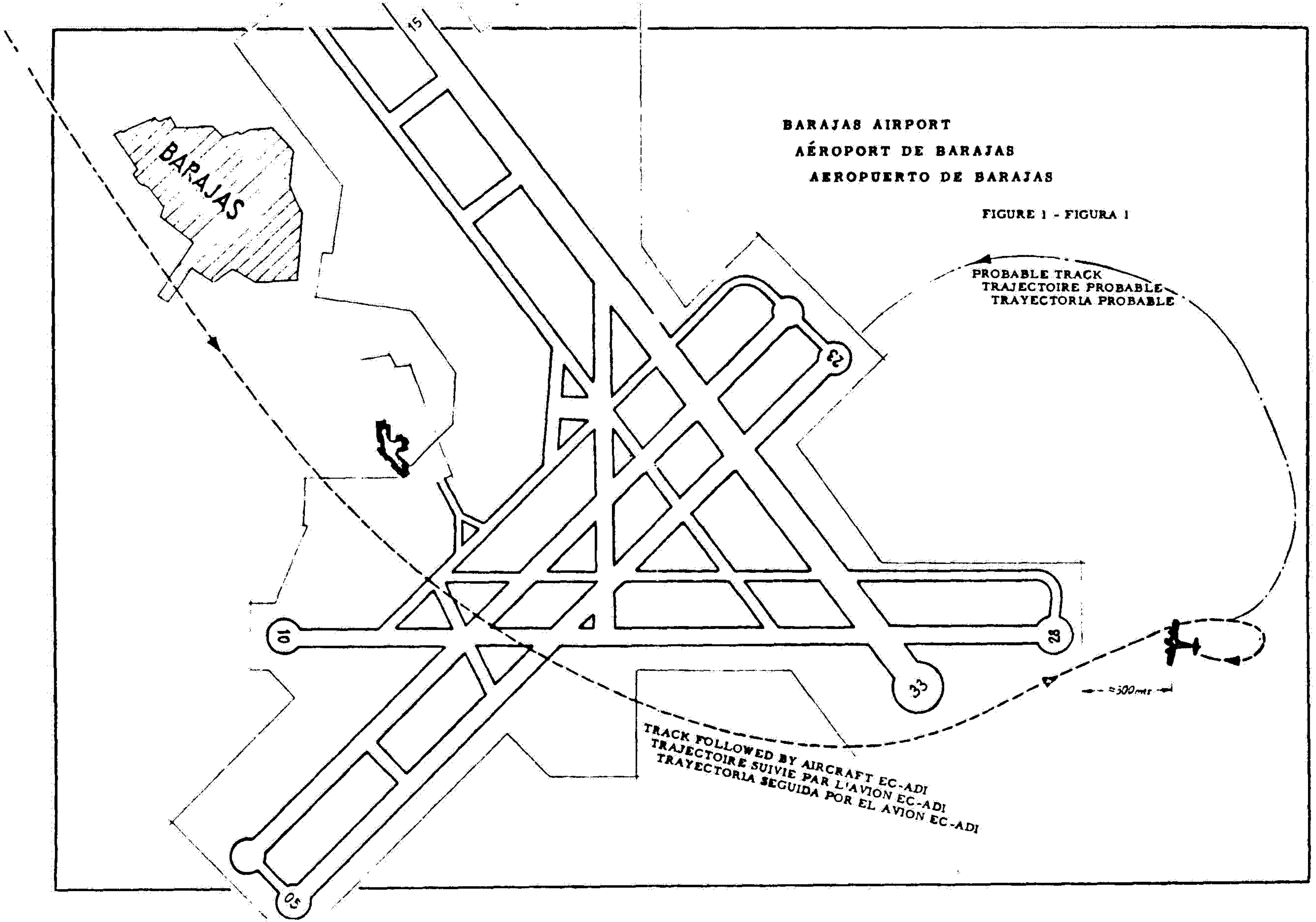
ICAO Ref: AR/543

Scheduled
Landing
Stall



BARAJAS AIRPORT
AÉROPORT DE BARAJAS
AEROPUERTO DE BARAJAS

FIGURE 1 - FIGURA 1

No. 3

Polish Airlines "LOT", IL-14, SP-LNF, accident 4.5 kms northeast of Wnukowo Aerodrome, U.S.S.R. on 14 June 1957. General description of accident released by the Department of Civil Aviation, Ministry of Communications, Poland.

Circumstances

The aircraft took off from Warszawa/ Okecie aerodrome on a non-stop scheduled flight to Moscow, following the normal route of flight LO/232. It carried 8 passengers, 5 crew and 819 kgs of mail and cargo. The flight was routine as far as Klimentiewo, 75 km west of Wnukowo aerodrome, and communication between the aircraft and the relevant units of the Air Traffic Control service was established. During the flight leg between Wiazma and Klimentiewo the aircraft followed its route and lowered altitude as instructed by the air traffic controller in view of the bad weather conditions (storm) in that area. Over Klimentiewo the aircraft was at an altitude of 400 m, altimeter setting 737.4 mm Hg (current QFE at Wnukowo aerodrome); the pilot reported sighting the ground and was cleared by the air traffic controller to descend to 300 m and to head for Wnukowo aerodrome. At 2307 hours local time, i.e. 5 minutes before the scheduled time of arrival at the aerodrome, the crew requested approach clearance. The air traffic controller had transferred control of the aircraft to the approach control service; the latter, having established contact with the aircraft, gave the pilot the QAM and cleared him for approach in accordance with the instrument approach procedure prescribed for that aerodrome.

Although the pilot acknowledged receipt of the approach clearance, according to established procedure, he failed to adhere to the prescribed procedure and descended to such a low altitude that the aircraft hit the ground. The aircraft was completely demolished. Five passengers and 4 crew were killed and 3 passengers were seriously injured.

Investigation and Evidence

There is no doubt about the technical condition and functioning of the aircraft and engines during the flight. The destruction of the aircraft and engines proves that the impact occurred at a time when the aircraft was flying at high speed and engine power exceeded normal operating power.

All crew members complied with the regulations concerning the experience and knowledge required for flying this type of aircraft; furthermore, all the necessary instructions and charts were available on board the aircraft for orientation during flight and for the performance of approach procedures.

Weather conditions in the area where the accident occurred were as follows: very low ceiling, heavy turbulence, distant lightning, driving rain.

Probable Cause

The aircraft hit the ground while flying at an excessively low altitude following the crew's application of an approach procedure other than that prescribed by Wnukowo aerodrome. The bad weather conditions which set in during the night and were not forecast in the messages had their influence on the disastrous end of the flight.

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Scheduled
Landing
Collision - ground

ICAO Ref: AR/576

No. 4

Swissair, DC-3C, HB-IRK, crashed into Lake Constance near Arbon, Switzerland, on 18 June 1957. Report released by the Federal Air Office, Switzerland.

Circumstances

The aircraft took off from Kloten aerodrome at 0857 hours on a training flight. At the same time members of the Swissair planning service were to undertake flight performance tests. At 1020 hours the aircraft went into a spin and crashed into Lake Constance about 4. 5 km northeast of Arbon. The aircraft was destroyed, and all nine persons aboard were killed.

Investigation and Evidence

Crew Experience

The pilot-in-command and flight instructor had approximately 2 800 hours flying experience as well as the following licences:

private pilot licence
military pilot licence
commercial pilot licence
airline transport pilot licence - type ratings: C-47, CV 240 and 440
pilot-in-command DC-3
pilot-in-command Convair
flight instructor for commercial pilots

The co-pilot had 263 hours flying experience and the following licences:

private pilot licence (ratings: aerobatics and aero-tow; aircraft types: Fairchild, Cessna 170 and Cessna 172)

commercial pilot licence (ratings: DC-3 and DH-89 Dragon Rapide)

In 1956 he failed IFR rating test and was dismissed by Swissair as airline transport pilot candidate, owing to unsatisfactory blind-flying performance and on medical grounds. He subsequently re-joined Swissair planning bureau as technician.

Also aboard the aircraft on the flight were five student pilots and two Swissair engineers.

The Flight

The flight was being conducted for two reasons:

1. training of airline transport pilot candidates (VFR flight exercises in cutting of one engine and feathering and unfeathering propellers in cruise);
2. Swissair planning department tests for a revision of the DC-3 flight performance table.

The aircraft left Kloten at 0857 hours and two minutes later informed the control tower by radiotelephony that it intended to operate in the Lake Constance-Schaffhausen area in VFR conditions. That was the last communication received.

The exact flight path could not be determined. However, the statements of numerous witnesses revealed that the aircraft flew in various directions between approximately 1 000 and 3 000 metres above sea level in the Lake Constance area. Furthermore, several witnesses claim to have seen the aircraft operate on one engine.

Shortly before 1020 hours HB-IRK flew in an easterly direction between Romanshorn and Arbon. Several witnesses noticed a brief sinking motion in the level flight, immediately followed by a climb during which the aircraft suddenly stalled and went into a spin. The aircraft's altitude at the beginning of the spin is estimated at 1 100 to 2 100 metres above ground. There were conflicting statements with respect to the direction of the spin and the number of turns.

The aircraft struck the surface of the water and sank in a few minutes.

Technical Investigation

Thorough investigation of the wreckage revealed no evidence of any technical malfunction.

On impact with the water the aircraft was in the following configuration:- undercarriage fully extended; flaps retracted; trim position impossible to determine; right propeller not feathered; twin RPM indicator showed left engine - 1 550 RPM, right engine - 1 350 RPM.

Discussion of Evidence

At the time of the accident the co-pilot occupied the left pilot seat. Although officially this was in order, it did not correspond to the flight programme. The Investigation Commission believed that the initiative for this change most likely came from the co-pilot.

In the Commission's opinion, the flight performance tests had no connection with the accident.

On the basis of extensive domestic and foreign experience, DC-3 aircraft can be described as relatively spin-proof. No systematic spin checks for transport aircraft of this size and larger are required within the framework of airworthiness tests. Therefore, no official results are available either from the manufacturer or from the trial authorities. Thorough studies have been conducted in the U.S.A. by the National Advisory Committee of Aeronautics (NACA) with a view to determining the spin characteristics of large transport aircraft as well as the procedure for pulling out of a spin.

According to a number of witnesses, the level flight of HB-IRK first turned into a brief descent immediately followed by a climb, and then suddenly the aircraft stalled and went into a spin dive. Examination of the wreckage revealed that the aircraft struck the surface of the water in a very steep dive, practically without a turn along its longitudinal axis. Statements of witnesses on the number of spin turns vary between four and twelve, and estimates of the altitude before the commencement of the spin range from 1 100 to 2 100 metres above ground.

On the basis of these indications concerning events immediately prior to the crash, the Commission reached the following conclusions: after an unknown manoeuvre over Lake Constance at an altitude of 1 100 to 2 100 metres above ground the aircraft reached a point where its airspeed became too low and thus quite unexpectedly went into a spin. Although the crew were able to stop the spin shortly before impact, it was impossible to level off the aircraft within the altitude available. It was not possible to determine the action taken by the pilots during this sequence of events.

Probable Cause

The accident is attributed to the stalling of the aircraft following loss of airspeed, whereupon it unintentionally went into a spin. In view of insufficient altitude, it was not possible to level off the aircraft.

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ICAO Ref: AIG/ACC/REP/GEN/No. 15

Training
En route
Stall

No. 5

Maritime Central Airways, DC-4, CF-MCF, accident near Issoudun, P.Q. on 11 August 1957. Report of Board of Inquiry released by the Minister of Transport, Canada

Circumstances

CF-MCF departed London, England at 2148 GMT on 10 August on a charter flight to Toronto, Canada, with planned refuelling stops at Keflavik, Iceland and Goose Bay, Labrador. It carried a crew of 6 and 73 passengers (including 2 infants). The aircraft departed from Keflavik at 0512 GMT on 11 August, after a stop of 1 hour 6 minutes during which it was refuelled to capacity. At 1320 GMT it advised that it would overfly Goose Bay and proceed to Montreal. It arrived over Goose Bay at 1403, nineteen minutes ahead of its ETA, over Seven Islands at 1558 GMT and over Quebec Radio Range at 1807 hours. Quebec Radio Range Station relayed a message to the aircraft at 1810 requesting it to contact Montreal Range approaching Rougemont for clearance - this was the last contact with the aircraft. It crashed at approximately 1815 GMT, 4-1/2 miles west of Issoudun, killing all persons aboard.

Investigation and Evidence

The Aircraft

All servicing and maintenance procedures had been satisfactorily carried out in accordance with the Operations Manual of Maritime Central Airways Limited as approved by the Department of Transport. The Certificate of Airworthiness had been renewed on 13 March 1957 and was valid at the date of the crash.

The Crew

All crew members were properly licensed, medically and mentally fit and adequately experienced to make the flight.

The captain had flown a total of 13 500 hours, of which 2 000 were with Maritime Central Airways and of these 1 000 were on DC-4 type aircraft. He had been involved in a previous accident and had been the subject of a number of medical boards, which had assessed him fit for aircrew duties.

Loading

The licensed take-off gross weight for CF-MCF was 73 800 lbs. The load sheet at London showed a take-off weight of 72 869 lbs including a fuel load of 15 540 lbs. The fuel tanks were, however, filled at London and Keflavik to capacity - i.e. 2 868 U.S. gallons weighing 17 208 lb which would make the gross take-off weight in excess of the maximum permissible.

The overload on take-off from both London and Keflavik was calculated to be approximately 1 840 lb.

The landing weight at Keflavik was calculated to have exceeded the maximum permissible landing weight by approximately 2 830 lbs.

At the time of the accident, the weight of the aircraft was well below the maximum permissible figure. The actual distribution of the load was unknown. However, it was calculated that at the time of the accident the centre of gravity was at or beyond the aft limit - the aircraft was trimmed for a tail heavy condition.

The Flight

The flight from London to Keflavik was completed at 0406 hours GMT, seven minutes ahead of flight plan. Following refuelling, the aircraft departed Keflavik at 0512 for Goose Bay, cruising at 8000 ft until it was cleared at 0946 to 6 000 ft. At 1320 hours the aircraft, following receipt of the Montreal weather forecast, advised Goose Bay that it would overfly Goose Bay and proceed to Montreal. Approaching Goose Bay a request for a clearance to cruise at 4 000 ft to Lake Eon and at 6 000 ft to Montreal was denied, following which the pilot chose to proceed VFR on Airway Red 1 until a clearance was issued at 1607 GMT for an IFR flight at 6 000 ft. At 1654 CF-MCF reported having passed Mont-Joli at 6 000 ft, estimating Quebec at 1758 and Montreal at 1850. The aircraft reached Quebec at 1807 and then estimated arrival at Montreal as at 1902 - this would make the aircraft 27 minutes behind the original estimate of 1835 hours GMT. The last contact with the aircraft was at 1810 hours GMT and at that time everything seemed normal. The accident occurred approximately 5 minutes later.

The Wreckage

The aircraft had embedded itself deeply into the ground and the crater contained the front section of the fuselage frame with the engines and the badly disintegrated port and starboard wings. The fuselage crater was approximately 15 ft deep, and the engine craters were between 10-1/2 and 11 ft in depth, the engines and fuselage being covered by water. The left wing had made a groove to the left side of the main crater and in alignment with the fuselage. The crater conformed to the aircraft striking the ground vertically. Large sections of the left wing skin were found to be corrugated indicating that the left wing had struck parallel to the ground and in so doing had caused the skin to corrugate very uniformly. The right wing was almost completely demolished, but it showed a different type of failure which would indicate that the aircraft must have hit the ground with the left wing leading slightly.

All major components of the aircraft were found in the wreckage, the pieces of which covered an area of about 125 000 square feet. The wing spar caps and ailerons were found in their correct position in relation to the centre line of the aircraft which would indicate that the aircraft came in straight, not spinning.

Conclusions following Examination of Wreckage

The following facts were established:

1. The aircraft struck the ground in an almost vertical attitude of approximately 70° from the horizontal and a few degrees left wing down;
2. The aircraft hit the ground at a speed calculated to have been in excess of 200 kts;
3. The two pilots at the controls had their seat belts on and fastened at the time of the accident;
4. Control of the aircraft had probably been lost prior to the crash;
5. Structural failure of the aircraft, engines or propellers prior to ground impact, premature in-flight failure or lack of adequate engine lubrication, explosion, foul play or sabotage, fire in the air or lightning strikes could be eliminated as being the probable effective cause of the accident.

The Fuel Situation

The flight plan showed the fuel on board the aircraft to be 16 122 lb and the figures for fuel remaining transmitted in the Aireps are consistent with this figure. The investigation, however, showed that the actual fuel on board was 17 208 lb (16 992 lb after taxying and run-up) and it was considered that the flight plan and

Airep figures were adjusted to be consistent with the incorrect figures shown on the load sheet. According to previous records the captain normally reckoned full tank capacity to be 16 650 lb and it is probable that his computations of fuel remaining were based on this figure. Using such a figure, the captain would have reckoned on 553 lb remaining on arrival over Montreal and on this basis 1 238 lb would have remained at 1815 hours (the time of the accident). The Board computed, however, taking the initial fuel load as 16 992 lb instead of 16 650 lb, that the fuel on board the aircraft at the time of the accident would have been approximately 1 580 lb. The Board, despite conflicting evidence of expert witnesses about the fuel situation, rejected the possibility of fuel shortage as the immediate cause of the accident. The Board was satisfied that there was sufficient fuel on board for the revised VFR flight plan from Goose Bay to Montreal bu: the amount of fuel was insufficient to satisfy the IFR reserve fuel requirements prescribed in the Air Regulations.

Weather

All ground witnesses stated that around the time of the accident there was a thunderstorm accompanied by heavy torrential rain and high gusting winds. Some also mentioned hail.

Several storms were radar plotted by the McGill University Stormy Weather Group at Montreal Airport, one of which was plotted to be on Airway Red 1 southwest of Quebec. The strength of this storm could not be ascertained owing to the extreme range. Also, owing to active thunderstorms between the radar plotting station and the storm plotted on Airway Red 1 southwest of Quebec, the strength of this plot was reduced.

Fifteen minutes after the estimated time of the accident (i.e. at 1830 GMT), the Quebec Radio Range Station issued a special weather report as follows:

"Estimated 3 000 broken, 12 000 overcast, visibility 6, with thundershowers, wind west 10, clouds cumulus 6, altocumulus 4, visibility northeast through southeast 15."

A Research Meteorologist, specializing in aviation hazards, stated -

"Turbulence is a significant thunderstorm hazard to aviation perhaps having the most serious of the thunderstorm hazards. The air motions which constitute this hazard are of two kinds. There is a relatively large scale vertical motion referred to as a draft. The drafts measure perhaps a couple of miles across with velocities in updrafts being measured at 90 ft per second or more and somewhat smaller in downdrafts. An aircraft caught in such a draft would experience a steady vertical motion which could cause up to 5 000 ft gain or 2 000 ft loss of altitude during a traverse of the draft in a flight starting at 6 000 ft. Such motions would not cause a severe structural strain but if the pilot attempted to maintain his altitude he could be placed in a anusual nose-up or nose-down attitude."

..."Loss of control is another hazard that can be associated with severe thunderstorm turbulence. This is particularly true if the pilot had placed the aircraft in a nose-up or nose-down attitude to correct for drafts. Once control of the aircraft had been lost it would be difficult to recover in very turbulent air."

Pilots will, under ordinary circumstances, alter course to avoid, if possible, going through the storm area but two factors might have made it unlikely that the pilot of CF-MCF attempted to circumnavigate the storm:

1. Having refiled IFR, it is possible that the flight was in cloud and that the aircraft flew unknowingly into a hidden active cumulonimbus. It is to be noted, however, that one pilot, who landed at Quebec at 1806 GMT, having come from Mont-Joli VFR at a height of 1 500 ft, stated that the weather was clear all the way through from Mont-Joli to Quebec.

2. Being low on fuel and having no weather reports showing the possibility of cumulonimbus build-ups in the area, the pilot elected to penetrate what could have appeared to a tired crew to be a minor build-up.

Once the aircraft entered the turbulent area, one can only speculate as to what actually happened.

The possibility of fuel cross-feed being in use at this stage of the flight is considered remote. It is reasonable to assume that each engine was being fed from its main tank. As previously stated, the calculated amount of fuel on board the aircraft at the time of the accident was 1 580 lbs or approximately 263 U.S. gallons total, or 66 U.S. gallons approximately in each main tank. When the aircraft is not in a level flight condition the total amount of fuel carried cannot be drawn from the tanks. Therefore, the possibility remains that extreme aircraft attitudes caused by severe turbulence could result in movement of the small amount of fuel remaining in the tanks, allowing air to be drawn into the fuel lines. This would cause the engines to cut, not necessarily simultaneously but within a period of a few seconds of each other. This could all happen in a very short period of time with the crew being extremely occupied maintaining control. If these cuts occurred at a large throttle opening, as fuel was again supplied to the engines, the resultant power surge could cause the propellers to overspeed. The possibility of this happening to all four engines simultaneously cannot be overlooked.

It is possible that with all four propellers overspeeding, the buffeting vibration and drag caused complete loss of control, leading to a dive from which recovery from a relatively low altitude was impossible.

It is also possible that the aircraft encountered heavy turbulence unexpectedly, followed by a momentary loss of control during which time the aircraft assumed an extreme attitude, recovery from which was followed by a stall. In an effort to keep the airspeed within reasonable limits and maintain altitude, the crew would have had to alter engine power settings. With the engine windmilling at a high rate of speed and with the propellers in full fine pitch at impact, the pilot must have had occasion to close the throttles in an attempt to limit airspeed to the rough air penetration speed. If the aircraft was stalled in this condition, with the centre of gravity aft, or beyond the aft limit, this would likely give a more rapid and extreme angle to the nose-up pitch. It is to be noted in this respect that the wreckage revealed that the aircraft was trimmed nose-down at the time of impact (measured as 6° elevator tabs up.)

The natural method of recovery would be to apply power and push the nose down and because of the aft centre of gravity, complete and rapid recovery would probably require more power than normal. With power off at the stall, all propellers would move to the low pitch setting. A violent nose-down pitch at stall recovery with a resultant rapid build-up of airspeed and a sudden application of power could result in a tendency for the propellers to overspeed. Unless this was checked immediately, as the airspeed built up, the centrifugal turning moment of the propeller blades would not allow the propeller governor to regain control and the engine revolutions would then be controlled by the propeller. Recovery from this condition, even in favourable weather with normal elevator trim settings, would be extremely difficult and would be unlikely in heavy turbulence.

Loss of the control of the aircraft due to heavy turbulence and subsequent dive down to the ground are consistent with the established facts that CF-MCF struck the ground in an almost vertical attitude at a speed of over 200 kts and with the damage found in the strip examination of the four engines.

Fatigue

The crew had ample off duty time prior to their departure from London.

At the time the flight passed over Quebec, they had been on duty approximately 22 hours and 42 minutes, of which 19 hours and 20 minutes had been in the air.

When questioned as to whether he felt that there was a fatigue consideration in this case, a Specialist in Aviation Medicine replied:

> "I believe if a pilot is on duty for 24 hours continuously, he would be tired but I do not know whether he would be fatigued to the point where it would interfere with his judgment and the safe performance of his duties, especially a pilot with more than 12 000 hours of flying. If during the 24 hours on duty, he was able to be relieved of the duties and responsibilities and adequate rest facilities were available so that he could relax for one or two intervals of at least 1 to 2 hours, I do not believe he would be fatigued to the point where it would interfere with the safe performance of his duties."

The rest facilities provided for the crew in CF-MCF were a bunk in the main forward cabin over passenger seats on the starboard side of the aircraft. There were no seats available in the passengers' cabin.

Regarding the rest facilities, the Specialist said - "the location, accessibility and lack of privacy of them were inadequate and left much to be desired."

Another captain stated that when he flew the Atlantic with the captain of CF-MCF on a previous flight, depending on the weather en route, the three pilots shared their rest periods and these usually ran anywhere from 2 to 3 hours non-stop without coming back into the cockpit. This would allow the crew a certain amount of rest but it is felt that during a period of 22 hours and 42 minutes, of which over 19 hours were in the air, with only 2 to 3 hours' rest the crew would have been very tired, although their condition would, in all probability, not interfere with their normal duties. It is, however, felt that their capacity to deal with an emergency would have been very low.

The flight, as originally planned, with three approximately equal sectors, each within the operating range of the aircraft, appears to have been normal and reasonable.

There appears to have been no logical reason why the captain should have elected to press on to the extreme range of his aircraft, to land at an airfield still short of destination.

Probable Cause

The accident was attributed to severe turbulence encountered whilst flying in a cumulonimbus cloud, resulting in a chain of events quickly leading up to a complete loss of control and causing the aircraft to dive to the ground in a near vertical nose-down attitude.

Recommendations

1. Neither the Aeronautics Act, the Air Regulations nor the Air Navigation Orders directly prescribe any hours of duty for flight crews. The matter is dealt with indirectly by means of the Operating Certificate, Part VII of the Air Regulations and Information Circulars 0-43-51, 0-2-52 dealing with operations of aeroplanes, scheduled and non-scheduled air services respectively.

Section 6.3.6.4 of Information Circular 0.2.52 provides that:

"An operator shall establish limitations of the flight time of flight crew members. These limitations shall be such as to ensure that fatigue, either occurring in the flight or successive flights or accumulating over a period of time, does not endanger the safety of a flight. The limitations shall be approved by the Minister."

The result is that the limitation of flight time of flight crew members to ensure that fatigue does not endanger the safety of the flight may differ in various airline companies; some may fix a certain number of hours of duty per day while others will be on a basis of a certain number of hours per week, per month, or three month period. The Regulations may apply to all crew members indiscriminately or various categories may be treated separately. The Regulations may differ depending on the type of operations covered or whether the flights are scheduled or non-scheduled.

In the countries which carry on the largest air transportation services, such as the United Kingdom, United States, France and Italy, the Regulations are developed and issued by the State.

The Board, with a view to preventing undue fatigue of the operating crew, strongly recommended that appropriate Regulations applying to all types of commercial operations, scheduled or non-scheduled, be issued, establishing limitations of flight and airborne time of flight crew members. Such Regulations should also set out the minimum space to be allotted to crew quarters and rest facilities, such rest facilities to be separate from the space occupied by the passengers.

2. The Board considered that on international flights, for the safety of air navigation, there should be some type of flight watch system and that the Air Regulations should provide for such a system. The Board, however, did not consider that it had sufficient data in this respect to make any specific recommendations but suggested that the question be given serious consideration by the Department of Transport.

3. In the Weight and Balance Manifest of CF-MCF there was no allowance or provision for the weight of the various articles in the commissary's department. With a view to preventing overloading of the aircraft, the Board recommended that a proper allowance be made in the Weight and Balance Manifest of the aircraft for every item on board regardless of its weight.

4. The Board further recommended that in all cases of secondhand aircraft imported for commercial operation a close check be made of the standard of their previous maintenance and service, modification status and recording, major changes to role, weight and balance and that the said aircraft be weighed before being put into operation.

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Non-scheduled
En route
Loss of control

ICAO Ref: AR/575

No. 6

Airwork Ltd., Hermes, G-AKFP, and Indian Airlines Corporation, Dakota, VT-AUA, collided at Dum Dum Airport, Calcutta, India on 1 September 1957. Report released by the Department of Communications and Civil Aviation, Ministry of Transport and Communications, India.

(A formal investigation of the accident was conducted by the Government of India, which was attended by an accredited representative of the State of Registry of the Hermes aircraft /United Kingdom/).

Circumstances

The Hermes aircraft was on a non-scheduled passenger flight from Blackbushe Airport, England to Singapore with stops at Karachi, Delhi and Calcutta. While making a radar assisted approach to runway 01R at Dum Dum Airport, Calcutta, it collided (at 0000 hours GMT) with a Dakota aircraft which was lined up on runway 01L. The Dakota was destroyed and four members of the crew, the only occupants on board, were fatally injured. The Hermes sustained substantial damage. Two passengers were injured.

Investigation and Evidence

Schedule of events preceding the accident

2309 The Hermes arrived over Calcutta.

2311 The Hermes asked for and was cleared to make an ILS let-down on to runway 19L. The Air Traffic Control cautioned that there would be a slight tail wind component when landing on this runway. The let-down was carried out.

2318 The captain abandoned the approach at the break-off height as he could not see the runway due to a passing shower. During this overshoot the aircraft requested clearance for a visual landing on runway 01R, but this was refused as a York aircraft was at that time making an ILS approach on 19L. The Hermes was instructed to ascend to 2 000 ft and report over tne BQ NDB.

2320 The captain of the Hermes was asked if he would like to make another ILS approach. On his acceptance, the aircraft was cleared to climb to 3 500 ft and call over the Range Station.

2331 ATC asked if the Hermes would like to be positioned for a radar assisted approach. The captain replied, "if it will expedite our landing, yes please". He was informed by ATC that he would be No. 2 to land as the York aircraft was now carrying out an ACR let-down and was turning finals for 01R.

2338 The Hermes was handed over to the Radar Controller. The latest altimeter setting of 997 mbs was passed on to the aircraft.

2347 The aircraft was informed that it would be a right-hand circuit for runway 01R and from then on the approach progressed in accordance with the laid down procedure until -

2359 when the Radar Control cleared the aircraft to land visually. The aircraft at this time, according to the Radar Operator, was one mile from the threshold of 01R and to the left of the centreline.

However, according to the captain's evidence, during the talk down when approximately 1-1/4 miles away from the threshold of the runway on which he actually landed and at a height estimated by him to be between 400 and 500 ft the aircraft broke cloud heading 005. At this stage, noticing the outline of a runway ahead and slightly to the starboard, he considered himself in visual contact, turned down the R/T and decided to continue visually. He stated that as the runway appeared in the position that he expected to see the runway 01R, he concluded it to be the designated runway and continued the approach. In actual fact, he was approaching 01L. Had the pilot not turned down the R/T at this critical stage and complied with the 5° correction given, runway 01R and the visual aids of this runway would have come into his field of vision.

A minute or so earlier ATC had cleared the Dakota to line up and hold on runway 01L. The captain of the Hermes stated that he did not see the Dakota until it was too late to avoid a collision.

Weather

The weather observation made at 0000 hours GMT (0530 hours IST) by the Weather Section of the India Meteorological Department at Dum Dum on the morning of 1 September 1957 indicated the following conditions:

Wind	320° 04 knots
Visibility	3 nautical miles
Weather conditions	raining
Cloud	
Lower layer	4 octas St. 500'
Second layer	3 octas St. 800'
Third layer	3 octas As. 10 000'
Air temperature	25.6° C.
Dew point	25.6° C.
Pressure	QNH 997.0 mbs
	QFE 996.5 mbs

There was conflicting evidence regarding the visibility at the time of the accident - ranging from 3 miles as reported by the meteorological observers to nil visibility as stated by the first officer of the Hermes. It was concluded that what actually mattered in this case was how much the pilot himself saw or thought he saw.

The captain of the Hermes claimed that at no stage did his visibility go below 2 000 yards, probably because he saw the outline of a wet runway shining at a distance. Relevant evidence indicated that the aircraft was flying through rain, and the pilot did not have the advantage of the windscreen wiper operating. The first officer did not at any stage see anything at all. Had the runway not been reflecting light, it is doubtful whether it would have been possible for the captain to see it at all, particularly as, according to his own statement, nothing else was visible. Furthermore, the captain stated that he found himself high and fast.

Analysis of the evidence

The theory that the aircraft had been positioned left of the centreline of runway 01L by the ACR (Airfield Control Radar) was carefully examined and the Assessors were satisfied that this was not the case. All evidence indicated that the aircraft was to the left of the centreline of runway 01R as indicated by the ACR. The reason why the captain of the Hermes saw 01L to his right is that the heading of the aircraft at the time he saw the runway was offset to the left of the runway QDM.

Taking all factors into account it was considered that a single runway seen in such circumstances of poor visibility etc. provided insufficient orientation to justify continuing the approach. An overshoot action was called for under the circumstances that existed but the captain, however, failed to take such action.

As regards the facilities and assistance provided by the Aerodrome Control, there was some evidence that the red lead-in lights of runway 01R were on at the time the Hermes made its approach. It was also stated by the officer concerned that the high intensity lights were on, even though there was no corroborative evidence on this point. The sodium bar lights were definitely not on. In the conditions existing at the time, particularly as the Aerodrome Control officer himself estimated the visibility to be only 3/4 of a mile in rain and the fact that aircraft were making instrument approaches, both the high intensity and the sodium bar lights ought to have been on.

The note of Recommendation 1.5 of ICAO, Annex 14, Part III implies that two parallel runways separated by 700 ft should not be used simultaneously in any other conditions than visual conditions. In consequence, to allow the Dakota on to runway 01L whilst the Hermes was being talked down on to runway 01R, not only goes against the recommendation but constituted one of the hazards it envisages.

It was observed from evidence that only a driver and one set of fire fighting crew were on duty at the fire station even though two fire/crash tenders and an ambulance had to be manned.

The question of crew fatigue was brought up during the proceedings and this aspect was examined. It was noted that the last rest afforded the crew was at Karachi where there was a 16 hour stop - 14 hours rest. Although the rest period meets the flight time limitations laid down by the United Kingdom, the fact that the crew operated throughout two consecutive nights and rested only during the intervening daylight hours, may have induced sufficient fatigue to be of significance, having regard to the conditions under which the landing was made.

Fuel on board the aircraft when it departed from Delhi was 1704 Imperial gallons and this quantity conforms to the regulations laid down in the company's Operations Manual. It was considered that the requirement commits the pilot to land or divert immediately on arrival over the destination. It was suggested that in this case, the pilot had used up fuel necessary for diversion. The Assessors were satisfied that this did not cause the pilot any concern.

Probable Cause

The official report of this accident contains two statements of cause, one by the Court, the other by the Assessors, which do not differ in substance; the following summarizes the essential points of the two statements:

An error on the part of the Commander of the Hermes aircraft in turning down the R/T during the final stage of the radar assisted approach and in deciding to continue the approach under conditions which did not enable him to identify positively the correct runway.

Contributory Cause

The presence of the Dakota on the threshold of runway 01L.

Recommendations

1. The simultaneous use of parallel runways must conform to the recommendations contained in para. 1.5 Part III of Annex 14 (ICAO).

2. The importance of co-ordination between the captain and the first officer, particularly under instrument flight conditions, must be emphasized during training of pilots.

3. As far as possible the location of crash tenders and ambulance must be such that the crew manning these vehicles obtain unrestricted view of the entire airport.

4. The fire fighting should be strengthened and the medical facilities at the airport should be improved.

Observations

1. Regulations on flight time limitations must differentiate between night and day flying when laying down rest periods.

2. The operator's interpretation of ICAO standard 4.3.2.2 item (i) Annex 6 differs from what is envisaged in this standard. The fuel allowed for various sectors does not provide the reserve of forty-five minutes over the alternate unless an aircraft diverts immediately on arrival over the destination.

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ICAO Ref: AR/559

Non-scheduled
Landing
Collision - aircraft
(one airborne)

No. 7

British European Airways Corporation, Viscount, G-AOJA, crashed at Nutts Corner, Belfast, Northern Ireland, on 23 October 1957. Report released by the Ministry of Transport and Civil Aviation (UK). C.A.P. 150.

Circumstances

The aircraft departed London Airport at 1516 hours GMT on a flight to Belfast in pursuance of a special charter, carrying 5 crew and 2 passengers. At 1645 the aircraft was taken over by the Precision Approach Controller for a GCA talkdown on runway 28 (276°) in weather conditions which the captain thought would allow him to become visual at or above his critical height of 500 ft. Soon after "3/4 of a mile from touchdown" the aircraft was to the right of the centreline and shortly afterwards was "well right of centreline". Just after "1/2 a mile from touchdown" the Precision Approach Controller said "if you're overshooting turn left left 5° on overshoot over" to which the reply came "... overshooting". At about this time a number of witnesses heard the aircraft "rev-up". Shortly thereafter (at 1651 hours) the aircraft crashed within the boundary of the airport approximately 1 000 ft to the south of the western end of runway 28, killing all occupants.

Investigation and Evidence

Crew Information

In all, the captain had flown a total of 7 496 hours of which 316 were on Viscount 802 aircraft. In the last six months before the accident he had flown 301 hours and had landed at Nutts Corner on twelve occasions.

The first officer had flown a total of 4 739 hours of which 259 hours were on Viscount 802 aircraft. In the last six months he had flown 280 hours.

The Weather

A cold front was expected to clear through the Belfast area between 1600 and 1800 hours. Cloud at Nutts Corner was forecast to be down to 300 ft but improving after 1600 hours. The captain in conversation with Air Traffic Control discussed the possibility of diverting to Dublin or Aldergrove. After being informed that aircraft had reported a cloud base of 500 - 600 ft the captain decided to continue the flight to Nutts Corner. Four ground witnesses who were in the approach area at the time of the accident reported fog on the surface and gave varying estimates of the visibility. Although the aircraft crashed within the airfield boundary nobody saw the crash.

The Wreckage

As a result of the crash there was a far-reaching disintegration of the structure of the aircraft.

At the moment of impact all three undercarriage units were fully retracted and locked. On this type of aircraft it takes about 13 seconds from pressing of the selector button for the undercarriage to reach the fully locked position. The Court had no reason to doubt that when the aircraft was approaching the eastern end of the runway the landing wheels were down and concluded that they must have been selected up at the moment the decision to overshoot was taken. It was impossible to conclude that undercarriage drag had any significant effect on airspeed at any material time.

It was ascertained that the flaps were near to the fully up position at the time of impact.

Other reliable evidence suggested that the captain would have selected 85% (40°) flap upon identifying the approach lights which the Court considered he was able to do and almost certainly did.

A study of the ground at the place of impact suggests that the port wing had struck the ground a little before the starboard wing but not appreciably so. There were positive indications that the aircraft was not inverted.

It was concluded that the heading of the aircraft was 204° or 72° to the left of the line of runway 28.

The sixteen propeller blades had all been torn from the hubs and the indications were that they were all rotating under similar conditions at the time of impact. They had been at a pitch setting within the normal constant speeding range.

The engines were badly smashed up but enough could be observed upon examination to confirm that they had been rotating at the time of impact, and there was no indication of any failure or fire in any one of them.

The more delicate instruments in the aircraft were so badly destroyed that beyond saying that the gyros of the twin compass system were rotating at the time of the impact those who examined what was left were unable to point to any useful conclusions.

Although it is not, and was not claimed by any witness to be, conclusive the best evidence based on examination of the wreckage is that none of the controls were jammed before the impact.

Discussion

The experience of an officer who knew the captain well and had often flown with him as a co-pilot was that the captain was accustomed to fly his aircraft manually after take-off until he reached an altitude of 4 000 - 5 000 ft. When approaching his destination he used to disengage the auto pilot from the time he entered the aerodrome control area and fly manually until he had landed the aircraft. According to the same witness the captain's usual practice was to leave the clutches engaged with the auto pilot selected out.

The captain was familiar with and favoured the monitored approach procedure which BEA recommends. Whether he or his first officer did the flying or the visual looking out was a matter for his own decision in the circumstances of any individual let-down. He was regarded as a meticulous watcher of his approach speed.

The Court was satisfied that during the whole of the period of the talkdown eleven out of thirteen of the red low intensity approach lights, the red obstruction lights, the green low intensity threshold lights and all save one of the white directional runway lights were alight.

• The Court was satisfied that the captain was at no time in breach of the provisions of the Air Navigation Order 1954 relating to Aerodrome Meteorological Minima for aircraft registered in the United Kingdom and that he complied with the instructions issued from time to time by BEA which cover every aspect of approach and landing in limited visibility.

In all the circumstances the Court could not favour any explanation of the accident based upon pilot error. The elimination of pilot error resulted in concentrated study of other factors such as malfunctioning of the control mechanism which might make the aircraft uncontrollable. In this connection, the possibility of something jamming the controls was given detailed consideration.

BEA have a standing order the intention of which is to eliminate any possibility of loose objects being left about in the cockpits of aircraft. Provision is also made requiring those who are responsible for carrying out the various prescribed "checks" to satisfy themselves that no tools or similar objects are left behind when panels are closed or in any other section of an aircraft in which work was required in the course of the "check".

So far as the Viscount 802 is concerned, the only one of the controls into which a foreign object could find its way was the aileron servo motor on the port pilot's platform. After going through the complete control system a reliable witness from the Service Branch of the builders of Viscount aircraft was unable to find any other place into which any but insignificant foreign objects might get.

More than a month before the accident the builders put out a bulletin recommending the covering of an aperture through which objects might fall into the control mechanism governing the ailerons. The modification was given the value "desirable". A large number of "desirable" modifications are suggested from time to time and these are studied and applied as and when convenient.

There is not in this case a shred of evidence which would justify a finding that any interference with the controls had anything to do with the fatality. Two circumstances only have made it necessary for the topic to be discussed. The first of these is the elimination of any probability of pilot error. The second is the wide canvassing of the possible significance of the finding among the wreckage of the aircraft of a small screwdriver, of the type commonly used by electricians, in a badly distorted condition which indicated that it had been subjected to severe stresses.

While it was clearly possible for a foreign object like this screwdriver to have fallen through the aperture into the aileron controls the Court felt bound to accept the evidence of the scientific investigators that it was not probable that this screwdriver was jammed in the aileron controls on the occasion of this crash.

A detailed examination of the auto pilot equipment salvaged from the aircraft was carried out. There was nothing wrong with the auto pilot and it was not energized nor were the clutches engaged at the time of impact.

Careful work was done in the course of a study by an expert to try to establish the flight path followed during the final dive and particular attention was paid to the possibility of a bunt manoeuvre or of a partial recovery from a stall.

It appears possible to obtain conditions at impact similar to those reported without requiring any structural failure or unserviceability of the aircraft but also that the manoeuvre required would be of a fairly violent nature.

Something may have deceived the pilot into some violent manoeuvre of the kind envisaged. It would seem that the only possible source of such deception would be the Flight System and associated instruments.

All that was recovered from the wreckage was subjected to an exhaustive examination by an impressive body of experts and they failed to find anything which pointed to the malfunctioning of any instrument or indicator which could have led the pilot into a disastrous operation of the controls.

Probable Cause

The cause of the accident was not determined.

Recommendations

Consideration should be given to the disciplinary aspect of the switching on and off of aerodrome lighting. In this case there was a conflict of evidence between local residents and the airport staff as to whether the approach lights were on when the aircraft was coming in to land. The Court favoured the evidence given by the officials but not without some misgiving. It must help the man who is responsible for seeing that lights are switched on or off as is appropriate to the weather conditions prevailing if he knows that as a matter of drill he must make some record of the times at which he performs these duties. It is not for the Court to suggest the method by which or the form in which such records should be made but it is reasonably assured that some such drill could be insisted upon without putting any appreciable burden upon the personnel concerned.

The bent screwdriver was handed to the Investigating Officer of the Accidents Investigation Branch on the second or third day after the wreckage had been taken into a hangar for examination. The Investigating Officer put it aside in a box along with some other small components which were awaiting more detailed examination and when several days later he went to find it, it had gone. He found that the screwdriver had been picked up by a person employed at the airport, straightened by him and presumably used again as a screwdriver, no doubt in all innocence and good faith.

In this case the screwdriver was not taken and tampered with by an ordinary member of the public to whom the police could deny access to the hangar but, as has been said, by one of the persons detailed to assist in the moving of the wreckage and as such authorized to be in the hangar and so to have access to the impounded objects.

Again it is not for the Court to devise security methods designed to prevent this sort of thing happening again but it expresses the strong view that somebody ought to.

It is clear that the possibility of loose objects finding their way into the control mechanisms of aircraft and jamming them is in the mind of all concerned with the design, operation and flying of aircraft.

The Court takes this opportunity of calling for constant vigilance in this respect and for the devising of drills and disciplinary sanctions directed to the elimination so far as may be possible of carelessness which may lead to the leaving of tools or other objects loose in an aircraft in such a way as to create any possibility of the sort of mischief which has had to be considered in the course of this investigation.

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ICAO Ref: AR/546

Non-scheduled Landing Undetermined

No. 8

Aviación y Comercio, DH-114 Heron aircraft, EC-AOA, was damaged on landing at Fuenterrabía Airport, Spain, on 26 October 1957. Report released by the Directorate General of Civil Aviation, Spain, November 1958.

Circumstances

EC-AOA departed Barajas Airport, Madrid, on the morning of 26 October on a scheduled passenger transport flight to San Sebastián with a stop planned at Fuenterrabía. Brake failure occurred on landing at Fuenterrabía Airport, and the aircraft left the field and fell into a slough in the estuary of the Bidasoa River, approximately 20 metres from the airport limits. As a result of the accident, a passenger suffered a fractured arm, and two other passengers were slightly injured. The remaining 14 passengers and the crew were uninjured. The aircraft was destroyed.

Investigation and Evidence

The pilot had 15 hours flying time on Heron aircraft and a total of 2 500 hours to his credit.

Tests of the aircraft's pneumatic system disclosed that when in "gear down" position, the selector lever of the gear operating device produced an internal leak whereby the bottle pressure escaped to the outside air; both the flap and brake systems, however, were in perfect operating condition. With gear up and flaps 0°, the pneumatic system remained normal. Extension of flaps to 20° was carried out normally, but gear release and extension allowed the compressed air in the bottles to escape to the outside air and, consequently, the bottles were gradually discharged. Brake tests and flap extension to 60° were performed during this discharge, with satisfactory results as long as the bottles still retained some air pressure. Total bottle discharge left both the brake system out of order and the flaps free to retract, which prevented them from acting as aerodynamic brakes.

The Flight

On sighting Fuenterrabía Airport the aircraft was flying at 900 metres so the pilot circled the field once to lose altitude and enter Runway 05 in an ordinary glide. Touchdown was at about 150 metres from the threshold of the runway at a speed, considered by several witnesses to be excessive, and the aircraft continued on a normal run for about 300 metres at which point the pilot switched off the ignition of the inner engines and applied brake control. As this produced no effect, he repeated the manoeuvre several times and attempted to ground loop in order to avoid leaving the strip by the approach end of Runway 23. However, he did not fully succeed and merely performed a slight turn which did not prevent the aircraft from leaving the aerodrome and falling into a slough.

The pilot should not have relied exclusively on the flaps and the brakes, even in the presence of wind. He should have touched down at reduced speed, taking maximum advantage of the runway length.

Probable Cause

The total discharge of the air system bottles, owing to the internal leak in the landing gear selector, prevented brake functioning.

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ICAO Ref: AR/544

Scheduled
Landing
Overshoot

No. 9

IBERIA, Douglas DC-3, EC-ACH, caught fire and crashed in the vicinity of "La Marañosa" Getafe (Madrid), Spain, on 28 October 1957. Report released by the Directorate General of Civil Aviation, Spain.

Circumstances

EC-ACH was on a scheduled passenger transport flight from Tangier to Madrid carrying 4 crew and 17 passengers. When flying near Getafe it caught fire after an intense flare of light was seen, and the left engine fell free. The aircraft then lost height and crashed, killing all occupants.

Investigation and Evidence

Witnesses' statements showed that in its first stage the fire was set off by a magnesium compound or by a thermic-type mixture and not by liquid fuel, while in the second stage the burning of fuel with a high carbon content became apparent.

Examination of the wreckage showed that the fire started behind the fireproof bulkhead; the spar supporting the upper engine fittings gave way owing to the heat, and the engine rested on the lower fittings until they broke.

The aircraft hit the ground with its landing gear extended. The leading edge of the left wing in the de-icing zone was burned by a jet of flame which reached a temperature of over 800° C which had been directed during flight from the nacelle toward the wing and from the rear to the front.

It appears that the aircraft was flying normally when fire broke out in the left nacelle behind the fireproof bulkhead and spread rapidly, either because the pilot extended the gear to begin landing operations or else because the fire reached the oil container, raising the temperature sharply and probably setting off the fire detection system.

The temperature attained weakened the spar supporting the upper engine fittings as well as the lateral walls of the nacelle; the engine became loose and was supported only by the lower fittings whose bolts could not support its weight. The engine was, therefore, soon torn away. This could have occurred at 1804 hours at the latest - by which time the aircraft was no longer replying to R/T calls.

The oil and hydraulic lines, as well as the rest of the oil in the container fed the fire, and when the engine became detached taking with it a piece of the fireproof bulkhead, a direct current of air fanned the flames which spread to the left wing and the left side of the fuselage, reaching the rudder and the left elevator.

It is probable that in order to open the passenger door, in accordance with emergency regulations, and since the door handle must have been very hot, a water-soaked napkin was used; it was, subsequently, found near the engine. It is also probable that emergency exits were opened to permit rapid evacuation of the aircraft once it landed. However, before it reached the ground, fire must have entered the cabin by any one of these openings, as is shown by the evidence of intense fire in the interior of that part of the tail unit that was not totally destroyed. It may also have happened that the left side of the baggage compartment caught fire owing to the intense heat produced by the flames.

With fire inside the cabin, or at least in the baggage compartment, the aircraft attempted to land with its trimming tabs operated to their limit. It was, however, listing badly owing to the missing engine, probably aggravated by the fact that passengers on the port side had gone over to starboard in an attempt to escape the heat generated by the fire. Moreover, the landing gear could not be locked in place - the failure of hydraulic pressure prevented its retraction or its locking in an extended position.

The Flight

At 1759 hours the aircraft was in contact with Barajas Control Tower and reported normal flight and that the airport was in sight. It requested landing data and asked that the ILS be turned on to test the airborne installation in the prevailing visual meteorological conditions. Barajas replied: "Runway 33, wind calm, QNH 30.13, report on reaching base leg, ILS out of order". At 1803 the aircraft called the Paracuellos Area Control Centre asking for emergency entry clearance as its left engine was on fire. It was given absolute priority for the use of any runway. That was the last contact with the aircraft. Shortly thereafter an engine fell clear, and 30 seconds later an intense light was seen caused by a fire accompanied by columns of black smoke. After making a turn the aircraft began to lose height rapidly and fell to the ground.

Probable Cause

The accident was caused by a fire produced by extraneous objects, which developed in the left nacelle. A different type of fire would have burned the wheel, the magneto couplings and the landing gear leg; fuel combustion alone would not have been sufficient to weaken so rapidly the engine support fittings.

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ICAO Ref: AR/545

Scheduled
En route
Fire in flight

No. 10

Pan American World Airways, Inc., Boeing 377, N 90944, was lost in the Pacific Ocean between Honolulu, Hawaii and San Francisco, California on 9 November, 1957. Civil Aeronautics Board (USA) Aircraft Accident Report, released 20 January 1959, File No. 1-0119.

Circumstances

Clipper 944, a regularly scheduled around-the-world flight, originated at San Francisco with its first stop scheduled at Honolulu. It departed San Francisco at 1951 hours GMT on 8 November and arrival at Honolulu was estimated at 0550 hours on 9 November. Gross weight at departure was 147 000 pounds, the maximum allowable, and the weight included fuel for approximately 13 hours. Aboard the aircraft were 36 passengers and a crew of 8. All the required position reports were made and 944 reported to Ocean Station "November" at 0030; its position was fixed by radar as 10 miles east of the vessel. The last position report, at 0104, was routine with no indication of anything unusual. The next scheduled position report, due at 0204, was not received and 30 minutes thereafter the flight was designated unreported. An extensive sea and air search over thousands of miles of ocean ensued. Bodies of 19 of the 44 occupants were found as were small and light aircraft parts and cargo.

Investigation and Evidence

On 14 November, the fifth day of search, aircraft from the U.S. Navy carrier "Philippine Sea" located bodies and parts of wreckage some 940 miles east of Honolulu and approximately 90 miles north of the flight's intended track. A continued intense search was unproductive and was abandoned on 15 November.

Board investigators carefully examined the recovered debris for evidence of an inflight explosion. This examination included a thorough inspection of recovered items of cargo, passenger effects, and mail. No evidence of an inflight explosion in the fuselage was found.

The Board considered it possible that an emergency message might have been sent from the flight after the 0104 position report and that such message might not have been heard. Pursuing this possibility the Aeronautical Radio, Inc., recording tapes for the frequency in which such message would be recorded were carefully examined. Initially nothing was apparent. However, repeated playbacks of the tapes of the period following the 0104 position report disclosed previously unknown transmissions which were extremely weak and subject to varied and conflicting interpretation.

Despite comprehensive research, the Board could not definitely establish that any emergency transmissions came from Clipper 944.

There were no reports of turbulence, icing, lightning, thunderstorm activity, or precipitation of any kind.

Because of the limited amount of wreckage recovered, it became all the more important to determine as much information as possible from the recovered bodies in order to arrive at a better understanding of the emergency that had caused the accident. The Board enlisted the aid of expert pathologists familiar with aircraft accident fatalities to assist in the development of all significant information. Their examination of the 19 bodies recovered disclosed that 10 had probably died from drowning. Further, the lack of extensive crash-induced mutilation, together with the general condition of the bodies, suggested that the water impact, although severe, was not sufficiently great to cause complete disintegration of the aircraft. None of the bodies had been subjected to fire before or after impact.

As part of the pathological examination, a series of tests for toxic material was conducted. Initially these tests indicated elevated levels of carbon monoxide in several of the recovered bodies. This preliminary finding indicated

1) the need for further corroborating tests

2) that a study should be undertaken to determine how high concentrations of carbon monoxide could have been present in the inhabited portions of the fuselage.

To accomplish the latter objective a Board investigating group made a detailed study of the Boeing 377 systems to determine possible malfunctions which could lead to the generation of carbon monoxide. These were considered with probable variations in the pattern of airflow throughout the fuselage. This study disclosed that high levels of carbon monoxide could be generated and distributed unevenly throughout the fuselage in several ways. However, it was impossible to relate the elevation of carbon monoxide found in bodies with the seating arrangement and, consequently, with the source of the carbon monoxide.

Medical tests have continued from the time of the accident to the present to verify the initial findings relative to carbon monoxide concentrations in certain of the bodies. These tests, conducted independently by different federal agencies, verified the concentrations as found initially but raised doubt as to the suitability of any test method because of the decomposed state of the bodies. Additional studies are presently being performed which may answer the question regarding reliability of carbon monoxide results in cases of post-mortem decomposition, but as yet this question is unsolved.

Expert examination of five recovered wrist watches established a probable time impact as 27 minutes past the hour. Since the aircraft had reported at 0104 and did not report, as scheduled, the time of the crash is concluded to have been 0127.

An inspection was made of all company maintenance records of N90944. This included records of the aircraft structure, powerplants, and all accessories. A detailed study of these records, which were adequate and in good order, showed that all airworthiness directives had been complied with and that no known discrepancies existed at the time the aircraft was dispatched on this flight.

Examination of past discrepancy reports for the aircraft revealed a report of an unexplained "loud noise" during flight, and two cases of hard landings. Inspection of the aircraft had followed each of these incidents and no visible damage had been found. The inspection had not included, however, examination of the wing spars as this was not, at the time, considered necessary.

During the course of the investigation, and in view of the circumstances of the disappearance of the aircraft and the absence of living witnesses or crew members, an extensive investigation of personal activities and backgrounds of crew, passengers, and company ground personnel of the San Francisco base of PAWA was made by CAB and other governmental agency personnel. This investigation included personal interviews with all personnel who might have had access to the aircraft for any reason while the aircraft was on the ground on its last stopover at San Francisco from 6 November 1957 to 8 November 1957, and involved some 98 persons. This phase of the investigation disclosed that the aircraft received normal preparation for the flight and disclosed nothing relative to the character or behaviour of any person that might point to sabotage in connection with the loss of the aircraft.

Subsequent to the public hearing, the Board conducted an investigation of specific maintenance and overhaul practices and occurrences at the carrier's San Francisco base. The purpose of this investigation was to obtain information by which maintenance adequacy of the carrier's Boeing 377 aircraft and powerplants could be evaluated; consequently, a part of the investigation related directly to these aircraft.

A number of irregularities in maintenance procedures and/or practices were noted. However, because the aircraft was lost at sea with no message giving any clue as to the nature of the emergency and because there was no direct application of these irregularities to 944, it is obviously impossible to associate them with, or dissociate them from, the accident.

The subjects of emergency procedures, and crew training and competency therein, were investigated. It was established that the company's emergency training curricula, including ditching, fire fighting and smoke evacuation procedures, were adequate and that all crew members of N 90944 had successfully completed the required training.

It is obvious from the investigation portion of this report that an analysis to arrive at the probable cause of the accident is seriously handicapped by the scarcity of physical evidence. However, the following seems logical.

If a large-scale fire had occurred in the cabin, cockpit, baggage compartment, or lounge area, some evidence of such fire would most probably be present in the recovered pieces. Since none was found, it is reasonable to conclude that a large-scale fire did not occur in any of these areas. There was no physical evidence to indicate the occurrence of a powerplant or localized fuselage fire nor was there any evidence to indicate that there was no such fire. Although a powerplant or localized fuselage fire would not immediately destroy the structural integrity of the aircraft, both the indicated lack of directional control and absence of any distress message could well be associated with this kind of emergency. Such fire could generate considerable quantities of smoke which might present serious difficulties to the crew. However, equipment is provided to combat such an emergency, and the crew is trained in its use. Fire damage that was observed on the floating debris was confined to those surfaces which were above the waterline. Obviously, this damage could have been caused only by a surface fire following impact.

Clipper 944 made five routine hourly position reports after its departure from San Francisco, the last one 21 minutes prior to impact with the water. After the last routine position transmission, the aircraft descended from 10 000 feet going away from Ocean Station "November" which it had passed some 35 minutes before.

The location of impact was computed to be in the vicinity of latitude 29° 26' N. and longitude 143° 34' W. This is approximately 105 miles west of the last position established for the aircraft and about 30° off course to the right or north. Lack of knowledge of both the time and start of descent and precise impact point makes it impossible to determine by analytical means, or otherwise, the airspeed or the descent rate existing during the descent.

A fairly flat angle of impact is indicated by the nature of damage to the recovered material, its location within the aircraft, and by the lack of severe mutilation of bodies. The part of the aircraft from which the recovered wreckage came indicated breakage of the fuselage at about the same locations as has occurred on previous survivable ditchings of the same model aircraft. These circumstances suggest a nearly survivable ditching may have been available at the time of water impact. Exercise of such control would tend to rule out crew incapacitation. However, two pertinent conclusions regarding the final portion of the flight are evident. Consideration of the distance flown from the last reported position to the impact point, and of the time required to traverse that distance shows that the flight did not turn back toward Ocean Station "November". Also, the ditching to the north of the planned route indicates that appreciable lateral distance, not on course and away from the ocean station, was traversed after the start of the emergency.

It is difficult to understand why the captain would have elected to continue away from "November" had he been able to do otherwise. Weather was not a factor, and it is not believed that the shipping lanes to the north offered any inducement to turn in that direction. Conversely, "November", a fixed ocean station equipped with radio homing and radar devices and rescue equipment, was in close proximity with trained personnel readily available.

The condition of the sea at the time and place of the ditching is not known precisely, but it should not have been appreciably different from that existing at the weather vessel 105 miles to the east. That vessel's official observation at 0000, one hour and 27 minutes before the ditching, included: waves from 300° at a frequency of 11 - 13 seconds with a mean maximum height of 8 feet. Surface winds were southwest 11 knots. These conditions would produce a usable sea surface for ditching. One airline captain en route near the place and close to the time of the ditching stated that seldom had he seen the sea conditions more favourable for ditching. Due consideration of all these factors leads to the belief that either loss of directional control or crew incapacitation was the possible cause of the aircraft proceeding away from "November" after the start of the emergency.

There is a record of previous emergencies involving Boeing 377 aircraft which were accompanied by serious directional control difficulties. Emergencies referred to, except one, followed complete separation of a powerplant from the aircraft. The one exception occurred following take-off with the cowl flaps fully open. Common to all of these occurrences was heavy buffeting in flight and, in the case of powerplant separation, great difficulty in simultaneously maintaining altitude and directional control. Such occurrences bear a striking resemblance to what appears very likely to have occurred to 944.

Buffeting, which can be sufficiently violent as to cause concern for the structural integrity of the aircraft, is most likely caused by disrupted airflow over the empennage. Disrupted air flow, in turn, usually results from some occurrence which disturbs the smooth outer shell of the aircraft, such as an object passing through the fuselage; an explosion in an engine nacelle, wing leading edge, or the fuselage; or an engine being wrenched from the aircraft. A fuselage explosion has been discounted. Though not indicated factually or historically in any manner with respect to the propellers in use, failure of a propeller blade or portion thereof, or separation of an entire propeller by engine failure or nacelle explosion either from explosive fumes or turbosupercharger failure, are the most likely causes of the kind of damage being considered. These possibilities and their consequences are also suggestive of what may have happened to N 90944.

Lack of any known message from the aircraft after start of the emergency may be related to fuselage external and/or internal damage which broke antennae and/or caused major damage to the electrical distribution system. Crew incapacitation is a definite possibility.

Since pathological study indicated the possibility of carbon monoxide in the cabin prior to impact, the most likely sources thereof must be considered. CO is generated in most any type of a fire (electrical, combustible fluids and solids) or by the thermal decomposition of many substances. A large fire within the fuselage is not compatible with the condition of the recovered wreckage so a smouldering fire would appear to be more likely. Such a fire would cause considerable smoke in the cabin, in addition to the carbon monoxide, and contribute to the off-course location of the crash but should have been controlled by the emergency fire fighting equipment carried on board unless the fire had ignited some material like nitrate film. Such a fire should not have created the need for an immediate ditching unless the smoke accompanying it was excessive and irritating, and the fire was uncontrollable.

A more probable source of CO would be an unusual occurrence in a power package which could have initiated a chain of events leading to the introduction of carbon monoxide into the fuselage. Such an unusual occurrence could be a failure which would release part of a propeller blade or the entire propeller, or a failed turbosupercharger disc. It is likely that occurrence would be accompanied by serious flight control problems and possibly fire. If a propelled object, such as a propeller, came through the fuselage it could easily start a fire, knock out some radio equipment, make emergency smoke evacuation procedures ineffective, and destroy the crew's emergency oxygen supply. Such an occurrence fits the known circumstances better than any of the other possibilities.

A third type of CO source which also fits most of the known circumstances is the malicious introduction of pure CO into the cabin and preferably the flight deck. CO unaccompanied by smoke would not be recognized by the crew and occupants, and symptomatic quantities could be absorbed by the crew before they realized it. Under these circumstances complete incapacitation of the crew would result, and the aircraft could have been flown into the water.

Several techniques have been used in the past to make quantitative determination of carbon monoxide in bodies of accident victims. Because of the violence associated with certain types of aircraft accidents, the applicability of the results of some techniques and methods had been subject to question. The results were even more questionable when the bodies had passed through certain stages of putrefaction. Since the beginning of the Board's investigation of this accident, the Armed Forces' Institute of Pathology has devoted considerable time to verifying the suitability of the various testing methods available. Further, and more important, a new technique was evolved which adapted the use of gas chromotography to the determination of carbon monoxide levels in the blood of accident victims. This new technique was demonstrated to be both specific and applicable for use on the bodies which were not exposed to advanced post-mortem decomposition.

In a recent Navy accident, which involved multiple casualties and similar exposure to warm sea water, two of the eight immediately lethal fatalities demonstrated elevated CO values. In that accident there was no inflight fire, but a post-impact surface fire did occur. This casts some doubt on the nearly established conclusion that carbon monoxide is not a by-product of advanced stages of post-mortem decomposition. This question may take a considerable amount of time to resolve. The Board's report is being released, nevertheless, in the absence of a satisfactorily established cause.

The Board is deeply indebted to the Armed Forces' Institute of Pathology for its valuable assistance in the investigation of this accident and its research which continues and has already made a significant contribution to the field of aviation medicine and aircraft accident investigation.

The maintenance history of 944, as obtained from the records, was, in the main, normal, and there was nothing that could be related directly to the accident. However, in view of the incomplete hard landing check at San Francisco, and a somewhat cursory check following a report of a "loud noise" in flight, also at San Francisco, maintenance and the airworthiness of the aircraft cannot be accepted as being normal in all respects.

The omission of the main spar inspection during the hard landing check eliminated an important and what is probably the most onerous and time-consuming step of the procedure. This omission is considered to be significant and indicates that, in this instance at least, expediency rather than thoroughness prevailed. It can only be concluded that the "loud-noise" check was at best cursory. The Board's investigation of specific maintenance practices at San Francisco established these practices as not being entirely isolated cases. However, the Board did find at the time of this investigation that the carrier was in the process of reviewing and, where necessary, revising their maintenance manual and procedures. This effort also included a realignment of some personnel assignments and responsibilities. Furthermore, the results of maintenance investigation were called to the attention of the CAA, by memorandum dated 19 March 1958 with a recommendation that PAWA maintenance practices be re-assessed. The CAA has advised that suitable corrective measures have been taken.

There was no evidence of a bomb-type explosion within the fuselage. Had a large-scale bomb explosion occurred in the fuselage (cabin, cockpit, baggage compartments, and/or lounge), evidence of this would undoubtedly, have been found on some of the recovered wreckage material as well as on the bodies.

Probable Cause

The Board has insufficient tangible evidence at this time to determine the cause of the accident. Further research and investigation is in process concerning the significance of evidence of carbon monoxide in body tissue of the aircraft occupants.

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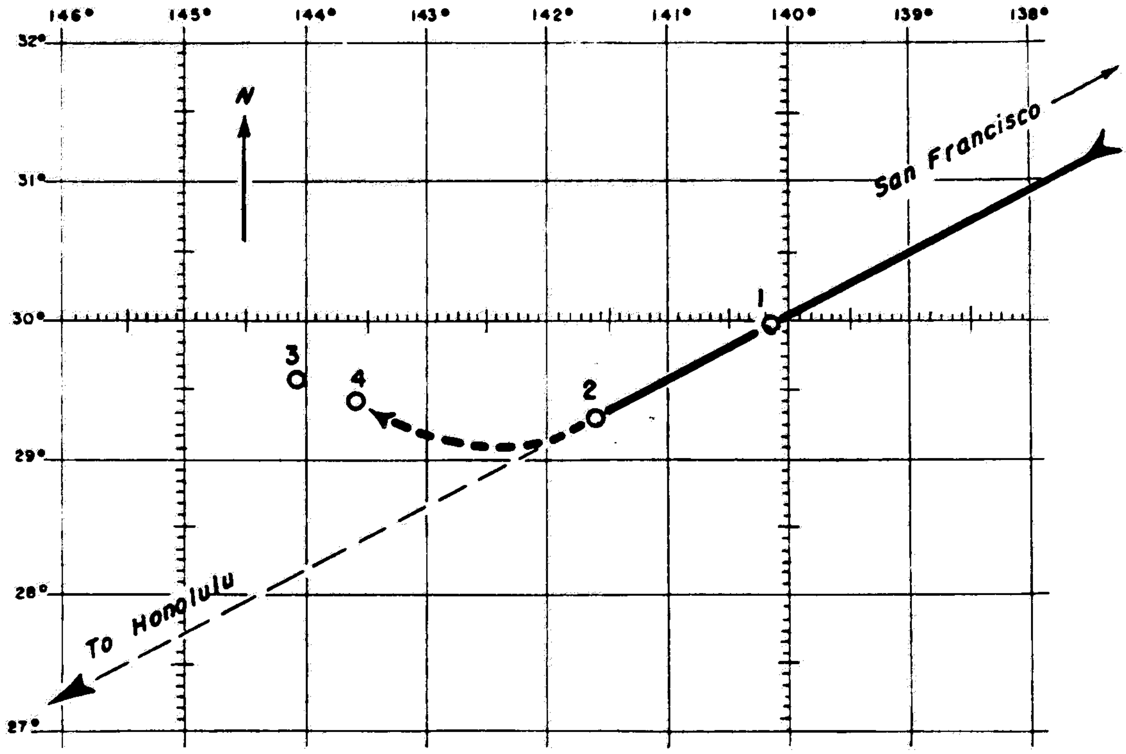
ICAO Ref: AR/554

Scheduled
En route
Collision - water



1. Weather Vessel. Approximately midway between San Francisco and Honolulu
(29° 59'N – 140° 8' W)

2. Last reported position of 944
(29° 20'N – 141° 35'W)

3. Wreckage and bodies
(29° 36'N – 144° 3'W)

4. Probable impact
(29° 26'N – 143° 34'W)

SCALE
0 50 100
NAUTICAL MILES

Known path

Probable path

Planned path

FIGURE 2
PAWA — N 90944
November 9, 1957

USCOMM-DC-25160

No. 11

Aviación y Comercio, de Havilland D.H. 114, Heron 2D, EC-ANZ, crashed into a mountain near Puigpuñent, Majorca, on 15 November 1957. Report released by the Directorate General of Civil Aviation, Spain.

Circumstances

The aircraft was on a scheduled passenger transport flight between Barcelona and Palma, Majorca. It took off from Barcelona at 1919 hours. At 2002 hours it reported to the Palma, Majorca Area Control Centre that it was above the MJ radio beacon at flight level 60. It was cleared by the Centre for an ADF approach to the Son Bonet Airport and at 2008 hours it hit a mountain located 14.5 km from the airport. The 2 crew members and the 2 passengers were killed, and the aircraft was completely destroyed.

Investigation and Evidence

The aircraft had flown a total of 465 hours and had undergone its last periodical overhaul 27 hours before its last flight.

The pilot had logged 1 912 hours of flying time, 95 of which were performed on this type of aircraft.

Weather

The synoptic charts taken at 0600, 1200 and 1800 GMT show that there was a low over the Western Mediterranean and the South of Spain. This depression was filling up rapidly and at 1800 it was confined to a small nucleus with its centre to the south of the Balearics. A broad occluded front was approaching the region of the Balearics from the south, crossing it at approximately 1800 hours. At this time, an area of continuous precipitation is shown with cloudbanks at some levels and moderate land winds from the north-east, covering a large part of the Balearics, the Spanish coast of the Levante and Cataluña, and reaching Corsica. At altitude, a depression is also shown with its centre approximately on the Balearics and extending to high levels.

EC-ANZ was completely destroyed in the crash and the resulting explosion and fire. Examination of the wreckage and of the aircraft's navigational instruments did not disclose the causes of the accident. As apparently no one saw or heard the aircraft at the time of the accident, it was impossible to determine the direction followed by the aircraft when it struck the mountain. Finally, as no bearings were requested from the Palma D/F station, there was no indication of the track followed, and, therefore, any reconstruction of the accident must be based on hypothesis.

Hypothesis

The aircraft took off from Barcelona at 1919 hours. Its pilot gave Palma Area Control Centre his estimated time of arrival as 2001, and at 2002 reported over MJ radio beacon at flight level 60.

At this stage, he had to perform a holding procedure passing from flight level 60 to transition altitude (flight level 40). As the time required for performing such a procedure is 6 minutes, the aircraft should have returned over MJ at 2008 at flight level 40.

Furthermore, such a procedure should have permitted the pilot to detect any defective functioning of the radio compass - any erroneous indications due to radio electrical disturbances would have been apparent if the pointer had not returned to its original indication after 6 minutes had elapsed.

ADF approach to Son Bonet Airport was cleared by Control Centre as no other aircraft was in flight at the time, and the aircraft was asked to report on starting its procedure turn, i.e. after 4 minutes on the outbound track.

If the aircraft did actually reach flight level 60 above MJ, since it did not carry out the holding procedure it is impossible to determine its rate of descent during let-down. To perform such a manoeuvre - once the radio compass has indicated passage over the radio beacon - the pilot should adjust his directional gyro to the heading of 195° indicated on the aerodrome chart (see Figure 3). In other words, he should have placed his aircraft on the outbound track toward Palma Bay and maintained this heading during three minutes after which he should have taken a 240° heading during one minute and then reported his procedure turn to Control.

Now if a line is drawn from the radio beacon MJ to the site of the accident, it will be seen that the direction of the line is 295°, i.e., that it forms an angle of 100° with the let-down heading (195°); it is possible, therefore, that in setting the directional gyro the pilot mistakenly added 100 degrees. The distance of 14.5 kilometres corresponds approximately to the distance from the beacon of a procedure turn.

The possibility of a 14-knot wind causing such a displacement in the track of the aircraft within such a short period of time must be ruled out.

Reasons supporting this hypothesis

Poor weather conditions and the rainfall prevailing at the time of the accident, coupled with the turbulence reported to EC-AHI on the Barcelona-Palma route might have influenced a pilot whose experience was limited.

The pilot had already performed five crossings: Palma-Barcelona; Barcelona-Mahón; Mahón-Barcelona; Barcelona-Mahón; Mahón-Barcelona; on the day of the accident. His mental and physical state may have been thereby affected; hence possibly an error in setting the directional gyro.

The fact that five minutes after he had begun cloud penetration (2007 hours) he asked for the marker beacon to be started - a request seldom made by pilots - would lead to believe that he was not quite sure as to the way in which he was performing his manoeuvre.

The height of the spot where the accident occurred is 450 metres (1 500 ft); assuming the pilot was heading 295° instead of 195° it is clear that he could only have hit the mountain inbound to MJ between 2007 hours and 2009 hours since at 2006 hours he was due to report to the Control Centre on the procedure turn at a height of 670 metres (2 200 ft).

Examination of the wreckage shows that the aircraft landing gear was already down, a procedure which is generally carried out at the last stage, i.e. on approach and not on the outbound track.

Reasons against this hypothesis

A visual examination on an identical aircraft belonging to the same airline revealed that the numbers and divisions on the directional gyro are very large, fluorescent, well lighted, easy to read, and, therefore, not very liable to errors.

Furthermore, this aircraft is equipped with a large-sized magnetic compass containing a mirror and its lighting is perfect.

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Scheduled
Landing
Collision - rising terrain

ICAO Ref: AR/561

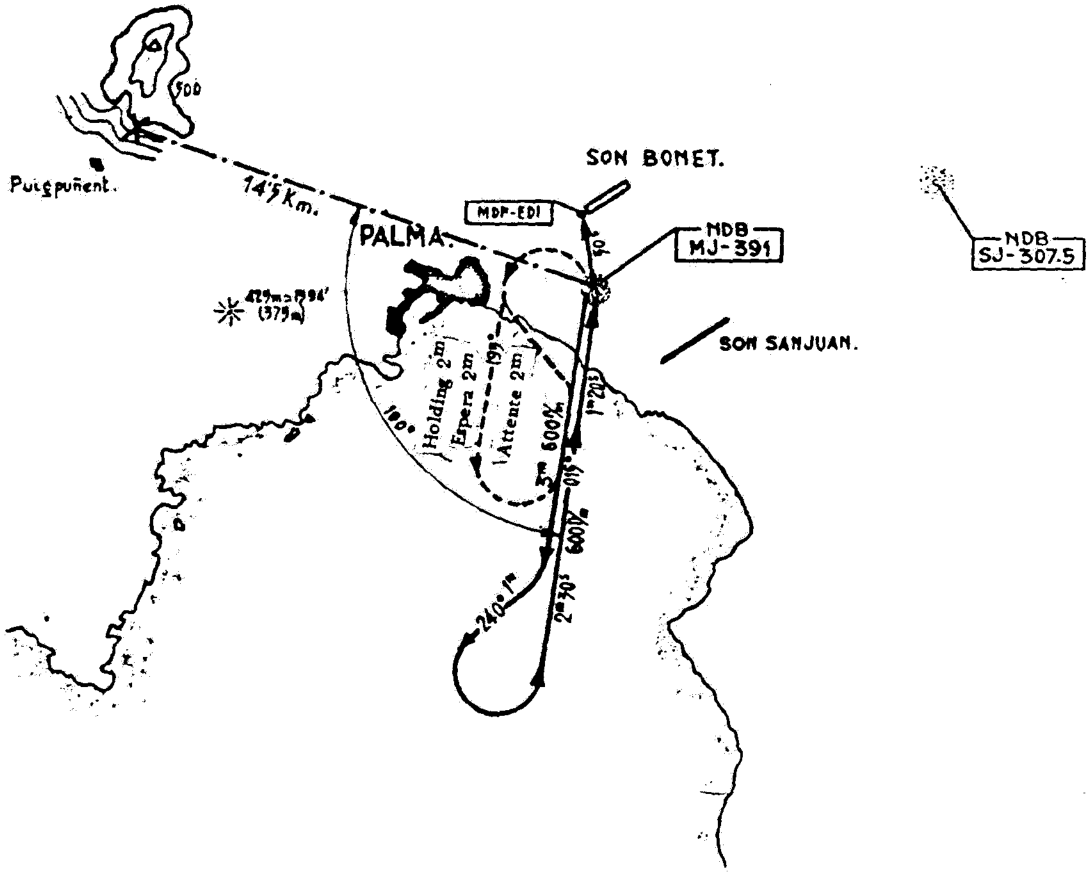

FIGURE 3 - FIGURA 3

HERON, EC-ANZ, ACCIDENT AT PALMA, MAJORCA - 15/11/1957

ACCIDENT DU HÉRON EC-ANZ, PALMA DE MAJORQUE - 15/11/1957

ACCIDENTE DEL AVIÓN HERON EC-ANZ, OCURRIDO EN PALMA DE MALLORCA EL 15/11/1957

No. 12

British European Airways Corporation, Vickers Viscount 802, G-AOHP, made a forced landing at Ballerup, Denmark, on 17 November 1957. Report released by the Director of Civil Aviation, Denmark.

(Reference was made to this accident in Digest No. 9. The summary was held over at the request of the United Kingdom pending discussions on the report with the Danish Authorities. The United Kingdom subsequently informed ICAO that the Danish Authorities had agreed to the attachment to the Danish Report of a statement by the aircraft manufacturer. The substance of the attachment appears as footnotes in the following summary.)

Circumstances

On the day of the accident the aircraft had taken off from London Airport at 0130 hours GMT on a scheduled flight to Kastrup Airport, Copenhagen, carrying a crew of 2 and a cargo of mail, freight and newspapers. The flight was without incident until when holding over Radio Beacon Bella, three of the aircraft's four engines stopped. It lost height and a forced landing was made at 0403 hours GMT, 14 miles northwest of Kastrup. The aircraft was considerably damaged, but there was no fire. The crew were not injured.

Investigation and Evidence

The aircraft had taken off from London Airport with 1 480 gallons of fuel on board. Take-off weight was 28 549 kilos (maximum permitted 28 576 kilos).

Climb was made to 21 000 feet where the flight was continued in clear air without incident. At 0327 hours, clearance was given to descend to 7 000 feet, and later to 3 500 feet. A layer of stratus cloud was entered at 4 000 feet and the propeller de-icing was switched on. At this time the temperature at 3 500 feet was -2°C. The aircraft arrived at Bella Beacon at 0346 hours and was held in the holding pattern whilst another aircraft, which was experiencing radio trouble, was cleared in to land. During this time the initial pre-landing drills were started, and it is estimated that the fuel heaters were switched on at 0348 hours. At 0351 hours Control indicated that further clearance could be expected in three minutes. The remaining initial approach drills were completed including lowering the undercarriage and switching off the flowmeters. After three minutes the captain decided that a clearance could be expected at any time and, therefore, started to make a procedure turn to the northwest in order to join the ILS.

During this time neither the windscreen de-icers nor wipers were used, and there were only light spots of ice on the windscreen. The airspeed was 135 knots, and the power settings approximately 12 000 rpm and 160 lbs torque.

At approximately 0357 hours, during the right-hand procedure turn, and soon after the captain had switched on the airframe de-icing, the port current flow warning light came on, together with the flashing central warning light. The aircraft swung to port, and having just switched on the airframe de-icing the captain associated the warning light with fire in No. 2 engine, but on checking gauges he saw that No. 1 rpm and jpt (jet pipe temperature) were falling. He, therefore, carried out the fire drill on No. 1. No other warning lights were seen. The aircraft was straightened up on to a northerly heading and the throttles of No. 2, 3 and 4 engines were set to full power, and the wing de-icer was switched off. The aircraft was now losing height rapidly, and the captain retracted both undercarriage and flaps and decided to turn to starboard to regain the ILS. This turn tightened up considerably reaching about 45° bank with 135 knots and a high rate of descent. Severe buffeting occurred resembling the approach to the stall. It was only during this turn that it was realized that Nos. 3 and 4 engines had now failed and the rpm gauges were seen to be at zero.

The manual feathering drill was completed but no current flow warning light showed on the starboard side.

The inter-engine and cross-feed cocks were opened and the fuel heaters were switched off. The power of No. 2 engine was observed by rpm at 14 500. This power was maintained during the descent until just before touchdown when the throttle was closed. The rate of descent with one engine operating was estimated at 600 feet per minute.

At approximately 1 500 feet visual contact was established and the aircraft was directed towards the darkest patch of ground in the immediate vicinity, and an emergency landing was made with flaps and undercarriage retracted about 14 miles northwest of Kastrup.

Weather

At 0400 hours the weather situation in the eastern part of Seeland was as follows:

The area was located on the southern side of a high pressure system and there were no fronts.

It was overcast, with occasional light rain and drizzle, visibility being 8 - 10 km (5 - 6,2 miles).

Cloud was 8/8 stratocumulus with base at 2 000 ft and tops ranging from 3 000 to 4 000 ft. Locally there were 2 - 4/8 of stratus at 400 - 600 ft. There were no clouds above the stratocumulus layer.

Wind direction and velocity were ENE to E 10 - 12 knots on the surface and at 1 500 - 2 000 ft 120°/10 knots.

Temperature:

At surface	+3°C	dewpoint value		+1°C
At 2 000 ft	0	"	"	-3
4 000	-4	"	"	-7
5 000	0	"	"	-4
5 500	+1	"	"	-2
6 000	0	"	"	-7
10 000	-5	"	"	-22
21 000	-23	"	"	-35

No icing had been reported by other aircraft.

Actual Weather at Kastrup

	at 0355	at 0425
Surface wind direction and speed	080° - 15 kts	070° - 13 kts
Horizontal visibility	10 km (6,2 miles)	8 km (5 miles)
Present weather and intensity thereof	int. sl. rain	int. sl. drizzle
Amount, type and height above the aerodrome elevation of cloud base	8/8, 2 000 ft	6/8, 400 ft 8/8, 2 000 ft
Altimeter setting	1 033,5 mb	1 033,6 mb
Surface temperature and the dewpoint temperature	+ 03/ +01°C	+03/ +01°C

Icing

The following statement was produced by the Superintendent of the Danish MET Office relating to the possibility of ice formation at the time of the accident:

"Normally the water content and drop size in clouds of this type will be rather small, and the type and intensity of ice formation will be light to moderate rime, but when soundings indicate conditional instability in the air below the inversion, the clouds will not be homogeneous and the water content may change from place to place. The possibility can in such a case not be excluded that the water content locally may have been rather large, causing more intense ice formation. In this connection the precipitation reports issued at 0355 and 0425 hours on the day in question are rather interesting and indicate a comparatively large amount of water in the clouds.

The possibility cannot be precluded that a rather large amount of ice may have formed on the air intake during a few minutes flight, unless special precautions were taken. When the temperature, as in this case, is ranging from 0 to -4°C, the ice formed will be wet and porous."

During the investigation considerable attention was attached to the possibility that release of an accumulation of ice on the engine cowlings into the air intakes might have caused flame extinction with resultant loss of engine power.

Even though accretion of light to moderate rime only would be the most likely assumption during the prevailing weather conditions, it is possible, on the basis of the meteorological evidence, that rather large quantities of wet porous ice could have built up on the cowlings unless special precautions were taken.

The aircraft was, however, equipped with an efficient de-icing system, i.e. around the leading edges of the cowlings, and this should without any difficulty have been able to prevent ice accumulation at these points, provided that the system had been switched on before icing began and had been working properly.

According to the statements and information given by the members of the crew, it seems unlikely that the de-icing system was switched on after ice had already formed, but there is a possibility that the de-icing system might not have functioned satisfactorily. The nature and consequences of such faulty functioning may have been as follows:

When the powerplant de-icing system was switched on as the aircraft entered the cloud layer at 0344, the cycling lights indicated that the power was on but, owing to a malfunctioning of the relay units which control the power supply to the heater pads on the cowlings, it is possible that full current was not being applied. Without full current full heat would not be available in the de-icing heater pads and, in these circumstances, ice would accumulate on the engine cowlings. If the intermittent fault in the relay unit made contact to supply the full current to the heater pads between 0351 and 0356 hours, the accumulated ice would become dislodged in sections and be sucked into the combustion chambers where it could cause partial flame out in three of the engines. This in turn would cause the auto feathering of the three propellers.

The pilots were not aware of previous cases of engine failure caused by shedding of an accumulation of ice on the engine cowlings, nor were they aware of instructions concerning the operation of the powerplant and propeller de-icing systems which appeared in the aircraft Flight Manual but were not included in the BEA Operations Manual.

* The examination of the electrical circuits insofar as the de-icing equipment is concerned revealed that it is possible that a failure therein might occur with resultant irregular functioning of the relay units which control the power supply to the heater pads on the engine cowlings and propellers. Although thorough examination was made of the system in G-AOHP, it was not possible to establish whether such a failure mentioned above did occur in this case.

* It should be mentioned in this connection that modification action has since been instituted in order to eliminate the possibility of such a failure.

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* The aircraft manufacturer agrees with these two paragraphs but contends that the possibility of a circuit failure is speculative. Nevertheless, the possibility of such a circuit failure in the future has been reduced by modification. The modification is not, however, considered mandatory either by the manufacturer or the Air Registration Board.

Air Traffic Control

On the morning in question an assistant, acting as a controller, was on duty in the tower.

The air traffic controller understood the word "fire" as "failure" when this was reported by the aircraft, but his reaction of summoning the fire and rescue services was correct.

The air traffic controller did not comply with the request for radio silence even though it was fully understandable, and, as a consequence thereof did not receive that part of the message which said that the aircraft was losing height on full power. If this message had been received, it is highly probable that the search would have been confined to the area around the holding position over Bella.

It is finally observed that the recording of the R/T messages revealed that the ATC official's voice was extremely husky, which must no doubt be put down to improper operation of the microphone by him.

Search and Rescue

The way in which the search was set in motion by the ATC Officer was in accordance with prescribed procedure, but the accident may give occasion for consideration of a revision of the SAR organization system, especially as regards the coverage of the area surrounding Copenhagen.

In the present case it took 2 hours and 15 minutes to locate the wrecked aircraft. The time lapse would have been greater but for the fact that the crew members themselves were able to get to a place from which notification of the forced landing could be made.

One of the most serious shortcomings in the system seems to be that teletypewriter messages are too long in reaching points where the search really is likely to yield a result.

In the present case Police Headquarters were notified at 0410 hours, but only at 0515 hours was the message telephoned from the Glostrup to the Ballerup Police Station (no teletypewriter is installed at the Ballerup Police Station), and only then was Kastrup notified that the aircraft had been observed flying over at 0400 hours.

At 0430 hours the Air Base at Vaerløse notified the police at Ballerup of the supposed crash. The police sent out patrol cars to investigate but did not contact the ATC at Kastrup until 0620 hours when the crash was confirmed by one of the patrol cars.

Evacuation

It appeared from the pilot's statement that it was very difficult for the crew to force open the door between the cockpit and the cabin after the forced landing.

Although according to the information given in the Operations Manual, Emergencies Section, it should be fairly easy to split this door along the vertical centreline, it was found necessary in the accident investigation to use an axe to gain access to the flight deck. The cause was found to be that the door, instead of splitting as mentioned, had got stuck in such a way that only the upper left corner of the doorway up to the diagonal of the aperture was free.

Another point brought out during the investigation was that the aircraft was not provided with emergency lighting in the cockpit.

Crew

The captain had flown a total of 9 034 hours, 426 of which were as pilot-in-command on Viscount 802 aircraft.

Apart from the fact that the captain erroneously took the lighting of the warning lights previous to the detection of the failure of No. 1 engine to be an indication of fire in that engine and ordered fire drill to be carried out, the crew appear to have taken correct action in the situations which arose during the different phases of the flight.

Probable Cause

The cause of the engine failures, which brought about the accident, lay in the accumulation of ice on the engine cowlings which, because of malfunctioning of the de-icing system, * was allowed to build up before being dislodged. Passage of the lumps of ice through the engines caused partial flame out, which produced sufficient loss of power to initiate the auto-feathering and thus to stop the engines.

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* The aircraft manufacturer does not concur with the conclusions arrived at in the report which refer specifically to malfunctioning of the de-icing system.

ICAO Ref: AR/535

Scheduled
Landing
Emergency conditions
engines failed-landing

FIGURE 4

VISCOUNT G-AOHP WHICH MADE

A FORCED LANDING AT

BALLERUP, DENMARK

ON 17 NOVEMBER 1957

No. 13

Straits Air Freight Express Ltd., Bristol 170, ZK-AYH, accident at Christchurch, New Zealand, on 21 November 1957. Civil Aircraft Accident Report No. 25/3/884, released by Accidents Investigation Branch, Air Department, New Zealand.

(Subsequent to the receipt of the report on which this summary is based, the investigating authority forwarded comments made on the report by the manufacturer and the operator of the aircraft concerned. The investigating authority did not, however, consider that these comments justified alteration to the conclusions reached in the report.)

Circumstances

The flight was a routine cargo flight from Woodbourne to Timaru via Paraparaumu. After take-off the aircraft was climbed to 2 500 ft on instruments and a period of asymmetric instrument flying followed during which the starboard propeller was feathered and rate half turns were made in both directions. The starboard propeller was unfeathered and when the minimum operating temperatures had been reached, normal power was applied. Two minutes later a sudden and severe vibration was felt throughout the aircraft. Feathering of the port engine was delayed until nearer the North Island coastline, and no further vibration was felt on the remainder of the flight to Paraparaumu.

The aircraft was then loaded and one crew member was off-loaded prior to take-off on the second segment of the flight to Timaru. At 1127 hours the flight called Harewood Tower giving its position as 6 miles north of the Waimakariri River mouth at 3 000 ft contact. It was subsequently cleared to maintain 3 000 ft to the Harewood Range Station. It then advised that it would descend VFR from the Range Station and proceed VFR to Timaru and was subsequently cleared for this procedure by Harewood Tower. At 1133 hours, at an approximate height of 2 000 ft, the aircraft was seen to suffer structural failure in the air. The starboard outer wing folded upwards and backwards and then separated. The remainder of the aircraft performed a series of violent manoeuvres while diving towards the ground at a mean angle of 35°, shedding a number of major components before finally striking the ground 1 000 yards beyond the point of wing separation. The 2 crew and 2 passengers aboard were killed, and the aircraft was destroyed.

The Weather

Strong northwesterly wind conditions, accompanied by severe turbulence, prevailed on the east coast of the South Island, on the day of the accident. Weather observations made within 1 500 yards of the accident scene two minutes after the accident were:

Cloud 5/8 CuSc base 3 500 ft, visibility 25 NM
Surface wind 200°T, 5 knots

The surface wind fluctuated and changed direction from 280°T through 200°T to 100°T between 1115 and 1145 hours. No observations of local turbulence were recorded but several pilots reported severe turbulence in the area. Simultaneously with the structural failure of AYH, a witness immediately beneath the aircraft noticed the passage of a whirlwind of sufficient force to raise two single bed mattresses, which were airing on the lawn, to a height of 15 ft from the ground.

The anemometer wind trace recorded at Harewood Airport indicates a 180° wind shift associated with gusts up to 33 knots at the time of the accident.

History of the Aircraft

The aircraft, ZK-AYH, was manufactured by the Bristol Aircraft Company Ltd. in England, in April 1951, and was flown to New Zealand in May 1951. The Certificate of Airworthiness was valid until 4 May 1958. The aircraft had flown 7 898 hours of a 10 400 hour life since new, and 1 011 hours since last complete overhaul.

The aircraft had been maintained in accordance with the approved maintenance schedule; special instructions had been fulfilled, and all mandatory modifications had been incorporated. During its life AYH had made 12 964 landings and had operated at an average of 80% of the total permissible all-up weight. It is estimated that 33% of ground/air transitions were carried out from rough aerodrome grass surfaces.

In 1954, after 3 018 hours and 4 843 landings, cracks were discovered in the starboard outer wing spar. These were repaired in accordance with an approved scheme by cutting out the cracked section of the spar web and the installation of a rivetted patch. Simultaneously Bristol Modification 1169, Extended Link Fittings, and 1192 - Redesigned Bottom Boom and Skin Angle, were incorporated.

The Wreckage

The complete wreckage trail extended over a distance of 1 200 yards on a mean track of 235°T. The distribution of components clearly indicated two distinct phases in the sequence of break-up. Over the first 250 yards the wreckage was directly associated with the separation of the starboard outer wing. A gap of 560 yards in the trail indicated that the second phase of break-up was as a result of the severe loading imposed on the structure by violent involuntary manoeuvres after the separation of the starboard outer wing.

It was evident from inspection of the wreckage that the starboard outer wing broke away from the aircraft in flight. It was also clear that the cause of the structural failure was metal fatigue in the lower boom of the starboard outer wing front spar. This fatigue originated in the outermost 1/4" bolt hole drilled in the boom by the Operator during the incorporation of Bristol Modification 1169, which called for the installation of an extended joint fitting outer wing to centre section. This modification moved the point of stress concentration in the boom to a new location and, as a result, prolonged the life of the aircraft to 10 400 hours. The modification was incorporated on 21 January 1954, after the aircraft had flown 3 018 hours and the failure occurred at 7 898 hours. Although the complete boom had expended 3 018 hours of its fatigue life, it can logically be assumed that the boom was incorrupt at the point where the 1/4" hole was drilled. Thus, the initiation and propagation to failure of the fatigue crack took place at some time during the accumulation of 4 880 flying hours, over a period of 3 years and 10 months.

The aircraft had made a total of 12 964 landings and of these 4 843 had occurred before the incorporation of Modification 1169. Therefore, the initiation and development to boom failure occurred during the accumulation of 4 880 flying hours or 8 121 landings. This represents failure at 66% of the 7 400 hours extended life guaranteed (granted) to the aircraft after incorporation of Modification 1169 at 3 018 hours.

A fatigue crack of less magnitude was discovered in an identical location in the port front lower boom. The presence of this fatigue crack in the port boom indicated that the failure of the starboard boom was not an isolated occurrence; on the contrary, it was an indication of the average life to failure of a Bristol freighter modified to ZK-AYH's state engaged in this kind of operating conditions.

No evidence could be found in the history of AYH of any unusual occurrence which could have precipitated the early onset of fatigue.

Sequence of Failure Starboard Outer Wing

The sequence of events was set in train some considerable time before the accident, when a fatigue crack originated in the last bolt hole of the starboard lower boom joint and gradually propagated over 25% of the effective section of the boom. Additionally, a vertical crack occurred in the shear strap. Simultaneously, fretting with associated cracking, was taking place near the outer end of the joint, in the spar web, doubler, skin angle, and shims. Fretting and elongation in the bolt holes also took place during this development stage.

It was considered that the crack in the shear strap transferred extra tensile loads on to the front lower spar boom. It should be noted, however, that the boom was designed to take all longitudinal tensile loads, while the shear strap carried only shear loads in the wing structure.

Fracture, as a result of encountering a severe gust, occurred in the starboard front lower boom under axial tensile loading at the section weakened by fatigue cracking.

The starboard outer wing then folded upward and backward, resulting in failure of the starboard front upper boom at the outermost bolt hole of the wing joint fitting. Simultaneously, horizontal fractures occurred at the upper and lower ends of the spar web doubler and shear straps, with bolt hole shearing at the upper end of the strap.

As the outer wing was carried backward in the airstream the rear spar booms remained attached to the centre section, resulting in a portion of the upper boom and the lower boom being filletted from the wing.

The filletting of the rear booms facilitated the breaking away of a portion of the wing aft of the rear spar. In carrying away, this portion of the wing pulled out the inboard and outboard aileron hinges, the centre aileron hinge bolt and actuating rod being sheared by the force of the airstream, thus allowing the aileron to fall clear of the wing.

Subsequently, the ingress of the airstream into the wing tore off the inboard wing tank lid and the petrol tank was thrown from the wing.

The disintegration of the remainder of the aircraft occurred as it performed a series of violent manoeuvres as it dived to the ground.

Assessment of Safe Lives of Aircraft Component Parts

The safe lives of the front spar lower booms of the Bristol freighter aircraft used by Straits Air Freight Express were progressively increased between June 1953 and September 1956 from 1 700 hours to 13 400 hours. In the case of ZK-AYH the increase was to 10 400 hours. These increases were recommended by the Bristol Aircraft Company, approved by the United Kingdom Air Registration Board and accepted by the New Zealand Civil Aviation Administration. The revised lives were considered justified as the result of laboratory fatigue tests and the incorporation of modifications to the wing joints.

It was evident that the data, from which the increase in lives was calculated, was not representative of actual fatigue damage sustained under operating conditions. As a result, a grave error was made in the assessment of the safe life of the front spar lower boom. While it is true that Straits Air Freight aircraft operate under particularly severe conditions, the number of fatigue cracks in the booms of aircraft operating in other theatres, and the radical change in lifeing policy since this accident, would indicate that the error in lifeing was general and not confined to its application to the aircraft operated by Straits Air Freight Express.

The accident raises the question of New Zealand's acceptance and assumption of responsibility for safe lives recommended and approved by an overseas source. Because the necessary facilities and information for assessing safe lives are not available locally it has become the practice to accept overseas figures, after certain local data has been supplied to the lifeing authority. As it requires virtually the same information to reject or modify a safe life as to make the original assessment, it follows that New Zealand aeronautical engineers, charged with responsibility in the matter, should be given opportunity to keep fully abreast of the latest research into fatigue and associated problems. The fact that the New Zealand Airworthiness Division accepts responsibility for lifeing figures evolved overseas, without having the necessary information to assess such figures, makes it essential that present policy should be reviewed by the Civil Aviation Administration.

As far as the future operation of Bristol freighters is concerned, the complete failure of the ZK-AYH boom in 4 880 hours or 8 121 landings has provided the Civil Aviation Administration with a criterion on which to modify overseas safe life figures. In consequence a local condition factor of .773 has been calculated. In addition a series of probe inspections of the three outermost bolt holes of all centre section and outer wing lower boom fittings has been instituted, commencing at 3 700 flying hours.

Operational Techniques

The discovery of fatigue cracks in aircraft operating in other theatres indicates that the fatigue failure of the aircraft was not essentially associated with the particularly severe flying conditions encountered by Straits Air Freight aircraft. It is opportune, however, to consider what steps could be taken to minimize the detrimental effect on fatigue life of incessant crossings of Cook Strait at low altitude in turbulent conditions.

The topographical features of the northern portion of the South Island and the southern portion of the North Island induce extremely unstable conditions in the winds channelling through the Strait. The track of Straits Air Freight aircraft across the Strait is approximately at right angles to the prevailing winds, and the short length of stage makes it inevitable that aircraft will spend the major part of flight times at the most damaging altitudes from the gust point of view. In consequence, the aircraft are subject to a high incidence of pitching, rolling and severe asymmetric gusts. As conditions are materially influenced by adjoining land masses, it seems logical to assume that some turbulence could be avoided by adjusting routes and heights to suit the varying wind conditions. A number of theories to achieve this end exist among pilots, but it would appear that no organized effort has been made to analyze and test the validity of the various claims. Alteration of routes involving increase in flight time might appear to involve economic penalty. The contrary might well, however, be the case, as a reduction in the exposure to turbulence may reduce the present high level of maintenance and repair requirements of aircraft. Furthermore, as lifeing is directly related to the frequency of gusts, a reduction in exposure could well result in an increase in total life.

Analysis of the captain's flight plan of ZK-AYH revealed that he maintained the normal operating air speed of 140 mph between Paraparaumu and Harewood. The flight was undertaken in northwesterly wind conditions along the east coast of the South Island, which inevitably result in severe turbulence. New Zealand pilots become so used to these conditions that they pay little attention to the extreme turbulence. It is noteworthy, that a United States Navy pilot flying over the same route at the time, and not familiar with New Zealand conditions, considered it expedient to materially reduce his air speed.

Vibration on Preceding Flight

With regard to the sudden vibration which was experienced on the first segment of the flight, the examination of the wreckage provided no logical answer. The absence of pounding on the surface faces of the primary fracture in the front spar lower boom rules out the possibility that the vibration was associated with fracture of the boom. The vibration could be reconciled with a crack in one of the shear plates, although the cracks appeared to be of long standing. It can only be stated that it is probable that the vibration was associated with the sudden relief of stress, evidence of which was destroyed by fire.

Workmanship

A report of the Dominion Laboratory, Department of Scientific and Industrial Research, on the examination of parts of the crashed aircraft, made reference to the ovality in the bolt holes in the port and starboard wing joint fittings and the failure of the bolts in many cases to meet the required Class B fit tolerance. It was pointed out that these departures from required standards applied to work carried out by both the manufacturers during construction, and to the operator during the subsequent incorporation of Modification 1169. In regard to the misdrilling of the shear plates, also referred to in the above-mentioned report, this took place during the incorporation of Modification 1192 on 21 January 1954 and represents a very serious defect in workmanship and inspection by the operator. Neither the departures from the required standard in the wing assembly joint nor the specific defects in workmanship on the shear plates caused the structural failure. Such defects together with the influences of fretting, anodizing and surface recrystallation could, however, contribute towards the variability shown in the life of the Bristol freighter wing joints.

Freight

The payload represented on the waybills recovered from the wreckage came to a figure of 11 823 lb, as opposed to the weight of 11 058 lb recorded on the load sheets presented to the pilot before take-off. If the waybills represented a true record, the aircraft would have left the ground at a weight in excess of that represented to the pilot, of which 550 lb would have been overload.

Investigation revealed that the waybills recovered from the aircraft did not, in fact, represent the load aboard the aircraft. The discrepancy was associated with the direct delivery of two cows to the airport - it was realized that the weight of the animals was considerably less than that recorded on the waybill. The loading certificate was, therefore, amended but the waybills were not, nor were they withdrawn from the aircraft. Thus the actual load being carried was 10 614 lb plus the weight of two passengers and a tarpaulin which made a total weight of 11 014 lb. The difference between this figure and the 11 058 lb appearing on the load sheet is accounted for by the inadvertent omission from the aircraft of a package weighing 44 lb.

As no facility exists in the Straits Air Freight Express cargon loading system for the weighing of loaded cargons, an inherent possibility exists of a clerical or weighing error causing the overload or unbalance of an aircraft. The only accurate method of ensuring that the aircraft is not overloaded would be for the loaded cargons to traverse a weighbridge en route to the aircraft. It is considered that, in long term planning, provision should be made to provide this facility. On the subject flight, however, it was concluded that the gross weight of the aircraft and the position of the centre of gravity were within the prescribed limits.

Probable Cause

The accident was caused by inflight structural fatigue failure of the starboard front lower spar boom.

The circumstances which made the accident possible were created by the assessment of a life which was materially in excess of the safe life.

The error in life assessment stemmed from the fact that simulated operational conditions from which the lifeing data was evolved were not truly representative of actual operating conditions.

Recommendations

It was recommended:

1. that the failure of ZK-AYH at 4 880 hours and/or 8 121 landings be used as a basis for amending the current maker's assessment of safe lives;
2. that as an interim measure Straits Air Freight Express should evolve and lay down operational techniques to minimize exposure to gusts on the Cook Strait crossing;
3. that the Civil Aviation Administration examine the desirability of sponsoring a full scale gust research project covering the Cook Strait area;
4. that the Civil Aviation Administration review the existing lifeing policy with special regard to the question of responsibility for the acceptance of overseas lifeing figures;
5. that provision be made to facilitate the weighing of loaded cargons at some stage in transit from the railhead to the aircraft. That, meantime, frequent snap checks be undertaken and recorded by the Civil Aviation Administration representatives.

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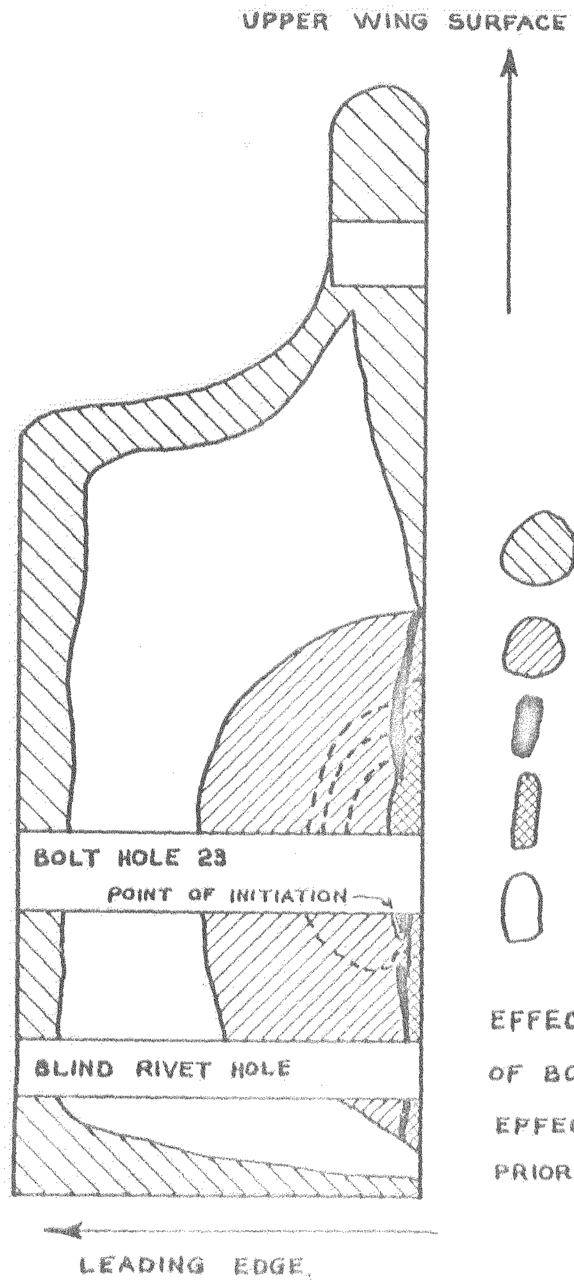
ICAO Ref: AR/551

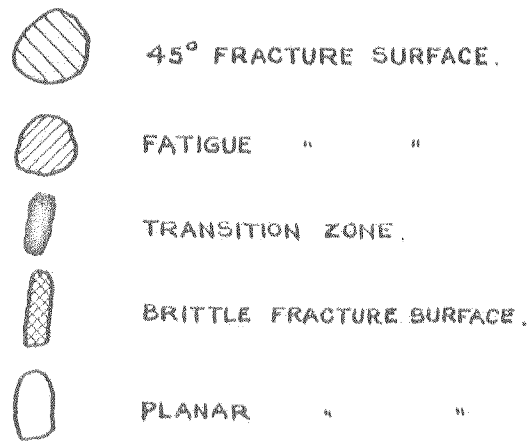
Scheduled
En route
Airframe -Air

FIGURE 5

ZK-AYH

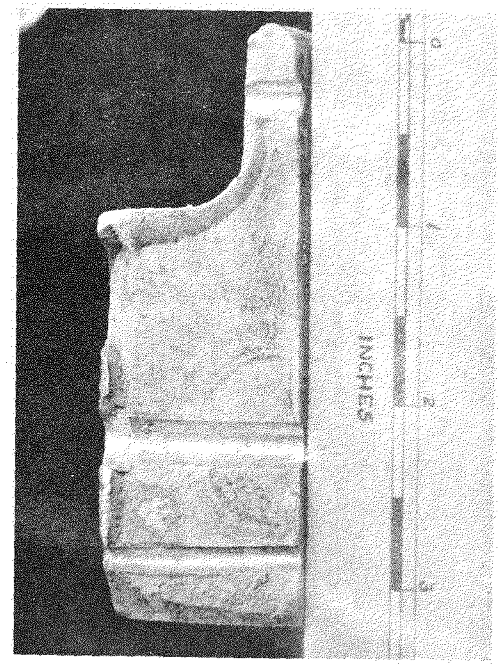
STARBOARD FRONT LOWER BOOM.





EFFECTIVE CROSS-SECTIONAL AREA OF BOOM AT THIS POINT — 2·8 sq. INS.

EFFECTIVE CROSS-SECTIONAL AREA PRIOR TO FINAL FRACTURE — 2·1 sq. INS.



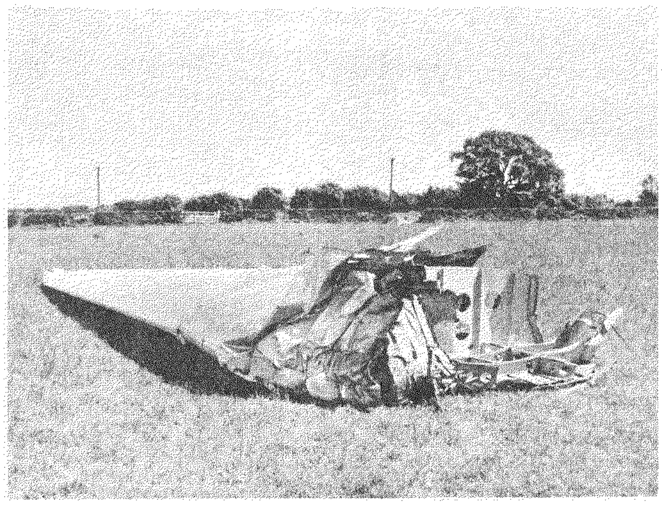
VIEW OF FRACTURE SURFACE SHOWING FATIGUE CRACK

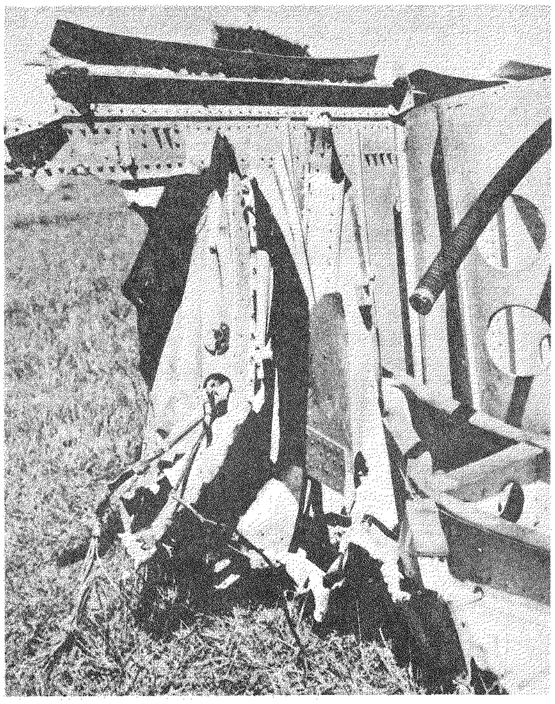
FIGURE 6

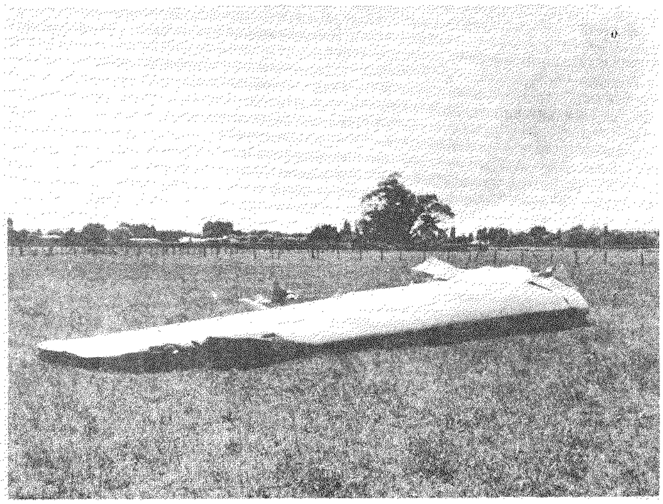
THESE ILLUSTRATIONS WERE CONTAINED IN THE REPORT OF THE DOMINION LABORATORY, DEPT. OF SCIENTIFIC AND INDUSTRIAL RESEARCH, N.Z., WHICH WAS ATTACHED TO THE ACCIDENT REPORT

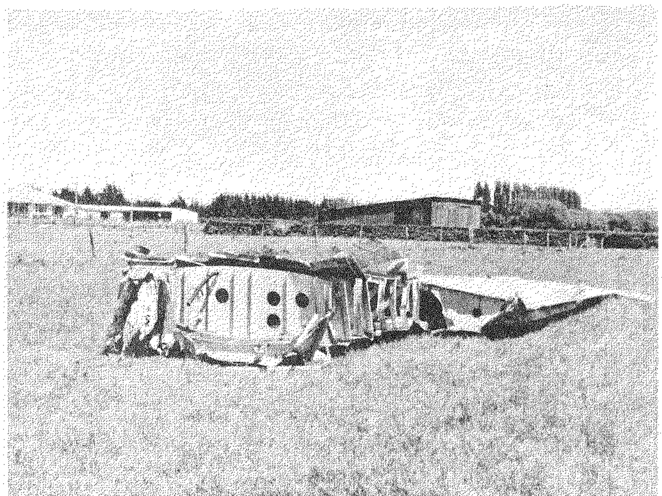
FIGURE 7

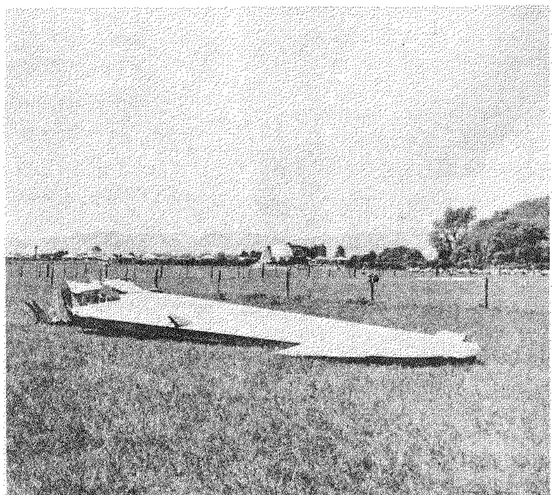
STARBOARD OUTER WING











No. 14

Department of Transport, Bell 47J, CF-JOV, crashed at Shirley Bay, Ontario, on 3 January 1958. Report released by the Department of Transport, Canada. Serial No. 58-1.

Circumstances

The aircraft departed from Ottawa Airport on a local flight at 1525 hours eastern standard time with the pilot and two passengers on board.

It was next seen at about 1545 hours flying in a westerly direction over Shirley Bay at an altitude estimated by a witness to be about 500 ft. The aircraft was then seen turning toward the south; witnesses stated that they heard a crack and saw the main rotor blades fly off. The aircraft then crashed into a field; the pilot and two passengers were killed, and the aircraft was destroyed in the crash and burned.

Investigation and Evidence

There was no evidence of malfunctioning of the engine or controls. However, it was established that there was a defective bond between the upper stack of metal laminations and the butt end of the wooden rotor blades. This was later found to have been caused by a fault in the bonding process of this particular blade, in that a layer of cellophane, which should have been removed, had been left between the two adhesive surfaces.

The pilot had a total of 2 150 hours of flying experience, of which about 1 250 hours had been acquired on Bell helicopters. Of this, a total of about 170 hours had been obtained on the Bell 47J type of helicopter, about 3 hours of which had been flown during the previous 90 days.

Probable Cause

It was concluded by the Board that failure by the manufacturer to remove the cellophane from the upper stack of metal laminates prior to bonding of the stack to the root of one of the main rotor blades produced a defective bond which resulted in failure of the blade in flight.

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ICAO Ref: AIG/ACC/REP/GEN/No. 1

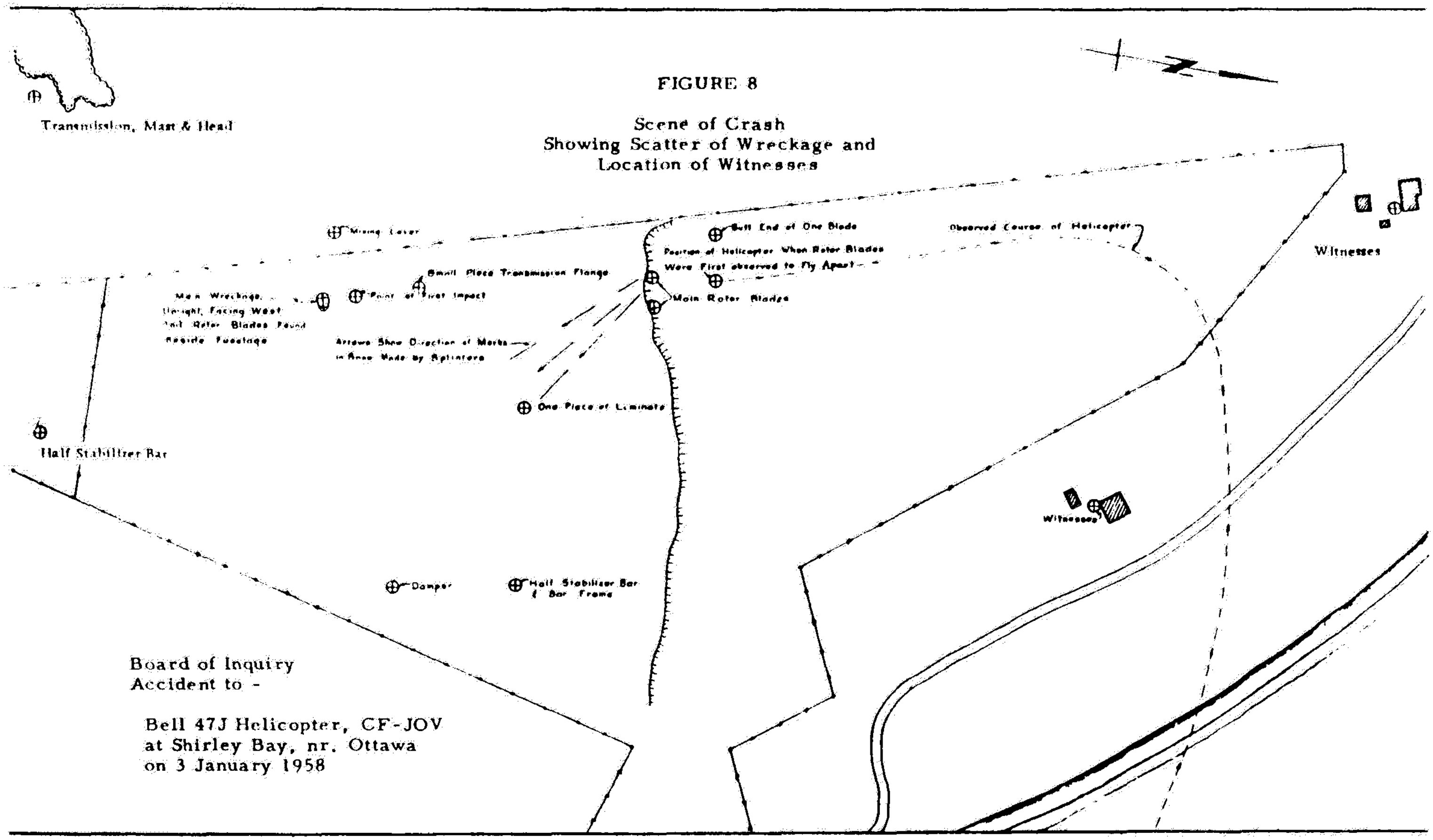


FIGURE 8

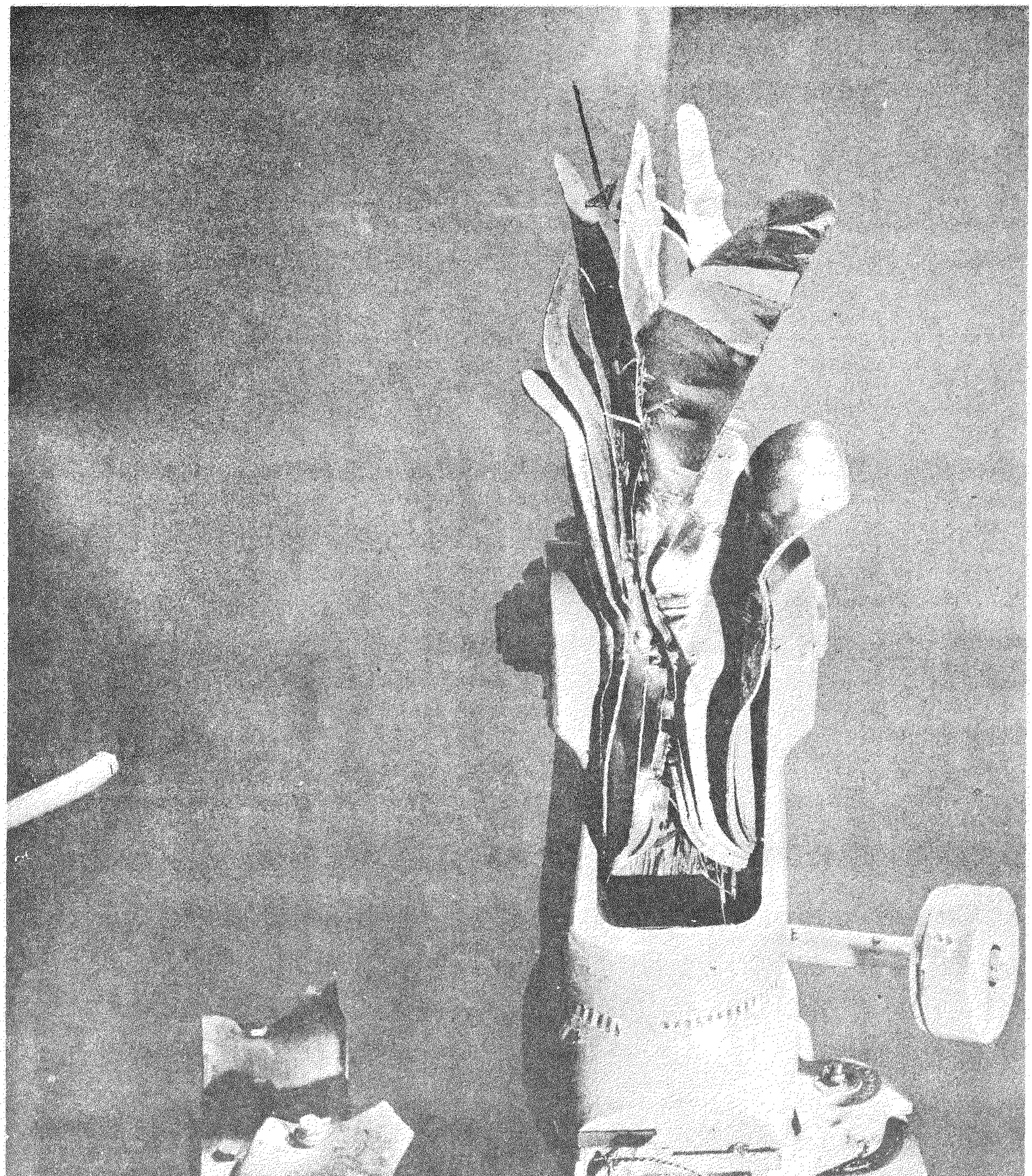
Scene of Crash
Showing Scatter of Wreckage and
Location of Witnesses

Board of Inquiry
Accident to -

Bell 47J Helicopter, CF-JOV
at Shirley Bay, nr. Ottawa
on 3 January 1958

Laminates of blade No. PI-259. Arrow points to screw remaining in laminate which was repaired.

FIGURE 9



No. 15

TransAir Limited, Norseman V, CF-BSL, crashed about 17 miles south of Chesterfield Inlet, North West Territories, on 31 January 1958. Report released by the Department of Transport, Canada. Serial No. 58-3.

Circumstances

The aircraft departed North Rankin, N.W.T. at 1440 hours on a non-scheduled flight to Chesterfield Inlet with a pilot, 2 Eskimos and freight on board. At 1455 low cloud and airframe icing were encountered. The pilot altered the aircraft's heading toward the coastline of Hudson Bay and when over the coastline, turned left in an attempt to reach Chesterfield Inlet. However, the pilot decided to land the aircraft at the first opportunity and, at about 1505 hours, struck the snow-covered ground during "whiteout" conditions.

The wreckage was found by an RCMP constable on his annual patrol about 30 minutes after the accident occurred. The aircraft was demolished, and the four occupants were seriously injured.

Investigation and Evidence

A Certificate of Airworthiness had been issued for the aircraft. The wreckage of the aircraft was not examined as the ice on which the aircraft crashed drifted out into Hudson Bay.

The pilot-in-command held a valid Commercial Pilot Licence and had accumulated a total of about 2 051 hours of flying experience of which about 319 hours had been acquired on Norseman type aircraft. About 96 hours had been flown during the 90 days prior to the accident.

At the time of the accident a cold front, which was moving slowly southward, lay in an east-west line about 100 miles south of Chesterfield Inlet. An overcast layer of stratus cloud lay to the north of the front and snow was falling. The probable ceiling and visibility at the front were 500 to 1 000 ft and 1 to 3 miles respectively due to snow. Surface winds were north-northeast at 10 to 15 mph, and the surface temperature was 10° F. South of the front, ceilings were generally unlimited with good visibility.

There is frequently a lead of open water paralleling the west coast of Hudson Bay produced by the action of wind and tide. The saturated air over such leads produces fog which may at times extend to a height of 2 to 3 000 ft. Icing is usually severe in this cloud due to the supersaturated air. It is not known whether an open lead was present on the afternoon of 31 January 1958. However, if a lead was present then the northeast winds behind the front would bring the fog inland, producing near zero conditions and a serious icing hazard.

Probable Cause

The pilot continued VFR flight into unfavourable weather conditions and, in attempting to land, collided with the ground.

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ICAO Ref: AIG/ACC/REP/GEN/No. 1

No. 16

British European Airways Corporation, AS 57 Ambassador (Elizabethan), G-ALZU, accident at Munich-Riem Airport, Germany, 6 February 1958. Report released by the Federal Republic of Germany and also published by the Ministry of Transport and Civil Aviation, United Kingdom, as CAP 153.

Circumstances

The aircraft had carried out a special flight on 3 February 1958, from England to Belgrade, making an intermediate landing at Munich-Riem Airport for refuelling purposes. On 6 February it flew back from Belgrade, bound for Manchester. As planned, it again made an intermediate landing at Munich to refuel, landing there at 1417 hours local time. A take-off was commenced at 1603 hours, but the aircraft did not become airborne. It overshot the boundary of the manoeuvring area and, when outside this area, struck a house and a wooden hut and was severely damaged by the fire which followed. Of the 44 occupants (6 crew and 38 passengers) on board, 21 were killed instantly. The others received injuries of a more or less serious nature. Two died later in hospital as a result of their injuries. The house which was struck by the aircraft was badly damaged by fire. The hut was destroyed by fire.

Investigation and Evidence

Crew Information

The captain completed a conversion course on Ambassador aircraft on 23 March 1955. Since then he had flown 1 722 hours on this type of aircraft. His last flight check was on 14 October 1957. His total flight time amounted to 7 337 hours up to the day of the accident. In the 30 days prior to 2 February 1958 he had flown about 26 hours and during the three days prior to the accident - 7 hours.

The co-pilot completed a conversion course on Ambassador aircraft in March 1953. He was qualified as captain on the type and since then he had flown 3 143 hours on this type of aircraft. His total flight time up to the day of the accident amounted to 8 463 hours. During the 30 days prior to 2 February 1958 he had flown barely 6 hours and during the last three days prior to the accident - 7 hours.

On the flight from England to Belgrade the aircraft was flown by the captain, and it was to be flown by the co-pilot on the return flight. For this reason, at the time of the accident, the latter was sitting in the left-hand seat, and the captain was sitting on the right.

Weather

The Munich-Riem meteorological office of the German Meteorological Service issued the following report:

Time 1504 hours (the accident occurred shortly after 1604 hours) - surface wind 300°/8 kt - surface visibility 1.6 NM slight snowfall - 8/8 stratus at 600 ft (precipitation ceiling) - QNH 1004.0 mb/29.65 inches - QFE 942.7 mb/27.84 inches - temperature 0°C - dew point = 1.6°C.

On 6 February the following observations (QNY) were made:

Snow + rain (mixed)	from	0420 - 0650 hours
Rain only	"	0650 - 1120 "
Snow + rain (mixed)	"	1120 - 1150 "
Moderate snowfall	"	1150 - 1550 "
Slight snowfall	"	1550 - 1850 "
Moderate snowfall	"	1850 hours

Munich-Riem Airport

Elevation:
528 metres (1 732 ft)
Density altitude:
884 metres (2 900 ft)
Length of Runway:
(249°), 1 908 m (6 260 ft)
Length of Stopway:
250 m (820 ft)

Accident Details

The aircraft made three attempts at take-off, two were abandoned, and the accident occurred during the third attempt.

The co-pilot abandoned the first take-off because the boost pressure readings of both engines showed upward variations, rising 2 or 3 inches above the usual reading of 57.5 inches. The second attempt to take-off followed immediately after the aircraft had taxied back to the beginning of the runway. The engine run-up was not repeated. The captain abandoned the second take-off because the boost pressure reading (this time on the port engine only) again rose beyond the normal maximum value to 60 inches.

In each case the take-off was abandoned approximately half way down the runway. After the second attempt the aircraft continued rolling as far as the end of the runway and from there proceeded to the terminal building. The passengers disembarked, and the BEA station engineer went aboard. He then pointed out to the two pilots that the variations in boost pressure were connected with the elevation of Munich Airport. After a short discussion, the pilots decided to make a third (attempt at) take-off, and the passengers were told to board the aircraft again.

Before the fresh (attempt to) take-off, a further engine run-up was carried out. After take-off had begun, the boost pressure reading of the port engine again fluctuated somewhat, but this ceased after the captain had throttled back slightly for a short time. After he had opened up the throttle fully again, no further fluctuations were observed.

The aircraft never became airborne in the course of the third attempt at take-off. It travelled on over the whole length of the runway and the adjoining grass-covered stopway (250 m). At the end of the stopway it crashed through a wooden fence which marked the aerodrome boundary, cleared a secondary road and struck a house standing on the other side of the road. The left wing was torn off outboard of the engine mounting. Parts of the tail unit were also torn off here. The house caught fire. The aircraft then crashed into a wooden hut standing on a concrete base about 100 m further on, striking it with the right side of the rear section of the fuselage. The fuselage was torn away on a level with the trailing edge of the wing. The hut and the part of the fuselage which was torn away caught fire. The remainder of the aircraft wreckage slid on for a further 70 m.

Discussion of Possible Causes of the Accident

The Commission was able to exclude at the outset a number of points which might have been taken into account as possible causes of the accident.

There were no indications that the airport services, the air navigation services or the German Meteorological Service had contributed to the accident through any defects in installations or functioning.

The presence of the house, 9.50 m high, outside the aerodrome, beyond the runway, and of the hut, 3 m high, did not contravene either the German regulations or the Standards and Recommended Practices of the International Civil Aviation Organization.

The members of the crew held valid licences, and the aircraft documents were valid and in order.

It was not possible to establish that there had been any defects in the technical installations of the aircraft.

The engines were working satisfactorily. The fact that take-off had been abandoned twice previously does not give cause for any conclusion to the contrary. The variations in boost pressure which led to the abandoning of the two first take-offs, were occurrences which commonly arise at aerodromes at elevations such as that of Munich without implying engine trouble. The two engines, which were only slightly damaged, were subjected to a test run by the manufacturer. Both engines showed the prescribed take-off power during the test run. No defects were found which could have been a contributory cause of the accident. The fuel was tested and found satisfactory.

The loading of the aircraft lay within the permissible limits.

Since none of these factors comes into consideration as a cause of the accident, and since, on the other hand:

- it had snowed during the afternoon of 6 February 1958,
- the aerodrome was covered with slush at the time of the accident, and
- the investigations in the evening showed a layer of ice on the wings of the aircraft,

the Commission considered itself primarily concerned with the question of whether the following explained the occurrence of the accident:

a) (Rolling) friction caused by snow on the runway,

b) The effect of slush on the free-running of the wheels, and

c) Alteration in aerodynamic efficiency caused by wing icing.

The following views were arrived at after detailed investigations and consultations:

a) <u>(Rolling) friction caused by slush on the runway</u>

It is obvious that snow or slush on the runway can increase the rolling friction to such an extent that a take-off is impeded or even becomes impossible. The Commission had before it numerous reports on experiences and accident reports concerning cases where slush led to difficulties. In brief, the extent to which take-off is impeded depends on the thickness of the slush and the type of aircraft. Aircraft with nosewheels are affected to a greater extent than aircraft of tailwheel design, because, in slush, the nosewheel causes an increasing nose-heavy moment as the rolling speed increases and this must be overcome by the pilot by means of considerable force on the elevator control. All experience goes to show, however, that it may be assumed that take-offs can be made with nosewheel aircraft without danger up to a slush-depth of at least 5 cm.

At Munich-Riem in the afternoon of 6 February the runway was first of all wet but free of snow and slush. From 1120 hours onwards snow fell. Temperatures were initially above zero but from 1500 hours onwards dropping to 0° and later below 0°. The records indicated that by 1600 hours a total of 4 - 5 cm of snow must have fallen, which, on the runway, would have subsided to form a layer of slush approximately 3/4 - 1 cm thick. This estimate tallies with the observations of a witness, who examined the condition of the runway between the first two take-off attempts. He stated that he found that the entire runway was covered with slush approximately 1/2 - 3/4 cm deep. None of it was snow, but it was a jellified, watery mass covering the entire runway.

As against this, another captain who landed at Munich at 1558 hours on 6 February stated that he estimated the slush depth as 1 - 1.5 inches in places but that in parts the runway was merely wet and was free of slush. This estimate was regarded as unreliable, since as this captain was judging during the process of landing and was looking from the pilot's seat, he could not have obtained a precise impression of the deposit of slush. Moreover, his report to the control tower on the state of the runway was: "Braking action fair".

According to the reliable statements of personnel responsible for inspecting the runway, the deposit of slush on the runway cannot have amounted, on an average, to more than 1 cm at the most.

The Commission was convinced that the (rolling) friction caused by so thin a layer of slush cannot have been a cause of the accident. No case is known in which this caused take-off to be abandoned on concrete runways, let alone caused an accident. An expert put forward the view that, assuming a rolling friction coefficient of $\mu = 0.06$, the rolling distance required for a normal take-off may be increased by approximately 110 m at the most. The captain of G-ALZU, who survived the accident, stated that he was satisfied with the condition of the runway, otherwise he would not have made a third (attempt at) take-off. The Commission was convinced that the layer of slush on the runway did not increase the rolling friction to such an extent that the accident could be attributed to this.

b) Icing of the Undercarriage

Nor, in the opinion of the Commission, did the slush have such an effect on the free-running of the wheels as to be a cause of the accident. Locking of the wheels owing to slush during the process of take-off was entirely ruled out. The wheel-tracks on the runway did indeed show that, at the end of the runway, both sides of the main undercarriage were locked at times. There must, however, have been other reasons for this. At the V_1 speed of 117 kt (216 km/h), which was attained and, at times, exceeded, the wheels (tire diameter 38" = 96.5 cm) were rotating at about 1 200 rpm. Added to this is the fact that, at the narrowest point between the tires, the twin wheels are 28 cm apart. Given such a considerable gap and such a high speed of rotation and corresponding force, there can be no question of the wheels having become locked owing to the watery slush from the runway (accumulating) either between the wheels or in the region of the oleo legs.

From the outset, the possibility that the snow could have become caught up and accumulated in the undercarriage of the aircraft during the take-off run to such an extent that the wheels would have been braked to a considerable degree also appeared to the Commission extremely remote, since not a single indication of this came to light. However, since the captain did not consider it out of the question that this might provide an explanation of the accident, the Commission went into this question with special care.

The possibility cannot be excluded that, with the Ambassador, in exceptional circumstances, snow and ice may pack the undercarriage and impair the smoothness of take-off when the manoeuvring area is covered with wet snow and temperatures around 0°C. prevail. There can be no doubt, however, that many very unusual factors would have to coincide in order to produce such an effect. A photograph placed at the disposal of the Commission taken before the third (attempted) take-off, clearly showed that there were no traces whatever of any ice or snow packing. Thus, besides general experience and probability, so many important points argued against the assumption that the undercarriage was braked by slush that, in the opinion of the Commission, this cannot have constituted the cause of the accident.

c) Wing Icing

It remained for the Commission to investigate whether there was a deposit of ice on the wings of the aircraft at the time of the (attempted) take-off and whether such a deposit led to the inability of the aircraft to take off within the take-off area available and constituted the cause of the accident.

At the outset, the fact that there was indeed a deposit of ice on the wings of the aircraft at the time of the (attempted) take-off did not appear to have been established with sufficient certainty, because exact observations concerning ice accretion were not made until 2200 hours on the day of the accident, i.e., not until six hours after the accident, and because snow had continued to fall steadily after the accident until 2200 hours. The Commission, however, came to the conclusion that the wings were iced up at the time of the (attempted) take-off.

At 2200 hours on 6 February, the scene of the accident was as follows:

The wrecked aircraft, which lay 70 m from the centre of the fire and to windward of the latter, was covered with a layer of snow 8 cm deep. This was powdery snow which could be pushed or blown off from the surface of the wings without difficulty. Underneath there was a very rough layer of ice. This had not blended with the snow lying on top. Its thickness amounted to about 5 mm. From numerous spot checks it was concluded that the entire surface was covered with this layer of ice and that it was interrupted only in the region of the two engines over the width of the propeller slipstream.

Purely on the basis of calculation, this deposit of ice, the thickness of which was established as 5 mm, could have formed from the wet snow which had fallen in Munich during the period between the landing of the aircraft and the accident. On the basis of records of the (aerodrome) meteorological office, at 1400 hours in Munich there was a thin layer of snow not yet of measurable dimensions, but that a further 4 - 5 cm of snow fell prior to the time of the accident. It was not possible to say exactly what thickness will remain when a layer of snow has turned into ice. It is possible that the thickness of the ice in such a case amounts to about 1/7 to 1/10 of the layer of snow from which it has formed. Thus - the observations regarding the ice deposit at 2200 hours, on the one hand, and regarding the snowfall between 1400 and 1600 hours, on the other, are not contradictory.

In point of fact, the (amount of) precipitation which, by calculation, corresponds to the ice deposit noted had collected on the wing of the crashed aircraft prior to take-off. This is borne out by the fact that during the stay in Munich the deposit had not been cleared from the wings of the aircraft, in spite of the snowfall, and that the snow must consequently have remained lying there. The snow which fell directly after the aircraft landed may, indeed, partly have run off the wings at first as observed by witnesses during refuelling. Snow which had fallen on the wings and perhaps melted at the outset must, however, very soon have begun to cling.

The aircraft flew from Belgrade to Munich at altitudes of 21 000 - 25 000 ft at an air temperature of -21°C. to -25°C. From this it must be concluded that the outer skin of the wings was thus severely supercooled. One witness observed that snow began to cling at an early stage: during refuelling he had already noticed, from the wing tips, the building-up of a layer of snow. Consequently, it is to be assumed that well before the first (attempted) take-off at 1519 hours the wings were already covered with snow and that later the layer which led to icing had formed, owing to the further snowfall. When the aircraft taxied out to the third (attempted) take-off two witnesses who had been watching it for some time stated that they saw the wings, outboard of the engines, covered with a thick, unbroken layer of wet snow.

The freezing-up of the layer of slush by the time of the accident can be explained. It is true that in the case of the first (attempted) take-off at 1519 hours, at a temperature of approximately 0°, the humidity of the air still amounted to 96%. Cooling by evaporation will thus still have been slight at this juncture. Only a film of ice will have formed on the cooled wing, under the layer of snow observed. When the last (attempted) take-off was initiated, however, the air temperature was already -0.2°C. and the humidity of the air was 91%. Thus there existed conditions which point to the fact that by the time the aircraft taxied out for the third (attempted) take-off and during the first phase of take-off, the cooling by evaporation had become so highly effective that the wet snowy mixture turned into the rough sheet of ice which was observed in the late evening of the same day.

Thus, even if all circumstances indicated that the ice accretion observed at 2200 hours did indeed arise from the layer of slush on the wing observed by the witnesses, the Commission had nevertheless still to consider the question of

a) whether it might not have originated wholly or partly from the precipitation which fell after the accident and, for this reason

b) whether it had indeed been fully established that icing was a cause of the accident.

It is true that the snow falling after the accident at temperatures of -0.2° (1600 hours) to -3°C. (2200 hours) was dry. Thus it could not have turned directly into ice. The question to be investigated, however, was whether, as a result of the fires caused by the accident, the snow (dry, in itself) had melted whilst still in the air or on falling on wings possibly heated by the fires to above 0° and had only solidified into ice when the fires were extinguished. The idea that the wings were perhaps warmed by the heat still remaining from the engines or by the fuel in the wing tanks was suggested. These and similar theories regarding subsequent ice formation all failed, however, to stand up to closer investigation. Arguing against the theory of subsequent ice formation is the fact that with such a process of melting and refreezing the snow would probably have become more firmly blended with the ice layer proper in the transitional zone. According to the report of the inspector making the investigation and the statements of witnesses, the lack of cohesion between the ice layer and the powdery snow on top was, however, extraordinarily marked. The snow could be "blown away", whereupon a sheet of ice immediately came to light. The fires which occurred would not have been sufficient to melt the snow in the air or on the wings. The minor outbreaks of fire in the immediate vicinity of the aircraft were soon extinguished and do not come into consideration as sources of heat. The hut, on the other hand, burned for a longer time, to about 1700 hours, according to the report of the Munich Airport Administration. This centre of fire, which was certainly considerable, was situated, however, 70 m from the wreckage. Added to this is the fact that the wind was blowing away from the wreckage, in the opposite direction. In these circumstances it is extremely improbable that the radiant heat from any of the fires breaking out in the region of the aircraft wreckage had any effect on the snow. The remaining engine heat cannot have affected the entire wing to such an extent; it cannot have radiated thus far. Finally, it also appears out of the question that the fuel with which the aircraft had been replenished could have warmed up the whole wing again after the accident. Since it was established without a doubt from statements of witnesses that the fuel failed to cause the snow which fell prior to the accident to melt on the wings, it is quite out of the question that this should have happened after a further drop in outside temperatures and one and a half hours after refuelling. Furthermore, the fuel remaining in the aircraft prior to re-fuelling, after a flight at high altitudes, must have had a very low temperature. According to information from the firm which supplied the fuel, the temperature of the fuel taken on was not above 0°C., because the tanker was parked in the open.

Even if all these points are not considered to be finally convincing, however, there nevertheless remains as a decisive argument against any theories regarding subsequent ice formation the fact that, on the parts of the wing above the two engine nacelles, there was no ice deposit on the evening of the accident and no layer of snow before the accident, whereas elsewhere the wing upper surfaces were covered with snow or ice before and after the accident. Thus to this extent the observations of the state of the wings before and after the accident are in agreement. The parts of the wing above the engines would, however, have been iced up in the same way as the other parts of the upper surfaces had the ice actually originated from the precipitation which fell after 1600 hours, for there is no way of explaining why a subsequent snowfall over the engine nacelles should have been different from that on the other parts of the wing. Engine heat continuing to exert an effect on the wing upper surfaces for a while after the accident could at any rate not entirely have prevented subsequent ice formation at these points. With the drop in temperature after 1600 hours, the engine heat would not have lasted as long as would be necessary for the formation of an ice layer 5 mm thick. Above all, during the accident the port engine broke away from its mounting as a single unit and lay 5 m away from the wrecked aircraft, so that on this side there was no longer any heat-conserving element. Thus, in the case of subsequent ice formation the remains of the port wing ought, in any case, to have been uniformly iced up throughout, outboard and inboard of the engine. But this was not the case. Consequently, the engine zones on both sides could only have been cleared by the engine heat, by the exhaust gases led over the upper wing surface and by the propeller slipstream before the accident. Hence the deposit of ice cannot have originated as a result of precipitation which did not fall until after the accident.

The Commission was convinced that the deposit of ice on the wings which, on the basis of all the foregoing, was undoubtedly present during (attempted) take-off, prevented the aircraft from becoming airborne at any time. The fact that, under certain circumstances, wing icing can render an aircraft unable to fly, or at any rate considerably impair its take-off qualities, is well known in aviation.

In order to check the general principle (founded on experience) that wing icing is highly detrimental to the flying qualities of aircraft, the Commission arranged for a scientific investigation relating to the crashed aircraft to be conducted and arrived at the following conclusions:

As the main starting point it takes, on the one hand, the fact that, even assuming an extremely high rolling-friction coefficient (due to slush) of $\mu = 0.10$, the aircraft would have been bound to become airborne after a rolling-distance of 1 080 m at the latest. On the other hand, given this intensity of rolling friction, the expert's calculations show that with wing icing of about 5 mm (the presence of which has been established) and a roughness height (based on this) of about 3 mm, the aircraft could not have attained the lift coefficient required for unsticking within a rolling distance of less than about 2 270 m (i.e. at a point outside the aerodrome). There is, however, much to suggest that the rolling-friction coefficient was lower. Even if we proceed from the relatively low rolling-friction coefficient of $\mu = 0.06$, however, the iced-up aircraft could still not have left the ground within a rolling distance of 1 900 m (i.e. not before the end of the runway).

There may be some uncertainty in the exact determination of the thickness and roughness of the ice and in the determination of the rolling-friction coefficient. The Commission has been assured by the inspector making the investigation, however, that a conservative estimate of ice thickness and roughness has intentionally been given. The rolling-friction coefficient had to be set higher rather than lower. Consequently, everything suggests that owing to icing there was no question of the aircraft's unsticking before the end of the runway, even had it still been accelerating unhindered at this juncture. At this juncture, however, for other reasons (discussed below), the aircraft was no longer accelerating. General flying experience and aerodynamic calculations are thus in agreement about the fact that an aircraft with such a degree of ice accretion as the aircraft involved in the accident would not, in the conditions obtaining at Munich on 6 February, be capable of taking-off and flying within the take-off area available.

The increase, owing to icing, in the required take-off distance is due to two factors: the decrease in the maximum lift coefficient, as a result of which the necessary unstick speed was increased, and the rise in profile drag which reduced acceleration. The expert calculates the reduction in acceleration thus: the V_1 speed of 117 kt was attained at about 1 680 m, given a rolling-friction coefficient of 0.10, or at about 1 400 m, given a rolling-friction coefficient of 0.06, assuming a roughness of 3 mm. This theoretical calculation corresponds approximately with the facts actually established, for in his description of the process of take-off the captain stated that the aircraft had accelerated normally. He could not indicate either the point along the runway at which he had made his observation regarding the decrease in the speed reading or the point at which V_1 was attained. Judging from the sequence of his whole account, however, the drop in speed can only have set in towards the end of the runway. The captain stated that during the process of take-off he at first only watched the instruments and did not look out of the aircraft. Only when he perceived a drop in speed did he look out. He then saw that they were in alarming proximity to the aerodrome boundary. The co-pilot's exclamation, made at about the same moment, "We won't make it", would naturally only have been made when they were already in a zone of the runway where catastrophe was seen to be unavoidable. There is, therefore, much to suggest that the drop in speed occurred approximately at or beyond the 1 800 m mark. According to the captain's account, the aircraft first attained V_1, maintained, for a while, the speed it had reached, and only then lost speed appreciably. A certain interval must, therefore, have elapsed between the attaining of V_1 and the drop in speed. At 117 kt a rolling distance of about 400 m is covered in 6.5 seconds and a rolling distance of about 200 m in 3.2 seconds. The interval during which V_1 was maintained would probably have lain within these values. If we proceed from this, and assuming that the drop in speed occurred within the zone beyond the 1 800 m mark, then it is highly probable that V_1 was indeed attained between 1 400 m and 1 600 m, as the expert calculated. The captain's statements thus provide a certain confirmation of the expert's calculations, as far as there can be any question of precise confirmation, considering the element of uncertainty in the captain's reconstruction of what happened. Under these circumstances the Commission considers it amply certain that V_1 was attained between 1 400 m and 1 600 m and was maintained or exceeded at any rate to within the region of the 1 800 m mark.

Nevertheless, although the nose was pulled up and the emergency tail bumper was at times on the ground, the aircraft could not be raised off the ground. For this, however, there is no explanation other than that given by the expert - that owing to icing and the resultant decrease in lift coefficient, an unstick speed considerably higher than the normal one was required, and the fact that V_1 was not attained until a rolling distance of about 1 400 m had been covered could be attributed only to the increase in profile drag, which, likewise, could be accounted for only by icing. Thus icing was a cause of the accident.

In spite of the foregoing facts, the Commission felt unable to declare with complete certainty that icing was the sole cause of the accident, owing to the fact that the captain's observation regarding the drop in speed towards the end of the runway can neither be refuted nor be explained with complete certainty. There may indeed be some uncertainty about the objective accuracy of the observation itself, since it is a generally acknowledged fact, based on experience, that, for subjective reasons, statements by witnesses are subject to error precisely when it is a question of giving an account of what happened in an unnerving catastrophe. On the other hand, it is entirely possible that the drop in speed of which the captain spoke so definitely did indeed occur. There is then the further doubt as to where it occurred and why it happened. There is much to suggest that the aircraft slowed down at the point on the runway at which the tracks of the locked wheels were visible after the accident. The loss of speed reported by the captain would then have the perfectly natural explanation that, in the final section of the runway, the co-pilot saw disaster approaching and braked the landing wheels sharply. All four landing wheels were locked, as could still clearly be seen during the Commission's inspection at Munich. A simultaneous locking of all the wheels, however, can hardly have occurred except as a result of braking. But if this were the case it is not out of the question that a misunderstanding between the two pilots played a part at this juncture, for, whereas the co-pilot (probably) applied the brakes, the captain in the hope of averting the catastrophe at the last moment, did exactly the opposite, (as he stated during interrogation), pushed the throttle lever forward as far as possible. Thus the measures taken by the crew to avert the accident or make it less serious cancelled each other out. Whether it would have made any difference to the accident or the severity thereof if either the brakes had been applied and the throttle closed or the brakes had not been applied and the aircraft had rolled on beyond the end of the aerodrome at full throttle cannot be stated with certainty. It is neither entirely out of the question that, if the aircraft had progressed unimpeded it would, before reaching the scene of the accident, have come within the limits of the required unstick speed (increased by icing); nor is it a sheer improbability that braking and closing of the throttle would have lessened the impact of the aircraft with the house and hut and could have made the results of the accident less serious. If the pilots did act in opposition in the manner outlined above, the Commission would regard this less as a pilot error (pardonable in these circumstances) than as faulty division of responsibility between captain and co-pilot.

As stated, it is not certain what actually happened at the point where the skid mark was made on the runway. Even if we do not doubt that the brakes were applied, there remains the question of wheter the drop in speed and the formation of the skid mark really occurred at one and the same spot or whether the speed decreased just before, for other reasons. The captain's statement (the only source of information that can be considered) did not clarify this, because he noticed no braking. Aerodynamic explanations for such a loss of speed have been discussed with the experts. It is not out of the question that the pilot, after attaining V_1, increased the angle of attack of the aircraft in order to initiate the unstick, with the result that the flow conditions over the iced-up wing changed and drag consequently increased. This, however, could not be proved by calculation. It is also possible that one of the pilots lowered the flaps just before the end of the runway; for, according to the definite statement of the captain, the aircraft was taking-off without flaps (as prescribed by BEA for Munich-Riem Airport). On the other hand, at the scene of the accident the flaps on both sides were found to be at take-off setting. Their design does not preclude the possibility that, when the accident occurred, the flaps fell out of their own accord to an equal angle on either side, but this is not very probable. Flap-deflection, however, would also fail to account with sufficient certainty for a drop in speed of more than 10 kt. No indication of any other influences could be found.

After all this there still remains an element of uncertainty in the reconstruction of the course of the accident. This makes it appear not entirely out of the question that towards the end of the fatal take-off there arose, in addition to wing icing, a further circumstance which was a contributory cause of the accident. But this does not rule out icing as the cause of the accident, for, even if a further circumstance affected the course of the accident in some way within a zone (of the runway) lying beyond about the 1 800 m mark, this does not alter the fact that the aircraft would normally have become airborne long before this and that the accident would not have occurred if the aircraft had not been iced up.

Probable Cause

During the stop of almost two hours at Munich, a rough layer of ice formed on the upper surface of the wings as a result of snowfall. This layer of ice considerably impaired the aerodynamic efficiency of the aircraft, had a detrimental effect on the acceleration of the aircraft during the take-off process and increased the required unstick-speed. Thus under the conditions obtaining at the time of take-off, the aircraft was not able to attain this speed within the rolling distance available.

It is not out of the question that, in the final phase of the take-off process, further causes may also have had an effect on the accident.

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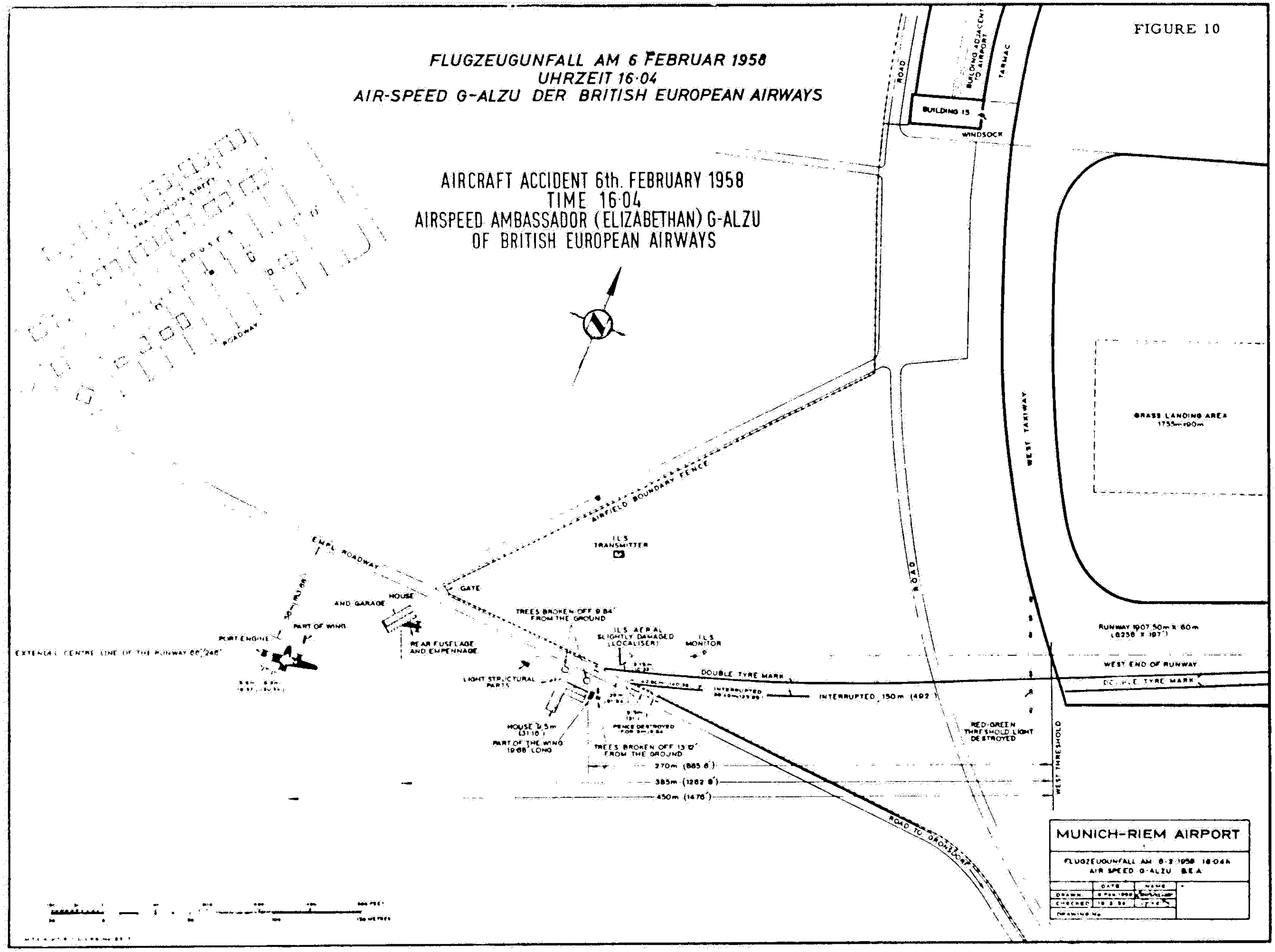
ICAO Ref: AR/565

FIGURE 10


FLUGZEUGUNFALL AM 6 FEBRUAR 1958
UHRZEIT 16·04
AIR-SPEED G-ALZU DER BRITISH EUROPEAN AIRWAYS
AIRCRAFT ACCIDENT 6th. FEBRUARY 1958
TIME 16·04
AIRSPEED AMBASSADOR (ELIZABETHAN) G-ALZU
OF BRITISH EUROPEAN AIRWAYS
ROAD
BUILDING ADJACENT TO AIRPORT
TARMAC
BUILDING 15
WINDSOCK
HOUSES
ROADWAY
GRASS LANDING AREA
WEST TAXIWAY
AIRFIELD BOUNDARY FENCE
ILS TRANSMITTER
EMPL ROADWAY
GATE
HOUSE
AND GARAGE
PART OF WING
PORT ENGINE
REAR FUSELAGE AND EMPENNAGE
EXTENDED CENTRE LINE OF THE RUNWAY 66°/246°
TREES BROKEN OFF 9.84' FROM THE GROUND
ILS AERIAL SLIGHTLY DAMAGED (LOCALISER)
ILS MONITOR
DOUBLE TYRE MARK
LIGHT STRUCTURAL PARTS
INTERRUPTED 150m (492')
RUNWAY 1907.50m x 60m (6258' x 197')
WEST END OF RUNWAY
DOUBLE TYRE MARK
RED-GREEN THRESHOLD LIGHT DESTROYED
HOUSE 9.5m (31'16")
PART OF THE WING 19.68' LONG
FENCE DESTROYED
TREES BROKEN OFF 13.12' FROM THE GROUND
270m (885.6')
385m (1262.8')
450m (1476')
WEST THRESHOLD
ROAD TO DORNACH
MUNICH-RIEM AIRPORT
FLUGZEUGUNFALL AM 6·2·1958 16·04h
AIR SPEED G·ALZU B.E.A.
DATE
NAME
DRAWN
CHECKED
DRAWING No

ACCIDENT TO BEA, AMBASSADOR AIRCRAFT, G-ALZU, AT MUNICH-RIEM

Taken on the day after the accident, after thaw had set in.

FIGURE 11

Left side of fuselage and port engine mounting.

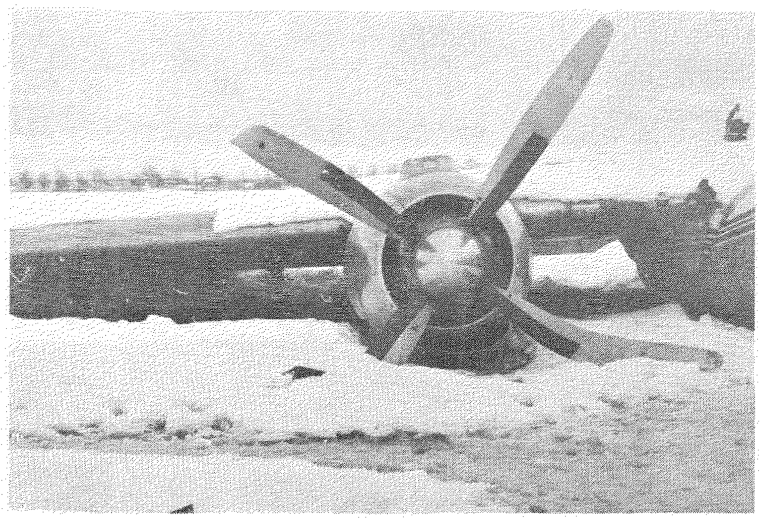


FIGURE 12

Starboard wing, with engine

FIGURE 13

Port engine

No. 17

Western Air Lines, Inc., Convair 240, N 8405H, made an emergency landing near Palm Springs, California, on 13 February 1958. Civil Aeronautics Board (USA), Aircraft Accident Report, SA-329, File No. 1-0004, released 13 August 1958.

Circumstances

Western Air Lines Flight 19 is a scheduled passenger service between Las Vegas, Nevada, and San Diego, California, with an intermediate stop at Palm Springs, California. At 1344 hours Pacific standard time on 13 February, just after take-off from Palm Springs, Flight 19 experienced severe control difficulty and made an emergency landing in the desert 4 miles north-northwest of the Palm Springs Airport. During the ground roll the aircraft struck large boulders in its path and fire occurred. There were no fatalities, but serious injuries resulted to 5 of the 18 passengers and minor injuries to most of the others. The crew of 3 received minor or slight injuries.

Investigation and Evidence

At the time of the accident the aircraft had flown two hours and nine minutes since its last inspection. A No. 3, areas 1 and 3, heavy maintenance, check performed by the company had recently been carried out at its overhaul base at Los Angeles International Airport. The aircraft had then been flown to Las Vegas as Trip 12 and had subsequently departed Las Vegas, as Flight 19, for Palm Springs and San Diego.

Following the take-off from Palm Springs Airport and when the aircraft had reached a height of approximately 500 ft, the pilots heard a sharp report, which was immediately followed by severe control difficulty. The problem manifested itself as severe vibration, buffeting and difficulty in raising the nose of the aircraft.

It was evident, following investigation, that the difficulty was caused by an inflight separation of the right wing leading edge section, normally installed between the right engine nacelle and fuselage. The control difficulty was compatible with the disruption of normal airflow over the right airfoil after the leading edge section separated. Undoubtedly normal lift was affected, and a turbulent abnormal slipstream was introduced to the horizontal stabilizer and elevator control surface. It was also apparent that the section of leading edge skin which remained attached to the hinge blew back and forth in the slipstream. This most likely aggravated the disruption of airflow and produced a spoiler effect on the right wing.

Examination of the leading edge disclosed no evidence which would indicate that the screws used to retain the leading edge were in place at the time of the accident. There were no stripped threads in the self-locking nuts, there were no sheared screws in the nuts, and there was no other evidence which would show the screws had pulled out.

Examination of the leading edge screw holes exhibited no indication of abnormal elongation, scratches, and marks which would be expected if some of the screws had vibrated loose allowing the leading edge to "work" or "balloon" against remaining screws. If the proper screws had been installed they would not have worked out and if shorter screws had been used it is extremely improbable that all 27 screws would work out evenly at the same time. Even in this situation evidence would have been present on the edges of the screw holes or on the self-locking nuts.

On the contrary, the screw holes and the 21 nuts recovered were in good condition. Therefore, after careful consideration, it was the opinion of the Board that the mechanic assigned to close the leading edge opening forgot to install the screws. It is obvious that he did install the gap straps which held the leading edge in place for about two hours of flight time before they failed under loads which exceeded their design limits.

According to Western Air Lines maintenance procedures at the time of the accident, the responsibility for ascertaining that all inspection openings were properly closed and secured was that of the lead aircraft mechanic. This is expressed in the company's maintenance manual (2.2.3(d)) as follows:

> "The lead mechanic will make a walkaround inspection of the aircraft to ascertain that ALL ACCESS DOORS, PLATES, OPENINGS AND CARGO PIT LINING IS IN PLACE AND SECURED and sign off the applicable line on the Master card."

The replacement and security of all access doors, plates, and covers is one of five items to be individually certified on the bottom of the master work record form. This item is to be signed for by the lead mechanic indicating satisfactory completion prior to returning the aircraft to service.

The lead mechanic who was charged with this responsibility stated that he made the inspection in his usual manner. This, he said, was to determine that no plates were open and/or hanging down. In response to questions he said that he did not check each plate "screw by screw" but that he went over the aircraft looking into various areas and sighting over its exterior surfaces and then checked the cargo pit lining. He said that he could not, from his inspection, state whether or not the leading edge screws were in place but that his inspection would normally reveal any screws sticking out or plates which were not flush with the aircraft surface. He said that he expected a mechanic with airframe and powerplant ratings to do the job of "putting up plates" properly. The witness indicated that he believed that there was a certain amount of work which those mechanics do which need not be checked on. He said, "I shouldn't have to check everything." The lead mechanic estimated that detailed inspection of each and every plate on the Convair would require about 45 minutes. He said that such an inspection, in consideration of his other duties of directing, coordinating, and assigning the work to be done by up to 12 men, would be very difficult. He added that in his view the inspection in issue was more properly the function of an inspector rather than that of the lead mechanic. The witness stated that after completing the inspection he had signed for the work on the master work record form and when he was relieved he reported to the incoming lead mechanic that the plates were closed.

The Board could neither justify nor excuse the manner in which the lead mechanic carried out his responsibility of inspecting the access panels for being "in place and secured." Considering that he was an expert in aviation maintenance, and the responsibility was clearly expressed in company material, its importance should have been evident to him. The Board was of the opinion that only a close and detailed inspection of each panel could satisfy the responsibility as it was expressed. The method of inspection of the aircraft, according to the lead mechanic's description, could not have assured him that screws were installed in the leading edge. From all the evidence, the Board was convinced that the lead mechanic treated the inspection in a cursory manner and as if there was an inadequate appreciation for its importance.

It is obvious that the inspection for proper closing and security of the access panels is an important airworthiness function, and the responsibility for it must be placed in the proper person. That individual must be selected considering such tangible factors as qualification and experience as well as his other duties and overall workload. From the evidence presented it is apparent that all these factors were considered before the inspection assignment was made.

Nevertheless, there are other factors which the Board believes are worthy of consideration or reconsideration. In order to provide an efficient and smooth working maintenance organization a definite distinction is normally made between the responsibilities and duties of the production and inspection phases of air carrier maintenance. One of the primary concerns of the production group is the expeditious completion of all maintenance on each aircraft involved and its return to service. In this operation quality is expected; however, the early completion of the work scheduled is paramount. On the other hand, the primary concern of the inspection group is quality control relative to workmanship of the maintenance group and the airworthiness of the aircraft before its return to service.

In general, Western Air Lines has followed this concept; however, the division of responsibilities is not sharply drawn within the structure of the maintenance organization. According to WAL maintenance manual all airworthiness items must be "Red Lined" which requires reinspection by an inspector.

Obviously, the portion of the wing leading edge which separated in flight is critically related to the airworthiness of the aircraft. Despite this, the inspection responsibility was delegated to the production group.

The importance of maintaining a distinct separation between production and inspection is well illustrated by the testimony of the lead mechanic who performed the inspection in this instance. In essence, he said that reliance should be placed on the working mechanic to do uncomplicated work without the necessity of his inspection. While many may consider this view to be an individual's viewpoint, the Board believed it may be a consideration which should be reviewed by the company before delegating any inspection responsibility to production personnel.

Civil Air Regulations, Parts 18 and 40, state the requirements to be met in air carrier maintenance. These regulations require that an inspection department be maintained within the maintenance structure; however, considerable latitude is allowed so that each carrier may have flexibility in its specific maintenance structure according to the many variable needs and considerations in air carrier operations.

The Flight

The pilots stated that the take-off roll was entirely normal and when the aircraft was approximately 30 ft above the runway the landing gear was retracted. Thereafter, take-off flap was raised and power was reduced to METO. When it was determined that no appreciable turbulence existed and about 1 000 ft (550 ft above the ground) was reached the first officer called for climbing power. The pilots stated the climb angle was normal, and the airspeed was 155 knots. The first officer made a slight right bank to keep another aircraft in sight and then rolled out. At this instant there was a noise which impressed the pilots as being a structural failure. The first officer, who continued to fly the aircraft, said the elevator control became "sloppy", and the aircraft began "bucking" and "buffeting" in a manner "as bad or worse than a secondary stall". The nose of the aircraft dropped, and elevator control would not raise it. The first officer said that at this time he doubted if he would be able to control the aircraft and told the captain he thought they must have a "broken elevator". They agreed a crash landing was inevitable and that the nose would have to be raised to accomplish it. The first officer stated that he then pushed the nose down to a 30 - 40 degree angle and added nearly full power. When the airspeed increased to 240 - 260 knots the first officer sensed a partial regaining of elevator control. He then added full power and when about 300 ft above the desert began decreasing the angle of descent. The first officer said that when the aircraft was about 50 ft above the ground the captain asked if he wanted the landing gear down. The reply was affirmative. When the landing gear extended the first officer said that he noted somewhat more positive elevator control. He was able to raise the nose of the aircraft so that ground contact occurred main gear first, the nose slightly raised. The first officer estimated that the specific touchdown speed was in excess of 200 knots.

Probable Cause

The probable cause of this accident was the failure of a mechanic to secure properly the right wing leading edge section as a result of which the unit separated in flight. This improper installation was undetected because of inadequate inspection.

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ICAO Ref: AR/533

No. 18

Gulf Aviation Company Ltd.. De Havilland Heron, G-APJS, accident on Mount Scifarello, Italy, on 19 February 1958. Report released by the Ministry of Defence-Aviation, Republic of Italy

Circumstances

The aircraft was on a ferry flight from Athens, Greece to Ciampino Airport, Rome - it was being transferred from Bahrein to England to be checked and to undergo certain modifications. It had departed Athens at 1407Z on an IFR flight plan and later reported that it expected to fly over Caraffa at 1730 and requested clearance to fly at a lower level. This clearance was not granted since the flight level requested was below the safety minimum for that route segment. There were no further contacts with the aircraft. It crashed between 1735 and 1808Z on the southeast slope of Mount Scifarello at a height of approximately 1 730 metres (5 675 ft). The 3 crew aboard were killed, and the aircraft was destroyed.

Investigation and Evidence

The Certificate of Airworthiness of the aircraft was valid until 9 March 1958, and the Certificate of Maintenance for the aircraft, valid at the time of the accident, had been issued on 17 February 1958 at Bahrein. The aircraft was equipped with HF and VHF transmitter/receivers as well as ADF and fan marker receivers.

The captain held a valid Airline Transport Pilot's licence, and he had completed a total of 2 294 hours flying on Dove and Heron aircraft.

Weather

A depression centred over Lazio-Tyrrhenian at 1200Z. Associated with it were two frontal systems very close to each other, very active and accompanied by a sharp lapse rate, observable at all levels, and by considerable cooling.

This system spread to central and southern Italy at 1800Z. The first cold front (further to the south and over Ionia at 1800Z) gave very unstable conditions.

The second front (over the Lower Tyrrhenian, Lucania-Puglie, at 1800Z) caused precipitation, mostly snow.

The movement of both systems was southeast up to the Central Mediterranean and thereafter eastward.

In the frontal area and behind the cold front from Tunisia-Naples-Foggia, observations at 1800Z indicated:

- scattered rain; forward visibility approximately 10 km; surface wind ahead of the front around S-W 20/30 kts; behind the front between N-W and N 20/30 kts with local increases. The mountain stations reported snowfalls (Monte Scuro-Potenza- Trevico-Guarcino and Guadagnolo).
- The Caraffa Station reported wind 280° at 35 kts; past weather: light rain.

  Visibility 4.5 km.
- The Monte Scuro Station reported visibility 0.
- Capo Palinuro Station reported cumulonimbus.

- At 2100Z scattered thunderstorms were reported (Monte Scuro-Potenza Capodichino) and wind changing to N-W during passage of cold front.

Analysis of the general weather picture over Ionia and Greece showed increased cloudiness with intermittent rain, horizontal visibility 5-10 km.

Analysis of thermodynamic soundings and of the two active frontal systems, with considerable and extensive cloudiness, indicated the possibility of moderate to severe icing, particularly between 1 500 - 3 500 metres.

In view of the presence of convective cloud (cumulonimbus), icing above 3 500 metres was also a possibility.

The chart of isotachs, the analysis of soundings and the presence of maximum velocity winds indicated the existence of a layer of moderate to severe turbulence between 3 000 and 10 000 metres.

Besides kinematic turbulence, there was also a layer of turbulence below 3 000 metres, caused by the particular terrain features of the region.

Analysis of upper air charts indicated a jet stream from Tunisia to Sicily and Albania. The maximum wind velocities determined by rawin observations were 136 - 140 kt over the southernmost Italian regions.

Wreckage

The wreckage was found on the SE slope of Mount Scifarello (1 767 m) 26 metres below the top of the mountain. The aircraft had apparently struck the steep slope at an altitude of 1 730 metres in a slightly nose-up attitude when on a northerly heading and the wreckage was scattered over the slope above the point of impact.

Examination of the wreckage revealed the following significant evidence:

There was no evidence of lightning strikes or structural failure before impact and no trace of fire.

There was no anti-icing equipment on the leading edges of the wings.

The control for carburettor air was selected to supply warm air and the pitot heater was switched on.

The hands of a watch indicated the probable time of impact as 1808 hours.

Reconstruction of the flight

The aircraft passed the following position reports:

a) To Athens:-
   1429 hours over Corinth estimating Araxos at 1500

b) To Rome ACC
   1700 - departed Athens 1406 estimating Ciampino 1900 FIR Boundary 1600 at 8 500 ft estimating Catanzaro (Caraffa NDB) 1710

   1725 - estimating Caraffa NDB 1730 request descent to 6 500 ft to which Rome ACC replied -
   "Unable to approve 6 500 below limit maintain 8 500 ft call Catanzaro"

This was the last radio contact with the aircraft. No D/F stations received or intercepted calls from the aircraft. *

These messages from the aircraft indicated that the pilot was having difficulty in holding to the estimated time of overflight, in finding reporting point G8A, probably due to the actual wind being stronger than those forecast;

* ICAO Note The report indicates that between 1608 and 1648 the position of the aircraft was plotted by radar, which showed it to be some distance north of, and diverging from the Advisory Route (ADR 528). This information was apparently not available to ACC or the aircraft prior to the accident.

and also in maintaining flight level possibly due to icing. It is also possible that ice formation on the antennae may have interfered with the reception of MF bearing signals.

The cruising speed of the aircraft was assumed to be 140 kt TAS as indicated in the flight plan and this was later reduced to approximately 130 kt. The wind force was also taken as 45 kt from 240° - the average between the forecast wind at Athens and as later deduced from meteorological information.

Beyond Araxos the flight was most likely conducted not along the line joining Araxos and point B (airway G8 and ADR 528) but along the line joining Araxos and point A. (See Figure 14) This latter path corresponds to the radar scans and the times transmitted by the aircraft.

It very likely arrived in the area of point A at approximately 1721, the pilot possibly mistaking the lights along the coast for those in area B.

This would explain the message at 1725Z estimating overflight of Caraffa at 1730Z.

The pilot, believing he was over B, intended to fly over Caraffa at 1730Z and then fly to D, over the sea, and thereafter to turn towards airway A-13 on a heading of 320°. Presumably he mistook his position abeam of Caraffa at C for over Caraffa, and then flew towards E thinking it was D.

From this last point E, the aircraft turned approximately 320° (parallel to A-13) arriving at the point of impact at approximately 1808Z.

Probable Cause

The accident was caused by a navigational error.

The following were contributing causes:

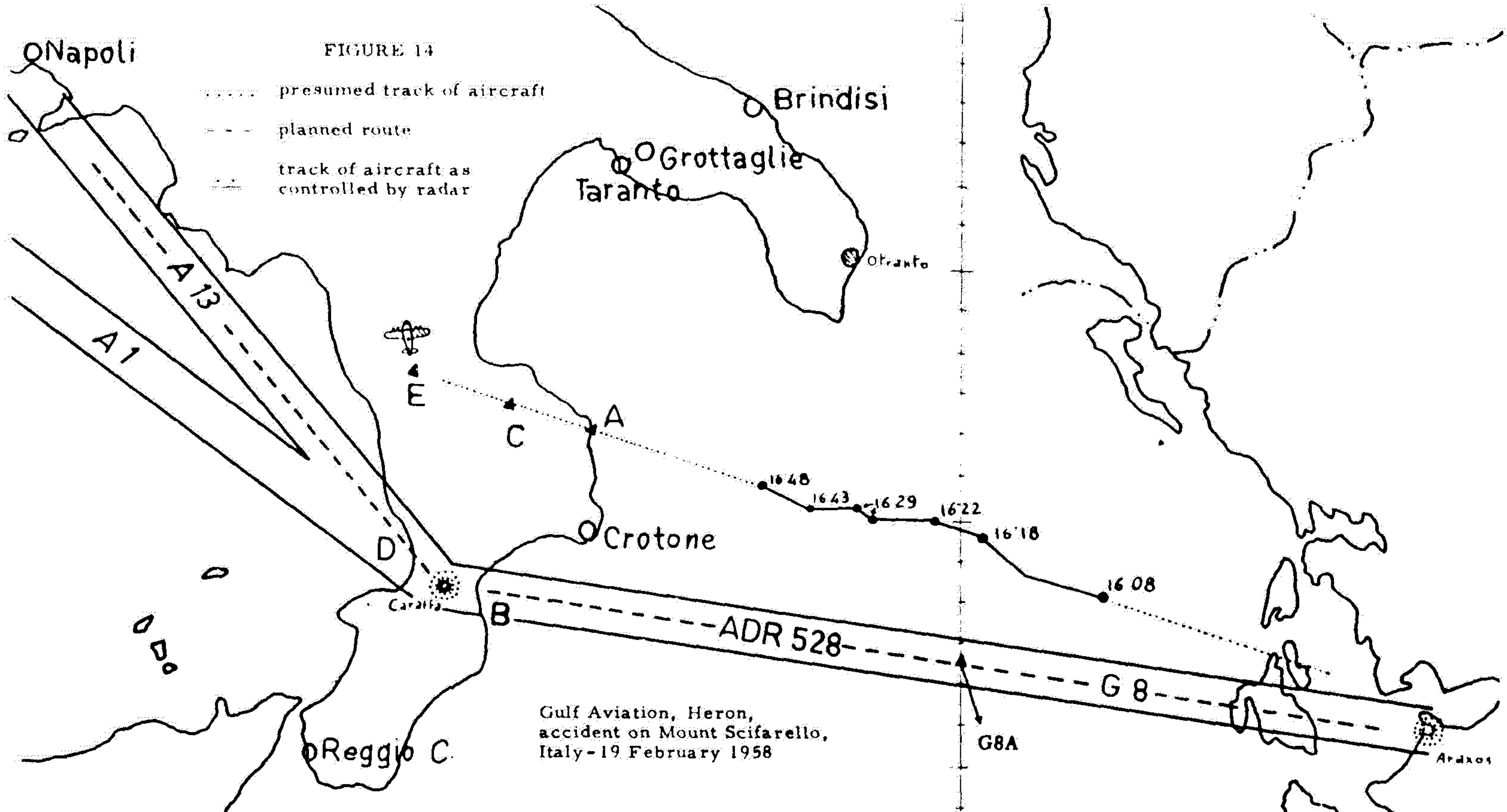
a) the weather conditions encountered were worse than those forecast;

b) the pilot had difficulty in receiving MF bearings;

c) there was no anti-icing equipment on the wing surfaces.

- - - - - - - - -

FIGURE 14



Gulf Aviation, Heron, accident on Mount Scifarello, Italy - 19 February 1958

No. 19

Silver City Airways Ltd., Bristol aircraft, G-AICS, crashed near the summit of Winter Hill, 5 miles SE of Chorley, Lancashire, on 27 February 1958. Report released by the Ministry of Transport and Civil Aviation (UK). C.A.P. 152.

Circumstances

The aircraft, operated by Manx Airlines Ltd., took off at 0915 hours from Ronaldsway Airport, Isle of Man, on a flight to Ringway Airport, Manchester. It carried 39 passengers and a crew of 3. At approximately 0945 hours the aircraft crashed near the summit of Winter Hill, killing 35 of the 42 persons aboard. The pilot was seriously injured.

Investigation and Evidence

The Route and Procedure

The route which was chosen for the first part of the flight is known as ADR 159 (see Figure 15). It is an advisory route and brings aircraft from the Isle of Man to a point - marked as "Reporting Point" - which is over the sea about 3 miles from Squire's Gate, Blackpool. An aircraft coming to the Reporting Point off Squire's Gate must obtain a clearance from the Air Traffic Controller in Manchester Control Zone before it may enter the Zone. This clearance is given to the aircraft by the Air Traffic Controller at Northern Air Traffic Control Centre, Preston. Preston Control obtains the necessary clearance from the Air Traffic Controller at Manchester Control Zone and passes it on to the aircraft. When the aircraft has passed into the Manchester Control Zone, having obtained its clearance, any further instructions come to the aircraft direct from Manchester Control, which is located in Antrobus.

The route chosen for G-AICS was ADR 159 to the boundary of the Manchester Control Zone. From the Reporting Point the intention was to fly to Wigan Beacon and from there there were two possible routes either of which might have been ordered by Manchester Control to Ringway Airport.

Wigan Beacon is one of a number of beacons in the Manchester Zone. It is a non-directional beacon and has a range of approximately 25 miles. Its frequency is 316 kilocycles and its recognition signal is the letters MYK transmitted in morse code. One of the other non-directional beacons in the Manchester Zone is Oldham Beacon, which is also shown on Figure 15. It is considerably more powerful than Wigan Beacon, having a range of about 50 miles. Its frequency is 344 kilocycles and its recognition signal is MYL.

On the chosen route no ground within 5 miles of the track is higher than 567 ft above sea level. Between 7 and 8 nautical miles from Wigan Beacon, in a northeasterly direction, lies Winter Hill on which the aircraft crashed. Its summit is 1 498 ft above sea level and on the summit there is a television station and mast. The mast is 445 ft high, so that the top of the mast is 1 943 ft above sea level.

The captain had flown a number of times previously on the intended route from Ronaldsway to Manchester. On most previous occasions he had either flown the whole way at a height of 2 500 ft or 3 500 ft or, if he crossed the sea at a lower height, he had been sent up to at least 2 500 ft before entering the Manchester Zone. On one previous occasion he had flown this route at 1 500 ft the whole way. The first officer had not previously flown to Manchester via the Wigan Beacon. He had flown to Manchester on a number of occasions by the "Red Three" route, via Wallasey.

On this flight, it was intended to fly at 3 500 ft and the first officer, with the captain's approval, had made out his flight plan accordingly. In fact, the flight was made at 1 500 ft, for the following reason.

Prior to take-off, in order to avoid delay, a clearance to fly at 1 500 ft was offered and accepted. In the light of past experience the captain anticipated that he would be cleared to a higher altitude on crossing the English coast.

Between Ronaldsway and the Reporting Point at Squire's Gate the flight was made below cloud practically all the way. Visibility was reasonably good. When approaching the Morecambe Bay Light Vessel the captain obtained a bearing from Ronaldsway - this showed that the aircraft was very slightly to the North of its planned course. He then went below to talk to the passengers for approximately a five minute period. During his absence the first officer flew the aircraft, kept a lookout and tried to set up the Decca apparatus. It is probable that during this time, unknown to the captain, he made what he describes as an "S turn", to bring the aircraft slightly further south towards the Reporting Point. It was also during this brief period that the first officer set the radio compass on what he thought was Wigan Beacon, but, was in fact, Oldham Beacon.

On his return to the cockpit the captain took over the piloting of the aircraft and continued to do so until the crash occurred. When he took over he assumed that the radio compass was tuned in to Wigan. At this time he looked at the magnetic compass and the course being flown appeared to him to be consistent with a course to Wigan. Thereafter he concentrated his attention on the radio compass.

Shortly after the captain took over, a series of messages was exchanged between the aircraft and Preston Control for the purpose of obtaining a clearance into the Manchester Zone. The ATC Officer (Preston) was the one who had arranged with Ronaldsway Control the original offer of a clearance at 1 500 ft which had been accepted. Just prior to 0938 hours the aircraft reported to Preston Control "abeam Blackpool at this time estimating Wigan at 43". Having received this message, the ATC Officer, Preston, spoke to Manchester Control to ask for a clearance for the aircraft into the Manchester Zone. Because of other traffic in the area, the Zone Controller, Manchester, gave the ATC Officer, Preston, a clearance, to be offered by him to G-AICS, at 1 500 ft. What was offered was a clearance to Wigan Beacon at 1 500 ft, "visual contact" or "contact". Two points must be emphasized. First, the clearance offered was to Wigan Beacon only. A further clearance would have been required from Wigan Beacon onwards to Ringway Airport. This clearance might have been given before or after the aircraft reported at Wigan Beacon. If it had not received a further clearance before arriving over Wigan Beacon, it would have had to have "gone into a holding pattern"; that is, circled northwest of Wigan Beacon until a further clearance was given. In fact, no further clearance, in the events which happened, was ever given. Secondly, it is to be noted that the clearance was subject to the condition of "contact" or "visual contact".

When the ATC officer (Preston) had been given this clearance by the Zone Controller (Manchester), he immediately passed it on to the aircraft. At 0939 he said to G-AICS: "You are cleared to Wigan 1 500 ft remaining contact. Call Manchester Zone ... for onward clearance." The captain accepted the clearance as offered. His acceptance was reasonable and proper in the circumstances as they were known to him, including the meteorological information which he had been given at Ronaldsway, his knowledge of the terrain over which his supposed course would take him, and the actual weather conditions as they then appeared - all on the assumption that he was homing on Wigan Beacon. The aircraft, flying over the sea at 1 500 ft, had been about 500 ft below the cloud base; visibility had been reasonably good; and, so far as the captain could see and estimate, visibility would remain reasonably good as far as Wigan Beacon, so that he would be able to see the ground, without cloud interference, all the way, preserving his height of 1 500 ft.

When this clearance was passed to the aircraft the Barnsley QNH should normally also have been included. The ATC Officer (Preston) said that his decision not to give the Barnsley QNH was deliberate and that it was based on his interpretation of the Regulations. It may be that if the Barnsley QNH had been given to G-AICS this accident would, fortuitously, have been avoided. The Barnsley QNH at that time was 1 021 millibars. The Holyhead QNH, to which the altimeters of the aircraft had been set, was 1 024 millibars. If the captain had received the Barnsley QNH he would have reset his altimeters 3 millibars lower than they were in fact set, which would have made a difference of 90 ft. If the captain's altimeters had been set 90 ft lower, he would, in attempting to maintain a height of 1 500 ft, probably have been flying 90 ft higher than he was in fact flying. The crash occurred at a height of approximately 1 460 ft, 38 ft below the summit of Winter Hill. An extra 90 ft of height would have resulted in the aircraft clearing the summit of the hill with some 50 ft to spare, but the possibility of collision with the television mast would have remained. The primary responsibility for this error lies with the ATC Officer. However, the captain is also concerned, since it was his duty to ask for the Barnsley QNH, if it was not given to him by the traffic controller.

At 0942 hours Manchester asked G-AICS: "What was your estimate for Wigan again please?" The reply was, "Forty-three". At this moment the aircraft should have been very close to the Wigan Beacon. In fact, it must, as a result of the wrong setting of the radio compass, have been already too far to the east, and to have been heading for the neighbourhood of Winter Hill on its course to Oldham.

At approximately 0944 the aircraft was in cloud and out of contact with the ground. A message from Manchester Control at this time was, "Charlie Sierra will you make a right turn immediately on to a heading of two five zero. I have a faint paint on radar which indicates you're going over towards the hills." Shortly thereafter in the course of making the right turn as ordered, the aircraft crashed on the northeast slope of Winter Hill, at a height of approximately 1 460 ft.

The Setting of the Radio Compass

The control unit of the radio compass in this aircraft was in the roof of the cockpit, above and perhaps slightly behind the first officer's seat. In order to bring the radio compass into use for the purpose of "homing" on a particular beacon, the procedure is:- first, turn the selector switch on the control unit to the position marked "ANT" (meaning "antenna"); then turn the tuning handle on the same control unit, until it indicates the frequency in kilocycles of the particular beacon. If the aircraft is within range of the beacon's transmission, the operator in the aircraft will then hear the recognition signal, in morse, of the particular beacon, repeated at intervals. The selector switch is then moved from the "Antenna" position to the "Compass" position, and the volume of sound may be lessened by turning a control called "Audio". The recognition signal can probably still be heard, but probably only with difficulty and indistinctly. The pointer of the radio compass itself, which is in the instrument panel in the front of the cockpit will then point to 0° when the aircraft is flying directly towards the beacon.

There is thus a double check that the radio compass has been set on the intended beacon:

1. there is the setting to the particular frequency of the desired beacon;

2. there is the recognition signal.

The frequencies and recognition signals of all beacons in a particular area are given in a book known as the "Aerad Flight Guide" which was carried in the aircraft and used by the first officer on this occasion. If he had looked correctly at the entries opposite "Wigan", he would have found that the frequency was 316, and the recognition signal "MYK". If he had set the tuning scale to 316, he would have received signals from Wigan and not from Oldham, and he would have heard the recognition signal "MYK"; whereas if he had tuned on Oldham (frequency 344 kcs) and listened for the recognition signal, he would have heard the recognition signal "MYL". The letter "K" in morse is -.- (dash dot dash); the letter "L" is .-.. (dot dash dot dot); and no one with experience of the morse code should have confused the two. Of course, if he had failed to listen for the last letter of the call sign he would have heard only the letters MY in morse, and these are the first two letters of both stations.

Unfortunately, there can be no doubt but that the first officer for some reason tuned the radio compass to Oldham Beacon and not to Wigan Beacon. After the accident it was found that the frequency setting on the tuning scale of the control unit was 344 kilocycles (Oldham Beacon frequency) and, by test, that the actual frequency of the instrument was 344 kilocycles. Moreover, the position of the loop aerial and the reading on the bearing indicator are both consistent, having regard to the probable extent of the starboard turn which had been made before the crash, with the radio compass having been set on the Oldham Beacon at the time of the crash.

It appeared to the investigator that the most probable explanation of the error was that the first officer, without realizing it, had in his mind some, possibly subconscious, association between Oldham and Wigan and that, therefore, in looking at the Guide and running his eye down the page, when he saw the name "Oldham" he momentarily assumed that that was the place which he required and therefore deliberately, although of course without realizing that he had made this mistake, took the Oldham frequency from the Guide and tuned in the radio compass to the Oldham frequency, and heard the very recognition signal which he thus expected to hear.

This explanation was strengthened by the following:

1. the first officer's conversation with a Transmitter Maintenance Engineer in the Television Station shortly after the accident when he took the initiative in mentioning Oldham, though he may have mentioned other towns in the neighbourhood as well;

2. by his statement to an Inspector of Accidents the day after the accident, when, on being asked "Which beacon would you go to in the Manchester Zone?" - he replied -"I think you get Blackpool, Oldham, etc."

Another possible explanation, though less probable, is that, in turning the tuning switch, he somehow missed, or overran, the Wigan frequency of 316 kilocycles which he intended to select, and, when the switch was in the neighbourhood of 344 kilocycles, the Oldham call sign came in strongly. He then assumed that he had got Wigan Beacon, and failed to listen carefully to the recognition signal, so that he did not notice that he was getting "MYL", instead of "MYK", which on this hypothesis, he would have been expecting.

It was suggested on behalf of the first officer that one of the factors contributing to the mistake may have been that he was trying to do too much. He was, at the time of setting the radio compass, also flying the aircraft, keeping a look-out, and trying to set the Decca apparatus. He ought not at that time to have allowed himself to be distracted by the Decca apparatus. As it could not in any case have been brought into use until Wigan Beacon, he should not have done anything about it while he was actually flying the aircraft.

Ballast and Inaccuracies in the Load and Trim Sheet

Errors and carelessness in connection with these subjects were criticized. However, they did not contribute to the accident.

The Failure to Give to G-AICS the Barnsley QNH

The primary purpose of the QNH is not related to the clearance of an aircraft from terrain obstacles, but to the preservation of sufficient space between aircraft themselves, flying at different levels.

It is believed that the conception of the Air Traffic Controller, Preston, was that as the aircraft's flight was at 1 500 ft (and, possibly also, because therefore it was not at 1 500 ft above aerodrome level), the pilot would not require, or use, the Barnsley QNH and should not be given it. This was regarded as a misconstruction of the Regulations, even when read in the light of the QNH altimeter setting procedures. Apart from any other consideration, it was by no means certain that the aircraft would not be sent above 1 500 ft on a further clearance by Manchester Control.

As it now appears that doubt can arise in the minds of Air Traffic Control Officers as to the construction of the Regulations in particular circumstances, the wording of the Regulations, and the "procedures", should be carefully reconsidered in order to remove any possible ambiguity. This is already under consideration by the Ministry of Transport and Civil Aviation. The error of the Air Traffic Controller, which ought in any event to have been rectified by a request from the pilot, cannot properly be regarded as having contributed to the accident, except fortuitously.

Weather

Prior to the flight a forecast issued at 0820 hours was obtained from the Meteorological Officer at Ronaldsway. It showed that the wind velocity at 1 500 ft was expected to be 300°/25 knots. The lowest layer of cloud was forecast as 1/8 to 3/8 stratus, base 600 to 1 000 ft. The second layer, stratocumulus, was expected to have its base at 2 000 to 3 000 ft. The surface visibility was shown as 3 to 6 nautical miles, locally 1 to 3 miles. The general weather was given as "Cloudy, periods of rain". The aerodrome forecast for Manchester showed "rain" with a first layer of cloud of 4/8 stratus at 800 ft and a second layer of 8/8 stratocumulus at 1 500 ft.

With such a forecast there would be, at the least, a strong possibility of low and dense cloud existing or developing on hills. There was no change in the weather conditions, as given in the forecast before departure such as to require special notification to G-AICS.

Responsibility of the Pilots

The first officer admitted, in the light of the evidence, that he must have inadvertently tuned the radio compass to the wrong beacon. He could not himself give any real explanation for the mistake. The Court, after full consideration, concluded that no possible explanation could be consistent with the skill and care which the first officer ought, in the circumstances, to have shown.

There are two possible grounds on which the responsibility for the accident might be attributed to the captain. They are as follows:

1. the first depends on the suggestion that he continued to fly on his supposed course after weather conditions had become such that he ought to have realized that there was danger, or that the condition of "contact" in the clearance which he had been given was no longer being fulfilled;

2. the second is that he had a duty to check that the radio compass was in fact tuned on Wigan Beacon, and that he made no effective check.

When the aircraft was in the position which we now know was over Euxton or Chorley, it began for the first time to run into patches of cloud and there was light rain. Possibly it was, rather, patches of cloud below the aircraft. After that, there was a deterioration of visibility, and then a sudden complete envelopment in cloud. Up to the moment of sudden envelopment in cloud the captain had not, according to his interpretation of the phrase, lost "contact"; since, apart from momentary obscuring by patches of cloud, he had not hitherto been prevented from seeing substantially the whole of the ground beneath him.

It will be borne in mind that the captain was firmly under the impression that he was on the direct course to Wigan, and it never crossed his mind that he could be less than about 7 miles from Winter Hill. He was waiting for Wigan Beacon to show on the needle of the radio compass and he was from moment to moment expecting the needle of the compass to swing round, showing that he had crossed the Beacon. It is clear that he did not know, from any observation of the ground, precisely where he was.

Bearing in mind the doubt and ambiguity as to the meaning of the word "contact" in clearances such as this the investigator acquitted the captain of blame in respect of his continuing to fly for as long as he did without seeking further instructions from Manchester Control or reporting loss of "contact", or taking other action. After he had reported loss of "contact", the order to turn immediately followed. It was considered that the phrase "contact" should always connote sufficient forward visibility, in relation to all obstructions on, or within 10 miles of, the course. However, the captain did not so interpret it.

When the captain understood some time before the aircraft arrived at the Reporting Point that the first officer had set the radio compass on Wigan Beacon, he took no steps whatever to check the setting himself, other than to compare his radio compass course with the magnetic compass. He took no steps to ensure that the first officer checked, or re-checked the radio compass setting.

It is at all times the duty of the captain of an aircraft to ensure its safe navigation. It may be too high a standard to lay down that a captain should check every beacon tuned in by his first officer. There are, however, certain occasions when it is the absolute duty of the person in command to check the identification of radio aids. Checking is required when making an instrument approach to land, or when flying in a control zone, or when flying below the minimum safe altitude for the area, or when the particular radio aid is the only navigational aid available and there is no means of effective cross-checking by reference to something else. At least two of these factors existed on this flight from the Reporting Point to Wigan. The captain failed to check the correct tuning of the radio compass as he should have done. Had he done so, the mistake probably would have been detected and the accident prevented.

Probable Cause

The accident was attributed to the error of the first officer in tuning the radio compass on Oldham Beacon instead of on Wigan Beacon.

A contributory cause was the failure of the captain to check that the radio compass was tuned on the correct beacon.

Recommendations

Location of Equipment

It was suggested that in this aircraft the position of the radio compass control instrument was inconvenient in that it involved some difficulty for the first officer to operate it, reaching over his left shoulder to the roof of the cockpit; and greater difficulty for the captain to operate. In aircraft such as this, fitted with only one ADF, the control box should be within comfortable reach of both the captain and the first officer while actually flying the aircraft from their appropriate seats.

In G-AICS it was not altogether easy for the captain to speak into his microphone. It should be possible for the two pilots to communicate freely at all stages of the flight when both are in the control cabin. In aircraft which have a high noise level in the cockpit, consideration should be given to the advisability of the pilot at the controls wearing some type of boom microphone or, at the very least, having a hand microphone so mounted that it can be reached and used without any difficulty from his natural position while flying the aircraft.

Recognition Signals of Navigational Aid Stations

A number of navigational aid stations in the area in question have recognition signals beginning with the same letters, "MY", and still more of them have "M" for their first letter. This may contribute to errors of identification. It might be better if the recognition signals bore some general identification with the names of the respective stations. At the same time, it would undoubtedly be helpful if the "rate of coding" were to be increased. At the time of the accident, Wigan Beacon gave its recognition signal only twice in one minute, i.e. the pilot seeking identification may have to wait for 30 seconds before he can identify the station. It was thought that a rate of coding of less than six per minute was not really satisfactory. It is recommended that these matters be given urgent attention by the Ministry of Transport and Civil Aviation.

Regulations Regarding QNH

It is recommended that consideration be given by the Ministry of Transport and Civil Aviation to a clarification - if possible by way of simplification - of the wording of the U.K. Air Traffic Control Instructions as to Altimeter Settings and of the QNH altimeter setting procedures in the "U.K. Air Pilot".

Definition of "Contact" in Relation to Clearances.

In the present case, a clearance was issued containing the words "1 500 ft remaining contact". That clearance, in the view of the investigator, was intended to be and was acted upon as a clearance under the Special Visual Flight Rules. It was, and was understood to be, a clearance in weather conditions which did not permit an ordinary Visual Flight Rules clearance, subject to two conditions. These were first, that the aircraft should fly at a height of 1 500 ft above sea level and second, that it should at all times "remain contact". Different meanings to the word "contact" were given by different witnesses.

There were those who thought that "contact" implied ability to navigate by reference to the ground; those who thought that it implied ability to fix one's present position at any given moment by reference to observation of the ground; those who thought that it referred only in varying degrees to the ability to see the ground beneath one. It is noted that the captain did not apparently know his position, by reference to the ground, when he flew over Chorley, already well off his course, though he regarded himself at that stage as still "remaining contact".

It ought to be recognized that if a "contact" clearance is ever given, an essential condition of that clearance is that the pilot has, and will continue to have, adequate forward visibility.

It was considered whether it ought to be recommended that if the word "contact" is to continue in use as a condition of clearances, the word should be defined so as to include specifically a particular minimum range of forward visibility. It was concluded that such a specific and universally applicable definition would be undesirable for a number of reasons. First, it might properly be regarded as infringing the vital principle of the pilot's responsibility for terrain clearance. Secondly, it would be impracticable to lay down a satisfactory range of forward visibility which should be applied universally and in all circumstances. Thus, that which would be a safe forward visibility for a slower aircraft might be less than safe for a faster aircraft; or that which would be safe for one height or one area might be unsafe for another height or another area. Thirdly, if a universally safe minimum were to be prescribed, it might involve, in certain areas and for certain traffic, an undue interference with the movement of aircraft, without a countervailing additional safety factor.

It is strongly recommended that the MTCA should, by whatever is the appropriate means, bring to the attention of all concerned that, whenever a "contact" clearance is given, it is the responsibility of the pilot at all times to ensure that he not only keep contact with the ground but also that he should continue to fly on that clearance only so long as the forward visibility remains sufficient for safe navigation in all the circumstances of the particular flight. Those circumstances include the height and speed at which he is flying and the existence of obstructions not only on his direct course but also within a distance of at least 10 miles on either side of his direct course, whether or not he has any reason to suppose that he may be off his direct course.

It should be clearly understood by any pilot who is offered a "contact" clearance for a flight at 1 500 ft from Blackpool to Wigan Beacon that in flying on this clearance it is his responsibility to ensure that his forward visibility is never less than is sufficient to give him an adequate margin of safety, bearing in mind that Winter Hill, with a height of over 1 500 ft, is within 10 miles of his direct course. He will thus need to have - and continue to have - at all times a longer range of forward visibility than would be required in the case of a "contact" clearance in an area where there is no high ground within 10 miles of the direct course.

The MTCA should consider the whole question of Special VFR Clearances with a view to making it clear that a Special VFR Clearance should never be initiated by Traffic Control but should be offered only if it is specifically requested by the pilot; and, of course, even if it is requested by the pilot, it should be offered by Traffic Control only if the latter is satisfied that it is safe from the point of view of separation of aircraft. The U.K. Air Pilot, RAC 12, paragraph 6, shows that a Special VFR Clearance is to be regarded as a concession. It may be desirable to strengthen the concessionary concept in the way in which it has been suggested; since a pilot specifically requesting Special VFR will be more acutely aware of his responsibility in setting aside the protections of IFR or VFR than he might be if he were merely attempting to comply with a course of action suggested by Traffic Control.

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ICAO Ref: AR/562

AREA OF FLIGHT OF G-AICS ON 27TH FEB 1958

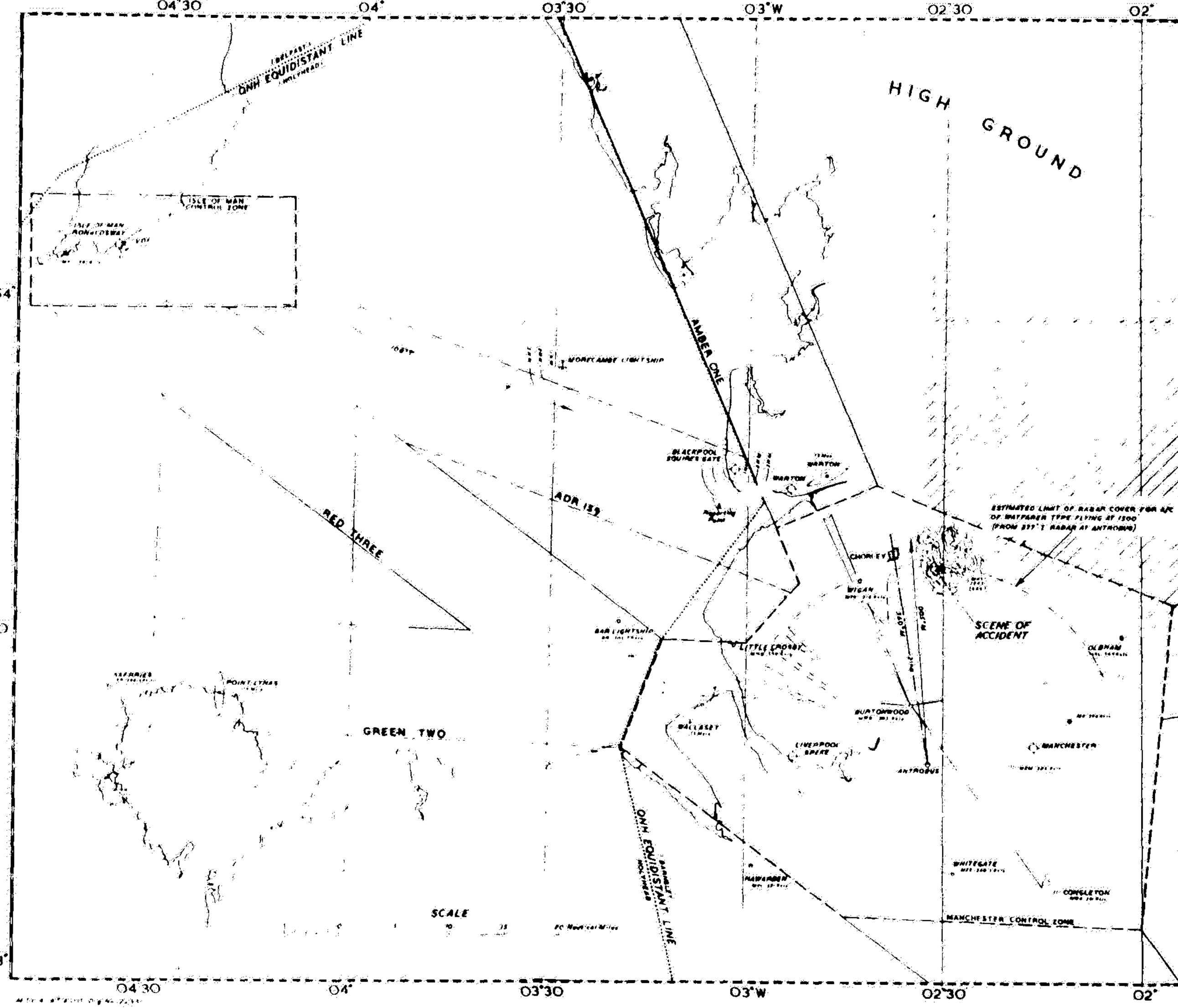

FIGURE 15

No. 20

KLM, Douglas DC-6B, PH-DFK, crashlanded 4 km southeast of Cairo Aerodrome, United Arab Republic, on 19 February 1958. Report released by Civil Aviation Department, Ministry of War, United Arab Republic (Egyptian Sector).

Circumstances

The flight, number KL 543, originated at Amsterdam, destination Cairo, with intermediate stops at Prague, Vienna, Athens and Beirut. It contacted Cairo tower at 0110 hours and reported that it was at 4 500 ft, 15 nautical miles out, aerodrome in sight and requested a visual approach. The tower then cleared it for landing. At 0113 the aircraft again contacted the tower, reporting downwind; the tower acknowledged the message and requested the flight to call on final. Then at 0114 hours the aircraft appeared to have hit something. One minute later the tower cleared it to land, but the aircraft asked for emergency landing. This last message was not acknowledged by the tower, who cleared the aircraft again to land. The message was repeated again by the aircraft with the same result. Shortly afterwards the aircraft touched down on runway 34 with the propeller of engine No. 4 missing, the starboard main landing gear and about 1/3 of the starboard stabilizer and elevator torn off. The aircraft ran for about 1 400 metres on the runway surface, gradually swerving to the right and then towards the runway end, ran off the runway into soft sands and swung sharply to the right before coming to rest. The second pilot was fatally injured by the rotating propeller of engine No. 1 when he was leaving the aircraft through an emergency window before the aircraft came to rest. None of the other occupants were injured, and no fire occurred.

Investigation and Evidence

Weather

The actual weather conditions on the day of the accident were as follows:

Time	Surface winds (direction and speed)	QNH	Upper winds (1 000 ft)
0000 Z	110°/2 kt	1019.6 mb	from 2 - 10 kt
0030	100°/2 "	1019.6	
0100	110°/4 "	1019.3	
0130	calm	1019.4	
0200	120°/6	1019.3	

The sky was clear and the visibility 12 km.

˙he Crew

There were five operating crew members aboard the aircraft on the Beirut-Cairo portion of the trip when the accident occurred. The captain was familiarizing the third pilot with the route to promote his experience, and the latter was at the controls. The third pilot had completed certain technical ground courses on the DC-6B and had a flying training of 15 hours on that type and had flown five trips on the Middle Eastern routes as third pilot. He had a total of 2 106 hours to his credit, 529 of which were on the DC-6B. The investigation revealed, however, that apart from his lack of experience in night landings at Cairo - he had landed only once at Cairo a fortnight before and that had been on runway 05 - the third pilot's technique in flying DC-6B aircraft was rather poor and needed some extra training. The captain-in-command had flown 10 448 hours in all, including 3 833 hours on the DC-6B.

Discussion of the flight

En route from Beirut a weather report from Cairo received at 0017 hours had given a surface wind of 110° at 2 kt. On that account the third pilot decided that the runway of intended landing would probably be either runway 16 or alternatively 05. He referred to the KLM route guide and Notam which were handed over to him by the captain for planning the landing. The captain drew his attention to some obstructions along the approach side of runway 05.

Although the runway in use at the time of landing turned out to be runway 34 and the wind was calm, the third pilot cannot be blamed for his assumption as to the probable runway of landing and for preparing himself in advance to land on runway 05 or 16. There appeared no evidence that the third pilot referred again to his route guide or Notam for re-planning a landing on a runway other than the one incorrectly assumed. The captain did not draw his attention to the need for replanning nor was he given any particular instructions about the features of the terrain south of the field where the approach end of runway 34 lies, before entering the circuit for a procedure turn.

The investigation committee was advised that if a request had been made for authorization to land on runway 05 or any other runway at that time, permission would have been granted promptly by the aerodrome traffic control. The terrain south of the aerodrome, which is the approach area for runway 34, is hazardous and scattered with high sand ridges of variable heights, above aerodrome level, but at an elevation below the 1:50 plane as required by ICAO and it does not technically constitute a flight obstruction.

By comparison, the approach area north of the field for runways 05 and 16 is nearly flat and at aerodrome level. Probably, the third pilot did not think it necessary to refer to his route guide for landing on runway 34 as he was performing his duties under the monitoring of the captain.

The circuit was joined and a course of 135° magnetic assumed downwind, which deviated 25° from a direction parallel to the runway axis, since the aircraft was fairly close to the runway. Power reduction was called for when over the radio range (1 500 rpm and 15 inches manifold pressure). This power was selected to decelerate the aircraft as the speed was relatively high at the beginning of the approach and maintained right to the end of the downwind leg. When abeam the threshold, a new heading was assumed by the third pilot, namely 120° magnetic and the aircraft flown for 35 seconds downwind on that heading, before turning into base leg. This heading change was effected because the third pilot believed that he was still too close to the field and unable to obtain a visual contact with the runway. On the other hand, the captain could always have a visual reference to the runway and did advise the third pilot as to the aircraft's position when abeam the threshold of runway 34. However, he did not interfere at any time with his third pilot's navigation during the let-down.

The figures stated by the captain and third pilot as to the aircraft altitudes during certain stages of the flight path do not reconcile. During the investigation the captain's statements about altitudes were shaken and he eventually testified that in his desire to assist the investigator in the reconstruction of the flight path he might have given some figures which stem from his recollection that everything was normal and, therefore these figures would have been applicable and instead of observations they may, therefore, have been reconstructions. On the other hand, taking into consideration the elevation of the terrain at the point of contact with the ground (580 ft) and the short time elapsed from the moment the aircraft was abeam the threshold until it hit the ground, the committee was satisfied that the figures given by the third pilot about the aircraft altitudes were generally more consistent within reasonable margin with the reconstruction of the flight path and on these grounds were accepted.

The aircraft altitude, according to the third pilot's testimony, when flying abeam the threshold of runway 34 was 1 300 ft. Unfortunately, during the last portion of the downwind leg and due to the inadequate engine power and the additional drag brought about by a 20° flap setting, the aircraft was losing speed at a fast rate. To restore the speed to normal, without altering the engine settings, a steeper rate of descent was unavoidable and some valuable height had to be sacrificed for speed. Afterwards the aircraft banked in for base leg and the third pilot called for landing gear down and only then the engine power was increased (2 400 rpm and 28 inches of boost) which gave a normal rate of descent of 500 ft/minute.

The aircraft altitude just before turning into base leg can be calculated from the following:

Aircraft altitude abeam the threshold:	1 300 ft
Duration of flight from threshold to base leg:	35 seconds
Loss of height after 35 seconds allowing for normal rate of descent (500 ft/minute):	300 ft.
Additional loss of height due to steeper rate of descent:	150 ft. approx.
This brings the aircraft altitude to	850 ft.

Half way base leg the third pilot was still unable to obtain a visual contact with the runway lights to gain a visual glide path. The captain looking outside the aircraft was unable to see the runway lights either. He then remarked to the third pilot that he was a bit too far out and reached unperturbed for the final check list. Being uncertain of the aircraft's relative position to the runway and the flight being conducted according to the visual flight rules by night over hazardous terrain, the captain's immediate concern should have been to check his altimeter by giving it a glance if he had not already done so previously. He would have become aware then that the aircraft's altitude was alarmingly low over a dangerous sector. An immediate change of aircraft attitude from descent to ascent should have been the reaction until a safe altitude above the terrain was reached and the aircraft's position relative to the runway determined. The captain testified that he did draw the third pilot's attention to the aircraft's low altitude. However, the third pilot denied that anything was mentioned about that. It was the captain's duty to see that corrective action was taken immediately. The third pilot did not recall any altitude below 900 ft before the impact although the aircraft contacted the ground at 580 ft. This can be explained by his disorientation brought about by the loss of any visual reference to the runway and his attempt to regain such reference by looking outside the aircraft during the last stage of the flight path shortly before the accident.

The distance from the runway threshold up to the first point of contact with the ground is 4 kilometres, which suggests rather a wide circle. Had the circuit not been so wide an altitude of 1 300 ft abeam the threshold of the runway with uninterrupted visual reference and a normal rate of descent would have allowed the aircraft to clear the terrain safely and land normally.

After the impact the pilot-in-command assumed control of the aircraft, altered the aircraft's attitude from descent to climb, regained a visual reference to the runway, cut short the aircraft circuit and endeavoured to reach the field directly on two starboard engines at METO power. The third pilot recalled that the first altitude he noticed after the impact was 700 ft, which suggests that the aircraft had already gained some height after the impact.

The flaps could not be fully lowered on final due to the loss of all hydraulic pressure subsequent to the teardown of the main gear and were kept at their initial approach setting (20°); the reverse pitch and hydraulic brakes could not be used either to decelerate the aircraft.

It is noteworthy to mention that during the last phase of the flight the captain-in-command displayed great courage and presence of mind. Emergency procedures were carried out systematically after the captain gave the orders.

The altimeters were removed from the aircraft after the accident and tested at Misrair workshops, with a standard barometer over the range 0 - 20 000 ft, and the errors found were within permissible limits. The range 0 - 1 000 ft was tested by increments of 100 ft and was found to be satisfactory.

Probable Cause

The captain did not check the aircraft's altitude from time to time during a night landing by visual means. A contributing factor was the appreciable drift of the aircraft from a normal circuit over hazardous terrain which resulted in the aircraft hitting the ground and partially disintegrating before crashlanding.

In accordance with the provisions of Annex 13 paragraph 5.3 an accredited representative of the Netherlands as State of Registry participated in the Egyptian inquiry, the report of which, in accordance with Annex 13, Chapter 6, was placed at the disposal of the Netherlands Government.

A public inquiry of the Netherlands Aeronautical Council was subsequently held at which the Egyptian report was utilized and the crew members concerned in the accident were questioned.

The Council reached the following conclusions:

The Council was of the opinion, that an uncareful preparation of the landing, insufficient control of the flight by the second officer, insufficient supervision of the captain and insufficient attention of both pilots to the indications of the altimeters with insufficient caution for the elevations of the terrain in the approach zone of Runway 34, caused the loss of altitude, which led to the collision of the aircraft with elevated terrain south of the aerodrome.

The Council considered whether the committed errors which caused the accident necessitated disciplinary action against the captain.

The Council expressed its special appreciation of the very competent manner in which the captain controlled the heavily damaged aircraft after the collision through which the extent of the accident was greatly reduced.

However, taking into account the evident lack of caution during the performance of a very responsible task, the Council was of the opinion that disciplinary action could not be omitted.

Furthermore, the Council considered the question as to whether the second officer can be blamed for the errors committed by him. The fact that the person concerned, although legally licensed as a first officer, performed his duties under the supervision of the captain, does not release him entirely from the responsibility for the errors committed by him.

The Council was of the opinion that his insufficient flight preparation, notably in respect of the landing, was not in accordance with the standards of devotion to duty, which might be required of him under the circumstances whereas his flying performance was below the standards, which may be expected of a legally licensed pilot.

In consequence, the Council suspended the captain's privilege to act as a captain on aircraft registered in this country, for a period of two weeks and at the same time reprimanded the co-pilot.

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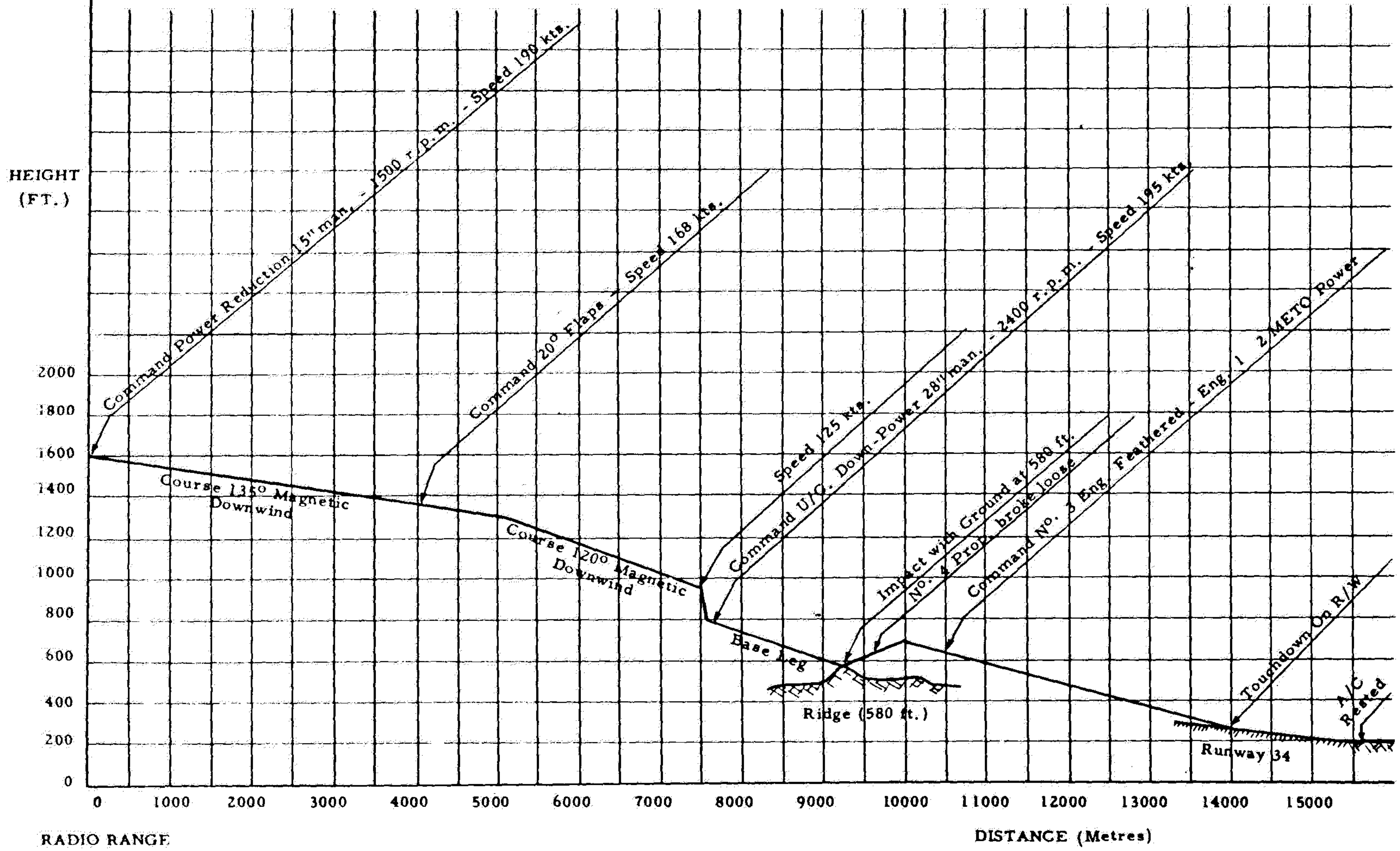
ICAO Ref: AR/542

FIGURE 16



RECONSTRUCTION OF FLIGHT PATH
OF PH-DFK ON 19.2.58

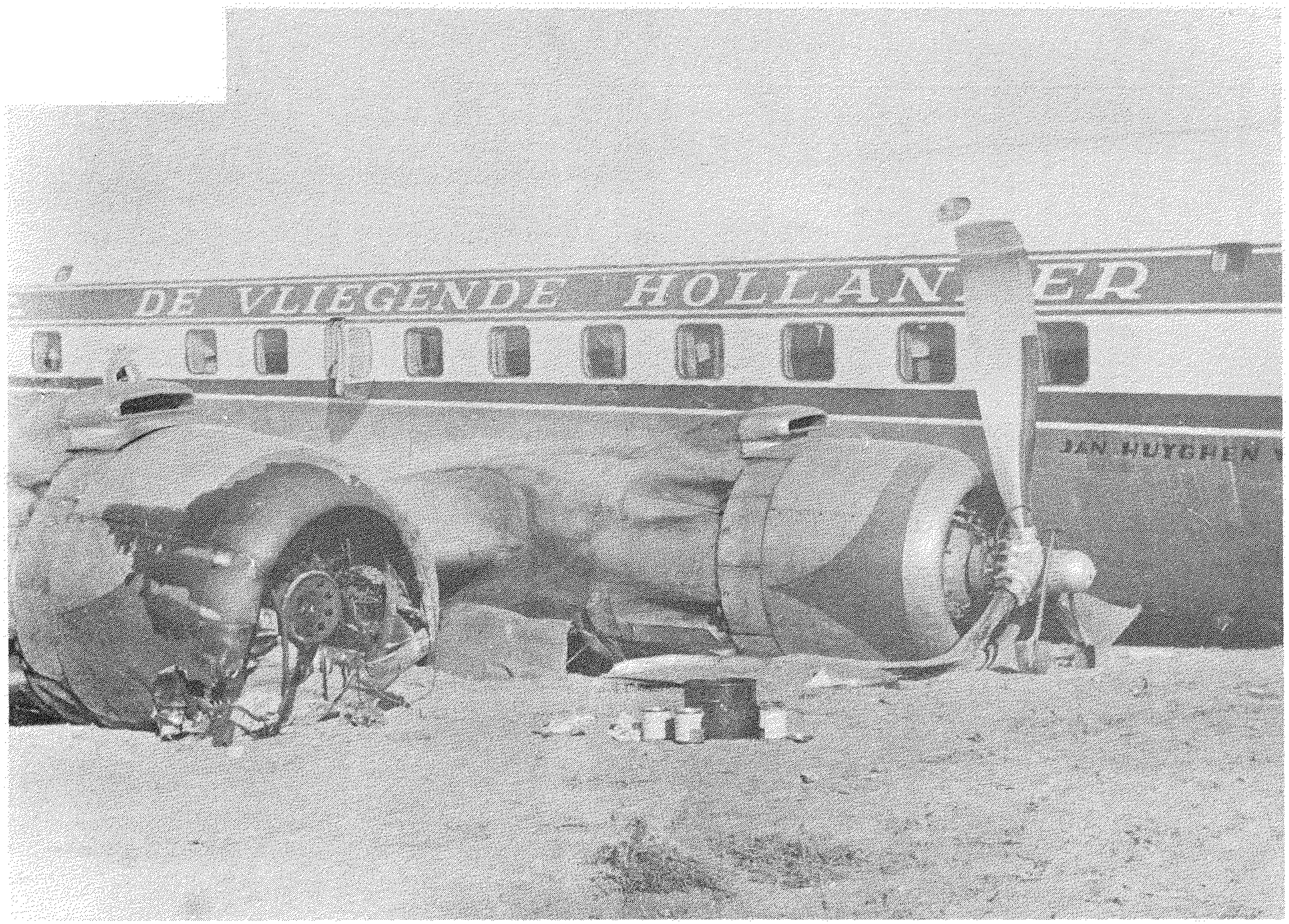


FIGURE 17

View of PH-DFK after coming to rest on soft sand. Picture shows engine No. 4 with propeller missing (was torn off at impact site) - Engine No. 3 propeller is shown feathered.

No. 21

American Airlines, Inc., Convair 240, N 94213, accident at New Haven, Connecticut, on 1 March 1958. Civil Aeronautics Board (USA) Aircraft Accident Report, File No. 1-0024 released 25 November 1958

Circumstances

This was a scheduled passenger flight from Boston to New York, with stops at New Haven and Bridgeport. A crew of 3 and 5 passengers were aboard. Following a five-minute stop at New Haven, the take-off checklist was completed, the aircraft moved onto the runway, and take-off was initiated on runway 14. Before the aircraft reached the intersection of runways 14 and 19 the landing gear was retracted, and the aircraft skidded down runway 14 near its centre and came to rest 1 050 ft from the far end. Fire around the left engine and left outboard wing area caused considerable damage. Two of the five passengers received minor injuries.

Investigation and Evidence

The gross weight of the aircraft was well under the maximum allowable and its centre of gravity was located within prescribed limits. The wind was calm and runway 14 (4 116 ft), one of two macadam runways, was selected for take-off. There is no air traffic control tower at New Haven.

The first officer made the take-off while the captain performed the duties of co-pilot from the left-hand seat.

The calculated ground speed of the aircraft at the time of ground impact, based upon the propeller slash marks and rpm governor settings, was approximately 93 knots, 7 knots below the V_1* speed of 100 knots.

The left engine was removed intact from the aircraft and installed on a test stand where it was operated at 1 000, 2 200, and 2 800 rpm. These three rpm settings were selected because they represented, in order, an average slow engine speed, an rpm giving a manifold pressure equal to the standard barometric pressure, and the maximum take-off rpm. All temperatures and pressures were found to be normal. The engine was shut down after each run and examined for oil and fuel leaks and none were noted. The engine was then operated at dry take-off power for approximately 30 minutes and a corrected brake horsepower of 2 095 was obtained. The engine was also operated for 15 minutes at wet take-off power and a corrected brake horsepower of 2 330 was obtained. Fuel flow and anti-detonation injection flow rates were normal during these tests. During the entire test stand operation, which totalled approximately one hour and forty minutes, there were no indications of fluid leakage, engine roughness, or below normal performance.

The fire warning system on the left engine was checked for continuity and was found to be intact and capable of normal operation. Heat checking of the fire warning detectors revealed there was correct polarity. The fire warning control relay box was removed and installed in another Convair 240, and the fire warning system of that aircraft, when tested, operated normally. The control box was also tested for relay sensitivity

* V_1 is the critical engine failure speed or the speed at which a sudden engine failure is assumed to occur and is the basis for determining the minimum required take-off and acceleration-stop distance. This speed is the minimum speed at which the pilot has, in the case of engine failure, the choice of continuing or aborting the take-off without exceeding the minimum required distances.

and was found to be properly adjusted. All tests of the fire warning system showed it to be capable of normal operation. The operational checks of this engine and its fire warning system, together with the minor damage found, preclude the possibility of fire having occurred prior to ground impact.

During the functional testing of the fire warning system in the cockpit, the landing gear safety solenoid was observed to be continuously energized. The solenoid is normally de-energized when the landing gear is extended and the weight of the aircraft is on the landing gear. The function of the safety solenoid is to prevent inadvertent retraction of the landing gear when the aircraft is on the ground. The safety switch cover plate was removed, and it was found that the circlip on the switch shaft, which positions the switch actuator arm, was missing. This missing circlip allowed the actuator arm to move 7/16 of an inch from its normal position, permitting the switch contacts to remain closed. In this condition, the defective safety switch energized the landing gear safety solenoid withdrawing the latch pin, thus allowing the gear selector handle to be placed in the "up" position and the landing gear to retract even though the weight of the aircraft was on the gear. Normally, the landing gear cannot be raised while the landing gear strut is compressed by the weight of the aircraft on the ground unless the latch pin, which protrudes through a hole in the landing gear selector handle, is depressed manually, permitting the handle to be raised. Neither the captain nor the first officer was aware of this unsafe condition. The switch cover plate was polished by contact with the displaced actuator arm, indicating that this condition had existed for an extended period of time. There were several entries in the pilot flight reports covering a period from 27 January 1958 to 26 February 1958 denoting that the safety switch had malfunctioned and had been repaired.

The captain said that before reaching V_1 speed in the take-off roll he observed the fire, heard and saw the fire warnings, and decided to scuttle the aircraft to bring it to a quick stop. It is difficult to reconcile these statements with at least three facts. The first is that having been a captain of Convair aircraft for more than two years and having acquired a total flying time of 4 660 hours on this type aircraft, of which 1 322 were acquired as captain, it was his responsibility and, therefore, he should have known how the landing gear retraction system functioned; also, that under normal operating conditions, the landing gear selector handle could not be raised to retract the landing gear until the gear no longer carried the weight of the aircraft.

The second fact is that the statements of passengers and eyewitnesses, which are substantiated by the examination of the physical wreckage, do not support the presence of fire prior to ground impact. The third and equally important fact is that at the time of gear retraction more than ample runway remained to brake to a successful stop and even had there been a fire in the left engine no necessity existed for scuttling the aircraft.

The testimony of the captain is inconsistent with the clear and substantiated evidence of record in this investigation. Under the circumstances, the Board could not accept the statement of the captain. The Board, therefore, concluded that fire did not occur until after the aircraft settled; that the captain, instead of intentionally raising the gear as he stated, not knowing that the safety switch was malfunctioning, actually caused the gear to be raised unintentionally. Poor piloting technique was displayed by the captain in placing and keeping his hand on the landing gear selector handle and by his uncalled for action in applying an upward pressure on this lever in anticipation of the first officer's command to raise the gear. This accident would not and could not have occurred without the captain's improper procedure in applying upward pressure to the landing gear selector handle and malfunction of the landing gear safety switch.

As a result of this accident American Airlines issued a "Fleet Campaign Directive" which required an immediate one-time inspection of the landing gear safety switch assemblies on all of their Convair aircraft. Several other corrective measures designed to preclude further maintenance difficulties were also instituted with regard to the switch overhaul procedures. As an additional precaution the company restricted the captain from flying as pilot-in-command for a period of six months.

Probable Cause

The probable cause of this accident was the improper technique of the captain resulting in the unintentional retraction of the landing gear prior to V_1 speed, which was made possible by a malfunctioning left gear safety switch. A contributing factor was inadequate inspection by the carrier.

ICAO Ref: AR/550

No. 22

Fleming Airways System Transport, DC-3C, PI-C626, crashed after taking-off from Bacolod Airport, Bacolod City, The Philippines, on March 1958. Report released by the Department of Public Works and Communications, Republic of The Philippines.

Circumstances

PI-C626 departed Manila on a non-scheduled flight to Cebu and return with intermediate stops at Marindugue, Iloilo and Bacolod. The flight as far as Bacolod was uneventful. However, shortly after taking-off from Bacolod at 1210 hours, and on reaching the height of 5 to 8 ft from the ground, the aircraft banked to the left. The pilot tried to correct the attitude of the aircraft but was unsuccessful. He, therefore, decided to crashland the aircraft. There were no fatalities, but the pilot and some passengers suffered minor injuries. Fire broke out on impact which destroyed the main front section of the aircraft.

Investigation and Evidence

The weather at the time of the accident (1213 hours) was gusty and bumpy with a north-northwest wind of about 25 to 30 mph, visibility unlimited, and ceiling estimated at 3 000 ft.

The captain held a valid Airline Transport Pilot's Licence and had completed approximately 5 000 flying hours.

The captain stated that he had very good control of the aircraft on take-off; the aircraft was airborne with an airspeed of 85 mph, and there was no stalling, but a sudden loss of power from the left engine caused the aircraft to bank and swerve to the left. On take-off the manifold pressure was between 45 and 46 inches of mercury, however, it dropped, according to the captain's statement to 36 inches of mercury. With an airspeed of 85 mph, the captain decided not to continue the take-off on a single engine.

The co-pilot noticed that there was some pre-stall buffeting before the crash-landing. He also stated that the captain never reduced power except when the aircraft was about to hit the ground.

Results of the strip inspection of the major component parts of the left engine showed nothing to indicate that a material failure had occurred. The pilot's statement that there was loss of power on the left engine was not altogether substantiated by the results of the tear-down inspection and was not accepted by the Investigation Board.

The facts established that the aircraft was airborne, tail low, at an airspeed of 85 mph indicated airspeed. Considering the estimated load of the aircraft (26 376 lbs), the pilot should have waited until the airspeed indicated 90 mph, a safe V_2 speed for the type aircraft before lifting the same.

Probable Cause

The captain prematurely "lifted" the aircraft before attaining the V_2 speed. A contributing factor could have been the presence of the 25 to 30 mph crosswind.

Recommendation

Non-scheduled operators utilizing equipment weighing more than 12 500 lbs should establish a more comprehensive and detailed pilots' training program. Such requirement should be a prerequisite before allowing the operator to start his operations.

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ICAO Ref: AR/540

No. 23

Braniff Airways, Inc., Douglas DC-7C, N 5904, crashed approximately 3 miles west-northwest of the Miami, Florida, International Airport on 25 March 1958. Aircraft Accident Report, File No. 1-0026, released 12 January 1959 by the Civil Aeronautics Board (USA).

Circumstances

N 5904 was ferried from Dallas, Texas, to Miami, arriving at 1915 hours eastern standard time on 24 March for use as Flight 971. The aircraft was serviced and made ready for the trip to Panama City, the first scheduled stop on the route to Rio de Janeiro.

The flight departed the Miami terminal at 2356, taxied to runway 27R where engine runup was made, after which a normal take-off was accomplished. Shortly after take-off, and in accordance with tower clearance, a climbing right turn was started. During the turn the No. 3 engine malfunctioned and a fire developed in that area. The aircraft, still in a right turn, started to lose altitude rapidly. While travelling in a north-northeasterly direction it struck in an open marsh containing scattered trees and underbrush. The aircraft was practically destroyed by impact and ground fire.

There were 24 persons aboard, including 19 passengers and a flight crew of 5. All 5 flight crew members and 10 revenue passengers survived. Four Braniff Airways supernumerary crew members and 5 of the other passengers died.

Investigation and Evidence

Ground impact marks revealed that the aircraft struck the ground with approximately 25 degrees of right bank while descending at an angle of approximately five degrees. The right wing tip contacted the ground first and the aircraft broke up immediately thereafter when the inboard right wing structure, the engines, and the fuselage struck the soft ground.

The wreckage was strewn along a half-mile track on a heading of 023 degrees. The fuselage structure broke into three major sections. The nose gear and the right main landing gear were separated from the aircraft during the ground breakup, and the left main gear remained attached to the wing centre section and was subjected to intense fire. It was determined that all three gears were in the retracted position at impact.

The primary flight control systems, although damaged by the ground impact, were sufficiently intact to indicate that no control failure had occurred in flight. All components of the elevator and rudder systems were available for examination. Parts of the aileron system were completely burned out or buried in the solidified masses of metal which resulted from melting of the wing structure by the intense ground fire in the left wing centre section. All failures of the individual systems' components which were located and identified were examined and all appeared to have been the result of overloading during the structural breakup of the aircraft.

In the right wing the aileron control system was not damaged by the inflight fire. Thus, while many of the parts of the control system were damaged or lost, nevertheless, sufficient parts remained which were in a condition that permitted an examination and a conclusion that the control system was functioning properly.

All four engines, found approximately 2 000 ft from point of first impact, were recovered from the swamp and examined by the Powerplant Group. A piston and a cylinder were found 1 350 and 1 550 ft, respectively, along the flight path. It was positively determined that these were the No. 11

cylinder and piston of the No. 3 engine. Investigation further disclosed that the other three engines were operating normally and developing considerable power at impact.

Inspection of the No. 11 cylinder of the No. 3 engine revealed that it had failed from fatigue approximately 1-1/2 inches above the cylinder mounting flange on the thrust side. The cylinder flange attaching cap screws were intact. The cylinder wall contained evidence of scuffing and ladder cracking was in evidence. The No. 11 connecting rod had failed approximately six inches outboard of its knuckle pin. All knuckle pins, including No. 11, were free from indications of maloperation at the master rod end. Cylinder wall scuffing was also found on No. 2 cylinder of the No. 3 engine.

All major portions of the four propeller assemblies were recovered. Most blades were shattered by contact with the ground. The No. 3 propeller was feathered. The propeller dome settings and shim plate impact marks on Nos. 1, 2, and 4 were examined and found to be positioned for a blade angle of approximately 43 degrees, which is 15-1/2 degrees above the low pitch stop and indicative that considerable power was being developed. Further, the Nos. 1, 2, 3 and 4 propeller governors were recovered. Subsequent bench tests revealed that they were positioned at 2 500 rpm (climb power settings). Test also revealed that the governors were capable of normal operation.

Following the accident the first and second officers were interviewed. The first officer stated that the captain made the take-off from the left seat. He further stated that take-off power was applied and that he adjusted the throttles to maintain a boost of 59-1/2 inches of manifold pressure. He said that the take-off was extremely smooth and that the aircraft was off the ground shortly after reaching V_2. The captain ordered the landing gear retracted, and the flaps were then raised. Just about the time the flaps reached the full up position he felt a thud and immediately noticed a flash of light. He turned to his right, looked out his window and saw fire. He said the fire seemed to him to disappear so he looked back to the engine instruments to determine if they indicated an engine failure. At that time he recalls the captain saying, "Feather 3." He stated he noted no propeller overspeed or engine vibration and he could not remember performing any of the emergency procedures involved in feathering.

The second officer said - "We applied power and started the take-off. All four engines developed about 250 to 255 BMEP which is normal for the temperature condition existing at that time. We broke ground and the captain gave the order to pull up the gear and flaps and ordered METO power. The co-pilot reduced the manifold pressure and I reduced the rpm. Everything was normal at that time. Then the captain called for climb power and decreased the manifold pressure and rpm. Things seemed normal and we went ahead with the take-off. The climb checklist was then accomplished. The bypass system was placed in the off position and the gear handle neutral; the "Fasten Seat Belt" and "No Smoking" signs were turned off and the turbine switch was turned to the off position." The second officer also said that he waited a moment and then reached around and picked up his second officer's log to record the take-off BMEP and fuel flow, and at this time the co-pilot said that No. 3 engine had failed and had a fire. He immediately turned back around and then the captain ordered No. 3 propeller feathered. He said, "I pulled back the No. 3 throttle and put the No. 3 in auto-lean-idle cutoff and feathered the No. 3 engine. The co-pilot pulled the firewall shutoff and pulled the Freon discharge from the right bank and the fire seemed to diminish somewhat at this time." He further said that as he was reaching up to turn off the No. 3 magneto he noted a bright flash. He stated that the engine fire was extremely intense. Asked if he had an opportunity to note any of the engine instruments prior to the warning by the co-pilot that No. 3 was on fire, he said, "Everything was normal - oil pressure, fuel pressure - everything normal operation at that time." He further indicated that take-off power used was 59-1/2 inches, 2 800 rpm, and that they reduced power to 40 inches for climb rpm. He confirmed the co-pilot's statement that the captain was in the left seat, co-pilot in the right seat, and he was at the flight engineer's station. When the aircraft broke ground, he said, the airspeed was 120 knots but he did not remember any other speed readings. After No. 3 was feathered they did not increase power on the remaining engines.

During the investigation of the accident the possibility was advanced that the captain intended to make an immediate off-airport landing because of damage to the airframe by the fire.

There is no doubt that a fire in flight existed; however, it was so confined within the No. 1 zone of No. 3 engine that the aircraft structure was not affected. Actually, only blistering of the paint was evident to the rear of No. 3 nacelle, which substantiates the small area and duration of the fire. Unfortunately, the crew could not be certain that the fire was under complete control. Regardless of the effectiveness of the fire control procedure, an immediate return to the airport was proper.

The evidence is clear that the captain did not intend to make a landing at the time or point of impact. His order to the first officer to advise the tower that they were returning to the airport precludes any thought of landing at a place other than the airport. The first officer was only able to start his radio transmission ("Braniff 971") before the accident occured.

Well qualified witnesses estimated the highest altitude of the aircraft during the flight to be approximately 800 ft. This estimate is consistent with the known performance of the aircraft under the conditions of power and configuration employed until the moment of engine failure. It is evident, therefore, that the aircraft descended rapidly from this altitude. Testimony of the flight engineer and statements of passengers showed conclusively that there was a sudden descent and an abrupt change in aircraft attitude. They said that the aircraft pitched down abruptly.

The captain took positive action to break the climb attitude and establish a shallow descent toward the airport. Nevertheless, the Board must conclude that he did not use proper technique and allowed the aircraft to descend to the ground. His injuries blocked all recollection of the flight despite his sincere desire to testify regarding his actions during the emergency. The first officer, also seriously injured, was able to recall some of his own actions during the flight. However, his recollections of detail and times were not as clear as those of the second officer. The second officer, although injured, did not lose consciousness in the accident and was able to describe events of the flight in more detail and better sequence when interviewed in the hospital several days after the accident.

Soon after passing the boundary of the airport on a heading of 270 degrees a right turn was started and the ground impact was on a heading of 23 degrees. It is obvious that the rapid descent occurred during this turn of 113 degrees. Ground marks indicated that the right wing tip was the first part of the aircraft to strike the ground. This impact occurred while the aircraft was in a right bank of approximately 25 degrees and descending at an angle of approximately five degrees below horizontal. The banked attitude and high airspeed at impact (178 knots - computed from propeller slash marks) offer further proof that an off-airport landing was not intended.

The captain was under considerable stress during the emergency and despite his 20 000 hours of flight experience (241 in DC-7 aircraft) it is probable that this situation brought out his former difficulties in maintaining altitude and control during turns. The aircraft was not heavily loaded and there should have been little difficulty in returning to the airport with three normal operating engines and the fourth, an inboard engine, feathered. Power was not advanced from the climb setting existing but, according to the DC-7 operations manual, more power was not required to maintain level flight and altitude. In fact, this aircraft, loaded as it was, and under the existing atmospheric conditions should have been capable of climbing with one propeller feathered at a rate of about 470 ft/min. The rapid and premature descent indicates that the captain displayed poor piloting technique by allowing his attention to be diverted from his flight instruments by the engine fire, objects on the ground, and the emergency procedures being taken by the other crew members. Investigation determined that the Nos. 1, 2 and 4 engines were operating normally. Also, there was no failure of the airframe prior to impact and the flight instrument systems operated normally when tested after the accident. The flight control systems, as hereinbefore indicated, appear to have been operating normally up to the impact. Had any control difficulty been experienced the crew could have been expected to take emergency flight control measures, but no indication of such measures having been taken was found. In any case, other crew members would have been aware of the control difficulties.

Visibility in the airport area was reported as eight miles by the tower. Since the scene of the accident was approximately three miles from the airport, patches of ground fog at the accident area would not have interfered with the return of the flight.

As N 5904 arrived on the ferry flight from Dallas, Texas, on 24 March, a Miami controller observed smoke trailing from the No. 3 engine. The crew, although informed by the tower that smoke was observed trailing from the No. 3 engine, did not enter this information on the flight log. It is possible that had this been done an inspection would most likely have detected the defective cylinder. It is difficult to understand why this was not entered as it would have required an inspection at Miami. Because of the fatal injuries to the crew of the ferry flight, the Board was unable to determine the reason for this incident not being written up in the aircraft log.

The problem of cylinder wall scuffing in the turbo compound engines has been industry-wide. The Civil Aeronautics Board and the Civil Aeronautics Administration are studying the problems related to this model engine. The Civil Aeronautics Administration on 30 June 1958 issued Airworthiness Directive 58-13-5. Part I of this Directive calls for the mandatory replacement of the second chrome-plated compression ring with a cast-iron ring at first overhaul after 1 August 1958 but no later than 1 March 1959.

Prior to the accident, Braniff Airways was in the process of replacing this chrome-plated piston ring on all of its engines as they reached overhaul. The No. 3 engine involved in this flight did not have the cast-iron piston ring installed as the engine had not reached its overhaul period. Since the accident, all Braniff engines have been modified to replace the second chrome-plated compression ring with the cast-iron ring in accordance with the Airworthiness Directive of 30 June 1958.

New procedures in the cylinder wall refinishing process, in the form of cross-hatching, are being incorporated to improve cylinder barrel lubrication, as recommended by the manufacturer's service bulletin dated 31 December 1957.

In addition to compliance with the Airworthiness Directive of 30 June, Braniff is boroscoping all cylinders which indicate combustion chamber difficulties as shown by the ignition analyzer. Also, all cylinders are being boroscoped during line maintenance inspections as the engines reach 600 hours operating time. Since the institution of these procedures following the accident, the carrier has not experienced a single instance of cylinder barrel failure.

As a part of this accident investigation, the Board has examined closely the qualification requirements and procedures of the carrier and its ground and flight training curriculum and facilities. No basic deficiencies which could be considered as contributory to this accident were found. The preoccupation of the captain under the conditions of emergency with which he was confronted is recognized as a matter extremely difficult, if not impossible, to anticipate. It is recognized, however, that the increased size of aircraft, the increasing cost of operation, the pressures of communities in the vicinity of airports which tend to discourage simulated engine failures during take-off, and increasing traffic problems, especially at high-density airports, tend to discourage training operations at air carrier terminals. The Board is of the view that these factors, as well as the vastly improved quality of aircraft simulation in recent years, add emphasis to the need for maximum exploitation by air carriers of training devices, such as aircraft simulators.

Probable Cause

The captain failed to maintain altitude during an emergency return to the airport due to his undue preoccupation with an engine fire following take-off.

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ICAO Ref: AR/556

No. 24

Skyways Ltd., Hermes 4, G-ALDV, accident at Manor Farm, Meesden Green, Herts., on 1 April 1958. Civil Accident Report No. C. 677 released by the Ministry of Transport and Civil Aviation (U.K.)

Circumstances

The aircraft took off on a test flight from Stansted Airport at 1059 hours and climbed steeply towards the northwest. A few minutes later it was observed approaching the airport from the west at a height of approximately 1 500 ft. At 1113 hours the Air Traffic Control Tower received a radio call from the aircraft in which the captain declared an emergency and said that the controls were jammed. At about the same time the aircraft was seen some 6 miles northeast of the airfield descending in a series of dives and climbs. It crashed in a field shortly thereafter killing the crew of three. The greater part of the wreckage was destroyed by fire.

Investigation and Evidence

Inspection at the scene of the accident showed that the aircraft had struck the ground on a heading of 040°M while descending at an angle of approximately 14°. The wreckage trail extended over a distance of about 200 yards. The fuselage had broken at the centre section and that part containing the flight deck had turned through nearly 180°. The port wing had torn off, all four engines had broken away and apart from the empennage the wreckage had been severely burned. An examination of the control runs in the fuselage and on the flight deck for signs of jamming was without result.

The wreckage was removed to a site with workshop facilities where the control mechanism in the stern frame bay was dismantled. Deep bright score marks were found on the face of the port side elevator datum lever (Figures 18 and 19) adjacent to the locking latch housing which are movable and fixed parts of the elevator control system. The appearance of these marks under microscopic examination indicated that a hard object such as a small split pin had fouled and jammed the mechanism. Judging by the depth and width of the score marks it was clear that considerable force had been applied to operate the elevator controls. The object referred to above, in spite of an exhaustive search, was not found and it is presumed that it was displaced when the aircraft struck the ground. Several small extraneous objects were, however, recovered from the stern frame bay (Figure 20). Thereupon an inspection of the stern frame bay of another Skyways Hermes aircraft was carried out and a similar assortment of extraneous objects was found. The attention of the Skyways' Inspection Department and the Air Registration Board Resident Surveyor was drawn to the matter at once. Experiments were carried out on a Hermes aircraft in which a piece of 14 swg* brass wire was introduced into the appropriate part of the control mechanism and an attempt was made to operate the elevator controls from the cockpit. It was found that they could be moved only with the greatest difficulty.

Laboratory examination of the elevator datum lever taken from the crashed aircraft showed differences in the colour of the oxide film among the score marks on one side of the locking slot indicating that some of these marks were of a greater age. The marks of more recent origin were superimposed on the others. The appearance of the superimposed score marks indicated that they were made on the same

* standard wire gauge

occasion as those on the other side of the locking slot where there is no evidence of previous scoring. There is, however, no record of any previous stiffness or jamming of controls.

Similar but shallower and less extensive marks were reproduced on the starboard side elevator datum lever of the same elevator control unit in a laboratory experiment.

A test rig was constructed so that the unit was rigidly supported and the datum lever operated by a tensile load applied to the control linkage attachment point. This point could be measured against a scale. A new 3/32" split pin was introduced between the datum lever and the latch housing. It was found that the split pin could be forced between the two components by the application of a load of between 110 and 115 lb and that considerable force was necessary to return the datum lever to its neutral position. This force could not be measured because the testing machine was not reversible but it is considered that it was in the order of, or possibly more than, 110 lb. The reversal of the jamming when the mechanism was forced back could well have distorted the split pin further and progressively increased the force necessary to move the datum lever. The datum lever was removed from the unit and an examination of the scores produced showed them to be shallower but very similar to those on the port side datum lever.

Observations

1. A force of between 110 and 115 lb at the control linkage attachment point is equivalent to a force of 55 to 60 lb at the spectacle of the pilot's control column. As the marks found on the datum lever after the accident are deeper and more extensive it must be supposed that they were formed by the application of a greater force than that produced in the laboratory.

It is reasonable to suppose that it was within the capabilities of the pilots to apply enough effort to force the object which caused the score marks on the datum lever between the relevant components and to move the controls to some extent. The resistance of the jammed components to movement would cease suddenly when the controls approached the neutral position and the locking slots in the datum lever and the locking latch housing came into alignment. It is unlikely that the pilots would be able to anticipate this and avoid over-movement and jamming on the other side of the slots.

It is evident from the appearance of the score marks that several such movements did take place. The heaviest scoring undoubtedly resulted from the progressive distortion of the object causing the jamming and it is reasonable to deduce that the force required to move the jammed controls became more than the pilots could exert.

2. The difficulty of keeping aircraft free from extraneous objects is something that constructors and operators have always been aware of as the structure of aircraft is such that small objects can find their way into crevices and inaccessible places. The importance of guarding against this happening and the necessity for absolute cleanliness cannot be emphasized too strongly.

Probable Cause

The accident was caused by the elevator mechanism becoming jammed - loss of control resulted. The jamming was due to the presence of a small extraneous object which entered the control mechanism.

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ICAO Ref: AR/598

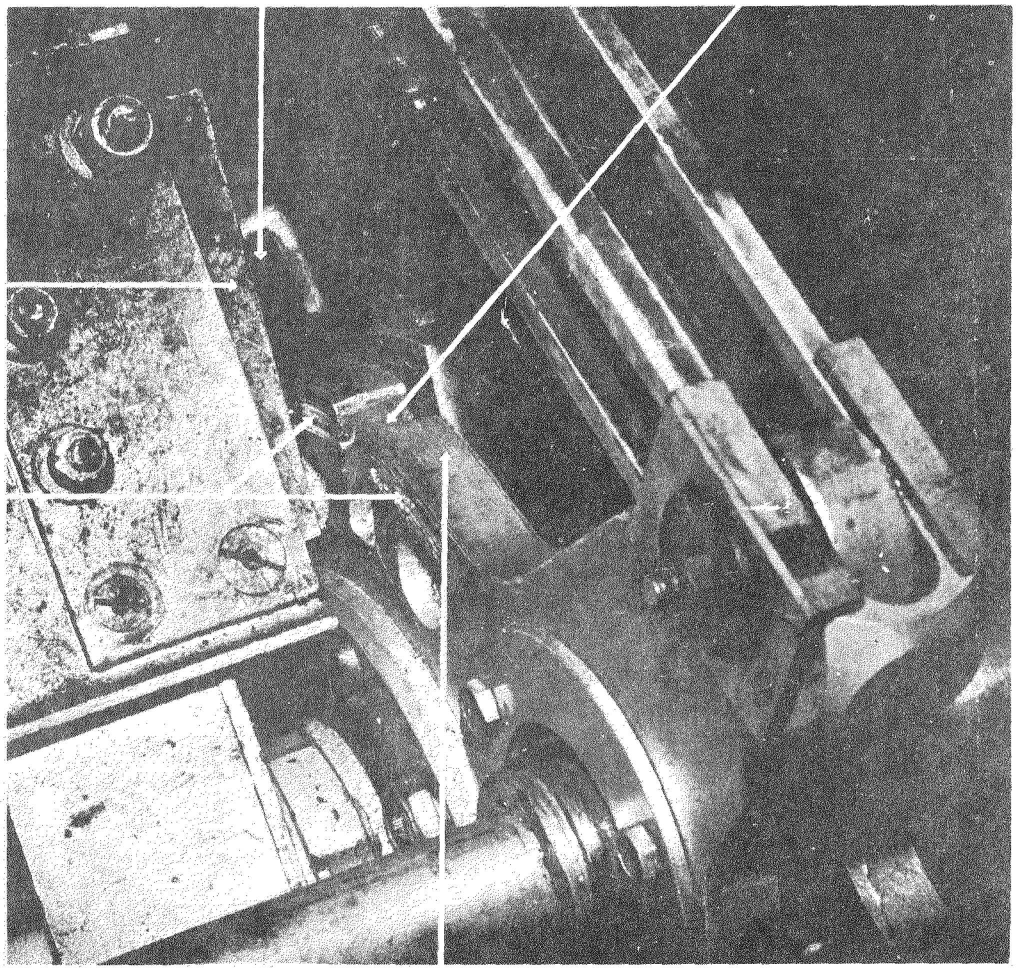

FIGURE 18

SHOWING SECTION OF ELEVATOR CONTROL ASSEMBLY WHERE JAMMING OCCURRED

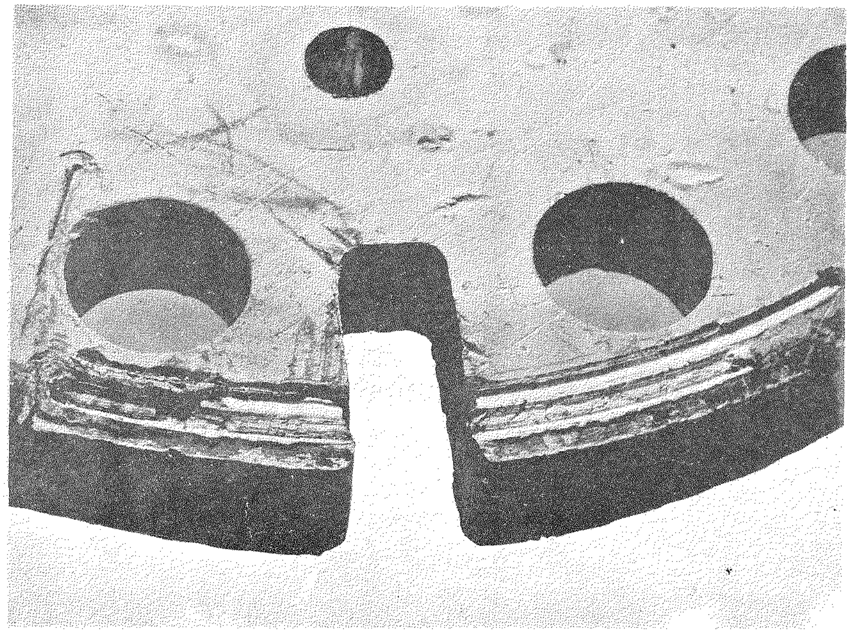

FIGURE 19

SHOWING SCORE MARKS ON BOTH SIDES OF LOCKING SLOT OF ELEVATOR DATUM LEVER

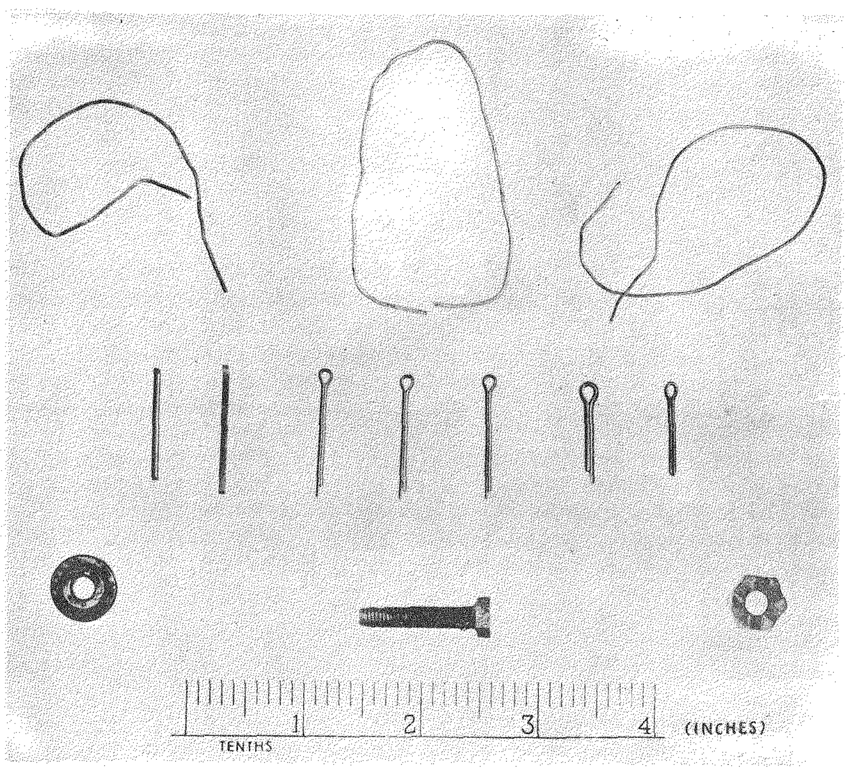

FIGURE 20

EXTRANEOUS LOOSE ARTICLES FOUND IN THE STERN FRAME BAY OF THE CRASHED AIRCRAFT

DS 40438/1/Wt. 2670/K7 7/59 XL

No. 25

Capital Airlines, Inc., Viscount 700-D, N 7437, accident at Tri-City Airport, Freeland, Michigan, on 6 April 1958. Civil Aeronautics Board (USA) Aircraft Accident Report, File No. 1-0031, released 15 April 1959.

Circumstances

Flight 67 was a regularly scheduled flight between La Guardia Airport, New York, and Chicago, Illinois, with numerous intermediate stops including Tri-City Airport, Michigan. Because of weather and field conditions at La Guardia the flight originated instead at Newark, New Jersey. The aircraft departed Flint, Michigan (one of the scheduled stops) for Tri-City Airport at 2302 central standard time on an IFR clearance at a cruising altitude of 3 600 ft. It carried 44 passengers and 3 crew. At 2310 Capital at Detroit relayed clearance for Flight 67's approach at Saginaw (Tri-City) Airport. The flight was also given the local 2300 weather and the runway in use - No. 5. At 2316 Flight 67 advised that it was over the airport. On making its final approach by visual reference to the ground, during a left turn the aircraft flew beyond the extended centreline of the runway, and its bank was steepened considerably to effect realignment. It then returned to level flight and (at 2319) pitched steeply to the ground, killing all aboard.

Investigation and Evidence

Emergency Equipment

Following the crash an intense fire broke out. Available emergency equipment was alerted and brought to the crash site. The operators of the equipment observed that there was some delay in making effective use of it due in part to its inaccessibility at the time of the accident and in part to their unsuccessful attempts to initially get it operating.

The Wreckage

The aircraft had struck the ground in an open cornfield which had been muddied from previous rain. A large tree, approximately 65 ft high was directly in the line of flight and 148 ft behind the point of impact. However, there were no marks on this tree made by the aircraft during its descent. The wreckage site was 2 322 ft from the approach end of runway 5, almost directly in line with the runway. The entire wreckage was confined in an area almost equal to the length and span of the aircraft and the aircraft components were approximately in their normal positions relative to the structure of the aircraft. It was determined that the aircraft struck the ground with considerable force on its nose and the leading edge of the right wing, with this wing sufficiently forward so that its leading edge was parallel to the ground. The angle of impact was approximately vertical.

The main wreckage, consisting of the major portions of the fuselage, empennage, and wings, was found lying in an inverted position. Most of the aircraft was consumed by the fire following impact.

Examination of all of the damaged controls failed to reveal any evidence of their malfunctioning prior to impact.

Most of the instrument gauges were so badly damaged it was impossible to obtain readings.

The nose gear and the main landing gear were determined to be in the "down" position at the time of impact. Seat belts, which were found, indicated that these belts had been fastened at impact.

Detailed examination of the damaged engines and their accessories did not reveal any condition which indicated maloperation prior to impact, nor was there any indication that a failure or malfunction occurred to any of the propellers.

Stall Warning System

The Dowmic switch that arms the stall warning system when the aircraft is airborne was found to be malfunctioning after the crash. Examination of the switch and acceleration tests conducted on similar switches indicated strongly that the malfunction existed prior to the accident.

In the course of its investigation the Board was provided test data by Vickers-Armstrongs, Ltd., concerning the effects of heat upon the Dowmic switch, and it was suggested that the malfunction of the subject switch could have been the result of its being heated in the fire that followed impact. The physical evidence indicated that the switch was subjected to crash fire heating; however, the Board noted that the behaviour of switches heated in laboratory tests did not coincide with the behaviour of the subject switch. The specimen switches either failed to function at all after heating or at best they functioned intermittently, whereas the subject switch, following removal and reinstallation of its magnets operated repeatedly with normal switching action.

Similar malfunctioning of Dowmic switches has been experienced by Capital Airlines in normal fleet operation without the switches having been subjected to high temperatures.

The stick shaker is designed to warn the pilot of an impending stall and this is accomplished by means of the ability of the device to sense the angles of attack during an approach to a stall. The device is further designed to furnish the pilot an adequate warning under all flight attitudes normally experienced during transport flight. Under the conditions of flight the captain is believed to have experienced this night, had the stick shaker been operating the warning should have been approximately 15 kts before the "G" break. During the flight tests which were performed subsequent to the public hearings, the tests made at banks of 60° did not have the stick shaker in operation. Therefore, the above figure is an approximation based on calculations made from actual flight test data.

The detector unit of the stall warning system had been replaced sometime prior to this flight. In view of the fact that this unit was not calibrated by flight testing prior to the flight, there is no assurance that an adequate stall warning would have been given, even had the Dowmic switch functioned normally.

The Crew

Both the captain and the first officer had considerable flying time in Viscounts, and were properly certificated by the Civil Aeronautics Administration. The captain had a total flying time of 16 050 hours to his credit - 1 702 of which were in Viscount aircraft. The first officer had a total of 2 030 hours - 975 of which were in Viscounts.

Airport and Facilities

The Tri-City Airport is located at Freeland, Michigan, at an elevation of 667 ft above sea level. It has three paved runways, the longest of which, No. 5-23, is 5 662 ft. This runway is equipped with high intensity lights having an intensity control of five brightness stages. The other two runways are lighted to a lesser degree of intensity. These lights, together with threshold lights, a rotating beacon, and a lighted tetrahedron comprise the lighting of the landing area. Located on the airport is a low frequency nondirectional radio beacon used for ADF approaches, and terminal omni for omni approaches. The airport does not have an airport traffic control tower or a weather station. Weather and other information is furnished the pilots by a local CAA ATCS (Air Traffic Communication Station). Capital Airlines does not have radio equipment available at Tri-City Airport. All information the company wishes sent to its flights must be transmitted by longline to Detroit and then relayed to the flight or must be given the flight by the

ATCS operator at Tri-City. Capital Airlines minimum ceilings and visibilities for Viscount aircraft making instrument approaches to Tri-City Airport are 500 ft and 1-1/2 miles.

The ATCS station at Tri-City was operated by one man at the time of the accident. This man was responsible for taking and transmitting hourly weather observations, maintaining a guard on the air-ground radio frequency, broadcasting weather observations and forecasts for a selected group of stations twice each hour, and operating the airport facilities (VOR, ADF, runway lights, etc.) There are no standard charts at the Tri-City Airport displaying visibility reference points. A table of such reference points is available and this relies upon such factors at night as automobile lights, house lights, lights on barns, etc., in determining visibility distances between 3/16 of a mile and 3-1/2 miles.

The lack of night-time visibility check points is a problem which is not peculiar to the Tri-City Airport at Freeland. Discussions with the Weather Bureau regarding this problem have revealed that they hope to overcome the problem to a large extent by installing automatic runway visibility measuring equipment at all airport weather stations. This visibility programme is part of the Weather Bureau's current five year plan.

Weather

As Flight 67 approached Tri-City, ceilings were between 900 and 1 100 ft with visibility reported as being 3 to 4 miles. There was light snow and a freezing drizzle. Surface winds were reported from the north-northeast 18 - 27 kts. Weather conditions at altitudes up to 5 000 ft were conducive to icing. Other aircraft which landed at Tri-City shortly before the accident reported moderate turbulence and icing conditions.

The airframe de-icing equipment of N 7437 was found in the "off" position. While it is customary for some company pilots to turn off the wing de-icers during the approach when wing conditions are considered not critical it is likewise considered important that at no time did ground observers see the ice lights in operation and atmospheric conditions favoured a rapid accumulation of ice. The Viscount windshield is continually heated and will not accumulate ice and, therefore, cannot alert the crew to airframe ice accumulation.

Wind velocity at Saginaw ATCS was determined by means of an instrument using both a light and a buzzer. The number of light flashes seen or buzzes heard during a given period determines wind velocity; wind direction is also noted by a flashing light. In order to arrive at a reasonable determination of wind conditions it is necessary for the operator to observe the instrument for at least a minute. Using this type of equipment it is impossible to measure accurately peak velocity of wind gusts. The Board was aware that this equipment was antiquated and in no way comparable in efficiency with more modern facilities used for this purpose. If modern wind equipment had been available, more accurate and up-to-date wind data could have been furnished the crew: (such equipment has now been installed).

It is probable that the existing weather conditions contributed materially to this accident. The close-in approach, short radius of turn, and the steep bank may well be attributable to an attempt by the pilot to keep the lighted runway in sight because of the restricted visibility occasioned by snow showers and freezing drizzle. Since the investigation disclosed that the wing flaps were 40° down it is believed that the pilot lowered the flaps to this position either just before or during the turn. This would suggest that the airspeed in the turn was 142 kts or less, the recommended never-exceed airspeed with flaps lowered beyond 20°. With the type of approach described, combined with a possible accumulation of ice similar to that encountered by another aircraft, maximum gusts in excess of those being recorded (tending to cause the natural stall warning buffet to be unrecognizable), increased stalling speed in the steep turn close to the operating speed, and an inoperative stall warning device, a veteran pilot could suddenly find himself in a stall situation from which he could not recover.

Analysis

During the investigation, it was determined that the aircraft while flying at an altitude between 400 and 900 ft above the ground pitched over and dived nose-down striking the ground in or near a vertical position while on a northeasterly heading.

The fact that the aircraft was found inverted is explained in this manner: Evidence indicates that it struck the ground in a vertical or near vertical position and that the rotational forces present during the descent caused it to continue over on its back with the engines contacting the ground at some angle beyond the vertical.

In an effort to determine the cause of the sudden pitch over and steep descent, considerable study was given to the propellers and their related systems with particular significance placed on the possible movement of the blades below the flight fine pitch stops during the approach.

It was evident that there was no malfunction or failure of the powerplants and aircraft structure prior to impact and, therefore, attention was focused upon the operational phase of the accident.

From the witnesses it was learned that the downwind leg of the traffic pattern was flown close in. It was also revealed that the aircraft, when on the base leg, flew beyond the extended centreline of the runway and that a steep left turn in the form of an "S" was made for realignment. Some of the witnesses said that they believed the aircraft regained a level attitude momentarily on final, and that this position was followed by a slightly nose-high attitude and then a vertical dive to the ground.

With the probability ruled out that the propeller blades moved into the ground fine pitch position during flight, the possibility that the aircraft stalled was carefully considered. Many flight tests have been made of the stall characteristics of the aircraft in level flight and shallow turns; under these conditions normal recoveries have been easily made. Also, the inherent stall characteristics of the aircraft in these attitudes are not vicious and recovery is normally made with little loss of altitude. Therefore, it seems extremely unlikely that a stall occurred from a level flight attitude. However, if an unanticipated stall occurred during a steep turn at any altitude below 1 000 ft, a safe recovery might be impossible.

A study of the stall tests showed clearly that with the stall warning device functioning the pilot should receive warning of impending stall in sufficient time to execute corrective action. However, with this device inoperative, and with the aircraft in steep turning flight, the warning and the "g" break occur almost simultaneously.

While tests indicated that the aircraft could be controlled within safe limits under all conditions tested, it is also true that a fully developed stall was never permitted. Further, the pilots who flew throughout these stall tests have considerable experience in flight test operations, and, since each individual test was carefully planned, there was never an element of surprise. Expecting the stall to occur, the pilots were able at all times to prevent the stall from reaching dangerous proportions. From previous tests made by the manufacturer it was learned that when a stall occurs during a steep turn the aircraft tends to roll to the outside of the turn, "over the top," and enter a spin in this manner.

The approved Flight Manual for the aircraft defines the stall as that condition of flight when the lift coefficient has reached its maximum value (C_L max). It further states that if the angle of attack is increased beyond this point a wing drop and a nose-down pitch cannot be prevented. Should an attempt be made to correct the roll in a power-on stall by use of ailerons alone and without simultaneous forward movement of the control column, the wing drop may be large (greater than 90°), probably associated with a large change in heading and a considerable loss of height.

It appears that the company's Viscount training programme lacked two important factors: the dissemination of necessary information to all pilots relative to the importance of the stall warning device with respect to adequate warning and the dangers confronted when it is inoperative, plus the stall characteristics of the aircraft with various flap settings in turns steeper than those normally made.

Probable Cause

The probable cause of this accident was a stall during a steep turn resulting in an over-the-top entry to a spin at an altitude too low to effect recovery. Contributing factors were an inoperative stall warning device, gusty winds, and possible ice accretion on the airframe.

Recommendations

As a result of this accident the Board recommended, that there be provided a means of checking for reliability the stall warning systems on all Viscount aircraft. As a result the CAA issued Airworthiness Directive No. 58-24-4 applicable to all Viscount models 745D and 810 aircraft, which provides as follows:

1. In order to provide a means of checking the electrical continuity of the stall warning system, install a switch in the cockpit and associated wiring for the nose gear oleo switch and Safe Flight wing detector vane. Revisions to the airplane flight manuals for models 745D and 810 include instructions to the pilot for making the necessary checks.
2. Periodic checking to assure proper calibration of the detector vane and correct functioning of the de-icing heater are also required.

The Board advised Capital Airlines that all pilots should be advised of:

1. The importance of the stall warning device with respect to adequate warning and the dangers confronted when it is inoperative.
2. The stall characteristics of the aircraft in turns steeper than those made normally.

In addition to the above the carrier, with the approval of the CAA, has taken the following corrective action:

1. Oleo switches on main gear legs have been changed to a hermetically sealed improved type.
2. A fleet project has been established to move the stall warning circuit, normally associated with the nose gear oleo switch, to one of the new type hermetically sealed oleo switches on the main gear. This has been done to obtain maximum reliability.
3. At each block overhaul the detector unit of the stall warning indicator is replaced with a zero time unit and the aircraft is flown to test its operation and accuracy. Instructions covering this procedure have been placed in the maintenance manual. Whenever a detector unit is changed for any reason the above procedure must be followed before the aircraft is released for scheduled flight.
4. The detector unit of the stall warning indicator has been made a no-go item and is listed on the cockpit "No-go List". Any malfunction reported must be corrected prior to dispatch of the aircraft.

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ICAO Ref: AR/578

No. 26

Aerovías Ecuatorianas, C. A., ("AREA"), C-47, HC-ACL, crashed in the Chugchilán Range, Cotopaxi Province, Ecuador on 7 April 1958. Report released by the Director General of Civil Aviation, Ecuador.

Circumstances

Flight 222 left Guayaquil at 0806 hours on a scheduled non-stop flight to Quito. The aircraft carried 32 persons, including 3 crew members and an infant. It was cleared to climb IFR on the Guayaquil-Esmeraldas track on a heading of 358°, then to continue in visual contact to Quito, after cancellation of the IFR flight. At 0819 the pilot contacted ATC and gave his estimated arrival over Manta radio beacon at 0841. One minute later the pilot reported at 4 000 ft, maintaining this altitude. At 0830 clearance was requested for a further IFR climb and the aircraft was told to wait. At 0836 clearance to climb was again requested and at 0840 clearance was given to climb IFR to 5 000 ft on the Guayaquil-Esmeraldas track. The pilot reported at 0841 as being over Manta beacon at 5 000 ft and estimated arrival at Quito at 0916. Clearance was granted for a climb to above the clouds on the same track. This was the last contact with the aircraft which, presumably, continued to fly in cloud without breaking through on top until it crashed at an altitude of 2 300 metres (7 500 ft) in the western mountains of the Chugchilán Range, killing all occupants.

Investigation and Evidence

The meteorological situation on the Ecuadorian coast from the latitude of Guayaquil to that of Esmeraldas on 7 April between 0700 and 0900 hours was the following:

From the surface to 4 000 ft, the Guayaquil rawinsonde station at 0700 recorded winds from 250° at 8 knots; from 4 000 to 6 000 ft, winds southwest with an average velocity of 4 to 7 knots; above 7 000 ft, the wind changed to the north quadrant with an average velocity of 5 to 6 knots.

The Guayaquil weather reports indicated the presence on the coast at this time of an almost continuous stratocumulus layer, broken, between 500 and 1 000 metres (1 500 to 3 000 ft). Above the stratocumulus, some altocumulus and altostratus formations constituted an overcast sky. Beneath the stratocumulus layer were some patches of fractostratus, more persistent at Manta and Guayaquil than at Esmeraldas. Manta station recorded local drizzle between 0700 and 0800, reaching the town at 0900. No surface winds were recorded by Guayaquil, Manta or Esmeraldas until 0900.

The following air navigation facilities were available to the flight: Guayaquil radio beacon on 365 kc/s, 500 watts; Manta radio beacon on 300 kc/s, 500 watts; Esmeraldas radio beacon on 385 kc/s, 500 watts.

Accident Site and Examination of the Wreckage

The aircraft crashed into a steep mountainside * which slopes to about 70°. The site of the accident is 2 300 metres (7 500 ft) above sea level, 600 ft below the crest of the range.

Wreckage was strewn over an area of about 12 metres radius on a rocky foothill of the range. Its condition showed that all the fore parts of the aircraft collided with violent impact with the steep

* ICAO Note: The direction of impact was presumably 025° since such a heading is mentioned in the Probable Cause.

side. But the traces left by the impact also revealed that the left wing touched the top of a tree growing on the hillside, the aircraft then crashing head-on against the slope, with engines apparently at full power. After impact the aircraft fell vertically about 12 metres and the wreckage came to rest in a small depression formed by a fault in the rock bed.

The cockpit, which suffered the full force of the impact, was totally destroyed.

The wings and their component parts disappeared almost completely, with the exception of a section of the right wing tip, about 1m50 in length, which was found near the rock eminence, and three fragments of the left wing which were in the top of the above-mentioned tree, some 15 metres from the depression containing the remains of the fuselage.

The right engine had disappeared. The left engine was found near the heap of debris. The propeller remained attached to the engine completely twisted backward and around the engine body.

The casings of the radio equipment were pressed into the fuselage, which was in the rock depression, but all instruments and parts were completely destroyed.

The burnt portions of the aircraft clearly indicated that the collision caused the fuel tanks to explode producing a fire which destroyed most of the wreckage of the aircraft.

No reliable information useful to the investigation could be derived from the equipment or the instruments.

Witnesses

There were no witnesses to the accident. The location at which it occurred is uninhabited, inaccessible and invisible from any populated area. On the day of the accident, it was raining and cloudy in this part of the country, and no one saw any fire from afar.

Analysis of the Evidence

There is no proof of the time at which the accident occurred, although a wrist watch found in the wreckage was stopped at 0859. This, however, is not a reliable clue as the hands may have been displaced on impact.

The collision was obviously completely unexpected as none of the pilot's message gave any hint that he was in the slightest doubt as to his position. Sudden malfunctioning of any operational part must be excluded in view of the absence of any reference to trouble in the pilot's last message to ATC.

Winds between 2 000 to 5 000 ft from 250° at 8 knots may have caused the aircraft to drift about 8 nautical miles east of the track. It is also likely that, in view of the atmospheric conditions prevailing in the area, considerable interference occurred which may have caused deviation of the ADF.

However, the influence of the west winds cannot have been such as to cause a drift off magnetic track from 358° to 25°

The Guayaquil-Esmeraldas track is the only one available for instrument flight from Guayaquil to Quito. Normal flight should have been as follows:

Visual flight out of Guayaquil until entering the overcast. From then on, IFR on the Guayaquil-Esmeraldas track until clear of cloud, then VFR again to Quito.

If the pilot, on starting his climb through the clouds had had any doubt as to his position, he would have either declared an alert or assumed a heading of 270° to get away from the mountains.

The pilot, who had 7 402 flying hours, was very experienced on the Guayaquil-Quito route. The accident was due, as stated above, to collision of the aircraft with an 8 100 ft peak, at a point 7 500 ft above sea level.

It is difficult to imagine this pilot attempting to pass over an 8 100 ft peak flying at 7 500 ft, particularly as the aircraft was capable of climbing more than enough to clear the range, since a C-47 with a gross load of 26 000 pounds, at continuous climbing power, has a normal rate of climb of 500 ft per minute.

The pilot was mistaken in his report at 0841 that he was over Manta beacon, as investigation discloses that the aircraft collided with the Chugchilán Range a few minutes after this message was sent, at a point 70 km east of the Manta fix.

Probable Cause

The probable cause of the accident is that the pilot did not follow the 358° Guayaquil-Esmeraldas track, authorized for instrument flight, until clear of cloud, but probably assumed a heading of 25° as soon as he left Guayaquil, in order to fly the most direct route between Guayaquil and Quito. In so doing while on instruments, he deviated from the Guayaquil-Esmeraldas track at too low an altitude to clear the Chugchilán Range before him with an adequate safety margin.

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ICAO Ref: AR/579

No. 27

United Air Lines, Inc., DC-7, N 6328C, and United States Air Force, F-100F, 56-3755, collided near Las Vegas, Nevada, on 21 April 1958. Civil Aeronautics Board (USA) Aircraft Accident Report SA-332, File No. 1-0066, released 19 August 1958.

Circumstances

United Airlines Flight 736 departed Los Angeles International Airport at 0737 hours Pacific standard time with 42 passengers and 5 crew aboard. It was a scheduled passenger flight to New York, which was proceeding normally in accordance with an IFR flight plan along Victor Airway 16 to Ontario, California, and Victor Airway 8 to Denver. The aircraft was cleared to a cruising altitude of 21 000 ft msl and advised to climb in VFR weather conditions. At 0735 the flight reported to Aeronautical Radio that it was over Ontario at 12 000 ft and was climbing in VFR conditions. Then at 0811 it reported over Daggett at its cruising altitude of 21 000 ft and estimated that it would reach Las Vegas (omni range station) at 0831. This was the last position report made by the flight.

At approximately 0745 hours that morning F-100F, 56-3755, took off from Nellis Air Force Base, Las Vegas, Nevada on an instrument training flight carrying an instructor and a trainee pilot. The flight was in accordance with a VFR local flight plan filed with Nellis Operations and the local traffic control tower. At approximately 0823, 755 called Nellis VFR Control and reported that it was "inbound on KRAM" (a local commercial radio broadcast station). The flight requested an altitude assignment from which it would conduct a simulated ADF instrument jet penetration utilizing KRAM. The VFR controller assigned 755, 28 000 ft and advised it to report over the radio station. At approximately 0828, the flight reported that it was over KRAM requesting a penetration. The VFR controller cleared it for an immediate penetration and requested that it report the penetration turn. 755 then reported leaving 28 000 ft. There were no other reports from the flight in connection with this procedure.

At 0830 the offices of Aeronautical Radio at Los Angeles, Denver and Salt Lake City heard an emergency message from the United flight. . . . " United 736, Mayday, midair collision, over Las Vegas."

At the same time, as nearly as can be determined, there was an unrecorded emergency transmission from the F-100F. This message was heard by the VFR controller and by the two pilots of another F-100F. All were agreed that the first portion of the emergency transmission was "Mayday, Mayday, this is 755." The last part of the message was either, "We've had a flameout," or "We're bailing out."

The aircraft collided at 21 000 ft over a position later determined to be about 9 miles southwest of the Las Vegas VOR station, on Victor Airway 8, approximately 1-3/4 miles to the right (southeast) of the centreline. Both aircraft fell out of control and crashed killing the 47 persons on board the DC-7 and both pilots of the F-100F.

Investigation and Evidence

Weather conditions in the Las Vegas area at the time of the accident were clear with visibility more than 35 miles. Winds at 21 000 ft were from 300 degrees at 45 kts.

Eyewitness evidence indicated that the aircraft approached each other quartering head-on, with the DC-7 flying northeast and the F-100F flying south or southeast.

The main portion of the DC-7 wreckage was located approximately 2.6 miles northeast of the estimated collision position. Investigation revealed that the aircraft was in a relatively flat attitude at ground impact with a high sink velocity relative to its forward motion. On impact it broke into numerous pieces along a heading of 160°. The wide separation between the ground marks made by each powerplant confirmed observations of eyewitnesses who stated that they separated in flight. Similarly, the wide distribution of many major wreckage pieces showed that a general disintegration of the aircraft occurred before the ground impact. Examination of the pieces of structure provided clear evidence that the inflight breakup of the aircraft after collision resulted from airloads which exceeded the design strength of the structure. There was no indication of structural failure prior to the collision.

The F-100F main wreckage site was located 5.4 miles south-southwest of the DC-7 site. The aircraft had contacted the ground on a northerly heading and, similar to the DC-7, it struck the ground in a relatively flat attitude with extremely high sink velocity as compared to forward motion. The impact, and fire which followed, caused major destruction of the structure. As near as could be determined from the evidence, at ground impact the landing gear and flaps were up and the speed brakes were closed. There was no evidence to indicate structural failure of the F-100F prior to the inflight collision.

Much of the wreckage after documentation as to location and identification was removed from the scene to a location on Nellis Air Force Base where certain areas from both aircraft were reconstructed and minutely examined.

Most important to these objectives were the right outboard wing sections of both aircraft and the right horizontal tail of the F-100F. These components were widely separated from the main wreckage areas and bore clear evidence of inflight contact which separated the wing sections as a result of and at the time of the collision. Examination showed these components were the only major ones directly involved in the inflight contact sequence.

Analysis indicated that initial contact occurred between the leading edge of the DC-7 right wing (at station 574) and the leading edge of the F-100F right wing 132 inches outboard of the aircraft centreline. The two wings progressively penetrated one another until the outboard portion of each was severed; in the case of the DC-7 the wing was severed along a swath line 34 degrees aft and outboard, and in the instance of the F-100F along a swath line 12 degrees aft and inboard. A second cut in the DC-7 wing, located about 24 inches inboard of the first, was made by the right horizontal tail of the F-100F which penetrated rearward until the cutting object, the outboard portion of the tail, was destroyed. This entire collision sequence occurred in less than 1/100 of a second.

A vector diagram, using the 34-degree fracture line in the DC-7 wing, estimated true airspeeds of the DC-7 and F-100F of 312 and 444 kts, respectively, and assuming a small angle of descent for the F-100F, indicated that at impact the aircraft were on quartering head-on courses about 122 degrees apart with a closure speed of about 665 kts. Believing the DC-7 was flying a magnetic heading to follow Victor Airway 8 and was in nearly straight and level flight, at collision the heading of the DC-7 was 23 degrees magnetic and the heading of the F-100F was 145 degrees magnetic. This heading for the F-100F seems reasonable because the aircraft was to the right of the desired 170-degree track and a normal correction to track procedure required a heading of 140 degrees. Because of its position, right of track, it would seem probable that the flight approached KRAM from the basic instrument practice area located east of the facility. Because of unknown factors, any estimate of the amount of turn required to the outbound heading cannot be determined or reasonably estimated.

The swath cut through the DC-7 wing by the F-100F wing was approximately 2 ft wide, and the edges were nearly perpendicular to the plane of the DC-7 wing. For a wing 8 inches thick and swept more than 45 degrees at the leading edge to have cut a 24-inch vertical swath through the DC-7 wing it would have been necessary for the F-100F wing to have contacted the DC-7 wing at a considerable angle of attack relative to the collision course and for the aircraft to have been rolled beyond a 90-degree bank. Paint scrape marks on the bottom of the F-100F right wing showed that it was the bottom side of the F-100F wing which made the contact, indicating that the F-100F was banked to the left. The distance between the swaths cut by the F-100F wing and tail surface indicated that the aircraft was in approximately a 15-degree negative angle of attack attitude at the instant of collision. The F-100F was also in a 12-degree nose-down attitude relative to the DC-7. An approximate 4-degree angle of descent would have been normal during the penetration.

From the angles of bank, descent, and attack indicated, as well as eyewitness information obtained, it was the Board's view that a last second evasive manoeuvre was initiated by the F-100F instructor intending to avoid the DC-7 by diving to the left, down, and under the aircraft. The F-100F passed the nose of the DC-7, narrowly missing its No. 4 propeller. Then the aircraft collided in the attitudes described.

To the Board the 15-degree negative angle of attack seemed extreme even under the circumstances. Because of this it is noteworthy that the angle would be reduced one degree for each degree that the DC-7 was yawed to its left. It would also be reduced by a greater speed than was estimated for the aircraft. Of the two possibilities, it was believed most likely that one of the pilots of the DC-7 saw the F-100F in the last seconds before collision and initiated a desperate evasive manoeuvre to avoid it.

Since the F-100F evasive manoeuvre was not initiated in time to be successful it can be assumed that the course of the F-100F was not altered appreciably during the manoeuvre. The two aircraft may then be backed apart from the point of collision for a reasonable distance along their courses at impact so that their relative locations to one another may be established and the possibilities of the pilots having sighted each other evaluated. The vector diagram indicates that the DC-7 was approaching the F-100F on a bearing 24 degrees to the right of the nose of the F-100F and it would have been at nearly eye level. This location falls directly behind the opaque canopy ring of the F-100F and, assuming no head movement, would make sighting the DC-7 at more than a mile nearly impossible and at more than one-half mile very difficult since at that distance the eyes of only one of the pilots would be in a position to see the DC-7 clearly.

The relative angle of approach of the F-100F to the DC-7 was from 34 degrees to the left and approximately 5 degrees above the horizon. This angle of approach falls behind the corner post between the captain's clear vision window and side window. The captain would have been able to see the F-100F approach with only one eye but if his head were two or three inches to the left of normal he could not have seen the aircraft at all until it was much too late to avoid the collision. The approach of the F-100F should have been unobscured to the copilot of the DC-7 through the captain's front windshield. The flight engineer on the DC-7 had no opportunity to observe the approach since his location in the cockpit was too high and too far aft to permit any upward visibility.

Nellis Training Procedures

Nellis instrument training procedures required that before a flight entered the 25-mile instrument practice area the pilot must secure a clearance and altitude assignment. This was accomplished through "Nellis VFR Control" which simulates an approach control. VFR control was incorporated to relieve the workload of the control tower, to provide separation between Nellis aircraft, and to give the trainee pilots practice in radio procedures. The VRF controller normally gave altitude assignments, 19 000 ft or higher, with 1 000 ft vertical separation.

The VFR control did not, however, perform an air traffic control function except for Nellis aircraft and its use did not relieve the instructor pilot of visual separation responsibilities required of all pilots by the Civil Air Regulations, restated in Air Force Regulations in equal or stricter requirements. It was stated that the VFR controller did not have knowledge of any air traffic other than the Nellis instrument training flights described. There were no procedures to alert the jets of other traffic known to Air Traffic Control. It was stated that such advisory service was beyond the capability of the Base and ATC facilities.

At the time of the accident seven jet penetrations were used for the Nellis Air Force Base. Three were published in the USAF Pilot's Handbook, and the other four were unpublished procedures. Although all seven procedures were formulated according to standard criteria for instrument approaches the latter four were approved through a local letter of agreement dated 10 May 1957, entered into between the Base and the Civil Aeronautics Administration. The KRAM penetration was one of the unpublished procedures. A review of the specified penetration track showed that it was nearly all within the lateral limits of Victor Airway 8.

For the KRAM penetration procedure the pilot would obtain permission to enter the instrument area and receive an altitude assignment. The flight should then "track in" on the commercial broadcast station. This inbound track would be one which requires less than a 45-degree turn to the penetration heading of 170 degrees after passing over the radio facility. If the inbound track required a greater than 45-degree turn, a right turn to intercept the outbound track was necessary. According to the established training procedures the speed of the aircraft should be 300 knots indicated airspeed. After overheading the radio station approval for the penetration is obtained with permission to leave the assigned altitude. When approved, the pilot should report leaving the altitude. At this time the "speed brakes" of the F-100 are extended and a descent is established holding 300 knots indicated airspeed. If necessary and when the ADF indications are stable, the pilot is expected to correct to a 170-degree outbound track from KRAM. Normally the descent is continued until one-half of the initial altitude plus 3 000 feet has been reached, in this instance 17 000 feet. At this altitude a right penetration turn is required to a heading of 35 degrees. The descent is continued throughout the turn and until a minimum altitude is reached on the 35-degree heading. The aircraft is again turned, if necessary, to establish a 35-degree inbound track to the runways at Nellis Air Force Base. At the proper time, and if remaining fuel permits, the penetration is followed by a simulated missed-approach procedure and/or another penetration.

United Air Lines Flights

The manager of United Air Lines flight operations stated that United pilots are instructed to plan their flights on airways, including the 1500 series, and on authorized high-altitude off-airways routes. Below 18 000 ft and in controlled airspace the pilots are permitted to plan a flight and file it according to a VFR or an IFR flight plan unless weather conditions permit only an IFR flight. Above 18 000 ft the flight must be planned and flown according to an IFR flight plan although VFR restrictions may be requested during climb and/or descent and when necessary. A flight over a high-altitude off-airways route must adhere to visual flight rules and only an IFR flight plan may be filed.

The witness said that the planning and operating of a flight above 18 000 ft according to IFR regardless of weather was to obtain as much air traffic control separation as possible. The witness stated that United understood that Civil Air Regulations and Air Traffic Control procedures did not preclude VFR flights in controlled airspace and during VFR weather conditions VFR and IFR flights would be intermixed. He said it was clear that in VFR weather an IFR flight received separation only from other like flights. Because of this, he said, it was United policy to require continued pilot vigilance for other traffic in VFR weather and, according to Civil Air Regulations, it was the pilot's responsibility to maintain visual separation regardless of flight plan or clearance. The witness furnished United company material and operation procedures reflecting this policy and said that cockpit vigilance was a subject of continuing emphasis.

Conclusion

The accident, which appears to have occurred under the most adverse conditions contemplated under VFR insofar as the opportunity for the pilots to see and avoid is concerned, raises the question whether the long established visual flight rules are adequate in uncontrolled operations. It is clear that, under certain conditions of speed and angle of convergence, insufficient opportunity exists for pilots to observe other aircraft and take avoidance action. As aircraft speeds and traffic density increase, this problem will be aggravated. To this end the Board has promulgated regulations under which a positive control service has been initiated by the CAA on certain transcontinental routes between 17 000 and 22 000 ft. It is essential that positive control be extended to altitudes as high as 35 000 ft and on additional routes as rapidly as practicable. While the problem of aircraft speeds and traffic density is serious, and growing more so, it is not sufficient cause to discard the see and be seen rule in entirety. Alternatives to this fundamental rule in VFR operations either do not exist as yet or are so extreme that they would penalize the expeditious flow of traffic to the point where U. S. aviation in general would be stifled. The practical consequences of immediate implementation of full positive control for such operations regardless of weather would be the grounding of a great majority of current aircraft operations. Therefore, until technological advances are made which will ensure separation of aircraft without reliance on the vigilance of the pilot, the Board will continue to retain visual flight rules with whatever refinements circumstances and the state of the art permit. The necessity for this position has been agreed by all major users of the airspace, both civil and military.

From a review of the operating procedures used at Nellis and all the evidence and testimony obtained during the investigation, the Board views critically some of the procedures which relate to this accident. Generally, the policies and procedures indicate full cognizance of the collision hazards inherent in the particular training performed and equipment flown. Air Force Regulation 55-19 contains numerous provisions in this regard. Through establishment of the local flying area and mission subdivisions, arrival and departure corridors, scheduling and altitude requirements, an effective segregation of aircraft operations is facilitated in most of the training phases.

It is the Board's view, however, that in the instrument training phase and in particular the VFR practice KRAM penetrations, insufficient attention was given the segregation of military training operations from other users of the airway.

It is apparent that simulated instrument approaches must be practiced and must utilize radio facilities which, in most cases, are located to form the airway structure. Nevertheless, penetration procedures intended for training manoeuvres to be flown mostly in VFR weather conditions should be those which create the least collision exposure. The KRAM penetration selected in this case, however, required a flight course which was almost wholly on Victor Airway 8 where most air traffic could reasonably be expected. The Board is of the opinion that, when it was determined no outlying facility could be established or used as provided in AFR 55-19, it was incumbent upon the military to establish procedures providing minimum collision exposure according to the intent of this requirement. The KRAM penetration did not fulfil this obligation.

The Board is well aware of the importance of the military mission, and there is no question as to the military right to use controlled airspace. Although such airspace is frequently described as "civil airways", except for portions specifically reserved, all airspace is open to all users, civil, and military. The Board requires that users must operate in accordance with the rules governing the airspace and expects such airspace to be used in a manner which takes fullest account of limitations of pilot capacity to maintain visual separation and which provide the best environment for visual separation.

In view of testimony of CAA witnesses, there is no doubt that the Administrator was cognizant of the extent and nature of the training activities at Nellis Air Force Base. The penetration agreement was approved by personnel of CAA and it was known by the nature of the training mission that the procedures agreed upon would be used primarily during VFR weather conditions for training. The CAA was also fully aware that the procedures, of necessity, had been established on the navigational aids in the Las Vegas terminal area where several airways intersect and over which there is considerable traffic flow. Furthermore, the CAA was aware of the difficulty in maintaining visual separation created by the speed and rate of descent of the F-100 series aircraft.

The Board believes that the CAA exercised poor judgment in failing to take any action with respect to conditions that existed on the airway structure which impaired visual collision avoidance and created unnecessary collision exposure. When the CAA agreed that the penetrations were necessary to the Nellis Training Program and that they would be established in the Las Vegas terminal area, it was reasonable to expect that the CAA would have made certain that such procedures would create minimum conflict with other traffic on the airways when used as a VFR procedure. As pointed out, Section 60.46 of the Civil Air Regulations is part of the instrument rules and, therefore, the CAA is not required by this regulation to consider VFR use of the penetration procedure as a factor for approval. However, the absence of such regulatory responsibility in this instance does not, in our opinion, excuse the Administrator for failing to take some action to reduce a know collision exposure in visual flight conditions.

Under Title III of the Civil Aeronautics Act the Administrator is directed, among other things, to encourage and foster the development of civil aeronautics and air commerce; to designate civil airways and to acquire, establish, operate and maintain air navigation facilities along such civil airways and at landing areas; and to make provision for the control and protection of air traffic moving in air commerce. The Administrator in performing these functions is directed by Section 2 of the Act to regulate air commerce "in such manner as to best promote its development and safety."

We do not feel this was done in this case. The record is clear that the Administrator was cognizant of the extent and nature of the training activities at Nellis Air Force Base and that the penetration procedures approved by him would be used primarily during VFR weather conditions for training. Yet, no action of any kind was taken by the Administrator, even after he had received complaints from United Air Lines. The record shows that the Administrator did not approach the Military in an effort to reach a voluntary agreement to alleviate the situation, nor was any attempt made to relocate the airway or to provide additional facilities for the jet penetration procedures. It was not until after the accident that a joint CAA-Military survey team was created to review Military activities throughout the country and to reexamine the jet penetration procedures used by Nellis Air Force Base. The Board recognizes the possibility that voluntary action by the Administrator might have met with resistance on the part of the Military. The fact remains, however, that no attempt at voluntary action was taken by the Administrator, nor did he advise the Board that he deemed himself powerless to act and, therefore, that regulatory action was required by the Board.

The Administrator, with his large staff of safety technicians stationed throughout the country, is familiar with all of the safety aspects of civil aviation as problems arise on the local level and therefore, has a working knowledge of these problems on a day-to-day basis. The Board believes that where the Administrator is aware of the existence of a potentially unsafe situation in which he believes himself powerless to act, he should immediately bring this to the attention of the Board. The Administrator's statutory duty under Section 301 of the Act to "cooperate with the Board in the administration and enforcement of this Act" clearly requires him to bring such matters to the Board's attention. This was not done.

Many of the actions initiated by the CAA and operational procedures effected by Nellis following the accident could reasonably have been taken before it occurred. The record indicates that when United Air Lines reported "near misses" on the airways near Las Vegas there were conferences but no other indicated corrective measures. It is the Board's conclusion that the incidents showed the need for and should have furnished the impetus for some of the later steps. All of the actions, in essence, reduce the collision exposure, take greater cognizance of other users, and utilize as much IFR Air Traffic Control service as can be obtained.

The testimony of various witnesses indicated that United Air Lines was aware of the general flying activity from Nellis Air Force Base. It was indicated that the company knew there was extensive flying training from the Base and that F-100 series aircraft were being used. It is also reasonable to assume that United knew that jet penetrations would be flown and this activity would normally involve some use of the established navigational aids. Nevertheless, the Board does not believe that from this information United should have suspected that the KRAM penetration with its unwarranted collision exposure would be selected and used regularly and frequently as a VFR training manoeuvre.

United had experienced numerous "near miss" incidents on the airway in the vicinity of Las Vegas. These, according to the United operations manager, were of major concern to United and were promptly reported to the CAA. The Board believes that United's action was proper and it was reasonable for the company to expect that appropriate corrective action would be taken by the CAA.

Probable Cause

The probable cause of this collision was a high rate of near head-on closure at high altitude; human and cockpit limitations; and the failure of Nellis Air Force Base and the Civil Aeronautics Administration to take every measure to reduce a known collision exposure.

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ICAO Ref: AR/534

No. 28

British European Airways Corporation, Vickers-Armstrongs Viscount, 802, G-AORC, accident nr. Law Farm, Tarbolton, Ayrshire, Scotland, on 28 April 1958. Report No. C. 679-C. A. P. 154, released by the Ministry of Transport and Civil Aviation (UK)

Circumstances

The accident occurred at 2208 hours during an unscheduled flight from London to Prestwick where the aircraft was to pick up passengers for BOAC under a charter arrangement and fly them to London. The aircraft took off at 2042 hours GMT from London Airport, cruised on the Airways at 18 500 ft and then commenced the descent to Prestwick with an initial clearance to 8 500 ft. Within a few minutes the clearance was amended to cross the Prestwick radio beacon at 4 000 ft. The descent appeared to the pilots to be normal until the aircraft struck the ground close to the site of the beacon very shortly after the captain had reported passing 11 000 ft in the holding pattern. The aircraft slid along the ground for 400 yards, and fire broke out in the starboard wing. Of the five crew aboard the aircraft, three were seriously injured.

Investigation and Evidence

Crew Information

The captain held a valid Air Line Transport Pilot's Licence with an Instrument Rating and an endorsement in Group 1 for Viscount aircraft. At the time of the accident he had completed 10 135 hours flying, of which over 9 000 were in command and 766 were on the Viscount Type 802. His records show his instrument flying, drills and procedures to have been of a high standard but there were comments on record that his reaction was somewhat slower than in the majority of airline captains and that he has a tendency to try to do too much. Again from the records it seems that the captain had some difficulty in co-ordinating his duties when on conversion training to the Viscount 802, which has been operated by a crew of two pilots since its introduction, and he had to be given an extension of the normal training period in consequence.

The first officer also held a valid Air Line Transport Pilot's Licence with an Instrument Rating and an endorsement in Group 1 for Viscount aircraft. At the time of the accident he had flown a total of 5 260 hours of which 544 were on the Viscount Type 802. His records with the Corporation show that his duties as a first officer were usually carried out competently and conscientiously, but there are entries which draw attention to a certain slowness and lack of self-confidence. At the end of his Viscount 802 conversion course, with which he had had some difficulty, it was said that in view of the amount of time and work taken to achieve an acceptable standard, he would require regular practice to maintain that standard.

The Captain's Statement

"The clearance to descend came through just before 2153 and I throttled back to begin a standard descent from 18 500 ft. At 2154, Scottish Airways passed me the 2150 Prestwick weather, which put the cloud base below the critical height shown in the Operations Manual. On hearing this, I gave Airways my intentions. Initial clearance had been to 8 500 ft and this was changed at 2156 to 4 000 ft or above at the Prestwick Beacon (GJR). I called passing New Galloway at 2157, gave an ETA for GJR of 2204 and gave my altitude as 13 000 ft. I do not remember this now, but believe that the altitude given must have been accurate. I was cleared then to Prestwick Approach.

Before calling Prestwick Approach, I gave the first officer instructions for the overshoot should we have to do one.

Before leaving London Airport I had told him that we would not do a monitored approach at Prestwick. I then called the Approach, giving them my intentions, ETA at GJR, and my height as 11 000 ft descending to 4 000 ft. They repeated the 2150 weather and gave me the airfield QFE and QNH, but because I had already had the weather, I only noted the QFE, because it is my own practice to compare QFE on my altimeter with the Zone QNH (not the airfield QNH) on the other. There were then further exchanges between us on the R/T at the end of which (2201-1/2 approx.) there was a short period of silence. I believe that it was during this period that I asked the first officer to get on with the initial checks, and towards the end of the period that I thought of checking one altimeter against the other. I think I said to the first officer 'We may as well check the altimeters now', or words to that effect. As I did so, I set the QFE on mine and added to the first officer 'What's your reading?'. I distinctly remember answering his reply by 'No, not that - what is the difference? It should be about 80 ft.' I was then looking on the let-down sheet for the airfield elevation when Prestwick Director transmitted to me just after 2203 and interrupted me. When I passed my altitude as 'fourteen point five', I believe that I gave it, certainly not by looking at my own altimeter (because it was on QFE), but rather as a result of my exchanges with the first officer a few seconds earlier, together with a glance across at his altimeter, which was still on Zone QNH, and which I remember reading as 14 300 ft. I believe that the first officer replied to my initial question by giving the altitude shown on his altimeter, and I think he probably said '14,500'. I know that as soon as I had got out of the aircraft a few minutes later, I knew what had caused the accident and I put the source of the error at this moment. Prestwick Director's reply of 'You are too high for me at the moment' could have done nothing but confirm the error in my mind, even though I know now that the radar operator was basing his remark only on what I had just told him. As I was looking at the let-down sheet on my knee to check the 80 ft, the red ADF needle (on GJR) started to go round, and I disengaged the auto-pilot, set the required heading on the Smith's System, put the aircraft into a left turn, and turned the selector to 'Radio Off' to disconnect the ILS from the Smith's System. I called the Approach in the turn, giving an altitude of 12 500 ft, which I can only have read from my own altimeter. As soon as I had reached the heading of 075°, I selected 43% of flap with the intention of increasing the rate of descent. After a one minute leg I turned back to regain the beacon. During this turn I must have sent my last height of 11 000 ft and just after completing the turn, we must have struck the ground, although I do not remember the impact."

The B. E. A. Monitored Approach System

This system was adopted as a "standard procedure" in B. E. A. as from 15 November 1956 "in the interests of safety and efficiency". It was felt that the problem of errors in the control cabin which were due to a lack of effective checking and cross-checking of all vital actions, together with an unsuitable distribution of duties between the two pilots, could best be solved by the Monitored Approach System, using the first officer to fly on instruments from the start of the descent until the captain was ready to take over and land. In this system, the first officer would be free to concentrate on flying the aircraft accurately, whilst the captain monitored and directed his flying, communicated with ATC and was free to control every situation as it arose. By such means the workload would be more evenly distributed between the two pilots, who must in consequence be more efficient individually and as a team, and the strain and fatigue on the captain would be reduced.

It was recognized that the system demanded a high degree of confidence from the captain in the skill and capability of his first officer, together with a high degree of understanding and co-operation between captain and co-pilot to avoid possible mistakes and also that rigid adherence to correct procedures would be of paramount importance. Having a standard procedure was stressed as being particularly valuable in helping the captain and first officer to work as a team even though they may not have previously flown together.

Although on the subject flight the captain was not manually flying the aircraft because the auto-pilot was engaged, he was controlling the descent and monitoring his instruments. On top of this he was doing all the R/T (the exchanges on which occupied about 4-1/2 minutes of the 12 minutes between the start of the descent and Prestwick Beacon), writing down the weather reports, studying the approach and overshoot procedures, briefing the first officer on a possible overshoot, attending to descent and initial approach drills and checking the altimeters. There seems little doubt that in so doing he overloaded himself to an extent that made possible the mental loss of the descent sequence.

The B.E.A. Monitored Approach System was not being used, although the instructions issued to flying staff suggest that it should have been. In his statement the captain said that he did not use it because he had never met the first officer before and because the first officer said he had not been to Prestwick since the war. He also gave it as his opinion that use of the system would most probably have increased his workload because he would have had the additional duties of reading check lists and tuning beacons.

Although the captain was within his rights in making this decision; nevertheless, it would appear probable that had he used the Monitored Approach System and followed the standard drills and procedures, or had he substituted some other procedure which made full use of his first officer, the altimeter reading error, if made at all, might then have been quickly noticed.

The B.E.A. Operations Manual requires the first officer to carry out all aircraft drills and to repeat each item verbally to the captain as it is completed. Had this been done on this occasion it is difficult to see how the confusion over the altimeter checking mentioned in the captain's statement could have occurred. Furthermore, the airfield elevation for which the captain says he was looking on the Prestwick let-down sheet had just been given to him on R/T as 64 ft, together with the QFE and QNH settings.

Observations

Calculations based on time and rate of descent confirm that when the captain read the altimeter between 2203 and 2204 hrs the aircraft was at 4 500 ft, not at 14 500 as he reported. He, therefore, failed to notice the position of the 10 000-foot pointer as he looked across at the first officer's altimeter. He subsequently perpetuated this initial error when reading his own altimeter at 2 500 and 1 000 ft when he gave his altitude as 12 500 and 11 000 ft respectively.

The captain had calculated the time for commencement of descent on the basis of a rate of 1 500 ft per minute and with the deliberate intention of not being too high on arrival at GJR beacon. He began the descent at the time planned and the descent was made as intended without interruption. Despite these facts, he accepted his height without any misgiving as 12 500 ft when he reached GJR.

The presentation afforded by pressure altimeters having three pointers is not always conducive to rapid and accurate reading especially in regard to the 10 000-foot pointer which can be overlooked or obscured, particularly at night. The possibility of ambiguous presentation with consequent wrong reading has been well known and there is constant endeavour to produce something better. The altimeter fitted in the Viscount 802 was taken to be a marked improvement on that fitted in the Type 701 in that it made a much clearer distinction between the three pointers.

The fourth item for the descent checks on the B.E.A. Viscount 802 Drill Card reads, "Spill Valves: OPEN as necessary - one at 15 000 ft, second at 8 000 ft." The pressurization spill valve operating switches are normally moved by the co-pilot. As the first officer had apparently opened the first, he must have realized that he had passed 15 000 ft. It is difficult to reconcile this with his recollection that he "was never conscious of being at any precise altitude, but only of descending."

During the descent from New Galloway the first officer seems to have spent too much of the available time trying to tune the PN Beacon. As the main Prestwick Beacon (GJR) had already been tuned satisfactorily on the other ADF set; as GCA was available to monitor their ILS approach; as the Decca Flight Log was working satisfactorily; and as the PN Beacon was only a short-range locator, this continued effort was unnecessary and was undoubtedly detrimental to his vital duties of monitoring the instruments and the R/T conversations.

The first height reported by the aircraft to the Prestwick Approach Controller was 11 000 ft. Because of the normal change of frequency he had not heard the previous call passing 13 000 ft neither did he know at what time the descent had commenced. When therefore the aircraft, some five minutes later, reported itself at 14 500 ft, he at once noticed the discrepancy. Although there was no conflicting traffic, he spoke to the GCA Controller, who was working the aircraft at the time, and asked him to request its altitude. Before the GCA Controller could do so, however, the aircraft reported itself over the GJR Beacon at 12 500 ft. This was received about 90 seconds after the 14 500 ft report and effectively dispelled from the Controller's mind any momentary doubts as to the aircraft's altitude.

Probable Cause

The captain flew the aircraft into the ground during the descent to Prestwick after misreading the altimeter by 10 000 ft. Whilst a somewhat ambiguous presentation of height on the pressure altimeter may have initiated this misreading, a lack of co-operation between the captain and first officer and a lack of alertness on the part of the first officer were the main contributory factors.

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ICAO Ref: AR/567

No. 29

Wheeler Airlines Limited, Douglas DC-3, CF-DME, collided with snow-covered mountain top at 72°45' North, 84°25' West on 14 May 1958. Report released by the Department of Transport, Canada. Serial No. 58-7.

Circumstances

At about 1000 hours the aircraft took off from a DEWline site on a non-scheduled flight to Arctic Bay, N.W.T., with a crew of two, two cargo handlers and a mixed cargo of freight.

The flight, which was conducted under VFR at an altitude of 3 000 ft, was routine until about 65 miles south of Arctic Bay. The aircraft then encountered a scattered to broken cloud or ice fog condition and the flight continued for about ten minutes without reference to the ground, at which time it collided with a snow-covered mountain top (higher than 2 800 ft), became airborne momentarily with the engines on fire, and then crashed to the ground and burned. The four occupants of the aircraft were seriously injured.

Investigation and Evidence

The pilot had a total of approximately 5 500 hours of flying experience, of which about 2 000 hours had been on Douglas DC-3 type aircraft and about 180 hours had been flown during the 90 days prior to the accident.

The co-pilot had a total of 2 760 hours of flying experience.

The map of the area used by the crew contained a printed note in which it stated that the highest elevation was unknown and that from sources available, the elevations ranged from sea level to about 6 000 ft. The only "spot heights" shown on the map within a circle of radius 30 nautical miles centred at the scene of the accident are 1 600, 1 800 and 2 200 ft. The altitude of the accident site, according to the altimeter of another aircraft, is 2 865 ft ASL.

Weather reporting and forecast information in the area of the accident is meagre. The aviation forecast issued by the Edmonton District Aviation Forecast Office for the period 0800 hours to 2000 hours on 14 May, for the northern Somerset and Resolute Regions indicated that an active low pressure area was situated 100 miles southeast of Chesterfield Inlet and was moving to be southeast of Coral Harbour by 2000 hours. This weather system was expected to give scattered variable to broken cloud conditions at 1 500 ft with the tops at 3 000 ft in the Northern Somerset and Resolute Regions.

The terminal forecast for Arctic Bay from 0700 hours to 1900 hours, indicated that cloud conditions varying between broken and scattered could be expected at 2 000 ft with an overcast at 9 000 ft; the visibility was expected to be occasionally 3 miles in snow. The pilot stated that the weather forecast obtained from Edmonton (via Frobisher) was, "10 000 ft scattered to broken, visibility ten miles for the Arctic Bay area".

A broken stratus cloud layer with its base at about 900 ft and top at about 1 400 ft was encountered by the flight in the Fox area. This condition persisted until the aircraft was about 20 minutes north of Fox.

The weather then cleared and remained clear until a position about 60 miles south of Arctic Bay was reached when partial and then complete instrument flight became necessary in what was described by the pilot as an ".... ice crystal fog condition". While light and occasionally moderate, rime icing in clouds was forecast; this was not considered to have been a factor in the accident.

Probable Cause

The aircraft struck the ground while the pilot was flying on instruments in cloud in an area in which the height of the ground was uncertain.

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No. 30

Pakistan International Airlines Corporation, Convair 240-7, AP-AEH, accident near the western boundary of Delhi Airport (Palam), India, on 15 May 1958. Report released by the Civil Aviation Department, Government of India, on 8 August 1958.

Circumstances

The aircraft, which was operating PIA Flight No. PK 205 (scheduled) from Delhi to Karachi, with 6 crew and 32 passengers, crashed soon after getting airborne from Palam aerodrome. Fatal injuries were sustained by 4 members of the crew, 17 passengers and 2 others who were in the vicinity of the crash. Nine passengers and one other were seriously injured. The aircraft was destroyed by impact and fire.

Investigation and Evidence

The Flight

The aircraft had landed at Palam at 1902 hours following an uneventful flight from Karachi. A thorough service check was carried out, and it was refuelled and loaded for the return flight to Karachi.

The total take-off weight indicated on the load sheet was 41 589 lbs. The investigation revealed an error in the empty weight of the aircraft and the actual gross take-off weight was determined to be 41 319 lbs, which is 1 181 lbs less than the maximum permissible all-up weight.

At 2018 hours the aircraft commenced its take-off run and was airborne at the latter half of the runway. Soon afterwards flames were observed at the western boundary of the airfield. The crash crew chief had watched the aircraft take-off. He saw the aircraft becoming airborne and then climbing to a height estimated by him to be 50 ft. He then noticed the landing lights pointing downwards and the aircraft losing height. He feared that a crash was imminent and immediately instructed the crew to proceed in that direction. At about this time the crash siren was sounded. The crash tender reached the site of the accident in about 7 to 8 minutes by which time the fire had reached large proportions.

Evidence of witnesses at the aerodrome

The following statement was made by a senior station officer of an international airline who witnessed the take-off:

"The aircraft take-off on runway 27 appeared perfectly normal taking into consideration the knowledge that it was well loaded. At roughly 2/3 to 3/4 of the length of the runway the aircraft became airborne and by means of its tail light I was able to follow its flight path and again taking into consideration the fact that the aircraft was well loaded, the initial climb seemed perfectly normal. At what appeared to be a height of roughly 200 ft the aircraft appeared to level out. For a few moments I thought it was an optical illusion but a couple of seconds later it was quite obvious the aircraft was descending. There was a momentary blackout caused by some trees obstructing my view as the aircraft disappeared behind them. But within two seconds a huge ball of fire appeared followed by a muffled "Woof". I had the impression that the flight path of the aircraft from the point of take-off to the point of impact described was rather a flat parabolic arc. From the time I picked up the tail light of the aircraft as it moved down the runway on its take-off run until the moment or two when I lost sight of that before impact I saw nothing whatsoever to suggest that the aircraft was on fire neither did I hear any other sound which would suggest that the aircraft was not executing a normal take-off."

Statements of Survivors

"...Almost at the last moment, however, we became airborne, I remember seeing the black and white stripes marking the end of the runway below a second or two after we had lifted. Then the headlamps were switched off."

"The aircraft climbed sharply for a few seconds then abruptly levelled out (far sooner than I expected) and began to point, as it seemed to me, slightly downwards. I remember, in my astonishment commenting on this to my neighbour. I concluded at once that the pilot had decided to make a forced landing and looked out of the window expecting to see the headlamps switched on again immediately. The aircraft, however, continued to fly through the darkness in apparently normal fashion, except for a slight slant to the port side and I had just begun to tell myself that my fears must be groundless, when the impact occurred."

"I wish to state categorically that at no time did any sparks emerge from the port engine, nor was there any explosion or fire while in the air."

The statements of most of the passengers who appeared to have a clear recollection of the events preceding the crash were substantially the same excepting that they had not experienced any change in attitude of the aircraft after getting airborne.

Technical examination of the wreckage

The wreckage trail commenced 720 ft from the end of the runway and 325 ft to the left of the extended centreline of the runway. The trail when extended backwards intersected the centreline of the runway at an angle of 11°.

The aircraft struck the ground at a shallow nose-down angle with the port wing slightly low.

Both the propellers were in fine pitch and were rotating at an equally high speed considered to be equivalent to the take-off rpm at the time of the first impact with the ground.

The engines were developing substantial power at the time of the crash, and the flaps were 5° down. The nose and port landing gears having completed retraction were locked in the "up" positions. The starboard landing gear was not locked - being still in the process of retraction.

All gyro-driven instruments were uncaged.

Landing lights were in the retracted position.

There was no evidence of any pre-crash explosion or fire, or malfunctioning of the aircraft prior to the crash.

The aircraft had flown a total of 12 668 hours since manufacture and 452 hours since the last major overhaul.

The Pilot

At the time of the accident the captain had flown 4 775 hours. His total flying experience on Convair aircraft was 324 hours as first officer and 65 hours as captain of which 53 hours were by day and 13 hours by night. Since obtaining his command, he had operated six night flights prior to the flight resulting in the accident. This was his first night flight involving a take-off from Palam in command of Convair aircraft.

The captain was properly qualified and licensed to undertake the duties expected of him as a commander on Convair aircraft. He, however, had not acquired much experience as a captain on this type of aircraft. He had obtained his command on 2 April 1958. He had, however, adequate instrument and night flying experience as a commander on DC-3 aircraft.

Medical Fitness of the Pilot

The stewardess stated that when she saw the captain sitting by himself in the Palam restaurant before the commencement of the flight he did not appear to be looking too well. The steward who later on joined the captain stated that the captain had told him that he was not feeling too well. On the captain's request he felt his pulse and considered it to be normal. The senior traffic assistant of PIAC stated, however, that he "looked hale and hearty".

The captain's widow stated that on 14 May, he was scheduled to go on a flight, but returned at about 1800 hours as the flight was cancelled due to bad weather. He did not have his dinner and complained that he was not feeling well. He was running a temperature and was restless throughout the night. The following morning he also complained of not feeling well and did not have any breakfast. He left for the airport after taking only "lassi".* Before leaving he said that as he was not feeling well, he would have "khichri" ** only for his meal at night. The widow stated that her husband's relations with the first officer were strained. The captain, on reporting at the Karachi Airport, told the flight dispatcher of PIAC that "he was feeling feverish or perhaps unwell". He was advised to consult the Corporation's doctor. The doctor took his temperature and on finding it to be 98° F advised him that it was normal. The doctor also found his pulse, throat, heart and lungs to be normal. The captain is then reported to have said that as he had no fever he would fly.

The captain's airline transport pilot licence was due to expire on 20 May 1958. He had been told by PIAC to present himself for medical examination on 15 May 1958. However, he did not report for the examination as he was detailed for this flight.

The Committee did not consider themselves competent to comment on the medical fitness of the captain for the purpose of this flight. There is no doubt, however, that he was quite worried about his state of health before leaving Karachi and while he was at Palam. From the aspect of flying fatigue, however, the Committee was satisfied that he had had adequate rest not having flown on the day preceding the accident. He had flown a total of 18 hrs 35 minutes during the preceding seven days and 112 hrs 25 minutes during the preceding 30 consecutive days.

Criticism of Fire Fighting and Rescue Action

The fire fighting and rescue action was the subject of criticism of some survivors. Briefly, the comments were made in respect of the inadequacy of the equipment, the way it was handled and the absence of lighting during fire fighting and rescue operations.

There are normally two crash tenders available at Palam, a "Pyrene" and a "Sun" crash tender. Of these, the "Pyrene" crash tender was unserviceable that day and the "Sun" crash tender was manned by four individuals as against the normal complement of five. On noting that a crash was imminent, the crash crew chief immediately instructed the driver of the "Sun" crash tender to proceed to the site. Considering the difficulties of the terrain, the crash tender reached the site quite expeditiously. A runway controller also soon reached the site to assist in the fire fighting. Although the fire had reached rather large proportions by that time, there is some evidence that the rear section of the passengers' cabin was still comparatively free of flames. The crash tender commenced fire fighting action immediately, but in the earlier stages a branch line burst. The foam supply to the branch lines was shut off and the foam was thereafter delivered from the monitor. This, however, caused some delay during which the fire continued to

*a sweet drink, the principal ingredient of which is buttermilk.
**fried rice with split peas.

spread. The foam stream from the monitor was not fully effective as the crash tender was located at some distance away from the wreckage. The tender was, therefore, moved forward and fire fighting action resumed. The statement of a passenger that the handling of the crash tender was defective and caused delay has not been substantiated by other evidence. The equipment was at this stage handled by the driver and the chief of the crash crew as only the monitor was in action. The remaining two crew members were in the meantime helping in the rescue work. The total quantity of water was exhausted without the fire being brought under control. The 35 gallons of foam compound that still remained in the tender could not, therefore, be utilized as replenishment of the water was not possible in the absence of a separate trailer, static tanks or hydrants.

The Committee appreciated the difficulties of aviation authorities in dealing with the complex problems of fire fighting. They, nevertheless, recommended that the fire fighting equipment and crew at Palam, an international airport, should be augmented.

The Committe also recommended that fire fighting equipment located at Palam should include adequate provision for lighting a crash area.

Comments on the Evidence

There have been a number of accidents where aircraft were airborne normally at night but soon afterwards lost height and flew into the sea or the ground. A common factor in these accidents was that the night take-offs were all under fully instrument conditions, there being no moonlight or carpet of ground lights. Such accidents have been the subject of study by the Royal Aircraft Establishment, Royal Australian Air Force and Flight Safety Foundation (USA).

In accidents under these circumstances, there is a possibility of the pilot experiencing a sensation that the aircraft is climbing when it is in fact losing height, if there is no visible horizon to provide a visual reference to the attitude of the aircraft. This is due to the fact that for a short time after take-off the aircraft continues to accelerate and the pilot experiences a backward inertia which gives him the impression that the aircraft is climbing. Once the aircraft starts to lose height it keeps on accelerating so perpetuating the illusion that it is still climbing. The Royal Air Force carried out flight tests with blindfolded pilots acting as observers. These tests established that as the aircraft continued to accelerate after take-offs, a turn and a dive could develop without any change in attitude being felt by the observer who thought that the aircraft was climbing normally.

In this particular case the take-off was on a moonless night from runway 27 at Palam. The direction of take-off was away from a built-up area, the visibility being 1-1/2 nautical miles due to dust haze. After becoming airborne there was nothing which could have given the pilot a natural horizon. In case the pilot was not fully on instruments, the sensation caused by the acceleration could have led him to lower the nose thus permitting the aircraft to enter into a shallow dive.

Probable Cause

The captain did not properly observe and interpret his flight instruments and thus inadvertently permitted the aircraft to descend to the ground immediately after a night take-off during which no visual reference was possible. A contributory factor may have been the slow reactions of the captain due to his state of health.

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ICAO Ref: AR/570

No. 31

Capital Airlines, Inc., Viscount, N 7410 and Maryland Air National Guard, T-33, 35966, collided in mid-air about 4 miles east-northeast of Brunswick, Maryland, on 20 May 1958. Civil Aeronautics Board (USA) Aircraft Accident Report, File No. 1-0074, released 9 January 1959.

Circumstances

The collision occurred at approximately 1129 hours eastern daylight time at an altitude of about 8 000 ft on Victor Airway 44 while the Viscount was descending en route from Pittsburgh to Baltimore-Friendship Airport. It was operating on an instrument flight rules flight plan but in visual flight rules weather conditions. The T-33 pilot was on a VFR proficiency flight from Martin Airport, Baltimore, Maryland. Just before the collision the aircraft were observed in the area west of Brunswick flying parallel easterly courses with the T-33 some distance behind and to the left of the Viscount. The T-33 quickly overtook the Viscount and made a gentle right turn, during which it struck the forward left side of the fuselage of the Viscount. Seven passengers and the crew of four aboard the Viscount were killed. A passenger in the T-33 was killed but the pilot, although severely burned, parachuted safely. Both aircraft were totally destroyed by inflight collision, ground impact, and the ensuing fire.

Investigation and Evidence

The T-33 took off from runway 14 at 1107. The flight proceeded southward climbing to 3 000 ft. The captain said the weather briefing he had received prior to take-off indicated there would be an overcast at 5 500 ft in the Baltimore area. He continued south to about Gibson Island, Maryland, on Chesapeake Bay, keeping below the overcast, and then turned to a westerly heading, passing north of Washington and south of Friendship Airport to Leesburg, Virginia. He could not recall his various altitudes, headings, or speeds because he was not flying a constant course. He said it was not uncommon for these to vary considerably on a VFR flight. The clouds in the Washington area were about 10 000 ft and he climbed at one time to about 9 000 ft between Washington and Leesburg. From Leesburg, he proceeded up the Potomac River to Harper's Ferry, West Virginia. He remembered descending from 8 000 to 5 000 ft just prior to reaching Harper's Ferry. He also remembered that he had selected 85 per cent rpm but could not recall his airspeed. He said that he made a left turn from Harper's Ferry at 5 000 ft and picked up an easterly heading, intending to proceed to Baltimore via the Frederick, Maryland area. According to the captain, after straightening out on this course, he began a slow climb, still maintaining 85 per cent rpm. He did not know his airspeed or rate of climb but did recall seeing the altimeter indicating 8 000 ft. At this point he said, he thought the aircraft exploded. It was not until he had been taken to a hospital that he learned that his aircraft had been involved in a collision.

Throughout the flight he had maintained a constant lookout for other aircraft; the windshield and canopy of the T-33 were clean and no distraction or cockpit duties had interfered with his lookout prior to the accident.

The Viscount was on a regular flight from Chicago, Illinois to Baltimore, Maryland, with one en route stop at Pittsburgh, Pennsylvania. An IFR flight plan had been filed and clearance obtained to cruise at 11 000 ft to Millsboro intersection, thence to Baltimore via Victor Airways 92 and 44. At 1115, when crossing

Grantsville intersection on course, the flight contacted Washington Centre (Washington Air Route Traffic Control) reporting its position and estimating Martinsburg at 1127. At approximately 1124 Centre cleared the flight to the Lisbon intersection to descend to and maintain 7 000 ft. At 1126 the aircraft reported over Martinsburg, leaving 10 000 ft, estimating Baltimore at 1139. Recordings of the conversation between Centre and Flight 300 were analysed. From these it was determined that approximately 41 seconds after the flight reported over Martinsburg it was given a further clearance by the Centre controller to descend to cross Sugar Loaf intersection at 5 000 and to maintain 5 000. Flight 300 acknowledged this clearance and reported leaving 9 000 ft. This transmission was made approximately 48 seconds past 1126 hours and was the last transmission from the flight.

The Washington Centre controller who was controlling Capital Airlines Flight 300 stated that at the time the target was first identified on the radar scope, Flight 300 was on V-44 proceeding eastward and there was no other traffic noted within 15 miles of it. In addition, no other target was seen in the vicinity of Flight 300 at the time of the final radio contact. He said that a few minutes after the final transmission, on one sweep of the antenna he saw a faint return of a target near CAP 300. On the next sweep the target had disappeared and the "blip" which was known to have been the Viscount was somewhat enlarged. The controller initiated a call to the flight to determine its altitude and to advise of possible VFR traffic but was unable to contact Flight 300. The target of Capital 300 remained almost stationary on the scope for about a minute and then faded. It was determined that this call was made three minutes and three seconds after Flight 300 had made its report over Martinsburg.

The wreckage of both aircraft was widely scattered over an area of about one mile by 1-1/2 miles approximately 4 miles northeast by east of Brunswick. Although pieces of wreckage from both aircraft were intermingled over the entire area, there were concentrations along separate paths on the ground. Pieces of the fuselage forward of the wing of the Viscount were strewn along a path about 4 500 ft long, running roughly west to east. The remainder of the aircraft came to rest about 1 300 ft south of this line of wreckage. It hit in a nearly level attitude on a heading of 65 degrees with little horizontal speed. Impressions and furrows in the ground indicate the aircraft was in a flat spin to the right at ground impact.

Various pieces of the T-33 fell along a line about 7 500 ft long which diverged southeastward from the Viscount wreckage path. The wreckage path of the T-33 was on a bearing of approximately 155 degrees with the more dense portions of wreckage coming to rest in more southerly positions.

Examination of the Viscount engines and propellers disclosed no evidence of operating difficulties prior to impact. The four engines remained in their approximate relative positions to the main wing spar and all four propellers were tight on their shafts.

The propeller blades were bent in various directions and angles. The pitch changing mechanism in each was in good condition. The Nos. 1 and 2 propeller piston positions were 84°20' and 74°30', respectively, in the feather range. The Nos. 3 and 4 were positioned at 42° 30' and 41°, respectively. The propeller control units on the Nos. 1 and 2 were found in the feather and 1-1/16 inch from feather position, respectively. The shutoff cock on the fuel control unit for No. 1 engine was halfway between closed and feathered position, while that for No. 2 was closed. The control pedestal was broken free of the cockpit area and found approximately one fourth of a mile from the cockpit floor. The positions of throttles on this section of pedestal were found to be one half open. The positions of the controls and the Nos. 1 and 2 propellers in the feather range, are not considered as reliable evidence of their operational positions prior to the accident. The distortion and mutilation of the engine control systems, sustained in the collision, could have repositioned the controls to the settings found during examination.

All four engines showed similar damage from ground impact and ground fire. The engine mount struts were bowed and the engine mount attachments were broken. The turbine assemblies were crushed by the airframe firewall and the auxiliary gear case.

The T-33 engine struck the ground, accessory section first, disintegrating that section as well as the accessory drive and compressor sections. The turbine buckets were broken from the turbine wheel but did not indicate evidence of rotation at ground impact. This was also true of the vanes of the compressor unit. All the evidence indicated that the engines of both aircraft were operating normally prior to collision.

Maintenance records for both aircraft indicated they were maintained in an airworthy condition in accordance with applicable regulations. There were no outstanding discrepancies affecting their airworthiness.

A witness from the General Rules Division, Bureau of Safety, Civil Aeronautics Board stated that Part 60 of the Civil Air Regulations has been developed by the Board to govern the operation of all aircraft, civil and military. There are two major sets of rules contained in this part. First, the Visual Flight Rules which have been developed on the principle that when weather conditions are above certain minima pilots will be able to see and avoid other aircraft. The second group of rules governs the operation of aircraft when weather conditions are below these minima when it is assumed pilots will not be able to see and avoid other aircraft. These rules are known as Instrument Flight Rules and under them Air Traffic Control guarantees separation from other controlled aircraft.

Generally, if there is a ceiling of less than 1 000 ft or visibility less than 3 miles in controlled airspace, an aircraft cannot be operated according to VFR. In addition, an aircraft while operating in weather conditions above the minimum may not be flown closer than 2 000 ft horizontally, 500 ft vertically underneath, or 1 000 ft vertically on top of clouds. If the ceiling or visibility is less than these minima, or these minimum distances from clouds cannot be assured, a pilot must operate in accordance with IFR. In addition, a pilot may elect to conduct his flight in accordance with IFR even though weather conditions are above the minima. In this event, because the weather is above the minimum, other aircraft can be operated according to VFR without knowledge of ATC. Under these circumstances the pilot operating in accordance with IFR is guaranteed separation only from other aircraft similarly operating according to IFR. He must, therefore, maintain the same degree of vigilance required during VFR operations to see and avoid other aircraft.

The witness defined "positive control" as a traffic control which provides separation between all aircraft notwithstanding weather conditions. After many months of study by the Board the initial step for this control has been taken. The Board has adopted regulations for positive control at high altitudes on certain specified routes. Formerly, the limiting capabilities of air traffic control facilities have made this infeasible. Expansion of this programme will be accomplished as rapidly as increased air traffic control capabilities permit. Elsewhere positive control is not exercised except when the weather conditions are below VFR minima and then only in controlled airspace. Pilots operating VFR in controlled airspace are required to maintain cruising altitudes in accordance with those designated for the particular airway they are using. In uncontrolled airspace the altitudes are governed by quadrantal rules, i.e., a certain altitude designated for a particular compass heading. These rules apply only to an aircraft in level cruising flight and do not apply to aircraft climbing or descending.

The witness also testified that the right-of-way rules which are applicable in VFR flight are set out in Part 60 of the Civil Air Regulations which applies to all types of aircraft operating in the U.S., civil and military. In addition, all Air Force aircraft must be operated in accordance with the provisions of Air Force Regulation 60.16, which is essentially the same as CAR Part 60 but may contain more stringent rules applicable to some operations. The witness said the two regulations are not in conflict but if they were Part 60 would govern.

A witness for the Civil Aeronautics Administration testified that the primary purpose of the Air Traffic Control service is to provide for the safe and efficient operation of aircraft operating according to instrument flight rules. In order for a pilot to avail himself of this service he must first file an instrument flight plan with an ATC facility. His flight must be planned within controlled airspace. He must obtain an air traffic clearance prior to taking-off and, finally, he must adhere to the clearance throughout the flight.

The witness said controlled airspace is normally that area within airways structure extending from 700 ft above the ground upward to infinity. In terminal areas controlled airspace extends upward from the ground and is extended laterally beyond the confines of civil airways. In addition, all airspace, exclusive of restricted areas, above 24 000 ft is controlled airspace. Part 60 of the Civil Air Regulations delegates to the Administrator of Civil Aeronautics the responsibility and authority to designate controlled airspace and when the Administrator has determined that IFR traffic density justifies it an airway is designated. Airways are provided with radio facilities making it possible to navigate along the airway by the use of instruments and radio. The airspace over the accident area is such controlled airspace and is defined as Victor Airway 44.

CAA maintains an extensive network of air-ground communications for the purpose of efficiently controlling IFR traffic. Washington Centre, which controls all IFR traffic in a designated area around Washington, within which the accident occurred, is equipped with such communication equipment. All IFR traffic, civil and military, is handled with this equipment.

The witness stated that Washington Centre is also equipped with radar which is used to augment the basic non-radar system of air traffic control. If the traffic can be seen and identified on the scope, control can be exercised by radar. If the target fades or contact is lost, control reverts to the basic non-radar system. He said radar is used in conjunction with air traffic control services rendered between Martinsburg and Baltimore. Radar-assisted air traffic control also provides pilots with advisories on all observed targets. This service may be limited by the radar coverage and volume of traffic, and workload. In addition, many pilots do not desire the service and request that it be withheld.

The witness said that because of the poor return from a T-33 type aircraft, it would present a poor target for radar in the Brunswick area below about 8 000 ft. The Viscount under the same conditions, however, being a larger aircraft, presents a good return and would be readily identifiable. Because of this uncertain return from the jet fighter, he doubted that the faint target seen by the controller was from the T-33. The enlarged "blip" seen on the screen may have been but was not necessarily the collision.

A representative of the Air National Guard testified at the public hearing. He said that Martin Airport is located in an area completely surrounded by controlled airspace or restricted areas. An area roughly 100 miles square has been designated around the airport as a local flying area. In it, acrobatic and engineering flights are conducted off airways but because of the concentration of airways in the area all other types of training flights are of necessity flown in controlled airspace. Various congested areas, restricted areas, and Air Defence Identification Zones (ADIZ) within the area are avoided. The establishment of the local flying area was coordinated with the Aberdeen Proving Ground as the ANG is allowed to use part of this restricted area for training. Departure and arrival corridors have been set up through this area to avoid congested areas and reduce conflict with other traffic as much as possible. It was not considered necessary to issue NOTAMS describing the ANG activity because of the relatively small amount of traffic generated at the base - about 100 flights per week. The squadron training procedures stress the necessity and importance of pilot vigilance and that Civil Air Regulations place the responsibility on the pilot to avoid collision under VFR conditions.

The witness testified that certain Standing Operating Procedures (SOP) have been established in the squadron. These are operating rules for the squadron and do not carry the same weight as Air Force Regulations in that they are written at squadron level. SOP's covering operational phases in the squadron are constantly monitored by the operations officer and if it is determined one has been violated disciplinary measures are taken.

The witness stated that subsequent to this accident the Air Force accepted certain voluntary flight restrictions. The resulting directives are voluminous but basically the effect is to preclude non-tactical flying in jet aircraft below 20 000 ft under visual flight rules. They also direct other similar action be taken to reduce as much as possible any conflict with other traffic. These directives again caution pilots about the provisions of regulations requiring a constant vigilance to prevent the recurrence of similar collisions.

The Capital Airlines training curriculum was described by a company official at the public hearing. All new pilots are given a three-week course of instructions in Civil Air Regulations, company policy, and operations, as well as flight and simulator training. Each pilot is given and required to study two manuals which include the pertinent Civil Air Regulations. In addition, all captains are required, twice yearly, to demonstrate proficiency in flying as well as knowledge of Civil Air Regulations, company policies, and the aircraft in which they are qualified. In all co-pilot instruction and/or upgrading, knowledge of Civil Air Regulations must be demonstrated. The company also constantly published operational bulletins concerning, among other things, air traffic control and cockpit vigilance.

The witness said that all Capital flights in the "Golden Triangle" (an area bounded by an imaginary line drawn between New York City, Chicago, Washington and back to New York) are operated according to IFR above 9 500 ft. Pilots will not accept VFR on top climbs or descents above this altitude, nor will they accept VFR on top in this area, except in emergency. In addition, Capital, since the accident, has applied this "Golden Triangle" rule to all its flights. VFR climbs and descents and VFR flight may be conducted below 9 500 ft but not above this altitude. It is company policy that all scheduled flights be conducted on airways or on approved off-airways routes. Below 12 500 ft on approved off-airways routes flight may be planned and flown according to either IFR or VFR, except when weather conditions permit only instrument flight. Above 12 500 ft, on approved off-airways routes, pilots must file an IFR flight plan but must operate according to VFR.

The witness said that clearing "S" turns during climbs and descents are not required by Civil Air Regulations, but the pilots are constantly reminded of the need for keeping alert and vigilant to see other traffic. In addition, there is contemplated a policy revision requiring clearing manoeuvres during descent. The Vno (velocity normal operation) of the Viscount is 238 knots indicated and this is the maximum operating speed permitted in descent except for emergency. A company rule states that logbook notations will not be made during climb or descent or in congested areas. Capital continuously conducts flight checks to ensure compliance with all regulations and to ensure cockpit discipline to further safety and efficiency of flight.

During the investigation it was learned that the T-33 pilot had been involved in two previous collisions and one major landing accident. Also, the co-pilot of the Viscount had been involved in a collision and one other incident, but it is evident from the nature of these accidents that they in no way indicate a lack of training or patterns of behaviour which are of significance to this investigation.

Analysis

It appears probable to the Board that the faint return on the radar scope followed by the enlargement of the Viscount target seen by the centre controller working Flight 300 was, in fact, the collision. No other reasonable explanation can be advanced to account for these observations. Allowing 10 seconds (one sweep of the radar antenna) for the controller to verify the target first observed and 8 seconds for evaluation and initiation of his transmission, it was possible to estimate closely the time of the accident. As stated before, the controller's transmission was made three minutes and three seconds after Flight 300 had reported over Martinsburg at 1126. Subtracting the 18 seconds estimated to have elapsed prior to the call it is determined the accident accurred about 2 minutes and 45 seconds after 1126. As the point of collision determined from ground witnesses, was 14 miles from Martinsburg, it was calculated that the ground speed of the Viscount was approximately 304 knots. With corrections for altitude, temperature, and wind it was further calculated that the indicated airspeed of the Viscount was about 235 knots. This speed is approximate and may vary slightly but it is within the range of normal operation. Any variation in this speed would not affect this analysis, which is based on damage patterns and which indicates relative motion only between the two aircraft.

From a study of the inflight damage to the two aircraft, it was determined that initial contact between them was when the nose section of the T-33 right tip tank struck the left side of the Viscount fuselage just ahead of station 132 below the floorline. As a result of this impact the nose section of the tank was crushed inward and rearward. Rivet scratches on the tank also running inward and rearward confirm the fact that the damage resulted from loads acting inward and rearward at an angle of approximately 47 degrees. The Viscount fuselage conversely was destroyed by loads acting from left to right with some indication of an upward component at station 132.

Following this initial impact, which separated the nose section from the T-33 tip tank, the main section of tank contacted the Viscount fuselage below the forward entrance door. The next area of impact was between the T-33 wing and the Viscount fuselage, upward and forward of the initial impact area. This destroyed the right wing of the T-33 and shattered the nose structure of the Viscount. The forces which destroyed the wing acted rearward, inboard, and downward as evidenced by the bending of the front spar upper cap and scratches running aft and inboard at angles of 42 degrees to 45 degrees on the top surfaces of wing fragments. Damage to the Viscount nose structure was caused by loads acting predominantly from left to right.

The outer portion of the right horizontal stabilizer of the T-33 was destroyed when it struck the upper left Viscount fuselage between stations 198 and 232. Scratches found on fragments of this structure ran aft and inboard at angles of 35 degrees and 45 degrees. Again the damage to the Viscount was due to forces acting from left to right.

A study of this damage showed best agreement in matching the observed collision damage of the two aircraft when the longitudinal axes were pointed toward each other with an angle of approximately 42 degrees between them and with the aircraft rolled into one another with an angle of approximately 25 degrees between the vertical axes. With this relative attitude constant during the period, there was generally good correlation between the damage from the time the nose section of the tip tank contacted the Viscount fuselage until the T-33 right horizontal tail hit. Because the vertical closure between the two aircraft was obviously small, it was assumed to be negligible as compared to the horizontal closure.

From this study it was determined that the airspeed of the T-33 was approximately 55 knots greater than that of the Viscount at the instant of impact. The rate of closure between them was approximately 195 knots.

It is significant that the eyewitness' descriptions of the collision are entirely consistent with the inflight damage to the two aircraft. The Board believes, from all the evidence, that the Viscount was flying a straight course but descending at a normal rate and at an indicated airspeed of approximately 235 knots; further, that the T-33 was flying a straight course which was parallel and to the left and behind the Viscount. Although in a shallow climb of a few degrees its airspeed was higher and it was overtaking the Viscount. A short interval before colliding the T-33 began a normal right-hand turn and continued in this turn until striking the side of the airliner. Although the T-33 was in a slight climb and the Viscount was in a descent, it is doubtful that the small vertical closure would be perceptible to ground witnesses.

Based on the above-mentioned evidence, a study was made of the relative opportunities for the various crew members to see the other aircraft during the 60 seconds immediately prior to collision. At the instant of impact the flight path of the Viscount was assumed to be straight while that of the T-33 was assumed to be in a coordinated turn to the right. At an angle of bank of 25 degrees and an airspeed of 290 knots IAS (551 ft per second true), the T-33 would have a radius of turn of about 20 300 ft. To have struck the Viscount at an angle of 42 degrees, the T-33 would have had to have started its turn about 26 seconds before collision from a parallel course about 5 200 ft to the left. The resultant angular relationships of the two aircraft were as follows:

Time to collision in seconds	Angle of T-33 from Viscount in degrees to left of nose	Angle of Viscount from T-33 in degrees to right of nose	Distance between aircraft in feet
5	90	55	1 700
10	93	61	3 150
15	97	65	4 200
20	102	68	5 000
25	107	70	5 450
30	113	67	5 650
45	126	54	6 400
60	136	44	7 450

A comparison of these angles with the cockpit visibility charts for the Viscount shows that the co-pilot could not have seen the T-33 until at the instant of impact. The pilot could not have seen the T-33 until about 26 seconds prior to collision because of the intervening fuselage aft of his left window.

As for the T-33 pilot, there was no obstruction to his seeing the Viscount for well over a minute before collision.

From a study of weather reports for the area, supported by testimony of ground witnesses, it appears most likely that the cloud coverage below 12 000 ft in the accident area consisted of one - to two-tenths of fair weather cumulus clouds based at approximately 4 500 ft with very little vertical development. One or two eyewitnesses stated that the jet momentarily passed through or behind one of these small clouds, but all witnesses were in general agreement that both aircraft were clearly visible for a considerable period of time prior to the collision.

Civil Air Regulations require that all pilots in VFR weather conditions maintain separation from other traffic visually, irrespective of the type of flight plan or clearance. In addition, these regulations have established right-of-way rules governing the flight of converging aircraft. Here the evidence shows that both aircraft were being operated in VFR weather conditions; also, that the T-33 was behind and overtaking the Viscount. Civil Air Regulations clearly state that an aircraft being overtaken has the right-of-way. The overtaking aircraft, whether climbing, descending, or in horizontal flight shall keep out of the way of the other aircraft by altering its course to the right, and no subsequent change in the relative position of the two aircraft shall absolve the overtaking aircraft from this obligation until it is entirely past and clear.

The evidence is clear that the T-33 pilot had ample opportunity to see the Viscount and avoid it.

With respect to the Viscount, whether the 26-second sighting possibility is adequate is less clear. Numerous studies have been conducted on this subject and the conclusions reached are nearly as numerous. Most of these studies agree that after another aircraft is sighted evasive action can be accomplished in less than 26 seconds. An area of disagreement exists, however, as far as the time required to scan for and detect other aircraft and to determine that a collision course exists.

In this accident it is obvious the Viscount pilot did not see the T-33. It is fundamental that a pilot's primary responsibility is to direct his attention to the most critical area, which is ahead of the aircraft. This is in no way intended to mean pilots should not look around and take any action necessary to avert collisions. It does mean, however, that a greater degree of vigilance is required in the direction the aircraft is flying.

In this collision the T-33 could have been seen about 26 seconds before collision. The Board does not believe that the fact the Viscount pilot did not see the T-33 in this period of time indicates a lack of vigilance. It is believed there may be periods of time considerably longer than this in which a pilot may not have the opportunity to clear behind him. It is not unreasonable, therefore, to place responsibility for collision avoidance on the aircraft which is behind and overtaking and, in fact, under the Civil Air Regulations, the overtaking aircraft is clearly burdened to see and avoid other aircraft.

As stated before, the Board believes that the collision was observed on the radarscope by the controller. It is tragic that no return was received from the T-33 in time for the controller to take action to alert the crew of the Viscount. As more advanced and sensitive equipment is developed many limitations of radar traffic control will be alleviated, and it should be possible to prevent this type of aircraft accident.

Conclusions

From all the available evidence the Board concludes that the weather at the flight altitude was VFR and that both aircraft would have been free from clouds about nine-tenths of the time without taking any action whatsoever.

It is also evident that the captain of the T-33, from his overtaking position, had ample opportunity to see the Viscount ahead of him and take evasive action. No unusual cockpit distractions or structural limitations to visibility precluded him from maintaining a lookout for other traffic. The Board believes that he was not exercising the normal lookout for other aircraft required and expected of him. Had he done so this accident might well have been avoided.

Conversely, the Board does not believe the Viscount pilot's failure to see the T-33 in the 26 seconds which it could have been seen is evidence of a failure to maintain a normal vigilance.

The Board is mindful of a current consensus concerning the obsolescence of the visual flight rules. We recognize the fact that these views frequently involve generalizations based upon assumptions of extremely high closure rates. However, prohibitively high aircraft closure rates were not involved in this accident. A requirement still exists for the continuation of visual flight rules substantially as contained in the present Civil Air Regulations for the large majority of aircraft operations such as those with which we are here concerned. With this, all responsible spokesmen for the principal airspace users, including military and civil, are in agreement. Emphasis must again be made, therefore, on the fact that the obligation to see and avoid other aircraft under visual flight rules conditions constitutes a condition precedent to the use of navigable airspace. This responsibility cannot be evaded by allegations that the Civil Air Regulations are inadequate or obsolete or that traffic control procedures which allow visual flight are improper. Accordingly, the air traffic rules clearly establish that failure to maintain a constant vigilance for other air traffic endangers the lives and property of others and, therefore, constitutes a disregard for the safety of other users of the airspace. A corresponding responsibility flows upon the operating agency which must maintain vigorous training and indoctrination programs in which cockpit vigilance is the subject of continuous emphasis and surveillance and in which failure to maintain such vigilance is subject to effective corrective action.

Subsequent to this accident the Air Force published directives requiring that the operations of all aircraft along airways, between 10 000 and 20 000 ft, be according to IFR. However, pilots may accept VFR climb or descent restrictions. In addition, some Air Force commands have imposed further restrictions on locally based jet aircraft which essentially preclude their operation below 20 000 ft under visual flight rules.

Since this accident Capital Airlines has required that all its flights be conducted according to the procedures set out for the "Golden Triangle", i.e., aircraft above 9 500 ft on airways must be operated according to IFR. VFR restrictions on climb and descent will not be accepted above this altitude.

Probable Cause

The probable cause of this accident was the failure of the T-33 pilot to exercise a proper and adequate vigilance to see and avoid other traffic.

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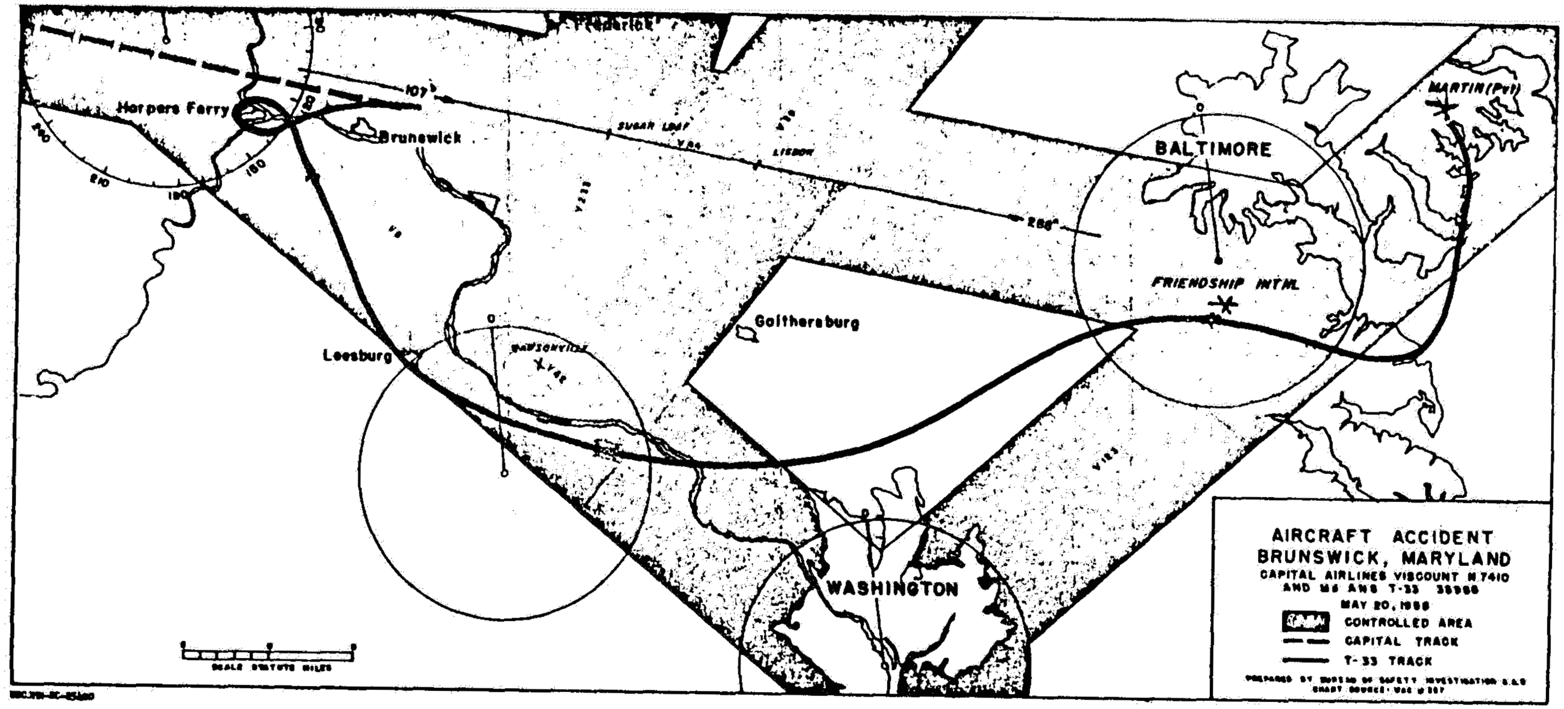
ICAO Ref: AR/557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Harpers Ferry
Brunswick
107°
SUGAR LOAF
LISBON
288°
BALTIMORE
FRIENDSHIP INT'L
Gaithersburg
Leesburg
WASHINGTON
AIRCRAFT ACCIDENT
BRUNSWICK, MARYLAND
CAPITAL AIRLINES VISCOUNT N 7410
CONTROLLED AREA
CAPITAL TRACK
T-33 TRACK

FIGURE 21

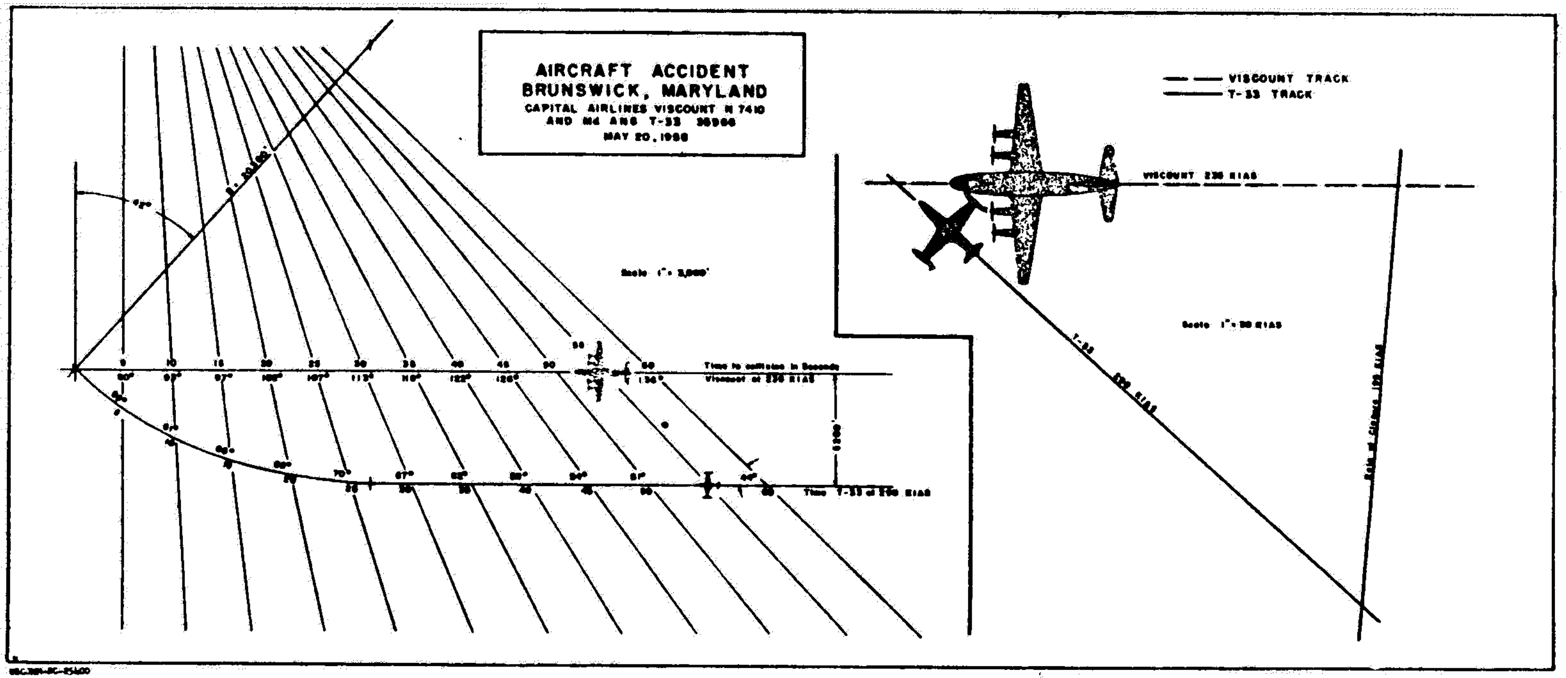
AIRCRAFT ACCIDENT
BRUNSWICK, MARYLAND
CAPITAL AIRLINES VISCOUNT N 7410
VISCOUNT TRACK
T-33 TRACK

FIGURE 22

No. 32

Pan American World Airways, Boeing 377, N 1023V, landing accident at Manila International Airport, The Philippines, on 2 June 1958. Report released by Civil Aeronautics Administration, Department of Public Works and Communications, Republic of The Philippines.

Circumstances

The aircraft was on a scheduled flight from San Francisco, California to Singapore with numerous intermediate stops including Manila, The Philippines. It carried a crew of 8 and 49 passengers including one infant. At 2123 hours (1 June) GMT * the aircraft landed on Runway 06 at Manila. During the landing roll, the main landing gears of the aircraft collapsed. The aircraft skidded and swerved to the right until it finally settled on the right shoulder of the runway approximately 2 850 ft from the west end and 27 ft from the edge of the runway. One of the blades of No. 3 propeller flew off and penetrated the cabin area causing the death of one passenger and seriously injuring another. The aircraft was seriously damaged.

Investigation and Evidence

The aircraft arrived within the Manila area at approximately 2032 hours, and a clearance was issued by the Manila Tower to approach Rosario Homer at 5 000 ft. At 2112 the aircraft reported over Rosario Homer at an altitude of 3 000 ft in-bound on a straight-in approach to Runway 06 at Manila. The aircraft arrived over the Manila VOR at 900 ft and was too high for the landing, hence, a right turn was executed by the pilot-in-command for a circling approach. A landing was not made on the second approach because the captain believed that it would result in an uncomfortable rate of descent and flight manoeuvre to align the aircraft with the runway. So the pilot elected to make another right turn. On the third attempt the aircraft came in for landing with full flaps with an indicated airspeed of 130 mph. Touch-down was made on the two main wheels, wings level and with the nose a little bit high off the ground. Immediately thereafter, the aircraft started to settle on its right wing until No. 3 and No. 4 propellers began striking the runway. The aircraft skidded and swerved to the right. The pilot tried to hold the aircraft on the runway by using the left brake, left rudder and the steering wheel with no positive results. The swerving continued until the aircraft settled to a stop on the right shoulder of the runway.

The terminal forecast issued by the Tokyo Meteorological Office for Manila and Clark on the time of the estimated arrival of the aircraft in Manila was as follows:

> 2100 to 0700 hours: 2 500 ft scattered, occasionally broken, 10 000 ft broken, variable overcast, 25 000 ft overcast, visibility 15 miles, occasionally 6 miles in scattered rain showers. Wind southwest 5 knots, freezing level 16 000 ft.

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* All times given in the report are GMT which is 8 hours earlier than Manila local time. (The accident occurred on 2 June at 0523 hours local time.)

The latest weather report given to the aircraft when en route within the Manila area was as follows:

> 2100 hours: Est. 1000 overcast, visibility 2, temperature 75, dew point 75, alimeter setting 29.75, wind E-4, thunderstorm and rain.

The meteorological conditions existing at approximately the time of the accident were cloud - 1 000; visibility 2 miles; wind NW 7 to 8 knots. Actual rainfall as recorded was two inches.

The crew testified that during the final approach and landing they encountered heavy rains and overcast condition. Nevertheless, they stated that they had a full view of the runway and its lights.

Examination of the aircraft disclosed no evidence that the aircraft or its landing gears had struck any object prior to the touchdown. The wing flaps were symmetrical and in the "down" position. All flight instruments were in operating condition. Tests conducted on the brakes showed normal operation. The main landing gears had collapsed and folded up into the wheel wells. The nose gear did not retract but was sheared off when it plowed into the runway shoulder.

The settings of Nos. 1, 3 and 4 propellers were found to be at full low pitch. The No. 2 propeller was found to be 2° from the low pitch stop.

Subsequent inspection of the main landing gear and nose gear actuating mechanisms revealed that the main landing gears and nose gear were in the down and locked position. Failures were found in the structural supports of both main landing gears confined to the structure supporting the forward ends of both the "V" strut and retracting screw which were believed to have occurred at, or soon after, touchdown. The failures at the "V" strut support were primarily at one leg of the "V" strut and in a forward direction, allowing the apex of the "V" strut to move forward and inboard. The failure of the screw support allowed the screw to move aft. The "V" strut support failure is believed to have occurred first or almost simultaneously with the screw support failure. If the screw support had failed first, the "V" strut support failure would not have occurred at all. No evidence of fatigue or incipient defect was found. The failures noted were of typical tension type resulting from impact forces. The extend-retract screw jack of the right-hand landing gear was found in the fully extended position, but the electrical circuit of one of the three green lights associated with the retracting mechanism of the right main gear was damaged, causing the red light to be on.

The captain testified that the landing gears were down and locked as indicated by the three "green L. G. position lights" which were "on" during the initial and final checks. He stated that the landing, however, was a little bit harder than normal.

The first officer and flight engineer, who were in direct view of the instruments' panel, testified that on the final roll of the aircraft, after two or three seconds, they saw that one of the three "green L. G. position lights" went "off". Simultaneously, a "red L. G. position light" went "on" and the warning horn sounded. Thereafter, the aircraft began to settle to the right.

The flight engineer further stated that he noticed the aircraft bounced thrice. After the red light indicator illuminated he shut off the electrical switches and fuel shut-off valves.

Crew Information

The pilot-in-command had logged a total flight time of 12 495:33 hours with 5 466:31 hours on the B-377, of which 642:58 hours had been logged as pilot-in-command. Hours flown during the flight which ended in the accident were 12:36. The pilot was route qualified on the Wake-Manila route but had not flown into Manila for a period of two months preceding the accident.

Probable Cause

The hard landing of the aircraft caused the failure or collapse of the right main gear "V" strut support.

Contributing factors were the heavy rains and gusty wind.

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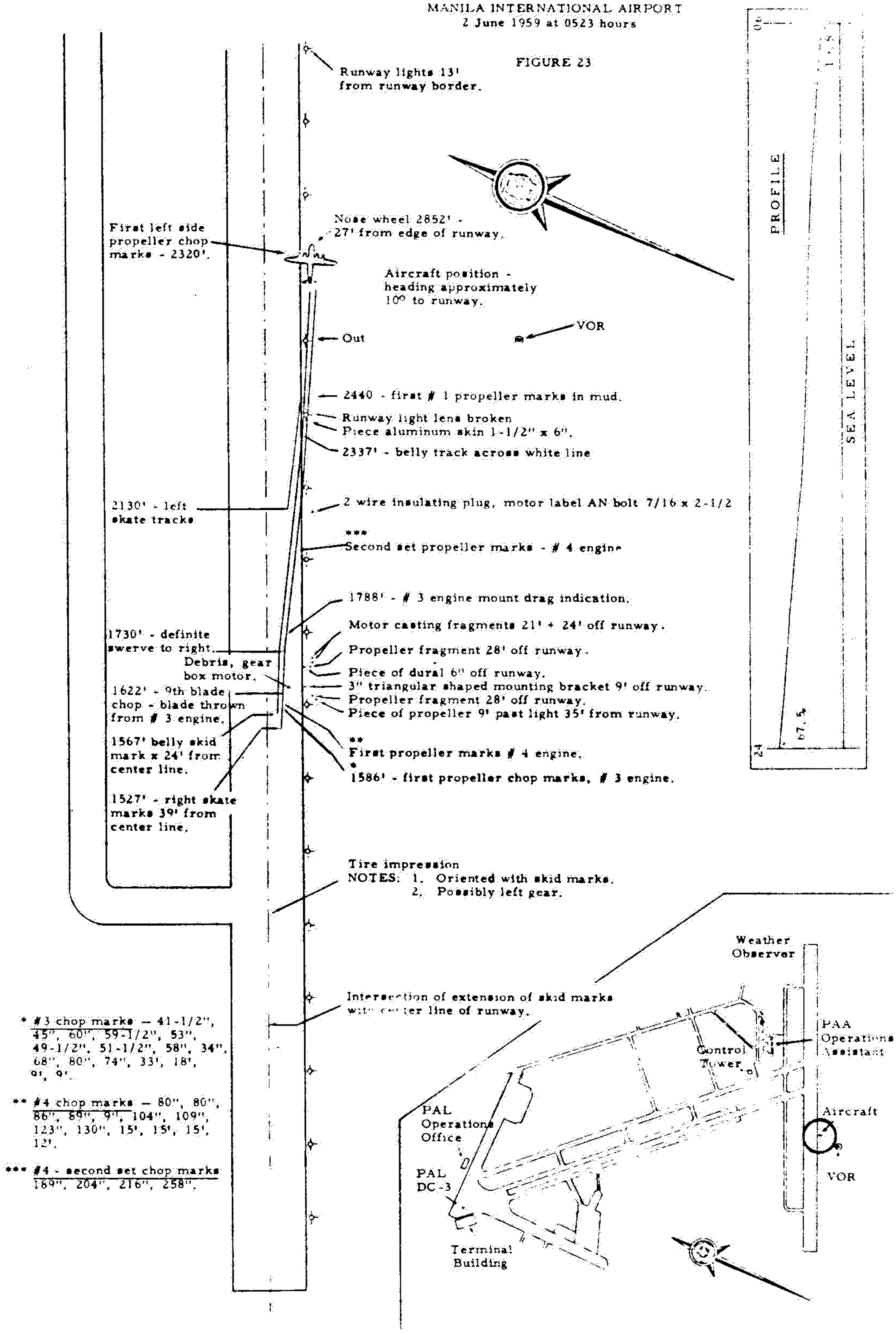
ICAO Ref: AR/547

N 1023 V ACCIDENT

MANILA INTERNATIONAL AIRPORT
2 June 1959 at 0523 hours



No. 33

Aeronaves de Mexico, S. A., Constellation 749-A, XA-MEV, accident west of the Guadalajara City Airport, Mexico, on 2 June 1958. Findings of the Accident Investigation and Reporting Commission as submitted to the Director General of Civil Aviation, Mexico.

Circumstances

The aircraft took off from Guadalajara Airport on a scheduled flight to Mexico City, carrying 38 passengers and a crew of 7. It did not follow the established climb-out procedure and crashed at approximately 2206 hours local time against La Latilla mountain, approximately 13 kms from the radio beacon west of Guadalajara Airport, killing all persons aboard.

Investigation and Evidence

The aircraft's Certificate of Airworthiness was valid at the time of the accident. The captain and co-pilot both held valid Airline Transport Pilot licences.

At take-off time the weather conditions were adequate for air navigation.

The initial cause of the accident can mainly be traced to the following manoeuvres performed by the aircraft during the take-off and climb-out stages.

XA-MEV made a routine take-off from runway 28 according to the traffic pattern. A turn to the left was made as though to perform the procedural "drop-shaped" turn prescribed by the Airports Manual for climb-out on instruments. Instead of completing the procedural turn, the pilot continued on a straight course for about two minutes in a south-westerly direction. Then, on making a right turn the aircraft crashed on the mountain peak.

Probable Cause

The aircraft did not climb out in accordance with previously approved procedures - the provisions of which are set out in the Airports Manual.

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ICAO Ref: AR/573

No. 34

Capital Airlines, Inc., Douglas DC-3, N 49553, accident at Martinsburg Airport, Martinsburg, West Virginia, on 4 June 1958. Civil Aeronautics Board (USA) Aircraft Accident Report, File No. 1-0061, released 6 July 1959.

Circumstances

Training Flight V-3 departed Washington National Airport at 1110 hours eastern standard time to operate VFR in the Martinsburg, West Virginia area for 4-1/2 hours of training. It carried an instructor and two pilot trainees. While practising take-offs and landings at Martinsburg Airport, during an attempt to climb out after abandoning a single-engine approach to runway 8, the aircraft stalled at an altitude too low to effect recovery and crashed injuring all 3 aboard. One trainee died the following day.

Investigation and Evidence

When the first trainee had completed his portion of the flight the second trainee took off and performed three or four touch-and-go landings, all of which were flown with a simulated 400 foot ceiling and one mile visibility condition. Most, if not all, of these landings were simulated single-engine approaches with two engine go-around and on the final landing preceding the accident the right engine was stopped by moving the mixture control to idle cutoff somewhere in the traffic pattern. This engine was then restarted and set at 1 500 rpm and 15 inches manifold pressure (a no-thrust condition) to simulate a feathered propeller. The landing gear and flaps were fully extended in preparation for landing.

The flight was observed to abort the landing and start a go-around. While still at an altitude estimated to be 50 ft and at a point approximately 3/4 of the distance down the 7 000-foot runway, the aircraft entered a right turn making a bank of approximately 35 to 50 degrees. The nose of the aircraft was observed to drop slightly, then rise again during the right turn. The right wing was then seen to contact tall trees, and the aircraft cartwheeled to the ground while travelling in a southerly direction.

The aircraft was extensively damaged at impact, and fire which followed consumed approximately 45 percent of the aircraft structure, particularly that area between the two engines and the forward passenger and crew compartments.

From examination of the terrain, the trees, and the aircraft structure, it was determined that the aircraft entered the wooded area in a steep right bank of approximately 80 degrees and came to rest on a heading of 320 degrees magnetic in a 30-degree nose-down attitude. The point of impact was 1 165 ft south of the centre-line of runway 8-26.

All components of the aircraft remained in their relative positions after impact, although both engines were separated from the aircraft. The wing flaps and main landing gear were found fully retracted. Examination of the aileron, elevator and rudder system controls revealed their cables to be intact from the control surfaces to the cockpit controls. Most of the control components in the fuselage and wings were extensively damaged by fire after impact, as well as by tree and ground contact.

Both engines were examined for evidence of malfunction. There was no evidence of structural failure or malfunction to either engine prior to impact, nor was there any evidence of fuel contamination or exhaustion.

Examination of the propeller assemblies revealed no failures or difficulties of any kind.

The instructor stated that at least once while the first trainee was in the left seat and once while the second trainee was flying, difficulty with the landing gear safety latch was encountered during gear retraction. This malfunction, according to the instructor, was caused by the lack of tension on the J-dog *spring located on the landing gear control valve, which prevented the safety latch from remaining in the upright or "latch-raised" position after it was manually pulled in preparation for raising the landing gear. A flight test was accomplished 16 July 1958, to evaluate the significance of the additional motions required to retract the landing gear. Tests were made to determine the time of gear retraction with a simulated malfunctioning landing gear latch. It was determined that with the J-dog spring disconnected, simulating the conditions of a malfunctioning gear, the operator would have to allow from 5 to 10 additional seconds to actuate the landing gear retraction controls.

The first trainee, who was seated in the jump seat at the time of the accident stated that he did not recall whether the wheels touched down or at what point power was applied for the go-around; however, he did remember seeing the instructor actuate the landing gear selector valve to raise the landing gear. He stated that he then recalled the aircraft was in about a 10-degree right bank and on a heading of about 30 degrees to the right of the runway heading, with a speed of about 60 knots. Following gear retraction he stated he saw the instructor's hands at the throttle quadrant and it appeared to him that the instructor was attempting to restore power to the right engine. He recalled hearing the instructor state he had the controls a moment before hitting the trees.

The second trainee and the instructor were both familiar with single-engine landings, and two-engine go-arounds. The second trainee had observed several single-engine approaches with touch-and-go landings while the first trainee was flying. The second trainee then moved into the left pilot's seat and made several single-engine landings followed by two-engine go-arounds prior to the accident. His touch-and-go landings were poorly executed and, since this was his first baulked, it was up to the instructor to monitor the instruments and the go-around carefully.

The final approach to the landing was made under simulated single-engine approach conditions. The right engine had been retarded to 1 500 rpm, and was only drawing 15 inches of manifold pressure. The pilot had cranked in eight degrees, or full nose-left rudder trim, the landing gear was down, and flaps were fully extended. It is evident that the aircraft was in its landing flareout, at an airspeed of between 60 and 70 knots, when the order to abort the landing was given with the command from the instructor to, "Take it around - both engines."

Following the instructor's command, the chronological sequence of actions would have been for the pilot-trainee to advance both engines to full power position, and call for flaps and gear up in that order. According to company practice and good operating procedures the rudder trim should have been returned to the neutral position during the approach. However, investigation at the wreckage area subsequently disclosed that the left rudder trim settings had not been changed, which would indicate that the trim mechanism had not been actuated. Even though the rudder trim was not returned to neutral and even if there was an actual or simulated loss of power of one engine, the trainee-pilot should have been able to maintain minimum control speed.

An examination of the maintenance records revealed no recent history of a malfunctional landing gear selector assembly and the failure must have arisen in flight.

* The J-dog is a component of the landing gear safety latch assembly which allows movement of the landing gear valve selector handle to the up position.

The instructor, who was serving as co-pilot for trainees, was responsible for retracting the gear and flaps in the situation described. Because of the gear latch malfunction, the instructor, in order to raise the gear, had to unfasten and pull up on the gear safety latch with one hand and pull up the landing gear valve control lever with the other. This would add additional time to the gear retraction process and result in the captain leaning over to the left with his head down. In this position it would have been almost impossible for him to monitor the instrument panel or the trainee-pilot's actions for several critical seconds during the go-around.

Investigation disclosed that the blade angles of the left and right propellers were positioned at 19 degrees and 16 degrees, respectively. The propeller blades of this aircraft were of the type that permitted constant-speed operation from a low-stop position of 16 degrees to a fully feathered position of 88 degrees. According to the instructor, both propeller control levers were advanced to take-off rpm prior to attempting the go-around. This could not be confirmed because the propeller governor control pulleys were disconnected at impact. However, there is no reason to believe both propellers were not set at the 2 400 rpm take-off position.

The left engine, with an rpm of 2 400, would have been developing between 887 and 952 hp for an airspeed of between 60 and 70 knots, and a blade setting of 19 degrees. By the same reasoning, the right engine, with an rpm setting of 2 400 would have been developing anywhere from zero to 650 hp with the same airspeed, and a blade setting of 16 degrees.

With the airspeed at or near minimum control, as was the case in this accident, the right propeller blades would position to the 16-degree stop if a malfunction of engine occurred, since the propeller governor would try to compensate for loss of rpm. Under the same conditions, the propeller blades would remain on the 16-degree stop position if the throttle was not advanced and the propeller was in the forward low-pitch high rpm position. Under these circumstances, with the right propeller in the 16-degree stop position, either the right engine failed to develop its normal power or the trainee failed to advance the right engine throttle.

After evaluating all evidence, the Board concluded that the trainee attempted a single-engine go-around following a single-engine approach; that he tried to climb the aircraft on one engine at an airspeed below minimum control speed, and that the instructor's attempt to rectify this situation was made too late to prevent the accident. The trainee apparently misunderstood the instructor's instructions to, "Take it around - both engines," and did not advance the right throttle for the two-engine go-around. The instructor was distracted, momentarily, in his supervision of the trainee because of the malfunctioning landing gear latch.

The trainee's actions were inconsistent with the degree of competence expected of a first officer. He was about to be upgraded to captain and had over 3 000 flying hours, 681 of which were in DC-3's. Nevertheless, the instructor was instructing the trainee and the final responsibility for the safety of the crew and aircraft was his.

Following this accident, Capital Airlines designated a qualified senior instructor on DC-3 equipment who will be charged with responsibilities for conducting and supervising all flight training for initial upgrading. This senior instructor will select and standardize a sufficient number of line training captains so that a DC-3 training supervisor will be available at each base that operates DC-3 equipment.

In addition to this staffing change, Capital Airlines took further corrective action by instituting a procedural change for DC-3 instructors. This change requires that the decision to either continue or abandon a single-engine approach to a landing be made before reaching an altitude of 200 ft; or, if a single-engine landing is made, the aircraft must be brought to a full stop.

Probable Cause

Following the trainee's failure to maintain minimum-control speed during an attempted go-around, the instructor failed to take control of the aircraft in sufficient time to prevent a critical loss of altitude. A contributing factor was the malfunction of the landing gear latch which delayed retraction of the landing gear and caused the distraction of the instructor for several seconds during a critical period of the go-around.

Concurrence and Dissent of One of the Board Members

I cannot concur in the probable cause of this accident as found by a majority of the Board. I agree with the factual report of the investigation and with the factual deductions made by the Board, but I cannot agree with the finding of pilot responsibility in the Board's statement of probable cause. I feel that such a finding is beyond the proper scope of an accident report.

Stripped of qualifying clauses, the Board has here determined that "The probable cause of this accident was that... the instructor-pilot failed to take control of the aircraft in sufficient time to prevent a critical loss of altitude." I would find rather that the probable cause of this accident was the failure to maintain minimum control speed during an attempted go-around.

We are dealing in this case not with a student pilot or with a pilot whose lack of experience was such that the instructor-pilot must clearly be held responsible at all times for the performance of the aircraft. The trainee was a first officer of long experience. He had over 3 000 hours of flying time, including 681 hours in a DC-3. He was being checked for a captain's rating. Under these circumstances, whether or not the instructor must bear full responsibility for the safety of the aircraft is by no means clear. I, therefore, think that the Board should confine itself to an accurate description of the sequence of events and a statement of the mistake in judgment which was responsible for the accident, leaving such matters as responsibility and liability to the pilot certificate procedures of the FAA, and to the courts if the issue of liability is raised therein.

The Board has always attempted to keep matters of liability and responsibility out of its accident investigations. The success of these investigations depends upon the cooperation of all parties, and their being kept non-adversary in character. While the mere recital of the factual chain of events and the factual cause of an accident may carry grave implications of responsibility or liability, the Board has always endeavoured so far as possible to keep legal conclusions out of its accident reports.

The matter of pilot responsibility has a long and somewhat inconsistent history. The basic case is Smith, Airman's Certificate,* decided in 1947, involving a mid-air collision caused by the failure of the pilots to keep a proper lookout. It was an airman certificate case and Captain Smith, of course, had a full opportunity in an adversary proceeding to present arguments in his behalf.

*13 C.A.B. 117 (1947). The Board stated: "Respondent Smith was the first pilot, and as such the pilot-in-command of the aircraft ... In this case Captain Smith failed to maintain a proper lookout himself or to have an effective arrangement with his co-pilot to ensure the maintenance of such lookout. Such failure was negligence on the part of Captain Smith." It is noteworthy that the Board in an accident investigation report (Transcontinental and Western Air DC-3 Boeing A75N1 Training Plane near Chicago, Ill. - September 26, 1945) covering the same incident did not attempt to assess specific responsibility. The Board there found the following probable cause: "Upon the basis of the foregoing the Board determines that the probable cause of this accident was lack of vigilance on the part of the pilots of both aircraft. Reduced horizontal visibility may have been a contributing factor."

Subsequent safety cases have not followed the Smith doctrine. In Administrator v. Hazen,* decided in 1958, for instance, the Board overruled the examiner's initial decision which had found the captain negligent under the "Command pilot" doctrine. In this case the CAA specifically requested additional argument on the captain-in-command issue, which I would have granted, but the Board dismissed the petition apparently on the grounds that the Smith case did not impose absolute responsibility on the command-pilot. In a recent report on an accident which occurred while a CAA Inspector was conducting a flight check the Board did not reach a conclusion that any overriding responsibility attached to the inspector-pilot.** Despite these two recent cases, the majority in this accident report now asserts the full pilot-in-command doctrine and builds around it the whole finding of probable cause.

During the period when the Civil Aeronautics Board was responsible both for accident investigation and for the issuance of Civil Air Regulations a certain confusion between our responsibilities in these respective fields may have been inevitable and in any event did not create any jurisdictional problems. Today, however, we no longer have the responsibility for the formulation of Civil Air Regulations and it seems to me, therefore, that the basic determination of the responsibilities of various members of the crew is beyond the proper scope of our authority.

As I stated above, if it were absolutely clear under the Civil Air Regulations or under the customs of the air, that the captain in this precise type of situation has absolute responsibility, the Board might possibly find his failure to act the probable cause. Since absolute responsibility of the type imputed in the present case is by no means clear, however, I think that question should be left to proceedings where the issue of responsibility and liability can more appropriately be determined.

When powers which have for many years been placed in a single agency are divided between two agencies, each must exert the greatest care and discretion to disentangle those powers and responsibilities in accordance with the new statutory scheme and to avoid encroaching upon the jurisdiction of the other agency. If absolute responsibility is to be placed on an instructor-pilot in this kind of situation, then that responsibility must be placed by the FAA under appropriate rule-making procedures or by an airman certificate proceeding rather than by the CAB as a part of an accident investigation.

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* Administrator v. Hazen. S-853, February 12, 1958.

** Aircraft Accident Report, Beechcraft Travel Air, N 819B, Near Little Rock, Arkansas, July 22, 1958. The Board's finding of probable cause reads simply: "The Board determines that the probable cause of this accident was the unintentional entry into a spin at too low an altitude to recover." In this case we further concluded that one of the accident factors may have been the inspector's unfamiliarity with the aircraft in question which would appear to heighten the degree of his responsibility. (See Summary No. 38 in this Digest.)

One other aspect of the Board's finding disturbs me. If the FAA should institute an airman certificate proceeding against the instructor in the subject accident, those proceedings may well come before this Board on appeal. In such a case the Board may seem to prejudge the matter by making a clear finding of responsibility in its accident investigation report. In extraordinary cases such a finding may be inescapable, but there is clearly no need to make such a finding in the present case. This type of situation - the overlap between a certificate case and an accident investigation - has recently given the Board difficulty in the case of Administrator v. Welling* although in that case the finding in the accident investigation was largely factual in character. The confusion between the two types of proceedings is compounded if the Board, as it does here, makes not only factual findings but also a finding of responsibility in an accident report prior to a possible hearing on an airman certificate appeal.

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* Administrator v. Welling, S-991, June 2, 1959.

No. 35

Serviços Aéreos Cruzeiro do Sul Ltda., Super Convair, PP-CEP, accident on 16 June 1958 at Capão Grosso, Curitiba, Brazil. Accident Report Form Summary as released by the Air Ministry, Brazil, 12 May 1959.

Circumstances

The aircraft was proceeding from SBFL (Florianópolis), when over NDB CT it received instructions from the tower to initiate the approach procedure for Runway 33, whereupon the pilot started his intermediate approach. After three minutes, since the aircraft had not reported on base turn, the tower operator called the pilot to check the aircraft's position, but received no reply. Having lost two-way radio contact, the tower gave the alarm, and later learned that the aircraft had crashed. The Aircraft Accident Investigation Commission found that in the final phase of the intermediate approach leg, the base turn and the beginning of the final approach, the aircraft was flying in cumulonimbus; it was therefore concluded that downward currents had affected the rate of descent to the extent of making the aircraft lose altitude and ultimately crash to the ground. Five crew members and 16 passengers were killed, and 5 passengers were seriously injured, and the aircraft was destroyed.

Probable Cause

The accident was due to downdrafts.

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ICAO Ref: AIG/ACC/REP/GEN/No. 8

No. 36

Indian Airlines Corporation, DC-3C, VT-COJ, accident near Damroh, North East Frontier Agency, on 25 June 1958. Report released by the Civil Aviation Department, Government of India, 28 August 1958.

Circumstances

The aircraft took off from Mohanbari at 0902 hours Indian standard time for a supply dropping sortie to Damroh. It was in contact with Mohanbari at 1028 hours when it was over Pasighat awaiting the weather to clear over Damroh. There was no further contact. At about 1345 hours the Duty Officer, Jorhat Control Tower received a message from Assistant Political Officer, Damroh that the aircraft had crashed at 1100 hours and four crew had been killed. In all there had been 3 flight crew and 4 ejection crew aboard the aircraft. One of the three seriously injured survivors died subsequently. The aircraft was damaged beyond repairs.

Investigation and Evidence

The aircraft had flown for 1 711 hours 20 minutes since overhaul and 12 576 hours 5 minutes since manufacture.

A pre-flight inspection was carried out by an aircraft maintenance engineer before the aircraft started its operations on the day of the accident.

The captain had a total flying experience of 7 131 hours including 6833 hours on DC-3 type aircraft. He had 248 hours of instrument flying experience. He reported for NEFA operations on 29 May 1958 and was checked out by the officer-in-charge of freight operations on six supply dropping missions before operating as a commander on these sorties. He had undertaken a total of 62 sorties of which 19 were landing sorties. He had done two sorties to Damroh previous to the accident.

The co-pilot's total flying experience was 2 115 hours including 1 797 hours on Dakota type aircraft.

Weather

There is no meteorological office at Damroh or on the route Mohanbari to Damroh except at Pasighat. NEFA authorities obtain the information regarding the actual weather conditions from Damroh through W/T. Such observations are made twice a day - once at 0530 hours and again at 0800 hours by the W/T operator who transmits the message to Mohanbari. This information is passed on to the pilots before they take off. The information received from Damroh at 0530 hours and at 0800 hours also on 25 June indicated that the weather was 'foggy'.

The meteorological observatory nearest to the place of the accident is at Pasighat about 27 miles south-southeast of Damroh. An extract from the current weather observations between 0900 hours and 1100 hours recorded at Pasighat is as follows:

	0900 hrs	1000 hrs	1100 hrs
Total amt. of cloud	8 octa	8 octa	8 octa
Surface wind	calm	calm	calm
Visibility	10 kms	10 kms	20 kms
Present weather	drizzle	light intermittent rain	rain in last hours

Individual cloud layer or mass

	Lowest layer	Second layer	Lowest layer	Second layer	Third layer	Lowest layer	Second layer
Amt. of cloud	2	8	1	3	8	[illegible]	[illegible]
Type of cloud	SC	AS	ST	SC	AS	SC	[illegible]
Ht. of base above ground level	750	3 000 m	240 m	750 m	2 700 m	750 m	3 000 m

Dropping Zone at Damroh

It is located at 28° 27' N and 91° 10' E and is situated at a height of 3 700 ft above mean sea level. It is on the bank of the River Yamni, one of the tributaries of the Dihang (Brahamputra) River. The direction of dropping is 340° or 170° with an oval circuit or a figure of 8. The surface of the dropping zone is uneven and gradually rises towards the southeast.

Experienced pilots state that the flying is normally smooth in the Damroh valley.

The Flight

The aircraft departed from Jorhat at 0658 hours on the first dropping sortie of the day to Panchang. After dropping the supplies it arrived at Mohanbari at 0828 hours.

The aircraft was refuelled under the supervision of a mechanic with 75 imperial gallons of fuel, thus making a total of 280 gallons of fuel on board distributed equally in both the main tanks. There was no auxiliary tank.

The second dropping sortie was to be at Damroh. It was reported that the fog would lift by the time the aircraft arrived over Damroh. The aircraft took off at 0902 hours and reported its position at 0907 hours as 10 miles from Mohanbari. At 1028 hours when circling over Pasighat it reported "Heavy rain over Damroh. Unable to get in. Waiting for clearance." At about 1035 hours Pasighat Tower informed Mohanbari that the aircraft had set course for Damroh. As the aircraft failed to return at the expected time, Mohanbari originated alert signals at 1148 hours and started overdue action at 1230 hours. At 1345 hours word was received that VT-COJ had crashed near Damroh, killing the captain, the co-pilot and seriously injuring three persons.

Loading

The aircraft was refuelled at Mohanbari and was loaded with 7 527 lbs of salt to be dropped at Damroh. The all-up weight of the aircraft was 26 884 lbs which was within the maximum permissible limits. The load was equally distributed on the cabin floor.

As usual with the flights of NEFA supply-dropping operations the pilot did not file any flight plan nor did he obtain any briefing for weather. The clearance for the flight was obtained on R/T when the aircraft taxied out at 0901 hours.

Statements of Witnesses

The aircraft was seen entering the valley from the south. The height of the aircraft was estimated as about 800 to 1 000 ft above the river bed - i.e. about 300 ft below the dropping zone. The aircraft regained height by circling to the south of the dropping zone and then proceeded to the north. After completing a circuit, it flew over the dropping zone at a height estimated to be 30 ft above the ground.

The load was not ejected over the dropping zone. The two survivors stated that on hearing the bell ring they pushed out 12 to 14 bags. It would appear that the signal for the drop was given too late and the first drop of salt bags was ejected out over the jungle to the north of the dropping zone from where it could not be recovered.

The aircraft was seen to return to the south along the valley at a height lower than the dropping zone. After taking a turn to the left, the aircraft was seen climbing and proceeding straight ahead leaving the dropping zone to the left. It had now, however, gained sufficient height to clear the hills ahead. During the course of a turn to the right to avoid hitting the hills the aircraft cut through tree tops and the port wing tip grazed the hillside thus causing the aircraft to swerve to the left and crash. It came to rest facing the direction from which it had come.

Partial dismantling of the engines showed evidence of adequate lubrication and no evidence of overheating. The filters were clean. No useful information could be obtained from the instruments, controls and the equipment in the cockpit and radio compartment due to the extensive damage.

Examination of the fuel system showed that both the engine fuel selectors in the centre section were selected to the starboard tank. These was no damage to the actual selectors or the cable operating drum but the operating cables had failed in tension. The starboard main tank was dry although there was no external damage or apparent leak. In the attitude of about 15° left wing low in which the aircraft was resting, fuel was flowing out of the port fuel tank cap.

The day following the accident 16 gallons of fuel were taken out of this tank. In the absence of adequate draining facilities it was not possible for the investigator to drain the tank completely and measure the fuel. The Assistant Political Officer at Damroh subsequently made arrangements for draining the fuel and a report from him stated that 63 imperial gallons were recovered from the tank in addition to the 16 gallons previously drained. It was calculated that the tank would have to contain a minimum of 105 imperial gallons for it to flow out of the filter cap with the aircraft in the attitude at which it came to rest.

It remained a probability that the fuel system was mismanaged thus causing the starboard tank to empty while retaining in full the contents of the port tank. Temporary cutting of the engine(s) when manoeuvring in the dropping zone area would have caused a loss of height, diverted the attention of the pilot and thus contributed to the accident. The time available and the height of the aircraft above the terrain were both insufficient for jettisoning the load to obtain a better rate of climb and to diagnose the trouble for taking corrective action.

Probable Cause

While manoeuvring at a low height in mountainous terrain during a supply dropping mission the port wing grazed the side of a hill thus causing the aircraft to slew and crash. A contributory factor might have been the mismanagement of the fuel system which caused temporary loss of engine power and height.

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ICAO Ref: AR/571

No. 37

Compañía Dominicana de Aviación, Curtiss Commando, C-46A, HI-16, crashed after taking-off from "General Andrews" Aerodrome, Ciudad Trujillo, Dominican Republic on 17 July 1958. Report released by the Directorate General of Civil Aviation, Dominican Republic

Circumstances

Flight 402 departed Ciudad Trujillo on a cargo flight to Miami, Florida, with a crew of 2 aboard and no passengers. Following take-off from Runway 23 and at a height of approximately 150 ft the aircraft fell to the left of the runway, some 300 ft from the centre line and 200 to 300 ft short of the runway end. Both crew members were killed by the impact which occurred at approximately 1016 hours GMT. The aircraft was destroyed by impact and fire.

Investigation and Evidence

The terrain at the site of the accident is covered with low rocks. A wall of cement blocks about 18 inches high marks the boundary of the airport with a private residence. The fuselage, which separated from the tail unit, came to rest in the courtyard of this residence.

The fuselage was split across at the main door. The tail unit came to rest approximately 10 ft away from the main section. The upper part of the rudder was torn off, and a fracture in the lower part of the tail unit was caused by violent collision with the terrain. The front section of the fuselage collided violently with the heap of blocks, which stopped its course and displaced both engines.

The right engine was slightly deflected from its normal position and the propeller hub pointed to the right. Only one blade remained attached; this was in high pitch. Break-off of the other three blades at the barrel guides was caused by stress contrary to propeller rotation. The hub remained intact and in an approximately normal position.

The left engine was torn free on impact, and it was displaced to the left and damaged by impact with the ground. A considerable portion of this engine was destroyed by fire. Two propeller blades remained attached, one apparently fully or nearly fully feathered. The other, which during investigation was found with the leading edge reversed, clearly struck the ground in a normal position and in full operation. As regards the two blades which fell off, one of them left its barrel guide when the latter split violently in consequence of stress contrary to propeller rotation, which shows that the causes were impact with the ground and power of the engine. The other blade left its barrel guide on impact, but there was no split of the guide, and the propeller's electric motor also fell off on impact.

Both left and right elevators were almost intact and normally positioned in relation to the tail unit, with trim tabs about 10° up.

The left mixture selector had been twisted on impact to the auto-lean position. The right one was on auto-rich. Both throttles were set to normal take-off power. The right propeller rpm selector was set to normal take-off position; the left one was one inch lower. The right engine cowl flap control was three-quarters open, the left one closed. Destruction of the rest of the control column prevented any further checking of the various controls.

The landing gear control showed that it was retracted at the time of impact.

The Flight

One hour before take-off the aircraft had been refuelled, and the pre-flight mechanical check as well as a visual inspection had been carried out by the crew.

The weather was as follows:

Ceiling and visibility unlimited; wind calm; temperature 23.2°C; pressure 1017 mb; dewpoint 23°C.

The take-off run was normal. The gear was retracted and the aircraft rose, according to witnesses, to about 150 ft before covering two-thirds of the 7 000 ft runway. It climbed rapidly with both engines operating normally until it reached a height of 150 ft. It is assumed that the port engine failed at this point. The nose went up and the aircraft yawed to port, banking about 30°, and began to lose speed and height. Apparently the crew cut the operative engine, possibly with the intention of effecting an emergency wheels-up landing on the remaining stretch of runway, but almost immediately reapplied full power in both engines, presumably in an attempt to use some remaining power in the failed engine and to continue the flight on one engine. However, as the aircraft continued to lose height it went into a stall and crashed, striking a cement block fence.

Assuming that the pilot employed the optimum technique from the beginning of the take-off run until he reached a height of 150 ft, and taking into account the distance covered on the runway and the height reached, the true airspeed would not be in excess of the minimum speed allowed for flights with one engine operative, even if maximum continuous power were used for climbing to this height. The speed loss caused by engine failure, combined with the minimum speed used in climb, apparently decided the pilot to discontinue the flight and to effect an emergency wheels-up landing on the section of runway still available. This is borne out by the fact that he cut both engines. However, imminent risk of stalling may have caused him to reapply full power in both engines when a faulty reaction in flight characteristics possibly caused him to lose control of the aircraft.

It is quite possible that the low speed involved in the high rate of climb adversely affected the single-engine performance. The destruction caused by impact and fire made it impossible to check the port engine for the cause of failure.

Probable Cause

The accident was originally caused by a mechanical defect in the port engine. The immediate cause may have been that the crew, encountering difficulties, applied an abnormal procedure, apparently attempting an emergency wheels-up landing and immediately thereafter trying to resume normal flight by applying full power to both engines, as there was no sign that either propeller had been feathered.

It is likely that propeller overspeed or excessive decrease in pitch, or difficulties in the attempt to reoperate the defective engine, combined with critical speed at the height reached on take-off, created abnormal flight characteristics which caused the aircraft to stall and crash.

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ICAO Ref: AR/531

No. 38

Central Flying Service, Inc., Beechcraft Travel Air, Model 95, N 819B, accident near Little Rock, Arkansas, on 22 July 1958. Civil Aeronautics Board (USA) Aircraft Accident Report, File No. 2-0054 released 1 April 1959.

Circumstances

N 819B took off at approximately 1102 hours central standard time from Adams Field, Little Rock Municipal Airport, Arkansas on a check flight. On board were the General Operations Safety Inspector, CAA, a pilot who was to be flight checked for a twin-engine type rating and two passengers. It flew the traffic pattern, landed and then took off again and departed the Adams Field traffic pattern at 1109 hours. Shortly before 1200 several witnesses saw the aircraft 9 miles west of Mayflower, Arkansas. It nosed down and started to spin from an altitude between 800 and 2 000 ft, and subsequently struck the ground 25 miles northwest of Little Rock, killing all 4 occupants.

Investigation and Evidence

The aircraft was relatively new, had been properly maintained and was in good operating condition.

At time of take-off the gross weight of the aircraft was approximately 4 000 lbs, or the maximum allowable gross take-off weight, and the centre of gravity was within the allowable limits.

The pilot being flight checked was relatively inexperienced in light twin-engine aircraft. His time in such aircraft was 10 hours, of which 5 hours were in the Beech Model 95. He had a total of 1 500 hours piloting time in various types of single-engine aircraft.

The inspector had to his credit 5 341 logged flying hours plus other unlogged piloting. He had completed the CAA's "light twin" checkout program in order to qualify for giving "light twin" engine rating flight checks. He had also completed a second course entitled "Aircraft Characteristics and Performance Below 12 500 Pounds". He had given 18 multi-engine flight checks since he had completed this course, of which five were in the 60 days immediately preceding the accident. The Beechcraft Travel Air, Model 95, with a maximum weight of 4 000 pounds, is classed as a light twin. The inspector had about 440 multi-engine flying hours, but no recorded time in this model aircraft.

The crash site was a cornfield on a flat river-bottom land, soft from recent rains. The aircraft had contacted the ground in a slightly nose-low attitude while descending nearly vertically. There was evidence of some forward motion and some motion to the right; however, the predominant direction of movement was downward. The aircraft initially struck the ground on a heading of 127 degrees magnetic, and then, except for the empennage, pivoted counter-clockwise on the right engine to a heading of 108 degrees. The empennage which was torn almost free came to rest on a heading of 080 degrees. The wreckage was not scattered, showing the predominant vertical motion at impact.

Except for the tail surfaces, the entire aircraft was extensively damaged by the severe ground impact. Examination of the wreckage accounted for all parts of the aircraft and determined that none were lost in flight. The flight control systems were generally intact and showed no evidence of malfunction or failure prior to impact. Examination of the powerplants disclosed that both were extensively damaged by impact as indicated by the crushed undersection of the engines and the twisted propeller blades. The tear-down inspection indicated that the crank-shafts and bearings and associated drive gears were intact, adequately lubricated, and free of indications of operating distress. Examination of all propeller blades revealed impact distortions consistent with a no-power condition, which is normal procedure for spin recovery in this aircraft.

The exact manoeuvre that was being attempted at the time the spin started cannot be determined from physical evidence, but it may logically be deduced. Normally this type of check flight for rating lasts from an hour to an hour and a half. Manoeuvres to be demonstrated to the satisfaction of the inspector are a simulated single-engine climb-out following a missed approach, an engine failure on take-off, and an engine failure at minimum-control speed. As the accident occurred after the check had been in progress for about an hour, and as these manoeuvres are normally done toward the end of the flight, it seems entirely possible that one of these was in process when the spin started.

It is most unlikely that a spin was started at low altitude intentionally. Spins are not called for in either the testing for type certification of most twin-engine aircraft nor during check flights for type ratings. The Board was of the opinion the spin occurred unintentionally.

The spin-recovery characteristics of the aircraft are good so that any conventional spin-recovery technique results in a rapid stopping of the spin. Stopping the spin does, however, leave the aircraft in nearly a vertical dive since the spin is a normal nose-well-down spin. Recovery from this dive with flaps up and the loading which existed on N 819B would take from 1 000 to 1 500 ft of altitude.

If a spin or any other manoeuvre is entered which endangers the safety of the aircraft during a flight test, the CAA inspector customarily takes over the controls and recovers from the manoeuvre. The performance of this function is possible with the single throw-over control column. However, during the entry of a spin or its recovery, particularly at low altitude, the Board believes this function would be considerably more difficult.

When N 819B contacted the ground it was in approximately a 20-degree nose-low attitude with the left wing down and was moving slightly forward and to the right but primarily vertically downward. This indicates that a recovery had not been effected even though opposite rudder (right rudder deflection) control existed at impact. The nose-up attitude (relative to a normal spin) was in all probability caused by the pilot's last-second attempt to pull the nose up by up-elevator movement just before contacting the ground.

The Board was of the opinion that a stall and spin occurred at a low altitude during the demonstration of one of the engine-out minimum-control speed manoeuvres. The Board was, however, unable to determine their reasons for entering the initial spin. Nevertheless, it believed that the following factors may have caused or contributed to the entry into the spin. The only experience that the inspector had in this particular make and model aircraft was during the flight ending in the accident. During this time, about one hour, it is reasonable to believe that the applicant pilot did most of the flying. It appears that the inspector was not familiar with the handling and stalling characteristics of the airplane. During the performance of simulated engine-out manoeuvres at minimum-control speed it is, therefore, possible that the aircraft reached a stall-spin airspeed condition before the inspector recognized it. In this condition, any mistaken handling of the powerplant or flight controls could lead to an unintentional spin.

Civil Air Regulations permit the use of the throw-over control wheel for type rating flight checks in lieu of fully functioning dual controls when the Administrator has determined that fully functioning dual controls are not necessary. This determination is made by CAA inspectors when and after considering all factors, they are satisfied that the test can be conducted safely. The Board was of the opinion that in a flight check with this type aircraft a spin should not normally occur but that if a spin is inadvertently entered, recovery may be effected with a throw-over wheel positioned on either side of the cockpit provided there is sufficient altitude. However, the Board was of the opinion that on this particular flight fully functioning dual controls might have prevented the accident.

Aviation Safety Release No. 405 was issued in June 1956 to combat a rising accident rate in light twin-engine aircraft operating on one engine. The release directed that an increased emphasis be placed on engine-out procedures and that examiners require that the applicants demonstrate satisfactory competence in flying the aircraft under these conditions. After the release of ASR 405 the accident rate trend reversed and has shown a steady decrease, attesting to the merit of this release. The Board recognized that the proper demonstration of single-engine manoeuvres necessitates the aircraft being flown at airspeeds bordering stall conditions. The Board recognized also that there are advantages in performing the manoeuvres as low as possible to most nearly simulate control and power conditions of an engine failure in the critical circumstance of take-off and landing.

Following the accident, the CAA instructed their flight inspector and examiner personnel to provide, during flight tests in multi-engine aircraft, sufficient altitude for safe recovery from inadvertent spins occurring during manoeuvres conducted at minimum-control speeds, engine out.

Probable Cause

The probable cause of this accident was the unintentional entry into a spin at too low an altitude to recover.

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ICAO Ref: AR/569

No. 39

Parsons Airways Limited, Norseman IV, CF-BZM and Ontario Central Airlines Limited, Norseman VI, CF-IRH collided in mid-air during an approach to land at Kenora, Ontario on 25 July 1958. Report released by the Department of Transport, Canada. Serial No. 58/118-8, B-26-13.

Circumstances

At 1005 hours, Norseman IV, CF-BZM, took off from Malachi, Ontario, bound for Kenora on a non-scheduled flight with a pilot and 3 passengers on board. At about 1020 hours the aircraft arrived over Keewatin, approximately 2 miles west of Kenora, at an altitude of 1 500 ft, heading downwind, and started a routine left-hand circuit, descending on the downwind leg to 1 000 ft. The aircraft turned at 800 ft into the wind which was WNW and descended at a rate of 500 to 700 ft per minute. At about 20 ft above the water, the pilot saw a red and yellow flash on his right wing tip and then heard a loud noise. The aircraft went out of control, rolled to the left then right, and crashed into the lake in a slightly nose-down attitude, swung 200 degrees and came to a stop in a southerly direction about 60 ft from the other aircraft.

On the same day, Norseman VI, CF-IRH, took off from Bell Lake, Ontario, on a non-scheduled flight with the pilot and 7 passengers on board. At about 1020 hours, the aircraft arrived in the vicinity of Kenora and turned onto the final leg of the approach to land, about 1-1/2 miles from the selected landing area. A straight power-on approach for approximately one mile was made and when about 20 ft above the water, the pilot looked out of the left window, saw the streamlined portion of a wing tip of another aircraft and heard the noise of the impact. The aircraft went out of control, struck the water, bounced about 25 ft, dived into the water and turned over.

CF-BZM was destroyed, while CF-IRH was damaged substantially. No fatalities occurred, but one of the passengers on CF-IRH was seriously injured.

Investigation and Evidence

The Certificates of Airworthiness for both aircraft were valid at the time of the collision. No evidence was found to indicate malfunctioning of the engines, airframes or controls of either aircraft prior to the accident.

The pilot of CF-BZM held a valid Commercial Pilot Licence and had accumulated a total of about 7 865 hours of flying experience of which about 4 500 hours had been acquired on this type of aircraft.

The pilot of CF-IRH held a valid Commercial Pilot Licence and had accumulated a total of about 3 200 hours of flying experience of which about 1 500 hours had been acquired on this type of aircraft. About 15 hours had been flown during the 90 days prior to the accident.

Probable Cause

Both pilots failed to maintain an adequate look-out during the initial and final stages of the approach for landing. The two aircraft were flown on converging courses and a collision ensued at a height of approximately 20 ft above the surface of the water.

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No. 40

Central African Airways Corporation (Salisbury, Rhodesia), Viscount, VP-YNE (Mpika), crashed on the hills 5-1/2 miles to the southeast of Benina Aerodrome, Cyrenaica, on 9 August 1958. Report released by the Ministry of Communications, United Kingdom of Libya.

Circumstances

The flight is a scheduled service from Salisbury, Rhodesia, to London and is known as the Zambezi service. This service is operated by three crews, one crew operating from Salisbury to Entebbe, the second from Entebbe to Benina and the third from Benina to London. On 8 August this service departed from Salisbury at 0713 hours and a stop was made at Ndola for traffic purposes. At Entebbe, a relief crew took over the aircraft for the sector to Benina. Stops were made at Khartoum and Wadi Halfa for refuelling and the aircraft left Wadi Halfa at 2120 hours for Benina; the flight was completely uneventful and slightly ahead of schedule up to the time of the accident. At 0112 hours the aircraft was cleared into Benina control zone. At the request of the pilot, at 0114 hours, permission was given by Benina Approach Control to make a direct approach on to runway 330° Right, using the locator and the responder beacons. Between 20 and 30 seconds after this clearance had been acknowledged by the pilot the aircraft struck high ground 5-1/2 miles to the southeast of the aerodrome. Fire broke out on impact. Of the 7 crew and 47 passengers aboard the aircraft, 4 crew and 32 passengers were killed in the crash.

Investigation and Evidence

Weather

The following is a summary of the actual weather conditions prevailing in the Benina area at the time of the accident, taken from evidence given by the captain of an Argonaut aircraft inward bound to Benina from Khartoum. The aircraft was flying approximately 45 miles behind VP-YNE when the accident occurred, and the captain saw the flash as the aircraft struck the ground.

There was no upper cloud. The lights of Benghazi were visible 45 miles out from 14 500 ft, but the aerodrome lights were not visible at that range. It was estimated that there was 4/8 low cloud with tops at 2 000 to 2 500 ft in the Benina area and to the southeast of the aerodrome there was 7/8 stratus which started at the edge of the aerodrome and extended for about 30 miles to the east and southeast. To the west and north of the aerodrome there was only 2/8 cloud with mist patches below. Whilst the Argonaut was carrying out a visual circuit it was confirmed that the cloud base was 500 ft. On base leg of the circuit, patches of mist or low stratus were encountered which temporarily obscured the runway lights. Visibility on short final approach was good and estimated at 5 to 6 miles.

The Argonaut captain was also under the impression that the cloud base was lower than 500 ft to the southeast on the approach to runway 330° Right but had no means of confirming this.

The assessment of the weather reported by this pilot is regarded as an accurate picture of the weather conditions prevailing at the time of the accident, since he made two circuits of the crash at 6 000 ft and two circuits of the aerodrome before landing very shortly after the accident occurred. There was also a quarter moon which had risen at 2256 hours.

The weather minima given in the Central African Airways Operations Manual for compliance by pilots when landing at Benina by night, using VDF or the non-directional beacon, is that the cloud base will not be below 400 ft and the runway visual range less than 3 000 yards. Since the last weather report passed to the pilot advised 6/8 stratus, cloud base 500 ft, visibility 6 miles, wind 360° at 2 knots, conditions were above these minima.

Crew

The captain's Airline Transport Pilot's licence was last renewed on 21 July 1958. His total flying experience at that time on multi-engined aircraft as pilot-in-command was: by day: 8 603 hours; by night: 555 hours; as second pilot:- by day: 1 456 hours; by night: 100 hours. These totals included 768 hours as pilot-in-command, and 152 hours as second pilot on Viscount aircraft.

When his Airline Transport Pilot's licence was last renewed the first officer's total flying experience as pilot-in-command was:- by day 2 916 hours; by night: 288 hours; as second pilot:- by day: 1 136 hours; by night 163 hours. Included in these totals was 961 hours as second pilot on Viscount aircraft. He passed his annual instrument rating test on 28 July 1958.

Reconstruction of the flight

The take-off from Wadi Halfa was made at 2120 hours with an estimated time of arrival at Benina of 0126 hours.

After passing longitude 25° east, the boundary of the Malta Flight Information Region, two-way radio communication was established with Malta Area Control Centre and at 0047 hours the following message from the aircraft was transmitted to Malta "abeam El Adem 0036 flight level 16.5. Estimating Benina 0116, estimating Benghazi southeast 0111. Request descent clearance at 0101." This message indicated that a slightly better ground speed had been achieved than was anticipated when leaving Wadi Halfa. Over the greater length of this desert route the radio navigational aids would give little real assistance and for this reason astro-navigation would have been used. However, when the aircraft came abeam of El Adem it was possible for the navigator to obtain an accurate bearing and distance from this aerodrome and, therefore, he was able from this information to plot the aircraft's position with accuracy. At 0038 hours a bearing of 131° class "A" was given to the aircraft by Benina Homer, and at 0048 hours a distance of 93 miles from Benina was read off on the distance measuring equipment. Therefore, it can be accepted that, at 0101 hours when the aircraft commenced its descent from flight level 16 500 ft, it was at the correct distance of 46 miles out from Benina and on track. At 0052 hours Malta cleared the aircraft to Benina Approach Control and to a flight level of 4 000 ft.

Subsequently, the aircraft communicated with Benina and confirmed its estimated time of arrival Benghazi South East (the boundary of Benina Control Zone) as 0111 hours and on this first contact with Benina, Approach Control passed the 0100 hours weather observation "Surface wind 360° at 2 knots, visibility 6 miles. Weather cloudy with 6/8 stratus estimated base 500 ft QNH 1012. Benina Approach Control then asked the aircraft to report reaching flight level 4 000 ft and when at Benghazi South East, which was acknowledged. At 0112 hours, VP-YNE advised "At Benghazi South East this time and just coming up to flight level 4 000 ft." The aircraft was then under the direct control of Benina Approach Control. The controller then cleared the aircraft to continue its descent to a height of 2 500 ft which was acknowledged by "Roger, clear down to 2 500 ft request QFE and surface temperature." This was passed to the aircraft as 997 millibars, surface temperature 22°C, the aircraft acknowledging with "Roger 997 22°". Approximately one minute later the pilot asked if he was clear for a direct approach on responder and locator beacons. This was acknowledged by Benina Approach

Control "Affirmative, I have no other traffic. You are cleared to position for a direct approach on locator beacon and responder. Advise finals". This was acknowledged, "Roger leaving two-five now". This was the last call received from the aircraft.

Rescue Services

Due to misunderstanding mainly created by language difficulties in the control tower, the effort to locate the site of the accident did not get into full swing until 0300 hours.

At the time of the accident Benina tower was manned by the controller and an Air Traffic Control clerk, the normal staff complement. The controller instructed the clerk to alert the telephone exchanges and then to inform the airport fire section of the accident and to order the dispatch of fire and rescue vehicles, but to retain one fire tender to cover the expected departure of a Britannia aircraft. This conditional instruction, which had to be translated into Arabic by the clerk and passed to the fire section, manned at that time entirely by Arabic speaking staff, resulted in one ambulance only being dispatched immediately. The controller then asked the clerk to inform the British Military Hospital (BMH), the army fire brigade and the civil hospital that an aircraft with 54 people on board had crashed and to send ambulances and medical aid to Benina immediately. The controller contacted the U.S.A.F. at Berca 2 aerodrome, and the R.A.F. at El Adem and Malta, informing these units of the accident and requesting assistance.

The evidence relative to subsequent events is conflicting. However, the following facts have heen substantiated:

The fire and rescue vehicles ordered by the controller through the Air Traffic Control clerk were not dispatched at once. However, the ambulance was dispatched to a point just outside the aerodrome where it waited some considerable time and eventually followed other vehicles to the accident. The fire-rescue Landrover fitted with VHF R/T, which should have been the first vehicle away, did not leave the aerodrome until approximately 0230 hours when it was taken by the Fire Services Officer, who had driven by car from his residence in Benghazi after being notified of the accident.

A Landrover from the fire section, which had been asked for by the captain of the relief crew awaiting the arrival of VP-YNE, left the aerodrome approximately thirty minutes after the accident. Aboard this vehicle were the captain, his first officer, a flight hostess, the control tower clerk and the driver.

At approximately 0245 hours the controller realized that the ambulances from the BMH had not arrived, and, therefore, put a call through to the hospital himself, and was told that the hospital had not been notified before.

On this point the evidence is again conflicting since the clerk states that he spoke to the BMH when told to do so by the controller and thought that the controller had spoken to the BMH on one line while he, the clerk, was giving a message to the civil hospital on another. The operator in the Benghazi telephone exchange states that he put a call through to the BMH from Benina at about 0115 hours but the duty telephonist at the BMH states that no calls were received by him between 2230 hours on the 8th and 0300 hours on the 9th, when a call was received from Benina asking if the ambulances were on their way to the accident. This was confirmed by the Wardmaster who was in the hospital telephone exchange from 2100 hours to 0300 hours.

The ambulances from the BMH arrived at the scene of the accident at 0500 hours, led there by the Cyrenaican Defence Force vehicle that had located the accident a short time before.

No fire fighting vehicles arrived at the accident site.

In spite of the delay in the arrival of the rescue services there is evidence from the commanding officer of the BMH to show that an earlier arrival would not have affected the number of survivors. The delay must have caused additional suffering to those injured.

Accident Site

The first indications of contact with the ground were the track marks of the nose and mainwheel tires at a position surveyed as 6.058 statute miles from the Control Tower at Benina aerodrome and 539 ft above the height of the runway (964 ft a.m.s.l.). The magnetic heading of the aircraft at the time of impact was 328°, this being clearly shown by the ground markings. The path of approach had been over a rocky plateau with some undulations, but for the most part flat country.

Pre-crash failure

The possibility of any structural failure of the airframe or malfunctioning of the engines or propellers is dismissed in view of the complete lack of any evidence to support such a possibility. The examination of the wreckage, the survivors' statements, some of whom were expert witnesses, and the fact that the pilot was in R/T communication with Benina Approach Control 20, or at the most 30, seconds before the accident occurred all point to the conclusion that no emergency existed.

There is no reason to suspect malfunctioning of any of the navigational or radio aids. In this connection the DME responder on the aerodrome was functioning correctly at the time of the accident and the fact that the pilot had used this equipment when passing El Adem and on the approach to Benina indicates that the aircraft's equipment was also serviceable. The Benina non-directional beacon "BN" was serviceable since it was being used by the BOAC Argonaut at the time of the accident. The runway locator beacon "BN1" was operating and the fact that the pilot had asked to use this aid when within range would indicate that he was receiving the signal satisfactorily. The receiving equipment for the two radio compasses was recovered from the wreckage and found to be tuned to the correct frequencies.

Instrument approach procedures, Benina

At Benina aerodrome the pilot had the choice of three instrument approach-to-landing procedures. The first involves the use of the locator beacon "BN1", the second the locator beacon and DME, the third VDF.

In this instance the pilot elected to approach the runway using the DME and locator beacon without first establishing himself over the aerodrome by the appropriate radio aids. This decision had doubtless been influenced by the fact that the major part of the descent had been made in the clear and with the lights of Benghazi in sight and possibly those of the aerodrome, although the latter is considered to be unlikely. This method of approach, which in reality is the last part of the published DME locator procedure, can be regarded as acceptable if all the equipment is serviceable, and in this case the evidence indicates that it was so. However, with a cloud base of 500 ft the margin of safety must be reduced compared with the procedure whereby the pilot first establishes his position over the aerodrome at the minimum safe altitude. Nevertheless, the controller's evidence shows that the type of approach used in this instance by the captain of VP-YNE is often carried out by pilots when landing at Benina.

The captain's decision to make an approach using DME and locator beacon indicates that it was he and not the first officer who was flying the aircraft, since he was sitting in the left-hand seat and the DME indicator is on the lower left-hand side of the captain's instrument panel making it difficult for the second pilot to read this instrument when sitting in his seat in a normal position.

At a distance of 5-1/2 miles from the locator beacon the aircraft's mis-alignment with the extended centreline of the runway would only be indicated by a small deflection of the radio compass needle. Therefore, if the pilot was satisfied that he was at his correct height of about 1 650 ft above aerodrome level and 5-1/2 miles from the aerodrome then he would also have been satisfied that he had sufficient height and distance to turn on to the extended centreline in good time before reaching the runway. At the time of the impact he was closing on the centre-line, if only slowly, as shown by the air-craft's heading of 328° compared with the runway bearing of 330°.

The descent

The pilot commenced his descent from flight level 16 500 ft at 0101 hours. The descent was made in the clear until the aircraft entered the stratus cloud reported to the southeast of the aerodrome at probably 2 000 to 2 500 ft a.m.s.l. During the descent it is certain, from the evidence given by the Argonaut captain, that the lights of Benghazi would have been visible to the crew of VP-YNE, and it is possible, although unlikely, that some of the lights of Benina were also visible occasionally.

At 0112 hours the pilot reported that he was at flight level 4 000 ft and his position Benghazi South East (this is the entry point to the Benina Control Zone and is 14 miles from the aerodrome). The aircraft was then cleared to continue the descent to 2 500 ft, but before reaching this height the pilot asked for clearance to make a direct approach on to run-way 330° Right, using the responder and locator beacons. After permission was given for this approach, the pilot announced that he was leaving 2 500 ft which, as near as can be judged, was two to three minutes after he had called when over Benghazi South East. Twenty to thirty seconds after the call at 2 500 ft the aircraft struck the ground 964 ft a.m.s.l., 8-1/2 miles from the zone boundary and 5-1/2 miles from the aerodrome.

It is difficult to calculate with accu-racy the rates of descent and ground speeds during the latter part of the flight since R/T messages at Benina are not auto-matically recorded. The evidence concerning the time lapse between the last call from the aircraft and the crash, as estimated by the controller and subsequently checked by a timed demonstration, is sufficiently accu-rate to calculate that a rate of descent between 3 100 and 4 600 ft per minute would have been necessary for the aircraft to have struck the ground at a height of 964 ft a.m.s.l. assuming that it was actually at 2 500 ft when the call was made. Additionally, the evidence given by the Argonaut captain supports the controller's estimation of the short period of time between the last call and the crash.

Such an excessive rate of descent is unacceptable in view of the survivors' evi-dence on the normality of the descent, and it would have resulted in far greater initial structural damage than was evident from examination of the wreckage. Alternatively, since the distance of the crash from the aerodrome has been definitely established as 5-1/2 miles, and accepting that the last call was made 20 to 30 seconds before impact, the aircraft would have been between 6.25 and 6.6 miles from the aero-drome at the time of the call, assuming an approach speed of 135 knots. Therefore, if a rate of descent of as much as 1 500 ft per minute was being maintained the air-craft would have been located a little more than 4 miles from the aerodrome when it reached the height of 964 ft and at this distance would not have collided with the high ground. Although in this example a rate of descent of 1 500 ft per minute has been used, it should have been considerably less (nearer to 500 ft per minute) if the pilot was adhering to the procedure for approaching runway 330° Right when using DME and locator aids. Therefore, on this final descent it is evident that when the pilot made the call "leaving two-five now" he could not, in fact, have been at this altitude.

The main point at issue in this accident is, therefore, the determination of why the aircraft struck the ground 539 ft above aerodrome level and 5-1/2 miles out from the aerodrome on final approach, when it should have been at about 1 650 ft at this distance. If the pilot was aware of the distance from the aerodrome then he would have elected to be a great deal higher than he was, or, alternatively, if he was aware of his height then he must have estimated that he was considerably nearer to the aerodrome than he actually was. In regard to his awareness of distance, the earlier paragraphs give reasons for the assumption that the DME was serviceable, but the possibility of his misreading this equipment should not be overlooked. In this connection it will be remembered that the two scales 0 to 20 miles, and 0 to 200 miles on the indicator are presented on the same instrument dial; however, the very big difference in the position of the needle when reading 6 miles on the 0 to 20 mile scale and the same distance on the 0 to 200 mile scale makes the possibility of inadvertent range selection remote. This equipment would almost certainly have been used to establish VP-YNE's position when at Benghazi South East, 14 miles distant from the aerodrome, and the fact that it was necessary for this position to be established with accuracy supports the view that the correct lower range scale was selected then, as well as at the time of the accident.

Turning now to the error in height at the time of the crash when the aircraft was 539 ft above aerodrome level instead of at about 1 650 ft as given in the approach chart - three explanations are possible.

Firstly, the pilot deliberately descending to 500 ft above runway height in order to break cloud is considered to be extremely unlikely since there is no doubt that he was familiar with Benina aerodrome and the surrounding terrain. In support of this view, the captain had used this aerodrome on many occasions, and evidence given by a pilot who had recently flown as his first officer confirms that he was well aware of the presence of the high ground to the southeast of the aerodrome.

Secondly, the incorrect setting of the altimeter millibar scale by the pilots has been considered but rejected as unlikely. The QNH and QFE were repeated back to the controller by the pilot, and the dial of one altimeter was recovered from the wreckage; the dial of this instrument had the correct QFE set upon it and the 10 000 ft needle, the only one remaining, was found at the zero position. To minimize the possibility of incorrect settings of the millibar scale and to check the accuracy of two altimeters it is common practice for pilots to cross check their respective QNH and QFE altimeter readings after the settings are applied, the difference in altimeter readings indicating the published height of the aerodrome, or, that one of the altimeters is unserviceable. Central African Airways had issued an operational order to pilots requiring this to be done. In view of the foregoing it is unlikely that either of the altimeters was unserviceable or incorrectly set on the millibar scale.

Thirdly, the misinterpretation of the reading of the altimeter by the pilot is strongly supported by the evidence of the short lapse of time between the last call from the aircraft and the moment of impact. It must be taken into account that, since for the greater part of the descent the pilot had been flying in clear weather conditions with the lights of Benghazi in view, he had probably not made the same reference to his instruments as if the whole descent had been in cloud. It is possible that the initial incorrect interpretation of the instrument reading may have been made some time before entering cloud at about 2 000 ft. After entering the cloud at this height the pilot would have been commencing the direct approach and his attention would, in all probability, be more concerned with the 100 ft hand than with the 1 000 ft hand, so that an error made before entering the cloud would have been maintained subsequently. It is pertinent to consider here that if the pilot did in fact over-read his altimeter by 1 000 ft, then the rate of descent between the time of his last call and the time of the crash would be acceptable. A contributory factor when considering the likelihood of the pilot misreading his altimeter is the instrument panel lighting. VP-YNE was equipped with two lighting systems, ultra-violet and red. When the red system only is being used, the positioning of the lights causes a shadow to be cast over the upper part of the altimeter, thus detracting from the ease of reading. This is particularly noticeable when the 1 000 ft hand is between the dial figures 9 and 3. However, if the ultra-violet lighting is directed on to the altimeter, this difficulty is eliminated, but in any case it has not been possible to establish whether either or both systems were being used at the time.

Possibility of crew fatigue

Finally, the question of whether or not the pilots were unduly fatigued at the time of the accident should be considered. A surviving crew member stated in evidence that the crew had returned at about 1900 hours on 7 August and the following morning had taken breakfast at 0630 hours. The same witness was not aware of any crew member sleeping between breakfast time and 1230 hours, the time they reported for duty at Entebbe aerodrome. Therefore, at the time of the accident the crew would have completed over 19 hours without sleep, of which 12 hours, 44 minutes had been spent on duty, including 9 hours, 30 minutes flight time, although from 3 August until the commencement of this flight the crew, with the exception of the cabin staff, had been relieved of all duties. During the sector between Wadi Halfa and Benina the captain had complained to a flight hostess of slight pains in his stomach, for which he was given some kaolin. The fact that the captain was slightly indisposed is not considered significant in itself. Nevertheless, this, coupled with the long period he had been without sleep, and the fact that the flight was finishing in the early hours of the morning, make it possible that his efficiency had been lowered to some extent.

A pilot's flight time limitation, as prescribed in the Federation of Rhodesia and Nyasaland Air Navigation Regulations 1954, is 12 hours in any 24 consecutive hours.

Probable Cause

The cause of the accident was that when making an approach to runway 330° Right and whilst flying in cloud, the pilot descended below the correct height thus permitting the aircraft to strike high ground.

The reason why the pilot descended so low, 5-1/2 miles from the aerodrome, cannot be established, but the most probable cause is that he misinterpreted the reading of his altimeter. The possibility that his efficiency had been reduced by fatigue and a slight indisposition cannot be excluded.

Observations

Electronic recording of the R/T between Benina tower and the aircraft would have facilitated the Board's investigation into the accident and it is thought that this equipment should be provided at Benina and other airports having a similar traffic density.

Statements made by certain of the survivors indicate that difficulty was experienced in locating the operating handles of the emergency exits after the crash. When considering these statements it must be appreciated that the crash occurred in darkness and caused the fuselage to become inverted although some of the survivors were not aware of the fuselage position until after they had evacuated the aircraft. Whilst instructions explaining the method of operation are printed on the flap covering the operating handle of each emergency exit, it is thought that passengers should, in addition, be informed either orally or by illustrated printed instruction, of the correct method of operating these exits so that in an emergency the exits can be released immediately.

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ICAO Ref: AR/563

FIGURE 24

CENTRAL AFRICAN AIRWAYS, VISCOUNT, VP-YNE, ACCIDENT
SOUTHEAST OF BENINA AERODROME, CYRENAICA, 9 AUGUST 1958.
- General view of the main wreckage - fuselage

No. 41

Lóide Aéreo Nacional S/A, DC-4, PP-LEQ, accident on Carapí Island, Pará State, Brazil, on 11 August 1958. Accident Report Form Summary as released by the Air Ministry, Brazil, 29 April 1959.

Circumstances

When transmitting its position to SBBE (Belém/Val de Cas) tower, over "Piranha" reporting point, the aircraft reported it was descending on "night time visual". Failing to obtain subsequent contact with the aircraft, the tower asked a Catalina aircraft, flying over SBBE at the time, to proceed to the above-mentioned reporting point in order to check what had gone wrong. The accident was then discovered. Six crew members and four passengers were killed, and one passenger was seriously injured.

Probable Cause

In spite of every effort by the Aircraft Accident Investigation Commission, it proved impossible to establish the cause of the accident.

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ICAO Ref: AIG/ACC/REP/GEN/No. 8

No. 42

Northeast Airlines, Inc., Convair 240, N 90670, crashed at Nantucket, Massachusetts, on 15 August 1958. Civil Aeronautics Board (USA) Aircraft Accident Report File No.1-0121, released 26 March 1959.

Circumstances

The aircraft was on a straight-in VOR (very high frequency omni range) instrument approach to runway 24 (240 degrees) at Nantucket, the intermediate stop of regularly scheduled Flight 258 from La Guardia, New York, to Martha's Vineyard, Mass. At low altitude in the area of the "H" facility (a low-power nondirectional radio beacon) the flight encountered heavy fog in which the pilot lost orientation and ground reference. At approximately 2334 hours the aircraft contacted the ground almost simultaneously with the initiation of an attempt to discontinue the approach. The crew of 3 and 22 of 31 passengers received fatal injuries.

Investigation and Evidence

Investigation at the accident scene disclosed that N 90670 initially contacted the ground approximately 1 450 ft short of runway 24 and about 650 ft to the left (inbound) of the extended runway centreline. The initial contact was shown by light tire tracks made by the tires of all three landing gear components. The lightness of the tracks in soft ground showed the aircraft had little, if any, rate of sink or descent at initial contact. Because all the tracks began nearly simultaneously it was also evident that the aircraft was nearly level laterally and longitudinally. Tire tracks by all landing gear components continued for about 145 ft along a magnetic heading of 233 degrees and over bumpy but flat terrain which averaged about 50 ft mean sea level.

All major components of the aircraft, including flight control surfaces, were accounted for in the wreckage or along the ground path. All attach fittings were secure or there was ample evidence indicating they were secure before the ground impact. It was determined all doors and access panels were closed and secure at impact. There was no evidence of fatigue failure and from the examinable structure there was no suggestion of inflight failure.

Although portions of the aircraft wreckage were destroyed or badly mutilated no evidence was found to indicate the aircraft or its equipment contributed to or caused the accident.

Weather information pertinent to the route indicated that at departure visual flight rules weather conditions existed but that by the time the flight reached Nantucket, fog might necessitate an instrument approach. Accordingly, the flight departed VFR but on a dispatch release and flight plan which authorized instrument operation, if necessary.

While en route the flight was in radio communication with the company radio located in the Nantucket terminal building and with Otis Radar Approach Control. The latter is manned by CAA personnel as an Air Traffic Control facility which has as part of its responsibility the control of instrument traffic for Nantucket.

The radio communications between Northeast flights and the company radio are not electronically recorded although the essence of each is entered in a radio log by the ground communicator. Radio transmissions between flights and Otis RAPCON are electronically recorded.

N 90670 was equipped with one VHF communications transmitter and one VHF communications receiver; therefore, Flight 258 could not communicate with Otis RAPCON and Nantucket company at the same time. This fact, and learning that the Northeast and Otis clocks were in accord, made it possible to compare the times of the Otis communications with the time entries in the radio log.

The Northeast agent testified that the initial contact between Flight 258 and Northeast radio occurred about 2314 when the flight asked for the Nantucket weather. He transmitted the 2259 hourly sequence report. However, the senior agent then took the microphone and advised the flight that this weather report was obsolete and according to a special report of 2311, the weather was "partial obscuration, 3/4 mile, fog." The flight also requested that the strobe lights* be turned on.

At 2314 the flight contacted Otis RAPCON and advised Otis it was "visual" and past the Newport intersection (located 50 miles southwest of Nantucket on Victor Airway 46) at 2312. The flight requested an instrument approach clearance to Nantucket estimating it would reach Nantucket at 2326. The clearance was issued at 2315.

About 2324 Flight 258 advised Otis it was going to company frequency for "the altimeter, etc." The company radio log reflected that information as to the active runway, surface wind, and altimeter setting was given the flight and logged at 2314. Investigation showed this time was entered following an erasure and that the time originally affixed was 2326. Because at approximately 2324 the flight stated it would request the information from the company it would seem the time entry of 2314 should have been 2326 as originally fixed. Further, because the CAA communicator who turned on the strobe lights testified it was done during the five minute period preceding 2330, it is entirely probable that the request for lights occurred when the flight requested other landing information rather than during the previous communication.

It was the testimony of the senior Northeast agent that he gave Flight 258 a special weather report of "partial obscuration, one-half mile visibility, fog." This observation was completed and logged at 2327 and immediately given Northeast over an intercom system. The senior agent stated he transmitted it to another Northeast flight, 2289, and to Flight 258. The time affixed to the radio log entry was 2328. The log showed an acknowledgment from Flight 2289 but not from Flight 258. The senior agent stated acknowledgment should have been recorded because he was positive the information was received and associated it with a personal conversation between the first officer of Flight 258 and himself.

The captain of Flight 2289 testified that he recalled Flight 258 being given "partial obscuration, 3/4 mile" and that it was acknowledged. He stated that thereafter he recalled visibility reports from the company radio of 1/2 mile, 1/4 mile and 1/8 mile. These, he said, were given in rapid sequence and he recalled no response from Flight 258 for any of them.

According to the Otis RAPCON transcription, at 2327 Flight 258 did not respond to a call from Otis but before 2328 returned to the Otis frequency. At 2328, in response to an inquiry, Flight 258 stated it had not started procedure turn but was "... just past the marker outbound."

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* Two condenser discharge flashing approach lights located in the approach zone 250 ft from the threshold lights, one on each side of the runway edge extended.

Thereafter, at 2330, the flight transmitted "and Otis this is Northeast 258, procedure turn." Otis responded, "Roger, Northeast 258 change to company." There were no other communications between the flight and Otis.

At 2330 special observation No. 21 was logged by the Weather Bureau observer as "partial obscuration, 1/8 mile visibility, fog." This was given Northeast immediately, according to the observer, and it was the testimony of the senior Northeast agent that he promptly transmitted it to Flight 258. He stated he gave the information twice with a substantial pause between each transmission and while there was no verbal response from Flight 258 he recalled a sound over the radio which he thought was a "mike click." He said the sound followed each of the two transmissions of 1/8 mile visibility. The senior agent estimated that the action occurred during a 60-90 second interval before he logged it at 2333. He also stated that at no time was a 1/4 mile visibility report given over the radio. Examination of the Weather Bureau observation log reflected no 1/4 mile observation and the weather observer stated he made no such observation.

The senior agent testified that the next occurrence was a report of a fire in the approach area to runway 24.

The Nantucket Memorial Airport is located on the south central side of the Island. It has no tower and is equipped with two crossing runways. Each is 4 000 ft in length and 150 ft wide although at the time of the accident runway 6-24 was being extended to 5 000 ft. This work at the southwest end restricted the usable length to approximately 3 800 ft. The airport has a regular clear green, medium intensity, 3 000 000-candlepower rotating beacon.

Runway 24 is the instrument approach runway. There is no ILS or ladder-type approach light system. The instrument runway, as well as the others, is equipped with conventional threshold lights and medium-intensity elevated runway lights of low-, medium-, and high-intensity settings.

The strobe lights previously noted were designed as a visual lighting aid to the instrument approach. They were installed by Northeast Airlines after considerable testing for this purpose. The condenser discharge lights were located 250 ft from the threshold lights, 150 ft apart, in the approach area. They flash twice each second emitting a beamed white light rated at 10 000 000-candlepower. A technical witness stated the beam was projected into the approach zone at an angle of 3.4 degrees above horizontal so that the lower side of the projected beam would be 300 ft above the ground over the "H" facility located 6/10 of a mile from the runway threshold. This position and altitude would be coincident with the approximate position of an aircraft at minimum altitude during the instrument approach. The witness stated that below the projected beam the light diminished rapidly and estimated it would be diminished 75% approximately 50 ft below the lower edge of the beam.

The record indicates that the strobe lights were on several minutes before the accident, and clearly shows that airport beacon, threshold lights, and runway lights were on, the latter set to high brilliance.

The reported weather conditions required that Flight 258 execute a straight-in VOR instrument approach. For the procedure the ground radio facilities consisted of the VOR station located 1.9 miles from the runway threshold and a Northeast-owned and maintained "H" facility positioned 6/10 of a mile from the threshold of runway 24, between the VOR station and runway on an inbound track of 240°. The manoeuvring area for the approach is over relatively flat unobstructed terrain with the elevation of the runway 47 ft mean sea level.

The CAA-approved VOR instrument approach procedure required establishment of a 60° outbound track after station passage. This is followed by a standard procedure turn on the north side of the track within 10 miles of the VOR station. Minimum altitude in the procedure turn is 1 300 ft. An inbound track of 240° is then required to again cross the VOR station and "H" facility to the runway. Minimum altitude over the VOR is 600 ft after which descent is permissible to the appropriate landing minimum altitude. Flown in a normal manner the approach procedure from the VOR station outbound to the VOR station inbound requires about five minutes. In the Convair about 55 seconds are required from the VOR to the runway threshold.

The basic weather minima for the VOR straight-in instrument approach at Nantucket are ceiling 400 ft, visibility 1 mile. According to the ACA Form 51I, with both the VOR and "H" facility in operation, the minima for Northeast Convair flights are ceiling 300 ft and visibility 1 mile. CAA witnesses testified that these minima were the result of a deviation authorized by the CAA after the carrier requested it. It was stated that such deviation is provided for in Civil Air Regulations and, because it required no significant deviation from the approach obstruction criteria, it was permissible for the local CAA office to grant the request. After consideration of many factors involved, this was done. It was explained that the carrier was authorized the "Sliding Scale" which is a provision of the Operations Specifications applicable to the straight-in approach. Operations Specifications are rules of particular applicability prepared and issued by the Civil Aeronautics Administration under the enabling provisions of Part 40 of the Civil Air Regulations. Under "Airport Authorization and Limitations" it is stated "For each increase of 100 ft above the minimum ceiling specified, a decrease of 1/4 mile in visibility is authorized, until a visibility of 1/2 mile is reached." Because at the time of the accident a partial obscuration, which does not constitute a ceiling, was reported, the "Sliding Scale" was therefore applicable to Flight 258 and it was authorized to make the approach in 1/2 mile visibility. The authorized minimum altitude of 300 ft was unaffected by the "Sliding Scale" provision.

It is important to note the responsibilities required of the pilot involved when below-minimum weather conditions are reported to a flight during an instrument approach. Civil Air Regulations Part 40, Section 40.406(d) is applicable and states, "If an instrument approach procedure is initiated when the current report prepared by the U. S. Weather Bureau or by a source approved by the Weather Bureau indicates that the prescribed ceiling and visibility minima exist and a later weather report indicating below minimum conditions is received after the airplane (1)... (2) is on a final approach using a radio range station or comparable facility and has passed the appropriate facility and has reached the authorized landing minimum altitude (3)... such approach may be continued and a landing may be made in the event weather conditions equal to or better than the prescribed minima for the airport are found to exist by the pilot-in-command upon reaching the authorized landing minimum altitude." Except under the aforestated conditions, the approach should be discontinued. Obviously, to meet the terms of this regulation the below-minimum weather report must be received by the pilot.

The conditions necessary for a descent below minimum altitude during an instrument approach for landing are stated in Air Carrier Operations Specifications. Item 32 of these rules under "Limitations on Descent Below Authorized IFR Landing Minima" states, "No aircraft shall descend below the minimum altitude for landing specified in the applicable Form ACA-511 unless clear of clouds. Thereafter, except when landing minima of 1 000-2 or better are authorized, no aircraft shall descend more than 50 ft below such altitude, unless (1) it has arrived at a position from which normal approach can be made to the runway of intended landing, and (2) either the approach threshold of such runway or the approach lights or other markings identifiable with such runway are clearly visible to the pilot. If, at any time, after descent below the clouds the pilot cannot maintain visual reference to the ground or lights, he will immediately execute the appropriate missed approach procedure prescribed in the applicable Form ACA-511."

Investigation disclosed there were several 55-gallon drums spaced along the extended centreline of runway 24. The drums were spaced along this line for a distance of 1 700 ft beginning at the "H" facility and extending toward the runway. The tops of the drums were painted white. The testimony of Northeast officials indicated the drums were put there in 1953 and originally extended from the "H" facility to the runway threshold, but those which originally were located over the last 1 800 ft were removed to satisfy a problem they created relating to use of the land. Company witnesses stated the barrels were intended to identify a ground position over terrain which had no other distinguishing features or contrast.

It was the testimony of the assistant chief pilot that the barrels were not intended to lead the pilot to the runway threshold and that it was doubtful if the barrels could be seen at night, especially in poor visibility. Company supervisors also stated the barrels did not qualify as "other markings identifiable with such runway" because they could be moved and thereby lacked the permanency required. It was stated that no operational aspect of the instrument approach procedure was predicated on the barrels. The assistant chief pilot stated, in response to questions, that it was conceivable a pilot might use the barrels as a guide to the runway in poor visibility or might consider them as "other markings. . . . "

Witnesses at the terminal, about 1 mile from the crash site, said that fog became evident at the airport about 2300 and thereafter until the crash it became very dense. The fog was described as sea fog which moved in from the ocean in layers and waves. It moved northeasterly from the ocean across the airport into the approach area of runway 24.

One witness at the terminal said that he observed the right or rear side of a heavy fog bank moving with the other fog across the airport.

The description of the weather conditions by the weather observer on duty did not differ substantially from the description given by ground witnesses. He noted that stars were visible through breaks in the fog and estimated the fog was about 7/10 coverage at 2311, increasing to 9/10 coverage at 2330. He stated that when he took the 1/8 mile observation he thought the fog seemed fairly uniform and at that time he did not note a fog bank as such but being outside only for a short period he could have been in it at the time. The observer said that in his experience it was unusual to have a heavy fog at the airport with the surrounding areas generally clear. He testified that in measuring the 1/8 mile visibility there were references which showed the visibility to be equal to this value and not less. He said, however, that measuring visibility at Nantucket was hampered by the lack of reference in all quadrants and at varying distances.

Analysis

It is believed that at or about 2311 the flight was given the Nantucket 2311 special weather observation of "partial obscuration, visibility 3/4 mile". This is supported by the Northeast agent who stated it was given and by an appropriate entry in the Northeast radio log. Receipt of the information is supported by action of the flight when, shortly thereafter, at 2314, it contacted Otis, asked for, and received an instrument approach clearance. Because the flight had operated VFR before this and reported it was "visual" when the clearance was requested it would be logical to assume the crew knew IFR conditions existed at Nantucket and therefore requested the IFR clearance.

As indicated earlier, the Board is of the opinion that the landing information given the flight and logged as being given at 2314 was in fact given just before 2326, the original entry. This opinion is supported by several factors. First, Flight 258 informed Otis at 2324 it was going to company frequency to obtain this information. Second, logic dictates that such information would normally be requested by an inbound IFR flight two to three minutes before an instrument approach rather than 14 minutes. This is especially true in deteriorating and near-minimum weather conditions which existed. Furthermore, for these reasons the Board believes the surface observation would be requested again or would be given as a matter of practice by the radio operator with the landing instructions. Therefore, in all probability the "partial obscuration, visibility 3/4 mile" report was repeated at 2326. This would account for the crew of Flight 2289 having heard this report given to Flight 258 about that time.

There is no question that the special observation of "partial obscuration, 1/2 mile visibility" was transmitted by the Northeast senior agent. Because the crew of Flight 2289 did not hear an acknowledgment and the radio log did not reflect one, there was a question of whether or not Flight 258 was on the company frequency when the weather information was transmitted. This information was available to the senior agent immediately after 2327 and according to his testimony it was immediately given to the flight. This was completed and the action was logged at 2328. The Otis tape shows that Flight 258 did not return to that frequency until 2327:40, therefore, the Board is of the opinion the flight was on company frequency when the weather report was issued. This analysis permits the Board to accept the recollection of the senior agent which should have been most vivid, recalling the personal conversation that transpired between himself and the first officer when the one-half mile visibility report was issued.

A question of even greater concern is whether or not Flight 258 received the special weather report of "partial obscuration, visibility 1/8 mile" and, if so, when the report was received. This concern is generated because the reported visibility was below the authorized landing minimum for the flight; if, as has been explained, the report was received before the flight reached the radio facility on final approach, the captain was required to discontinue the instrument approach. After arduous study and careful evaluation of all the evidence, it is the opinion of the Board that the report was received and at a time when the approach should have been discontinued. This opinion is based on a determination of the time of the accident and again upon the accuracy of the Northeast radio log. Each of these supports the other and the Otis tape supports both.

At 2328, according to the Otis tape, the flight reported, "We're just past the marker outbound," and at 2330 it reported, "Procedure turn." These reports and ample evidence that the entire approach procedure was flown would place the accident very close to 2334. This time correlates reasonably to the report about 2335 from Flight 2289 that there was a fire at the end of the runway, which the senior agent recorded at 2336 after using approximately one minute to look for the reported fire. The time of the accident also substantiates the accuracy of the radio log. Its accuracy is further established by the fact that at 2330, according to the Otis tape, Flight 2289 was advised to obtain its clearance through the company and according to the radio log this action was completed and logged at 2331. For this action the various times involved correlate in a precise manner.

From the above evidence the Board accepts as accurate the log entry and the testimony of the company agents regarding the issuance of the below-minimum weather report. Testimony of the senior agent indicates the information was transmitted twice during a 60 - 90 second interval preceding 2333 when the action was completed and logged. Correlated to the timing of the approach procedure Flight 258 would not have passed the VOR inbound and, more specifically, should have been in its procedure turn when the information was first transmitted. Because Flight 258 was released from Otis to company frequency at 2330 and because each transmission of the 1/8 mile visibility was followed by a sound identified as a mike click the Board believes the information was received.

The nature of the local weather conditions may have been a factor in the captain's decision to continue the approach. From the available evidence it is apparent that a heavy rolling sea fog extending to at least 300 ft existed over the airport and into the approach area. It is believed that the fog was very heavy to the "H" facility, rapidly decreasing in density northeastward, until in the area of the VOR the conditions were generally clear. It is possible that as Flight 258 passed over the vicinity of the airport, lights on the airport were clearly visible vertically through the fog. This, together with generally clear conditions in the VOR area, could have led the captain to believe weather conditions were much better at the approach end of runway 24 than at the terminal where the conditions were being measured.

The approach was most likely continued inbound with reference to the ground and by the time the flight reached the "H" facility it was at a low altitude. The low altitude is shown clearly by the light touchdown of the aircraft and the short distance from the "H" facility to the touchdown. Considering the distance, the computed groundspeed, and that practically all descent had been arrested at touchdown, only an excessive rate of descent would permit the flight to have passed the "H" facility much above 100 ft. At this altitude and position the Board is convinced that intervening fog between the flight and runway threshold precluded visual reference to the threshold complex. This is clearly substantiated in that the ground tracks of the aircraft were proceeding away from rather than toward runway alignment. It is considered that the relatively short runway may have influenced the descent to low altitude and it is possible that a desire to pick up and follow the line of barrels was a contributing reason.

At low altitude in the area of the "H" facility it is believed that the flight entered a heavy fog bank. It is believed that at this time all ground reference was lost and before transition to instruments could be made and the approach discontinued the remaining altitude was lost and the aircraft contacted the ground.

Conclusions

In this report the Board has entered criticism of some of the Northeast operational policies and procedures and of the implementation of the operational programme. The criticisms are the product of a combined effort - the Board's accident investigation process and a CAA inspection, both of which had the cooperation and assistance of Northeast personnel.

Following the accident the company believed it advisable to discontinue the use of the "Sliding Scale" at Nantucket for a period of re-evaluation. In the absence of an ILS and ladder-type approach lights and in consideration of the authorized deviation, this action appears wise.

With reference to the ILS and approach lights the Board, through meetings with the CAA and the Weather Bureau, has learned that the installation of a lower, ILS, approach lights, and "end of the runway" electronic weather reporting equipment at Nantucket is being actively considered. Such installation would be in accordance with provisions of the CAA planning standards allowing for the installation as an exception to the general requirements. Many factors in the Nantucket situation qualify it as an exception. Installation of "end of the runway" weather reporting equipment would be in accordance with a Weather Bureau policy to install this equipment as part of the ILS package. Obviously, the above action would be a significant step toward modernization of the airport.

In the meantime, and following the accident, the Weather Bureau took measures to provide Otis RAPCON with all weather observations taken at Nantucket during IFR conditions.

From the considerable testimony regarding the correct interpretation of Item 32 of the Operations Specifications (Limitations on descent below authorized IFR landing minima) the Board believes that the best operating policy clearly requires adherence to the CAA interpretation. In order to effect its interpretation and because the interpretation is not clearly expressed, the Administrator is presently considering a revision to the language of Item 32.

The company has taken positive steps to eliminate deficiencies in its operational training programme which were disclosed in the Board's accident investigation and the CAA inspection. The foundation of the action was a re-emphasis of the training function under company supervisors with appropriate delegated authority. Accordingly, company policy now requires that the use of aircraft for training receive the highest priority. It also requires that the various training phases and curricula not be interrupted by controllable factors. An increased emphasis on recurrent training provides that in addition to the existing programme each pilot captain will receive a concentrated ground and flight training period preceding each semi-annual instrument check.

Through communications and meetings with company officials and the Administrator and his staff the Board has been kept informed of the aforementioned action as well as other allied measures. It has been reported that a determined effort has been made by the company to satisfy each criticism even though in some specific instances the company believes the criticism was not wholly warranted. The Board believes that rapid and substantial progress has been made and in many instances the deficiencies have already been corrected.

Most of the areas in which deficiencies were found are the subjects of express provisions of the Civil Air Regulations, some of which require approval of the CAA. Under the responsibility of the Administrator all of the areas require his continued scrutiny through his local staff. Obviously, the operational factors which were identified as deficiencies were generally known and accepted by the local CAA agents prior to the accident. The Administrator, recognizing this, took action to correct the local situation and also to establish an inspection process whereby closer supervision can be maintained over the effectiveness of CAA offices throughout the country having the same responsibilities.

Probable Cause

The probable cause of this accident was the deficient judgment and technique of the pilot during an instrument approach in adverse weather conditions in failing to abandon the approach when a visibility of 1/8 mile was reported, and descending to a dangerously low altitude while still a considerable distance from the runway.

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ICAO Ref: AR/568

No. 43

Alaska Coastal Airlines, Grumman G-21A, N 4774C, accident near Haines, Alaska, on 20 August 1958. Civil Aeronautics Board (USA) Aircraft Accident Report, File No. 1-0161, released 3 September 1959.

Circumstances

The aircraft was on a flight Juneau-Haines-Juneau and was carrying 8 passengers and a pilot. It departed Juneau at 1453 hours Pacific standard time for Haines and made normal position reports, the last at 1511. Nothing further was heard from the flight. The aircraft descended into Lynn Canal, near Eldred Rock, 65 miles NNW of Juneau, Alaska at approximately 1525 hours. Six passengers and the pilot were seriously injured.

Investigation and Evidence

The flight was scheduled to proceed to Haines and return to Juneau with a flag stop at Briget Cove on the return trip. The pilot stated he had planned to inspect Briget Cove from the air on the way to Haines to ensure that there were no obstructions in the water landing area or changes since his last stop there several months previous. He testified he became confused en route to Haines, flew up a bay he could not identify but which he thought was Briget Cove.

The pilot made position reports to the company radio at Juneau while en route. The next report was to have been made when passing Eldred Rock. He further stated he thought he had arrived at Haines when reaching Briget Cove, when in reality he was many miles short of his destination. He was trying to locate the Haines Airport while circling an area he later realized was Berners Bay.

To continue to Haines, the flight left Berners Bay, returned to Lynn Canal, and passed between Eldred Rock on the right and Sullivan Island on the left. His last recollection before impact was to reach for the microphone to call company radio presumably to report passing Eldred Rock.

Witnesses at the U.S. Coast Guard Lighthouse Station at Eldred Rock observed the plane fly into the water at a point approximately 3-3/4 miles northwest of the station. They stated the aircraft was flying at an altitude of 150 to 200 ft when it passed the station. It then began a slow descent as if the pilot intended to land on the water. However, these eyewitnesses agreed there was no change in the sound of the engines. As the aircraft neared the water, it began a slight bank to the right, simultaneously striking the water in a slightly nose-down, right-wing-down attitude. It cartwheeled, tearing both engines out of their nacelles and shearing the left wing off at its attachment point.

The weather along the route of flight was adequate for normal VFR operation. The air was smooth and stable, which would have permitted the airplane, when trimmed for level flight, to fly a reasonably straight course without flight control action by the pilot. A gradual descent such as the descent this airplane made could have resulted from pressure of the pilot's arm or body against the elevator control; however, there was no evidence to substantiate this. He stated the aircraft was operating normally prior to contact with the water.

Just prior to the accident, the pilot was flying approximately 200 ft above the water and along a course which offered a view of the shoreline 1/2 mile to his left. This land mass is an island with an elevation of 943 ft. A light drizzle existed and a low overcast sky prevailed. Patches of haze and fog were present and directly ahead the glassy water blended with the low overcast sky to obscure any definite horizon. The Board believed that the only visual reference the pilot had to assist him in contact flight in that immediate area was the island to his left.

Because of a possible distraction, and the lack of continuous visual reference, the pilot permitted his aircraft to bank to the right and enter a gradual descent into the water.

The pilot was unable to recollect the events immediately preceding the accident or to explain the reasons for the descent into Lynn Canal. The Board did not doubt the pilot's testimony that he "blanked out" "didn't remember what happened", and could not recall portions of the flight from Point Sherman until striking the water.

The Board believed that the pilot was subject to a fixation induced by the monotony of flying a familiar route and by preoccupation in searching for visual reference. When a pilot fails to consult his instruments, it is impossible for him to determine the relation of his aircraft to any of the three axes of pitch, roll, and yaw without some visual reference. He may have a sensation of flying level when, in reality, his aircraft is banked to the left or right, or is diving or climbing. These illusions occur when the pilot is deprived of knowledge which could give him his actual attitude in space. Lack of a discernible horizon because of a low overcast sky condition, or flying over glassy water with the pilot's intermittent reference to a coastline or other terrain are common circumstances in which this type of sensory illusion can occur. Flying at an altitude of 200 ft, however, is not considered hazardous if the pilot complies with company procedures which require him to fly along the beach line so that visual reference can be maintained at all times. This kind of low altitude over-water flight has also been conducted by other Alaskan air carriers with a high degree of safety.

Because of the remote possibility that he was suffering from a momentary mental affliction during part of this flight, the pilot voluntarily submitted to a complete physical examination at a clinic in Seattle, Washington. The results of this examination were negative.

The pilot was regarded by the chief pilot and company managers as a highly skilled, experienced, and competent pilot, and there was nothing in his record to indicate otherwise. He had taken adequate rest and had followed a normal daily routine preceding this flight, and pilot fatigue does not appear to be a causal factor. The pilot was familiar with the company's operating procedure when approaching for a landing under conditions of glassy water. Under conditions of limited visibility or for landing straight ahead, a power-on descent with wing flaps in the approach position was to be maintained until contact was made with the water. He had been trained and flight-checked on this procedure to the satisfaction of the chief pilot.

The Board concluded that the pilot was not sufficiently attentive to instrument indications of aircraft attitude and height above the surface. He also failed to utilize fully such limited outside visual flight references as were available to fix the pitch attitude of the aircraft. It is not possible to determine conclusively the nature of the fixation during the moments immediately preceding the accident, but it is considered probable that he was visually scanning, through the side window, the shores of the canal for geographic reference points on which to base a position report. During this preoccupation, the lack of discernible horizon and the glassy surface of the water prevented a sufficiently arrestive reference to alert the pilot to the nose-low attitude of the aircraft and its dangerous proximity to the water.

Probable Cause

The pilot failed to maintain control of his aircraft at a safe altitude during marginal visual flight conditions. A contributing factor was a glassy surface which caused the pilot to misjudge the height above the water.

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ICAO Ref: AR/590

No. 44

Frontier Airlines, Inc., DC-3C, N 64424, emergency landing at Pueblo, Colorado, on 23 August 1958. Civil Aeronautics Board (USA) Aircraft Accident Report, File No. 1-0107, released 2 July 1959.

Circumstances

Shortly after take-off from Runway 30 at Pueblo Memorial Airport on a flight to Gunnison, Colorado, the captain observed the cockpit fire warning for the left engine come on. The fire warning system was tested, but the warning light remained on. The left propeller was then feathered and the Pueblo control tower was advised that the flight was returning to that airport. To avoid rising terrain ahead a shallow left turn was made at 50-75 ft and at 95 knots indicated airspeed - however, neither altitude nor airspeed could be maintained. Power was cut on the right engine, and an emergency gear-up landing was made 2 miles northwest of the airport. None of the 19 passengers and 3 crew was seriously injured.

Investigation and Evidence

Marks on the ground indicated the aircraft made contact on a heading of 190° magnetic. It then skidded on the underside of its fuselage for a distance of 841 ft and passed over three shallow ditches or washes. At the third one it swung approximately 115 degrees to the right and the right engine was completely separated from its attachment at the firewall. One blade of the right propeller punctured the right side of the cockpit, severely damaging the right pilot seat and severing the CO_2 line thereby discharging the CO_2 bottle aft of the right seat.

Examination of the aircraft revealed no evidence of failure or malfunction of the airframe or powerplants prior to ground impact.

Because of the circumstances related by the flight crew, immediate attention was directed to the fire warning system. A review of pilot flight reports disclosed that N 64424 had experienced five false engine fire warnings between 9 July 1958 and 19 August 1958. In each instance the left engine was involved and in no case was there a fire. The crew in this accident was not aware of the false fire warning reports.

According to statements of the flight crew, the left propeller was feathered because of the left engine fire warning appearing as gear retraction was started. A minute examination of the left powerplant failed to disclose any evidence of fire or of a hot spot that could have actuated the fire warning signal.

The fire warning system on N 64424 consists of a series of thermocouples, any, one or all of which when subjected to rapid heat rise will generate a very low voltage current which is sent through the circuit to a very sensitive relay in the relay panel. This sensitive relay closes at approximately four milliamps completing a circuit to a slave relay, thus closing it. When the slave relay closes it connects the 24-volt circuit to the warning lamp circuit and lights the warning signal in the cockpit. The aircraft is equipped with a fire warning thermal test unit on the cockpit instrument panel which tests the system for normal operation by switching in 28 volts to the system. As the element lights, the thermocouple is heated and creates a voltage, thus operating the circuit. Also incorporated is a switch called the fire panel "opposite" switch. This switch transfers the circuit system from one relay to another thereby providing a check for a false warning from a relay malfunction. In the present incident the "opposite" switch was actuated and the right warning light came on which indicated absence of a fault in the left relay system and the probability of a fire.

In order to energize the cockpit warning signal, the sensitive and slave relays must be activated. With both relays operating normally a minimum current of four milliamps must be introduced into the sensitive thermocouple circuit. The two ways of accomplishing this are:

1) an actual fire resulting in a rapid heat rise at a thermocouple;

2) current as little as four milliamps from an outside source such as leakage of current from a 28-volt line in the same bundle of wire containing the fire warning circuit as the result of frayed wire covering, dampness, chafed wire insulation, etc.

Subsequent to the accident, the relays and cockpit test switch were removed from the aircraft for examination. Each unit, plus the left engine thermocouples, was subjected to bench tests designed to test their integrity. The tests proved that all units were operating normally in accordance with specifications and that they were, in themselves, incapable of actuating a false fire warning.

Since there was actually no fire during flight, the circuits of the aircraft were carefully tested for continuity as well as possible leakage and/or short circuits between wires. All circuits in the fuselage, wing, nose, and associated junction boxes and instrument panels were found to be without electrical faults. Extending from the firewall junction box to the inboard nacelle junction box is a flexible conduit, approximately 40 inches long and 3/4 of an inch inside diameter, containing 15 tightly bundled wires. These wires included the sensitive thermocouple circuit wires as well as 28-volt circuits. An ohmmeter indicated an irregularity in the thermocouple circuits. By moving one of the thermocouple wires in this conduit a variable resistance was present. Removal of the wires from the conduit disclosed a substance consisting of damp oxidized aluminum, oil, and dirt in the area of the conduit ferrule which connects to the junction box where bending and movement occurs. Two wires of the bundle were unnecessarily long and were found criss-crossing other wires. This condition was found to exist in the area where the electrical fault was found.

Frontier Airlines' Policy and Procedures Manual, Flight Emergency Procedures section, stipulates that a captain, upon the first indication of engine fire warning light in flight, will immediately check the warning light by switching the crossover switch to "opposite", as was done in this instance. If the transfer indicates "fire" he will call out the proper engine and immediately accomplish the single-engine checklist. The company's chief pilot confirmed that the emergency procedures in effect at the time of this accident did not call for a visual check of the engine prior to feathering.

The five previous false warnings occurred at different stations away from Denver and in various aircraft configurations. Pilot report copies were forwarded to the Denver base in each case but the base records do not indicate that corrective action was taken at the Denver base to eliminate the recurring false warnings.

Reference to the company weight versus indicated airspeed chart for flight reveals that for a gross weight of 24 420 lbs the airspeed for best single-engine climb and manoeuvring is 92 knots. The company manual minimum airspeed for single-engine is 84 knots. With an indicated 95 knots following take-off and the feathering of the left propeller, the captain had three knots above the best single-engine speed for straight climb or manoeuvring flight. According to competent witnesses, altitude was being gained very slowly as the aircraft left the airport boundary. The aircraft was then going toward higher terrain ahead and to its right. Testimony was received regarding the effect of air temperature upon rate of climb. It was shown that with the gross weight of 24 420 lbs and the temperature of 75 degrees Fahrenheit, the aircraft should have been capable of a rate of climb of 282 ft per minute on one engine. Even if it were possible to obtain this performance, the aircraft could not have cleared the high terrain lying ahead. Consequently, there was no alternative for the left turn away from the higher land. This turn, in conjunction with the loss of performance resulting from gustiness and turbulence caused by the high ground to windward, was a factor in the aircraft losing airspeed and altitude.

A glance back from the cockpit toward the left engine would have disclosed no evidence of fire and the action could have delayed the feathering of the propeller and averted the accident. However, the captain carried out emergency instructions as outlined in the company operations manual at that time. These instructions are currently being revised to give the captain an opportunity to use his own judgment regarding immediate feathering in the case of engine fire warnings.

Referring to maintenance practices it appears, in this instance, there was a definite failure to comply with the prescribed procedures in that the log office did not discover the recurring false fire warnings when they reviewed the pilot reports.

A study of the available evidence makes it obvious that regardless of the other circumstances of the accident, a false warning due to faulty wiring and/or the presence of foreign matter would not have occurred and triggered the events that followed had the maintenance department properly corrected the recent and recurring difficulties reflected in pilot write-ups of false fire warnings on this same engine and aircraft. A few circuit tests would have revealed the electrical leakage and pointed out the need for replacement of the wires. The Board, therefore, concluded that the log sheets of the aircraft were not properly monitored; that corrective action taken by the maintenance personnel was not adequate; that there was a laxity on the part of the maintenance supervisory personnel in not detecting this inadequacy; and that the maintenance department was amiss in not progressing prompt and adequate corrective action as a result of the continued write-ups concerning the fire warning system.

Probable Cause

The probable cause of the accident was a false fire warning during climb-out toward rising terrain, followed by the immediate feathering of a propeller. The false fire warning was due to inadequate maintenance.

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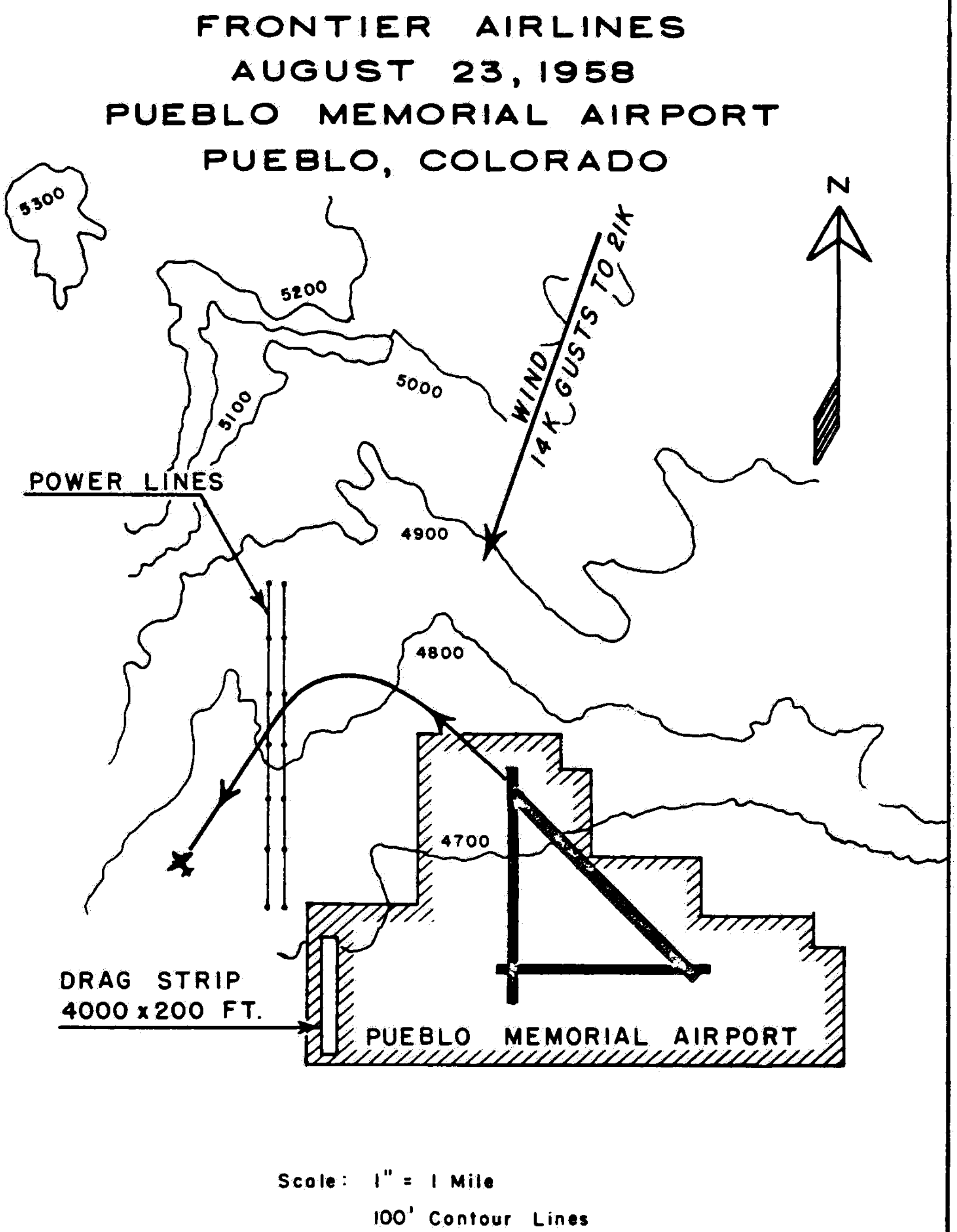
ICAO Ref: AR/585

FIGURE 25


FRONTIER AIRLINES
AUGUST 23, 1958
PUEBLO MEMORIAL AIRPORT
PUEBLO, COLORADO
N
5300
5200
5100
5000
4900
4800
4700
WIND 14 K GUSTS TO 21K
POWER LINES
DRAG STRIP
4000 x 200 FT.
PUEBLO MEMORIAL AIRPORT
Scale: 1" = 1 Mile
100' Contour Lines

No. 45

Northwest Airlines, Inc., Douglas DC-6B, N 575, accident at Minneapolis, Minnesota, on 28 August 1958. Civil Aeronautics Board (USA) Aircraft Accident Report, File No. 1-0089, released 2 July 1959.

Circumstances

Flight 537 is a regular flight from Washington, D. C. to Seattle, Washington, with numerous intermediate stops including Minneapolis, Minnesota. The aircraft took off normally on 28 August from Wold-Chamberlain Field, Minneapolis, and climbed to a height of about 100 ft. It then gradually nosed over and entered a descent which continued until it struck the ground at 0329 hours central daylight time. There were no fatalities among the 62 persons aboard, however, a number were seriously injured.

Investigation and Evidence

Study of the wreckage revealed that the aircraft had hit and damaged a chain link fence at the southern airport boundary. Sixty feet southwest of this fence the aircraft contacted the ground in a slightly nose-high right-wing-low attitude. The point of initial ground impact was 2 900 ft from the threshold lights on the southwest end of runway 22 and the wreckage came to rest 1 600 ft farther on. Most of the major components separated from the fuselage as the aircraft skidded along the ground. The fuselage came to rest on its left side and heading about 245 degrees.

During the investigation the captain and first officer were questioned extensively in order to determine as near as possible the exact sequence of events. The captain stated that the take-off was made under visual conditions. His only reference to his instruments was primarily for the purpose of monitoring the performance of the aircraft. He said the performance was normal and after the aircraft broke ground a normal climb was established by visual observation and by reference to the rate-of-climb instrument. He observed a thin wispy cloud to the right and above the aircraft, and called it to the attention of the other crew members. About this time the co-pilot called 155 knots. The captain said he increased back pressure to maintain his climb and ordered METO power; the flight engineer had started the power reduction when his (the captain's) outside vision was obscured by the reflection of the landing lights against clouds or fog. The captain said he looked back into the cockpit to refer to his instruments, noting an airspeed of 155 knots and a rate of climb of about 200-250 ft per minute; all indications appeared normal. He then turned off his landing lights. It was at this instant that the co-pilot called "pull it up" and pulled back on the yoke. The captain stated that the penetration into the cloud, the co-pilot's remark, the co-pilot's action on the controls, and the impact were almost simultaneous. All occurred within a very few seconds.

Both the pilot and co-pilot said there was no apparent change of attitude in the aircraft when the flaps were raised. The captain said he did not recall having to change the trim or attitude as the flaps came up. He thought that at the time of encountering the fog the aircraft was over the runway at a height of about 75 ft. He said he was watching for the runway threshold lights but never did see them. None of the crew members felt any sensation of descent. The captain testified that he intermittently referred to the rate-of-climb indicator and recalled seeing no indication of descent. The first realization that the aircraft was going down was when the co-pilot saw the fence.

Both the captain and co-pilot had received instrument training required by the provisions of Civil Air Regulations and NWA, which includes training in instrument take-off procedures. In addition, both pilots had passed the required instrument proficiency checks and must, therefore, be presumed to be thoroughly familiar with instrument take-offs.

Take-off techniques vary considerably with the pilot. However, NWA procedures in effect at the time of this accident were designed to standardize these techniques as much as possible. Based on these normal operating procedures the DC-6B would accelerate to V_2 speed, 115 knots, in approximately 35 seconds and cover a distance of 3 770 ft. After leaving the ground the airplane should be able to climb and accelerate, passing through 100 ft of altitude about 54 seconds after starting the take-off roll. At that point the aircraft would have covered a horizontal distance of about 7 000 ft and have attained a speed of about 123 knots. Again, under these conditions, in order to accelerate to 155 knots from start of take-off, about 85 seconds would be required. The aircraft would travel a horizontal distance of approximately 15 000 ft and reach an altitude of about 300 ft.

If the aircraft lifted off the ground at V_2 (115 knots) and climbed at that speed (best angle of climb), it would pass through 100 ft of altitude about 42 seconds after start of take-off roll and would have covered a horizontal distance of about 5 280 ft.

One further computation which the Board considered significant is that if the aircraft, after lifting off the ground, were allowed to accelerate without climbing, it would attain a speed of about 155 knots when the aircraft had covered a horizontal distance of about 9 400 ft.

Examination of the wreckage disclosed no evidence of any malfunction or inflight failure of any part of the aircraft. All four engines were uniformly developing considerable power when they struck the ground. Records showed that all maintenance and overhaul work was properly accomplished and was adequately supervised. From this physical evidence, along with the testimony of the crew, the Board determined that no mechanical or structural failure or malfunction occurred which in any way contributed to the cause of the accident.

The crew of N 575 were highly experienced. Both pilots thought the airplane was climbing out normally and neither realized it was, in fact, descending. With this in mind, the Board studied the phenomenon of pilot sensory illusion to determine whether such was applicable to this accident.

One authority* concluded that, "the forward acceleration of the aircraft after take-off causes a sensation of nose-up tilt because the pilot cannot distinguish between the direction of gravity and the resultant of gravity and aircraft acceleration. If the pilot is not fully on instruments, this can cause him to lower the nose, and the acceleration in the resulting dive perpetuates the illusion. The aircraft can enter a shallow dive, with or without turning, and the pilot will still experience a sensation of steady climb." The paper goes on to say, "If it is also very dark and the direction of take-off is away from a built-up lighted area, there is nothing to be seen which can give a horizon reference and the pilot is now very likely to get this false impression of the attitude of the aircraft in pitch. Because it is too dark to see the ground, loss of height is not apparent."

The Board believed that the conditions which existed at the time N 575 took off were ideal for the propagation of this illusory effect. Visibility was reduced by fog and take-off was made away from a built-up area toward a very dark unlighted space where the pilot had no reference to a horizon by which to determine the attitude of the aircraft. It is important here to recognize

* Dr John C. Lane, Superintendent of Aviation Medicine, Dept. of Civil Aviation, Australia.

that sensory illusions will not necessarily cause a pilot to dive the aircraft but can completely conceal the fact that a descent has commenced. *

From evidence adduced during the investigation it was shown that the aircraft took off normally, climbing to a height of about 100 ft. The aircraft should be roughly at this altitude as the flaps retract through the 10-8 degree position. This portion of travel of the flaps will produce the greatest change in attitude of the aircraft. At this point the aircraft nosed over and began its descent. Obviously the pilots were unaware of this change of attitude and, therefore, did not initiate any corrective action. It was equally clear that the absence of stimulation to the visual sense was instrumental in effectively concealing this change of attitude. Finally, the continued acceleration of the airplane in its descent sustained the illusion, giving the pilots the impression of a steady climb.

A pilot with the experience of the one in question must be familiar with night take-offs in conditions of reduced visibility and, therefore, should have realized that full utilization of all the aircraft instruments was mandatory. The rate-of-climb instrument is not a primary instrument during initial liftoff, because of ground effect and the inherent lag in its indications. However, as mentioned before, it would require approximately 15 to 20 seconds for N 575 to reach a height of 100 ft from liftoff. At this time the rate-of-climb instrument would be indicating correctly. Moreover, the artificial horizon, the airspeed indicator and altimeter are instruments which will give positive and immediate indications of attitude. To monitor one instrument to the exclusion of all others indicates a lack of the normal alertness and attention demanded of a pilot.

In addition, all normal procedures require that a positive climb be established before flaps are retracted. In order to maintain this climb, some positive control action must accompany the flap retraction. Again it is elementary that where visual reference to the ground is precluded the use of flight instruments is necessary in order to ensure proper control of the aircraft.

One further indication, which should have been apparent to the pilot through normal alertness, was the extremely rapid acceleration of the aircraft. As stated before, under normal operating procedures it would require approximately 85 seconds for the aircraft to attain a speed of 155 knots and it would have travelled a horizontal distance of 15 000 ft. Here the aircraft speed was 155 knots when it first hit the ground about 7 600 ft horizontally from start of take-off. According to the captain's testimony he thought he was still over the runway as he had not seen the threshold lights. To have attained a speed of 155 knots in this distance also should have alerted him that the acceleration was far greater than normal.

The Board determined that the pilot, in view of the reported conditions of restricted visibility and absence of ground reference lights, did not exercise the kind of judgment required by the holder of an airline transport rating during the execution of the take-off.

The condition of restricted visibility which existed at the time of this accident is not unusual and in no way affects the execution of a safe take-off; however, it was the Board's conclusion that under such conditions, the pilot should utilize all of the flight instruments available in the aircraft. In this case, if the pilot had devoted his attention to the flight instruments rather than attempting to maintain visual contact during the take-off, the accident could have been avoided.

* On an aspect of the accident history of taking-off at night, A.R. Collar ARC Tech. report R&M No. 2277 (9872) United Kingdom.

Further, it was the Board's conclusion that the co-pilot did not exercise the best judgment under the circumstances. One of the fundamental reasons for requiring a co-pilot in transport-type aircraft is to provide assistance to the pilot. Such assistance is not limited to that of monitoring the airspeed only, as was done in this case. If the co-pilot had given normal attention to the flight instruments, he would have seen indications that the aircraft was descending and alerted the pilot to this fact. The accident might have been avoided had this been done.

In view of the foregoing, it was the Board's recommendation that the company re-emphasize through its training procedures the proper operating techniques for night take-off when weather conditions or other factors restrict visibility.

Subsequent to this accident the company revised its take-off procedures. All pilots are now required to climb the airplane immediately after take-off at V_2 speed to an altitude of at least 50 ft. The landing gear is retracted when the airplane is definitely airborne. At 50 ft the airplane is allowed to begin to accelerate while still continuing a positive climb. The climb is continued until reaching 200 ft. Upon reaching 200 ft and a speed of at least 125 knots, flaps may be raised. The aircraft is then allowed to accelerate to 140 knots before take-off power is reduced. In addition, the co-pilot is now required to monitor the altimeter and call off altitudes every 100 ft until the aircraft reaches 500 ft.

Probable Cause

The probable cause of this accident was the pilot's inattention to flight instruments during take-off in conditions of reduced visibility.

ICAO Ref: AR/586

No. 46

Pacific Western Airlines, de Havilland DHC - 2, CF - GIX, crashed 2 miles south of High Lake, North West Territories, on 29 August 1958. Report released by Department of Transport, Canada, Serial No. 58-13.

Circumstances

CF - GIX took off from High Lake at 1745 hours M.S.T. on a non-scheduled charter flight to Desolation Lake, N.W.T., with a pilot and three passengers aboard. The aircraft failed to arrive at its destination and later, during the same day, it was reported missing. The wreckage was found on 30 August approximately 2 miles south of High Lake. All four occupants had been killed in the crash and the aircraft was destroyed.

Investigation and Evidence

Examination of the wreckage revealed no evidence which might indicate that the airframe or controls of the aircraft were not functioning properly immediately prior to the accident. However, an excessive amount of water was found in the fuel system. Witnesses stated that at High Lake, where fuel is stored in 45-gallon drums, in the past on occasions the hand-operated fuel pump had been primed with water to induce suction as the pump was known to be defective. In this instance, it was stated that the pump was primed with the fuel remaining in the hose. CF - GIX landed at High Lake at about 1700 hours on 29 August, and as the pilot was anxious to leave as soon as possible, he taxied the aircraft to the refuelling point. Between 30 and 40 gallons of fuel were pumped through a felt filter over a funnel into the aircraft. Whether or not the pilot drained the fuel wells of the aircraft to ensure that no water was present in the fuel system prior to the take-off, is not known.

When refuelling was completed, the aircraft proceeded to the north end of the lake and took off in a southerly direction. Two persons who observed the aircraft for a short while when it became airborne stated that the aircraft sounded quite normal.

From an examination of the wreckage it was found that the propeller was still attached to the engine and only slightly bent thus indicating that very little or no power was being delivered by the engine at the time of the accident. The propeller pitch control was in the coarse position and the throttle was closed. The magneto switch and fuel selector valve were in the "off" position. From the foregoing it would appear that failure of the powerplant had occurred and that the pilot put the propeller in coarse pitch, possibly to reduce drag, turning off the fuel valve and magneto switches to lessen the danger of fire in anticipation of an emergency landing.

The aircraft's port wing tip struck the ground first followed by the engine, which nosed into the ground, causing the aircraft to nose over onto its back. Except for small fragments of red glass, the port wing and port wing strut, which were found 65, 50 and 15 ft respectively from the main point of impact, the wreckage was almost in one piece, indicating that the aircraft had struck the ground at a very steep angle. It is, therefore, possible that the aircraft stalled during an attempt by the pilot to reach one of the many small lakes in the area. A small unnamed lake, which is approximately

1 000 ft long and on which the aircraft could have landed safely, was only about 100 yds away from the scene of the accident. Two seat belts, the straps of which had torn loose from the seats, were found still buckled.

The pilot held a valid Commercial Pilot Licence and had accumulated a total of about 2 700 hours of flying experience of which about 320 hours were flown during the 90 days prior to the time of the accident. His total experience on de Havilland DHC - 2 type of aircraft was about 560 hours.

The weather, as reported for the High Lake area at the time of the accident, indicated that scattered to broken cumulus clouds, the bases of which were between 3 000 and 4 000 ft above the ground, were present. The visibility was more than 15 miles, the wind was from the southeast at 7 miles per hour and the temperature was 51°F with a dew point of 31°F. Weather was not considered to have been a factor in the accident.

Probable Cause

The engine failed. Subsequent examination revealed sufficient water in the fuel lines, screens and filters to cause engine failure. A forced landing was necessary and the aircraft struck the ground at a steep angle, estimated at approximately 60° measured from the horizontal, indicating that the aircraft was out of control at the time of impact.

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ICAO Ref: AIG/ACC/REP/GEN/No. 1

No. 47

Independent Air Travel Ltd., Viking, G-AIJE, accident 3 miles NE of London Airport, England, on 2 September 1958. Report released by the Ministry of Transport and Civil Aviation (UK). C.A.P. 155

Circumstances

The Viking took off from London Airport at 0554 hours GMT with a crew of 3 for a flight to Nice, Brindisi, Athens and Tel Aviv. Fifteen minutes later the captain informed London Airport that he had engine trouble and wished to return to Blackbushe. During the return flight the aircraft initially maintained 7 000 ft. Clearance was given to descend to 3 000 ft, but the descent was apparently continued to 1 000 ft without informing Control. Shortly afterwards the aircraft reported "having difficulty maintaining height" and six minutes later, at 0632 hours, it crashed killing the 3 crew members and 4 other persons on the ground.

Investigation and Evidence

The Aircraft

The aircraft was built in 1946 and had been used chiefly on research and experimental flights prior to 1957. It had flown a total of only 2 319 hours since new, of which 783 hours had been flown since renewal of the Certificate of Airworthiness, which was valid at the time of the accident. Both the engines and propellers were within approved life since overhaul.

Maintenance at Blackbushe Prior to the London - Tel Aviv Flight

The aircraft was due to leave Blackbushe at approximately midday on Monday, 1 September, in order to fly to London Airport, and it was intended that the aircraft should leave that evening for Nice en route to Tel Aviv. As a result, the time left for maintenance was limited.

The Company's engineering department was not at that time an approved inspection organization and, accordingly, any work of repair or maintenance required certification by a licensed engineer whether it involved engines, airframe or radio.

On the morning of 1 September three snags were reported, the second of which was as follows:

> "Strb. engine C.S.U. oil leak also surging - suggest change C.S.U. (or seal)."

(The C.S.U. is an abbreviation for the "constant speed unit", a finely tooled part fitted on top of the engine close to the propeller and which serves to maintain the revolutions of the propeller at a constant speed.)

Two fitters carried out a Check I on the starboard engine which was completed by 0700 hours, but the snags were left for rectification in daylight. A Check I on the port engine was then carried out and the reported snags dealt with. A new stalk seal was fitted to the starboard propeller and the C.S.U. was removed and replaced with an overhauled unit taken from store. A new gasket was fitted at the base of the C.S.U. where it connects with the engine. When the work on the engines was completed, they were given a ground run by a licensed engineer, who carried out a full feathering test on each engine during the run and certified the work. Carrying out a complete feathering test on each engine was, in fact, departing from the requirements of the approved maintenance schedule of the Company, which prescribed a snap check only for a Check I... a full check if carelessly or too frequently conducted might tend to weaken the electric motor. The engineer explained that he had never seen the approved maintenance schedule. The fuel and oil tank contents were checked; each of the oil tanks contained between eleven and twelve gallons.

Whilst the notified snags were dealt with, it is doubtful whether the normal work of the Check I was properly carried out. Later events pointed strongly to the fact that the source of the oil leak was not in fact discovered. In short, the work of maintenance was carried out by tired men, working under pressure and without proper supervision or instruction.

Maintenance at London Airport

At London approximately one gallon of oil was found under the front of the starboard engine - either the oil leak reported previously had not been corrected or another oil leak had developed.

In view of the difference in the amounts of oil remaining in the tanks (port - 10 gallons, starboard - 6 gallons) the Commissioner found it impossible to believe that the oil had only begun to leak when the aircraft came to rest.

The Company's office at Blackbushe was informed that the aircraft was held up at London with an engine snag. This message reached the engineer in charge who knew that there was no licensed engineer in the party at London - he sent back the message that if help was needed they should contact Fields or Hunting-Clan at London Airport.

The crew called Blackbushe again and during the conversation one of the engineers, unlicensed for this aircraft, told the engineer in charge that the trouble with the aircraft was the seal on the C.S.U. and asked for a new seal. The engineer in charge said in evidence that the engineer must have meant gasket, because he knew that neither this engineer nor his companion, (another unlicensed engineer, who was to act as engineer on the flight from London to Lod Airport), would be justified in taking the C.S.U. to pieces. He stated that he had no spare C.S.U. in the stores but promised to send a spare gasket. The engineer in charge (Blackbushe) later said that the engineer had used both the words seal and gasket and had said that Fields could not supply him - presumably with a new C.S.U. He also stated that he had asked the engineer whether it was a gasket for the base of the C.S.U. which he wanted - to which the engineer assented.

The engineer in charge knew perfectly well that if a C.S.U. were taken apart and the seal exposed it could not be refitted until it had been rig tested and that none of the men at London Airport was qualified to carry out this work or to certify its proper completion.

Following the telephone conversation, the engine was cleaned off with petrol, and it then appeared that the leak was coming from the seal of the C.S.U. Accordingly, two of the engineers proceeded to remove the C.S.U. and open it, disclosing - so it was asserted - that the seal was malaligned. One of the engineers then attempted to rectify the trouble.

The gasket which was taken off when the C.S.U. was removed was reported to be in perfectly good order and examination of the seal of the C.S.U. revealed that it was not damaged. The C.S.U. was, therefore, reassembled using the old seal and the unit was reaffixed to the engine using the old gasket. (Following the crash, tests were carried out which showed conclusively that the seal was properly fitted and functioning perfectly, while the same was true of the gasket. The accident could not, therefore, have been caused by any leakage from the C.S.U.). Three engine runs were then made during which the starboard engine was completely feathered once.

If any written record of the work done at London Airport was made out, it must have been destroyed in the crash.

Loading

Prior to departure from London Airport the captain signed the load sheet which showed that the weight of the aircraft at take-off was 32 kilogrammes within the permitted maximum. However, the Commissioner believed that it was overloaded to an extent of nearly 400 kilogrammes. In spite of the overload, the aircraft, if properly handled, ought still to have been able to climb on one engine. It was not considered, therefore, that the overloading was a serious factor in the cause of the crash.

The Crew

The captain had a great deal of flying experience, having flown approximately 13 000 hours with BOAC and the Royal Air Force. He was taken ill on 17 August and was confined to bed with an infection diagnosed as streptococcal. He had been pronounced fit for duty on 26 August.

It was established that prior to 1958 he had not been given the six-monthly checks with the proper frequency or at the proper intervals.

Checks were applied on 13 April and 29 August 1958. During the former check, which was carried out in the Viking aircraft involved in the accident:

1. failure of the port engine was simulated;
2. the actual landing was not, however, carried out on the starboard engine only;
3. the aircraft was not loaded to the maximum permissible landing weight although it had been so certified;
4. the completion of the check form was lax.

It was concluded that the test was not sufficient to check the captain on his ability to fly and land the aircraft with one engine inoperative.

Similar criticisms applied to the check of 29 August, which was carried out in a DC-4 aircraft.

The first officer had had less than 1 000 hours flying of which only about 24 hours had been on twin-engined aircraft. He was employed as a probationary pilot from 30 August. The Commissioner believed that no proper six-monthly check had been carried out or could have been carried out on the first officer during a positioning flight from London to Blackbushe (10 minutes) on 30 August - as was suggested by the Company's Operations Manager and the chief pilot.

The engineer officer had been employed by the Company less than 3 weeks. He was an airframe engineer, not licensed to certify any work on the engines, and the captain had been advised by the engineer in charge (Blackbushe) to "keep his finger on him".

Fatigue

Following his return to duty and prior to the final flight the captain had not been allowed the rest times required by Article 34F of the Air Navigation (Fifth Amendment) Order, 1957. Under the regulation no pilot is to be required to make a flight in a public transport aircraft unless he has had at least ten hours rest since his preceding duty period.

On 30 and 31 August he made a series of flights. Under the Air Navigation (Fifth Amendment) Order, 1957, and under the provisions of the Company's operations manual designed to give effect to the Order, a crew is to be regarded as on duty 45 minutes before scheduled time of take-off and for 30 minutes after landing. In the result he was on duty as follows:

From 1225 hours on Saturday, 30 August, until 0200 hours on Sunday, 31 August. He accordingly, became entitled to 14 hours rest from 0200 hours that morning. In fact, in breach of Article 34F of the Order, he got 7 hours 15 minutes before he again went on duty. Under the Order, if the period between two duty periods is less than 10 hours, the two duty periods are to be treated as one duty period.

On Sunday, 31 August, he was on duty from 0915 hours until 1955 hours, and since this duty period was to be treated as one with that of Saturday, he had been on duty for 31 hours 30 minutes, a gross breach of Article 34E of the Order, since the maximum permissible flying duty period for a two-pilot crew is 16 hours.

However, he was again on duty on Monday, 1 September, at any rate from 1325 hours and owing to the trouble found at London Airport was evidently on the Airport and, consequently, on duty until at least 2000 hours. He cannot have had 10 hours rest from the time he left the Airport until he got back there, which on the evidence was at about 0400 hours (British Summer Time) on the morning of Tuesday, 2 September. In the meantime he had gone to bed without a meal and after drinking only a small whisky. He was disturbed at 0100 hours during a search for spares for the aircraft, did not eat his breakfast and had to be roused for the final flight.

The first officer had spent a disturbed night prior to the last flight and the engineer had not had more than approximately two hours sleep.

In short, this crew had not had the rest desirable, and to which indeed they were entitled under the regulations, before taking-off in an overloaded aircraft whose mechanical condition was suspect.

The gravity of this matter, and of the disregard of the regulations in the case of the rest time to which the captain was entitled, became apparent when it was disclosed that the Company had been prosecuted and convicted in May 1958 on 10 charges involving breaches of the regulations governing flight time limitations, and that these convictions involved both excess hours and insufficient rest accorded to pilots.

On 26 August 1958, following an investigation by the Ministry, it was pointed out during an interview with Company officials that a spot check carried out disclosed three breaches of Article 34(E) involving excess hours and three involving insufficient rest. When the facts in regard to the captain's insufficient rest are considered in the light of this interview only 4 or 5 days before, it is obvious that the regulations were being deliberately disregarded. The Operations Manager stated that he had spoken to the Managing Director of the Company (whose interest in the Company terminated on the first day of the inquiry) about breaches of the flight time regulations before the interview of 26 August, but the Managing Director took the view that a breach was not a breach provided it was reported afterwards. This was taken to mean that the Company would report the breaches with an explanation of why they had occurred and thus expect to receive a dispensation from the Ministry. This cannot serve as any explanation of a series of flagrant breaches - as the Commissioner was aware that none of them had in fact been reported and did not believe the Company had the slightest intention of reporting them. These matters were the subject of consideration with a view to prosecution when the crash occurred - thereafter action was deferred pending the inquest.

<u>The Flight</u>

Following take-off at 0554 hours the aircraft was cleared to Epsom (at 2 000 ft), Dunsfold (at 4 000 ft) and then to climb away to 7 500 ft at Seaford out of the Airway. Ten miles southeast of Dunsfold (at 0609 hours) the captain informed London that he had engine trouble and wanted to return to Blackbushe. He was told he could return to Dunsfold at 7 000 ft, and in answer to a query, he advised that he was able to maintain altitude. The events of the remainder of the flight were as follows:

0611 - had throttled down one engine but had not feathered
- aircraft was descending to 5 000 ft
- was cleared to Blackbushe Beacon at 3 000 ft or over

0616 - had feathered the starboard engine but would re-start it for the landing at Blackbushe

0617 - London Airways confirmed he had passed Dunsfold
- instructed him to set course northwest for Blackbushe Beacon and told him to contact Blackbushe
- Blackbushe weather and QFE were passed to aircraft

0620 - ATC at London saw on radar that the aircraft was on the wrong course heading east of north towards Epsom - a heading error of 70°

0621 - G-AIJE was observed by another aircraft to be flying at about 2 500 ft on a north-easterly heading

0622 - Blackbushe, at the request of London ATC, asked the aircraft to confirm it was on course for the Blackbushe Beacon
- G-AIJE replied, "I have your beacon, turning and going dead ahead" - meaning presumably, a turn to the west
- when informed that he was heading for Epsom, the captain said he would "retune"

0624 - G-AIJE asked for and was given a QDM (magnetic course to Blackbushe)

0625 - was offered GCA
- replied, "I'll take GCA please ... one engine feathered and I don't seem to be able to unfeather ..."

0626 - reported "10 miles E of Blackbushe" - "having difficulty maintaining height ... 1 000 ft .... 800 ft ....."

Thereafter a series of QDMs were passed; GCA attempted unsuccessfully to contact the aircraft which continued to lose height until it crashed at 0632 hours, 3 miles NE of London Airport and more than 20 miles from Blackbushe.

Eyewitnesses stated that the aircraft was flying on the port engine only, the starboard engine being feathered - facts which were confirmed by the examination of the wreckage. Examination of the wreckage further proved that prior to the accident the engines and propellers were in sound working order and that the starboard engine showed no signs of lack of lubrication. It was established that the starboard feathering motor was burned out and that this had occurred prior to the crash, a fact which explains the inability of the captain to unfeather this engine. The destruction of the sump was so complete that it was impossible to ascertain the source of any oil leak. Signs of oil sprayed from the starboard engine on to the starboard tailplane indicated, however, that there probably was an oil leak.

Discussion of Evidence

It was concluded that there probably was an oil leak which showed itself at 7 000 ft but was not considered to be serious and, therefore, the captain only throttled back instead of feathering the starboard engine.

It is difficult to understand why an experienced pilot should take the wrong course, despite the directional assistance of the sun and a magnetic compass - there were two possible explanations:-

1. the captain or first officer tuned the ADF equipment to Epsom instead of Blackbushe; or

2. the captain was misled by the Amsterdam Beacon.

Blackbushe Beacon was established some years ago operating on a frequency of 379.5 kilocycles and to an effective range of 15 NM, interrupting its signal at intervals of 8 times per min by the code signal MB. Meanwhile, Amsterdam, which is a powerful navigational beacon with a frequency of 381 kilocycles, transmits its signal interrupted at half minute intervals with its code sign P.H.A. If a set is mistuned towards Amsterdam at a point outside the 15 mile radius of Blackbushe, the effect may be that the radio compass needle will be influenced by the Amsterdam signal and will show a false reading. If the pilot follows this bearing he will fly an incorrect course and the error is likely to increase.

The ADF panel to which the pilot has to tune his set is rather above his head and is only marked at every 10 kilocycles. It is obviously easy to mistune, and if he mistunes outside the area of 15 NM, where protection is assured, he may find that his radio compass is pointing away from Blackbushe, with the result that if he follows it blindly he is flying off course.

The aircraft was clearly informed that it was off course, but it is apparent from the reconstruction of the flight (Figure 26) that the crew did not know their exact position.

A remarkable feature of the R/T record is that the pilot does not seem to have relied at all on his magnetic compass which ought to have suggested his error long before he was warned of it.

The real crisis arose when the captain found that he could not unfeather and could not maintain height. He had feathered the starboard engine at 0616 by depressing the feathering button. There can be no real doubt that either the button was held in, or more probably stuck in, with the result that by 0625 the motor was burned out. There is a warning light fitted which would normally show red if the motor was being run unduly. This cannot have been observed, possibly due to the bright sunshine in which the aircraft was flying. Alternatively, the motor may have been damaged in the course of the feathering checks on the various ground tests.

Evidence showed that the single-engine-climb performance of the aircraft was above average. It should, therefore, have been possible to climb the fully loaded aircraft at about 200 ft/min. Nevertheless, the pilot came down from 3 000 ft to 1 000 or 800 without a word of warning, and subsequently allowed the speed to drop so that he could no longer climb on one engine. The Commissioner believed that the captain was flying the aircraft in a manner quite out of keeping with his experience and attributed this behaviour to the fact that the captain was affected with fatigue to a very marked extent.

The Directors of the Company put the whole blame for this accident on the captain. It was said that the loading responsibility was his, and his the responsibility for taking-off in the aircraft. He also had been responsible for testing his first officer and in effect, as was suggested, had chosen his crew. They were not prepared to admit any criticism of their own actions or that the actions of this captain might have been affected by the policy of the Company.

A full and searching report into the affairs of this Company made by the Officers of the MTCA in December 1958 shows that since this accident the Company has taken great pains and spent a good deal of money in putting its affairs in order, with the result that its organization now bears favourable comparison with that of other larger companies and so that, if it is given a chance to do so, it is now able to provide a safe and proper service.

Probable Cause

The aircraft was allowed to lose height and flying speed with the result that the pilot was no longer able to exercise asymmetric control.

The conduct of the pilot and the whole course of events outlined were contributed to by the deliberate policy of this Company, which was to keep its aircraft in the air and gainfully employed regardless of the regulations or of the elementary requirements which should enjoin consideration for the conditions of working of its employees or the maintenance of its aircraft.

Any responsibility of the captain is to be viewed in the light of his position as an employee upon whose shoulders an intolerable burden was placed.

Recommendations

Six-monthly check

Recommendations in this regard were made in the report of 17 October 1957 (C.A.P. 146) on the accident at Blackbushe to Viking, G-AJBO, and were endorsed in the report of 19 July 1958 (C.A.P. 149) on the accident to Solent aircraft, G-AKNU, however, it was believed that they had not been implemented as at the time of writing of this report.

In particular, the following had been recommended:

a) that the check should be conducted on a special flight;

b) that in the case of a twin-engined aircraft it should include on at least every other occasion a landing with one engine inoperative at night;

c) that steps should be taken to facilitate the checking of a Company's records

Articles 34(B) and 34(E) of the Air Navigation (Fifth Amendment) Order 1957

These Articles provide a limitation on the flight time hours of the crew of public transport aircraft "for preventing excessive fatigue". A public transport aircraft is defined in Article 73 of the Air Navigation Order 1954 as "an aircraft carrying passengers or goods for hire or reward".

It was recommended:

- that in addition to stipulating a minimum rest time before a public transport flight and a maximum flight time for that flight a minimum rest time must also be stipulated after it and before any other flight whatever.

Tuning of ADF Equipment

It was agreed that the practice of seeking navigational guidance outside the service range of the wanted signal was undesirable.

However, assuming a pilot is warned of the risk and accordingly takes care to check the accuracy of the guidance he is receiving from his ADF equipment by the other methods available to him, there is no reason why he should not tune to a beacon from outside its strict service range.

Records of Maintenance

Article 17(8) of Air Navigation Order, 1954, deals with this subject. Its whole object is to ensure the making of the appropriate entry after each flight (as defined in Article 20(6) * and the preservation of the record of defects for a period of two years.

* "flight includes the whole of the period occupied in transit from an aerodrome to the aerodrome of next landing from the time when the aircraft is first in motion on the ground until the time when it comes to rest on landing."

It is recommended:

1. that in the case of the current record of defects any necessary amendment should be made to require that this record shall be completed in duplicate at the termination of each flight as defined by Article 20(6) and that in each such case one copy only shall be carried in the aircraft and that arrangements shall be made to ensure the preservation of the record for two years;

   (It may be useful to compare the practice in regard to load sheets where one copy is left on the ground.)

2. that the word "emergency" in the proviso to Regulation 49* should be defined as applying only to circumstances where an aircraft for some reason beyond the control of the operator or crew lands at an airport where facilities do not exist to enable the requirements of Regulation 49 to be complied with and as extending only to a flight from that airport to the nearest airport at which such facilities exist.

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* designed to cover the carrying out of temporary repairs in emergency.

ICAO Ref: AR/580

ACCIDENT TO VIKING GAIJE ON 2nd. SEPTEMBER 1958
RECONSTRUCTION OF PROBABLE FLIGHT PATH.

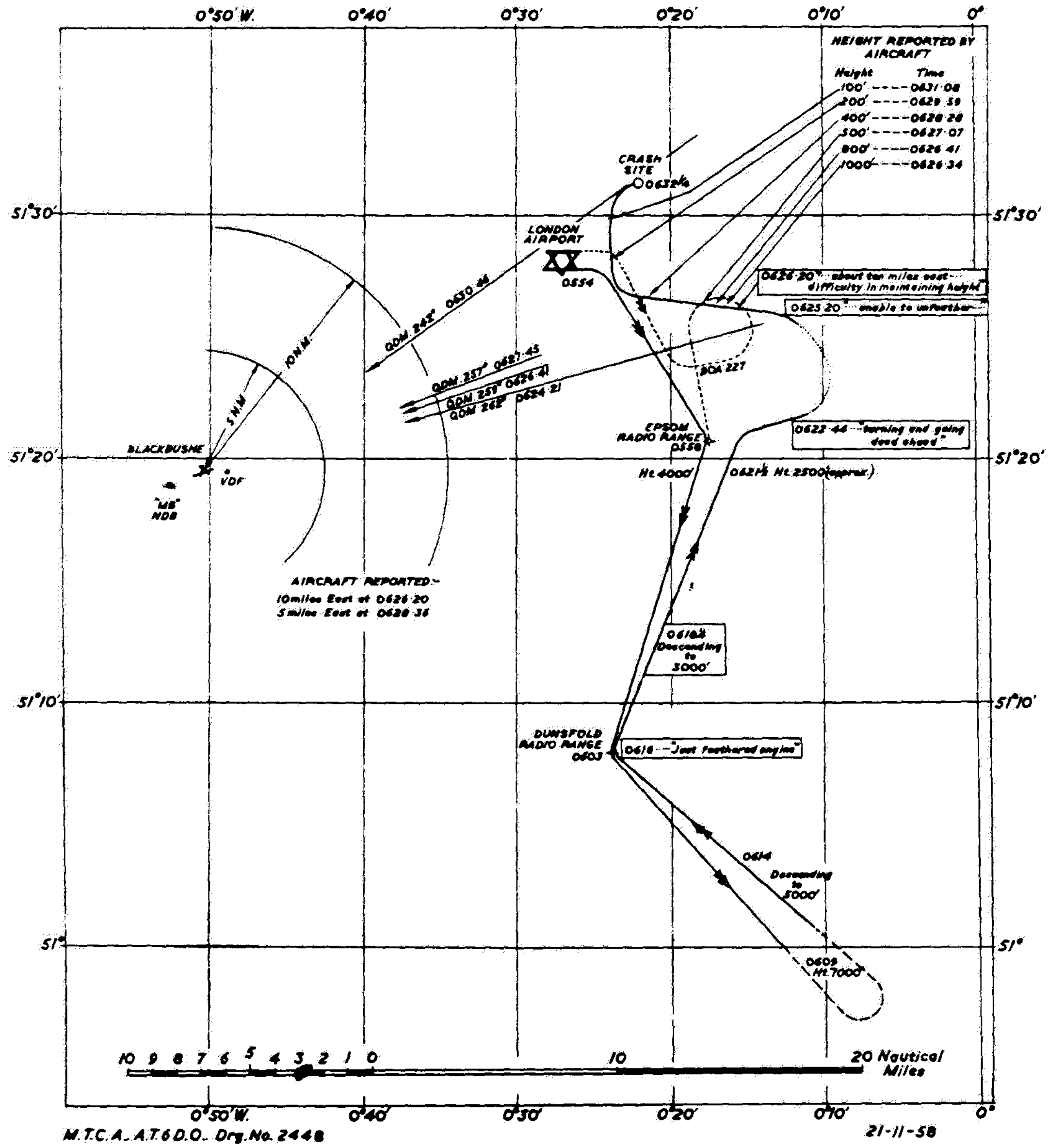

FIGURE 26

No. 48

Lóide Aéreo Nacional S.A., C-46, PP-LDX, accident at Campina Grande, Paraíba State, Brazil, on 5 September 1958. Accident summary as released by the Air Ministry, Brazil, 16 January 1959.

Circumstances

Clearance was given for the route segment PPRF - PPKG at the approved altitude of 1 800 metres. Upon reaching the position Nazaré, the pilot descended without clearance to 1 200 metres and passed over the PPKG facility at 1 000 metres, or 200 metres below the minimum altitude provided for initiating the procedure as prescribed by the Directorate of Air Routes. Having passed over the facility, the pilot consulted the procedure for PPKG and replaced it in the file. When the co-pilot asked him whether it should not be kept out, he said no, as he already knew it by heart. The procedure was initiated normally, the aircraft returning on a heading unknown to the Investigating Commission until it was at 520 metres (critical altitude 647 metres), when vertical visual contact with the runway was established; but it was not possible to come in, the aircraft having passed the critical point and being over the runway. The pilot tried to enter the traffic visual, so as not to lose sight of the runway, but this proved impossible on reaching final approach, with the result that the landing was again missed. He applied power and climbed in a spiral above PPKG to 750 metres. On reaching this altitude, he made a turn above the station, intercepting the outbound track. He maintained altitude up to the end of the base turn, when, starting the return, on heading 200 degrees, he began to descend, turning on the aircraft lights. After a few moments of flight, the co-pilot tried unsuccessfully to obtain visual reference by looking outside. At this time he felt a violent impact and heard the pilot shout that he was "hitting". Two crew and eleven passengers were killed, and two crew and three passengers were seriously injured in the accident.

The inbound heading of 200 degrees observed by the co-pilot and checked by the Investigating Commission showed that the procedure carried out by the pilot was not in accordance with that indicated in the approach chart approved by the Directorate of Air Routes. It was also found that at the time vertical visual contact with the runway was established, the aircraft was at most 40 metres from the ground, despite the fact that the meteorological information supplied by the Lóide station at PPKG was ceiling 130 metres with visibility 6 kilometres.

Causes of the Accident

The accident was due to pilot error - improper procedure during an authorized instrument flight. A contributing cause was an error on the part of other personnel - the meteorological forecast was incorrect.

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No. 49

Línea Aeropostal Venezolana, Super Constellation, YV-C-ANC crashed on Alto del Cedro Mountain, Venezuela, on 14 October 1958. Report released by the Directorate of Civil Aviation, Venezuela.

Circumstances

The aircraft was on a flight between Panamá and Maracaibo, Venezuela, carrying a crew of 6 and 17 passengers. It reported over the Riohacha intersection at 2351 hours at 15 000 ft and estimated its arrival at Maracaibo at 0030 hours. At 0015 hours the flight reported it was 35 miles out and at 10 000 ft. The last contact with the aircraft was at 0022 hours. It crashed on Alto del Cedro Mountain in the Sierra de Perijá killing all 23 persons aboard.

Investigation and Evidence

The wreckage was found 48 nautical miles from Maracaibo directly on the Maracaibo-Riohacha route, on the Colombian-Venezuelan border. The aircraft had hit very high tree tops in the wilderness of the high hills of the Sierra de Perijá, at a height of about 1 800 ft. It continued travelling through the air on a 120° course for about 1 500 ft among the trees, and for an additional 1 000 ft over a clearing. The final impact occurred directly against the rocky wall of a ravine at a height of about 1 500 ft. The heavier parts fell to the rocky bottom of the ravine, 125 ft below.

It was evident that on initial impact the aircraft was in a straight and level position, laterally and longitudinally, or at least approximately so. The aircraft disintegrated left wing and tail first, followed by the fuselage centre part and the right wing and tail. All impacts against the trees occurred between 60 and 80 ft above the ground. Although the fuel tank areas of the left wing had disintegrated during the early part of the accident, there was no evidence of fire prior to the final impact.

The evidence attracting most attention in the operational phase of the flight was the pilot's report that he was 35 miles out of Maracaibo, whereas the accident occurred a few minutes later at a distance of 48 miles out. It was proved that the report was sent at 0015 hours and that conversation was renewed seven minutes later, from which it is deduced that this position was at least 52 miles out at 0015 hours. It is proved below that he was possibly even further out. At a normal descent rate of about 600 ft/min, it would take about 13 minutes to descend from 10 000 ft to the 1 800 ft altitude at which the accident occurred; this gives rise to the belief that the accident took place at 0028 hours. If his rate of descent was above or below 600 ft/min, the time of the accident would, of course, be different; however it could not have occurred before 0022 hours.

Again on the assumption that the rate of descent was 600 ft/min at an average descent ground speed of about 232 knots, his position, when he reported at 10 000 ft, must have been 98 miles out of Maracaibo or six miles from the town of Riohacha. Further calculations prove that he must have initiated descent from 15 000 ft at about 0007 hours, 128 miles out of Maracaibo and only 16 miles on this side of the Riohacha intersection. (This calculation is based on an average flying speed of 280 knots, in descent, less the windspeeds according to the report). If a 165-knot TAS cruising speed at 15 000 ft is taken, less 15-knot headwinds, and his reported position over the Riohacha Intersection at 2351 hours, his true position at the time of that report ought to have been 191 miles from Maracaibo, or 45 miles from the Riohacha Intersection.

If this reported wind speed is applied, it can be deduced that when the pilot advised having reached position Tango/2, he was actually seven miles from that position. This is not considered a serious error since in view of the lack of radio aids in that area, it would have been difficult, if not impossible, to establish one's position with greater accuracy. It should be noted, however, that all his position reports up to and including Barranquilla were transmitted at exactly the estimated time. His subsequent position report over the Riohacha Intersection was made six minutes ahead of the planned time. By drawing a line between Tango/2 and the point indicated in the preceding paragraph (45 miles from the Riohacha Intersection), it can be seen that this line is exactly parallel to the required heading (account being taken of the wind) to maintain precisely the Barranquilla-Riohacha Intersection course (41°). If the pilot flew this route, he would arrive at the presumed Riohacha Intersection at 2349 hours, i.e., only two minutes before his report at 2351 hours.

Considering that the pilot was sending his position reports exactly according to schedule, it would appear that he sent them merely pro forma, including the report over Barranquilla which he never reached.

The minimum altitude for the Red 13 stretch between Riohacha Intersection and Maracaibo is 9 000 ft. If an emergency had occurred after the 0022 hour contact, and assuming that the aircraft was at the correct altitude, there would have been sufficient time (1) for a radio transmission and (2) for the passengers to fasten their safety belts. Neither of the two measures was applied. The differences in en route altimeter setting were not sufficiently significant to produce important errors in estimating altitude, and minor errors of this kind would not have brought about this accident. While it is obvious that a small difference in altitude would still have allowed the aircraft to overfly the mountain, this does not alter the fact that the pilot had descended to an altitude greatly below that recommended for this area where navigational aids are scarce.

It is known that the pilot descended from 15 000 ft without prior clearance. The Commission was, nevertheless, informed that such a procedure is correct provided that the aircraft is flown by visual reference. Weather conditions in that area during the night of the accident made it impossible to establish whether the descent could be performed entirely by visual reference. However, there were variable cloud conditions over the weather reporting stations, so that a visual descent would have been very difficult to carry out, to say the least.

Conclusions

The pilot turned northwest on reaching position Tango/2, instead of turning at Barranquilla, and flew towards a wrong position 45 miles from the Riohacha Intersection, having failed to take this discrepancy into account in calculating his distance from Maracaibo.

It is very likely that the pilot, when reporting 35 miles from Maracaibo, had seen the Carrasquero lights and the surrounding gas flares, through a thin layer of cloud below and believed they were the lights of Maracaibo.

The pilot had no way of definitely determining his position in the area, and, therefore, ought to have taken greater precaution against descent at a mistaken location. His best alternative should have been to remain at a safer altitude until (1) he sighted the Maracaibo lights (not the glare), or (2) obtained oscillation of the radio compass needle over Maracaibo.

Crew Information

The captain had a total of 2 134:12 flying hours in Super Constellations. However, with the exception of 147 hours, he had accumulated all this time as first officer. He had flown this route only four times having been assigned to it on 1 September 1958. During the 40 days preceding the accident he had flown 147:03 hours, and his last previous flight was on 10 October 1958. He held the necessary licences and his last checked flight proved satisfactory.

The first officer had 469:38 flying hours as co-pilot on Constellations, as well as 600 hours as captain on Martin aircraft. Like the captain, he had flown this route only four times. During the forty days prior to the accident he had flown 136:13 hours, his last previous flight being on 10 October 1958. He was properly qualified to discharge the duties of first officer.

Probable Cause

The accident occurred owing to premature descent caused by the pilot's failure to allow himself a suitable margin for (1) altered flight course and (2) shortage of navigational facilities in the area.

Recommendations

The following recommendations were made following the investigation:

1) to establish a procedure whereby a pilot in IFR flight must maintain his height until he is cleared to initiate descent or, failing that, is under the obligation to cancel his IFR plan, weather permitting;

2) the airline should not assign to the same flight two individuals (captain and co-pilot) neither of whom is sufficiently familiar with the equipment and/or route;

3) pilots should be given instructions to maintain cruising altitude until such time as a definite position check is obtained, either visually or by radio;

4) to teach pilots, during their training, the importance of adhering to the flight plan. Any deviation from this procedure should be communicated to the FIR. A regulation requiring the pilot to transmit any new ETA would make it more difficult for the pilot later to ignore or forget the new ETA;

5) to install additional radio aids in the area, such as radio beacons or radio ranges at the Riohacha aerodrome and/or an approach beacon on Red 13 at a suitable distance from Maracaibo, say about 25 miles. This approach beacon would be highly useful even if a radar facility at Maracaibo becomes feasible.

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ICAO Ref: AR/566

No. 50

BEA, Viscount 701, G-ANHC and Italian Air Force, F-86E collided over Nettuno, Italy on 22 October 1958. Report released by the Ministry of Defence-Aviation, Republic of Italy - April 1959

Circumstances

The Viscount, en route from London to Naples, flying on Airway Amber 1, reported over Ostia at 23 500 ft at 1144 hours advising that it was continuing to Ponza, estimating arrival over this point at 1157. At 1150 it collided east of Nettuno with an Italian Air Force Sabre which was taking part in group training of aerobatic manoeuvres. The 26 passengers and 5 crew aboard the Viscount were killed in the accident, and the pilot of the F-86 parachuted to safety. Both aircraft were destroyed.

Investigation and Evidence

Actual Weather Conditions at the Time and Scene of the Accident

Along the coast of Lazio and offshore there was clear sky or very little cloud with 1/8 cumulus inland, base between 700 and 1 400 metres, and top probably around 2 000 - 2 200 metres.

At higher levels, the sky was generally clear north of the Circeo promontory. From Circeo to the lower Tyrrhenian Sea, high cloud formation existed (cirrus and cirrostratus) with base above 6 000 metres.

Visibility was good and greater than 10 kilometres in all directions.

Freezing level in the accident area was at approximately 2 200 metres. Upper winds obtained from Ciampino radio soundings at 1200 hours were light at all levels. Particularly light winds from NE up to 1 000 metres; variable from E to SE with a maximum strength of 5 knots between 1 000 to 4 000 metres; rotating towards 240° and later 270° with maximum speed of 13 knots up to the 7 150 metre level.

Navigation Aids

The ground/air communications log indicates that the Viscount regularly transmitted the prescribed position reports over the various reporting points.

The aircraft carried DECCA, for which there are no stations in Italian territory; it could not make use of the VOR system as it was not equipped with the necessary receiving equipment. The crew, therefore, navigated solely on the basis of ADF.

General Description of Airspace (see Figure 27)

Airway Al is under the jurisdiction of ACC Rome. This centre is organized into three sectors: North - Central - South. Overflight traffic on Airway Al between Ostia NDB and Ponza NDB comes under the control of South Sector.

The segment Ostia NDB - Ponza NDB of Al crosses prohibited (vietata) * area No. 15, (the Approach Control Zone of the Pratica di Mare military base). Prohibited (proibita)* area No. 18 (Nettuno Artillery Range) is located to the east of Airway 1 and is contained within area No. 15.

* Translator's Note

Throughout the report both "vietata" and "proibita" are used with reference to areas 15 and 18. Both expressions have been rendered in English by the word "prohibited" but in each case the original Italian word has been added between parentheses.

Airway A1, 60 NM in length, 10 NM wide, extends from 4 000 ft MSL to 23 000 ft MSL; the whole airspace above from 24 000 to 40 000 ft MSL is part of area 15, that is to say of the Pratica Approach Control Zone.

Control Procedure of Pratica CTR (Area 15)

The control procedures applying at Pratica CTR are set forth in Military Notam No. 44/47 of 27 October 1957.

That Notam, which contains additional information concerning the practical application of service instructions from Rome ACC/FIC and of agreements between Rome ACC/FIC and Pratica APP/TWR, specifies that the airspace around A1 is to be used only for IFR exits below A1.

ATC Procedures between Pratica and Rome Terminal Control Area

CTR Pratica (Area No. 15) lies within the airspace of the Rome Terminal Control Area.

In view of the fact that the Pratica Base is not used on a continuous basis except in specific cases, operations at the Base are limited to the period 0530 - 1300Z on week days; Rome ACC normally uses the Pratica CTR airspace for its own traffic, after appropriate coordination with Pratica APP/TWR.

ATC Procedures applied to the Viscount (BEA Flight 142)

On the basis of

a) the communications between BEA 142 and Rome ACC

b) the control strips relating to the flight

it appears that:

BEA Flight 142 was normal up to NDB Ostia and in accordance with ATC procedures. At approximately 1100Z, the controller of Sector North, in view of the presence of other traffic over Ostia NDB at 21 500 ft, and in coordination with Pratica TWR/APP, cleared BEA 142 on A1 at 23 500 ft, in conformity with the procedures in force.

At 1144 hours the Viscount reported over Ostia NDB, estimating overflight of Ponza NDB at 1157.

At 1153 hours Rome Control, having received reports of an accident (at approximately 1150 hours) in the vicinity of Anzio, called the Viscount repeatedly without receiving any reply.

The Wreckage

The wreckage of the two aircraft lay east of Nettuno; most of it was scattered over the area between C. La Secchia and the sea along a distance of about 2.7 km.

The Viscount wreckage lay mostly in the southern part of the above area, that of the Sabre mainly in the northern part.

There was, however, no clear line of division between the parts of the two aircraft, nor was there any evidence of a precise distribution pattern in the wreckage trail, except that some of the denser components of the Viscount (2 turbo-props) were found towards the southernmost part of the area.

The turbine of the Sabre was located NW of the above area and at quite a distance from the other parts, indicating a somewhat anomalous trajectory.

Figures 28 and 29 show the main components of the two aircraft and the structural break-up following the collision.

Many parts were not located, could not be identified or were broken into small fragments. The only parts of the right wing of the Sabre that could be identified were a few pieces of the wing tank, the centre hinge of the aileron and the wing tip - considerably buckled and still carrying the undamaged pitot antenna - and a few other pieces. The rest of the wing was reduced to minute and irregular fragments indicating that the wing most likely exploded.

The condition in which the forward part of the fuselage of the Sabre was found, in contrast with the aft part, leads to the conclusion that the impact occurred on the under part of the fuselage, practically at right angle to its axis, and that, therefore, the Sabre was in a dive at the moment of collision.

As regards the Viscount, it is believed that No. 1 propeller struck the left wing of the Sabre dissipating part of its rotative force and became separated from the engine after failure of the reduction gear. Practically at the same moment No. 1 engine was torn free from the wing, following deceleration caused by the collision. Since the total kinetic energy absorbed by the bending of the propeller blades, the failure of the reduction gear and the failure of the engine mountings on the wing, may be considered as small in relation to the kinetic energy of the turbo-prop, it may be assumed that the trajectories of the engine and the propeller were practically the same and such that a line plotted back from the points on the ground where these two parts were found will give an approximate indication of the point of collision.

The Configuration of the Collision

The wreckage clearly indicates that impact occurred between the forward left part of the Viscount and the bottom part of the Sabre which was in a dive.

The fact that only a few parts of the right wing of the Sabre were found, in widely scattered areas, and identified, leads to the assumption that the wing disintegrated on impact.

Another clear indication of direct impact is furnished by the tears produced by No. 2 turbo-prop of the Viscount on the central section and on the right wing root of the Sabre, which impact destroyed the turbo-prop.

The condition of the leading edge of the left wing of the Sabre leads to believe that the point of impact was in Area A (see Figure 29), against the leading edge of the Viscount wing between No. 1 and No. 2 engines.

From the statements of the pilots of the flight formation, and on the basis of the likely configuration of the two aircraft and their respective speeds, it may be deduced that at the moment of impact:

- the longitudinal plane of symmetry of the Sabre was approximately in a vertical position,

- the longitudinal axis of the Sabre formed an angle B of 70° with the horizontal axis.

The angle, as seen from above, of the longitudinal planes of symmetry of the two aircraft was $45/50^{\circ}$. (See Figure 30)

The collision probably took place in the following manner:

- probable impact of right wing of Sabre against fuselage (nose) of the Viscount;

- impact of left wing of Sabre against Viscount No. 1 and 2 propellers with initial structural disruption of Sabre in area K (see Figure 29) and detachment of Viscount No. 1 propeller;

- impact of centre section of Sabre against No. 2 engine, with failure of centre section, and probable explosion of fuel in Sabre wing tank resulting in disintegration of right wing;

- projection outwards of Sabre ejection seat with pilot;
- separation by inertia of Viscount No. 1 engine;
- impact of leading edge of Sabre left wing (area A in Figure 29) against leading edge of Viscount left wing, failure and separation of parts 21, 31 and 38 of Sabre left wing;
- breaking-up of Sabre rear fuselage and Viscount left wing in area H (Figure 28) as a result of mutual inter-penetration and consequent destruction of both aircraft;
- smashing of Sabre and powerplant and separation of tail assembly.

As regards the Viscount the impact most likely generated angular accelerations causing yawing and rolling.

These accelerations contributed to the disruption of the rear fuselage cone with the tailplane, and to separation of No. 4 powerplant. Failure of the right stabilizer at the root must also be attributed to the aforementioned accelerations.

The multiple fractures in the nose section (Figure 28) as well as other fractures along the fuselage appear to be attributable to the cumulative effect of impact, momentum and pressure waves (initial explosive decompression, sudden dynamic pressures, explosion of the right wing of the Sabre).

Separation of the tip of the Viscount vertical fin and of the right stabilizer appears to have been caused by the shearing action of the sheets which broke off from the nose of the fuselage.

The figures in Figure 31 attempt to reconstruct the likely sequence of the collision.

The sequence of impact as described above was of extremely short duration, in the order of 1/10 of a second.

Reconstruction of Flight up to the Accident

The Viscount took off from London at 0841 hours for Naples and Malta and was to follow Airways A-3, A-1 and B-28. The London-Geneva segment was flown as planned. This was ascertained from the DECCA recording which was recovered from the wreckage of the aircraft.

The Geneva-Ostia segment was also flown according to flight plan as evidenced by the time of overflight over reporting point. The aircraft flew at cruising level 21 500 ft up to the border of Milan FIR but climbed to 23 500 ft before reaching Turin after obtaining clearance from Milan ACC. This altitude was maintained until the accident, by authorization from Rome ACC. The estimated speed (262 kts) was actually made good. The last communication sent by the Viscount to Rome ACC was the message reporting over Ostia at 1144 hours.

The collision between the Viscount and the Sabre occurred shortly before 1150 hours, the time at which the first report concerning the accident was sent by the control officer on duty in the Pratica di Mare tower, who saw the cloud of smoke caused by the explosion.

Having regard to the report sent by the Viscount from Ostia at 1144 hours and to the ground speed maintained up to that moment (approximately 262 kts) it can be assumed that the sector Ostia-Ponza-Naples would have been flown in 27 or 28 minutes. It is pointed out, however, that while the initial descent, according to the flight plan, was to have commenced at Ostia; the Viscount, following authorization from Rome ACC, maintained a cruising flight of 23 500 ft beyond Ostia.

The Sabre jet formation consisting of four F-86E, including the one that collided with the Viscount, had taken off from Pratica di Mare Airport at 1045 hours on a group tactical training exercise in the eastern part of area No. 15 specifically reserved for the 4th Air Brigade for training purposes, and prohibited to civil aircraft.

After about one hour of exercises the last phase of the training flight prior to the collision as reconstructed from the statements of the pilots of the Sabre formation was as follows:

The formation was in an area located approximately 5 km east of Anzio - on a heading of approximately 310° and was carrying out a reverse track manoeuvre consisting of an initial dive, followed by a climb turn to the right and a steep dive with final recovery in level flight. The formation was flying Indian file at 50 metre intervals.

The manoeuvre was initiated on a heading of approximately 310° and was to be completed on a reciprocal heading, that is approximately 130°.

Initial altitude was 25 000 ft, at the end of the initial dive 20 000 ft and back to 25 000 ft at the top of the climbing turn.

During the steep dive that followed the climbing turn, the leading aircraft collided with the Viscount.

None of the pilots of the formation saw the Viscount before the collision.

Discussion of Evidence

In the light of the foregoing data the following deductions are made:

Characteristics of collision

Obviously there was a single impact with immediate catastrophic results. In fact:

- the wreckage of the two aircraft form two distinct groups separated by a short distance;
- the wreckage of the Sabre indicates that it was in a sharp dive at the moment of impact;
- except for the turbine engine of the Sabre, all pieces of the wreckage were located close to the two main groups of components;
- no part of the wreckage shows any evidence of pre-collision damage or impact;
- the Sabre formation maintained close order until the collision of the leader;
- the pilots state that they did not see the Viscount before the collision.

Location of collision

There is no doubt that the collision occurred outside the Airway, in a well-publicized prohibited (vietata) area. In fact:

- all statements are in agreement as to the location inland of the black cloud sighted following the collision;
- the wreckage trail of the Viscount indicates a descent path from the NW sector approximately;
- even assuming that impact to have occurred on the eastern edge of the airway, the wreckage - bearing in mind all the circumstances - would not have fallen where it was found nor would the wreckage pattern have been the same.

The reference points given by two witnesses are sufficiently accurate to identify the location of the collision somewhere near Ponsarico.

This location coincides with:

- the distance from Ostia (48 km), in relation to the time elapsed (6 minutes approximately) and to the speed of the Viscount (500 km/h);

- the orientation of No. 1 engine and No. 1 propeller and their trajectories;

- the wreckage trails of both aircraft.

Deviation of Viscount from Airway

Flight from Ostia to Collision Point

No information was obtained from the Viscount or from other sources concerning this portion of the flight.

The only ascertained facts are the following:

- at the time of the collision the Viscount was coming from a NW sector approximately;

- wind force was negligible in relation to the speed of the Viscount (500 km/h);

- at 1144 hours the Viscount reported that it was over Ostia NDB and flying towards Ponza;

- at 1150 hours the collision had already taken place at a point approximately 48 km from the Ostia radio beacon.

It would take a minimum period of 6 minutes to cover the segment from the reporting point (Ostia) to the point of collision.

It is deduced that the actual track must have followed very closely the line joining the two points: in other words it is hardly conceivable that the Viscount departed significantly from a direct track along that segment.

Reasons for deviation from airway

The following three assumptions are possible:

1. voluntary deviation;

2. deviation to avoid a feared collision with Sabre formation;

3. deviation as a result of navigational error.

1. Starting from a point close to Ostia the pilot may have voluntarily headed towards the airport of destination (Naples), thus placing himself, some 6 minutes later, at the point of collision.

In support of this assumption it may be considered that the pilot of the Viscount, because of the flight level and the excellent visibility conditions, may have thought that there was no real danger in crossing the prohibited (proibita) area, thereby shortening the flight distance to Naples.

It is pointed out in this connection that the airline's schedule gives 1210 as time of arrival of Flight 142 at Naples. Having reported over Ostia at 1144 hours, the aircraft could not have arrived at Naples before 1217, having regard to the time required to cover the distance Ostia-Ponza-Naples (28 minutes) and to carry out the aerodrome procedures (5 minutes).

It is pointed out furthermore that upon reporting over Ostia the pilot did not request authorization to commence his descent, as indicated in the flight plan, but instead kept at 23 500 feet, in accordance with the clearance received from Rome ACC. The above assumption is in accordance with the direction of flight of the Viscount (approximately from a NW sector) as deduced from the wreckage trail. This direction of flight is more specifically confirmed by the position of the heading pointers (123° and 126°) read on the Master Indicator and Zero Reader and in the 31° shown on the radio compass, on the assumption, a likely one, that the power in the airborne circuits was immediately cut off at the moment of collision. Against such an assumption it may be said that any intentional deviation from the route, while not entirely to be ruled out, appears very unlikely, since the captain of the Viscount, on the basis of his service record was an extremely conscientious and qualified pilot and therefore would hardly have broken a rule of navigation which in any event would have resulted in an insignificant saving of time over the entire duration of the flight.

2. The pilot was flying near the eastern edge of the airway and may have been induced to leave the airway with the aim of avoiding the jet formation which he had seen from a distance and which appeared to him to be carrying out manoeuvres likely to bring them on a collision course with him in the airway.

Acceptance of this assumption would imply that the captain of the Viscount, having sighted the jet formation carrying out aerobatic manoeuvres east of the airway and believing that they were flying towards the airway, decided to turn to the left. The weakness of this theory is that it assumes that the pilot of theViscount not only sighted the Sabre formation from an excessive distance, but also that he was able accurately to determine that they were on a collision track, thus inducing him to leave the airway.

Furthermore, since such a theory presupposes that the pilot of the Viscount had sighted the Sabres from a distance it is reasonable to assume that after leaving the airway he vould have manoeuvred the aircraft so as to keep the Sabre formation under constant visual observation, and hence it is difficult to explain a frontal collision in the circumstances.

3. The pilot intended to follow the Ostia-Ponza airway and gradually and unconsciously deviated from the airway as a result of navigation error.

In support of this assumption it is observed that navigation was conducted in the conditions reported hereunder:

- on the day of the accident the winds, in the vicinity of Rome, had a somewhat irregular behaviour; in particular along the higher Tyrrhenian coast they were quite strong from the NE sector, but near Rome they practically inverted direction, and their intensity varied considerably;
- the crew were aware of this situation through the forecast received on departure from London, but nevertheless were required to make the necessary drift corrections by direct checking of the local situation; the aircraft did not carry VOR equipment;
- an ADF radio compass tuned on MF radio beacons sometimes gives unstable indications.

Under this assumption, as a result of the rapidly changing drift, the Viscount may have passed abeam and inland of Ostia NDB, whereas it reported over Ostia at 1144.

From that point it may have continued flying close to the eastern edge of the airway on a track diverging more and more from the centre line of the airway itself.

Against this assumption is the fact that navigation from London to Ostia had been normal and the consideration that the excellent visibility along the segment Ostia-Ponza permitted reaching Ponza by direct route without difficulty.

It is pointed out furthermore that along the segment Ostia-Ponza the airway passes between two prohibited (proibite) areas and this fact must have obviously made the pilot of the Viscount particularly mindful of the need to navigate accurately.

Conclusions

Regarding the validity of the various above-mentioned assumptions the investigating Commission expresses the following opinion:

4 members incline towards assumption No. 1 - voluntary deviation;

No member supports assumption No. 2 - deviation to avoid a feared collision with the Sabre Jets;

7 members consider assumption No.3 the most likely - deviation as a result of navigational error.

Causes

The accident was attributed to "an Act of God" - since neither of the pilots saw the other aircraft before they collided.

A contributory cause of the accident was deviation of the Viscount from the airway which placed it in a prohibited (proibita) area reserved for military activities.

Recommendations

The Investigation Commission made the following recommendations following the inquiry:

1. Prohibited (proibite) areas reserved for military activities should be removed from the immediate vicinity of terminal control areas and from airways. In the case of military airports located within the terminal areas, the reserved airspace should be limited to the control zones established for the inbound and outbound procedures.
2. The system of radio aids should be improved so as to permit easier and more accurate navigation for aircraft. As regards Italian territory, completion of the VOR plan should be expedited.
3. Airlines should be urged to provide their aircraft with equipment permitting maximum use of the facilities provided along the route.
4. Control units should be provided with radar equipment enabling them to give more effective protection and to exercise more positive control both in the terminal areas and along airways.
5. Pilots' attention should be drawn to the need for strict observance of air traffic regulations. (It is pointed out in this connection that prohibited (vietata) area No. 15 was overflown 36 times during 1958, 14 times following this particular accident.)

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ICAO Ref: AR 581

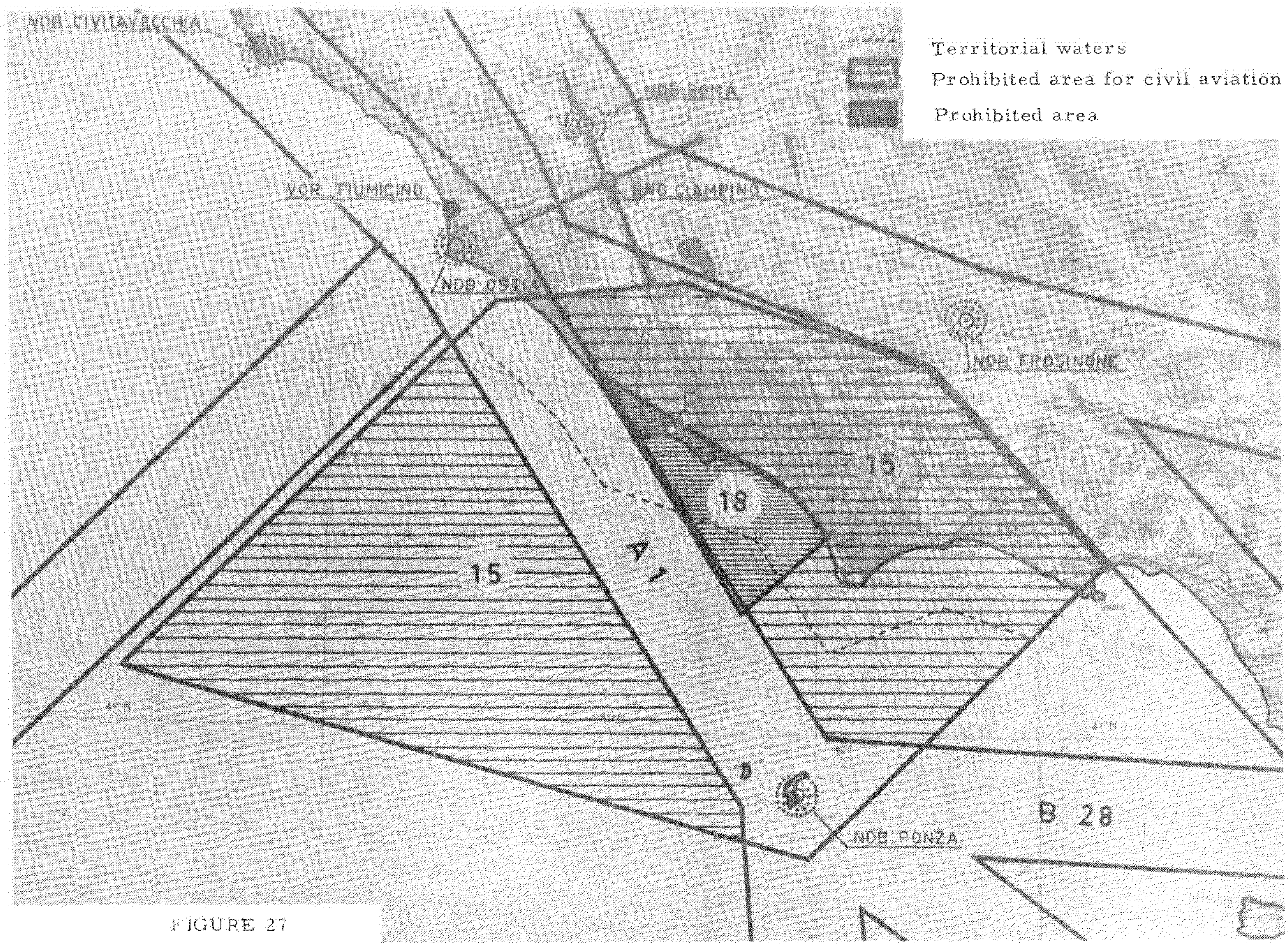

Territorial waters
Prohibited area for civil aviation
Prohibited area
NDB CIVITAVECCHIA
NDB ROMA
VOR FIUMICINO
RNG CIAMPINO
NDB OSTIA
NDB FROSINONE
15
18
15
A 1
NDB PONZA
B 28

FIGURE 27

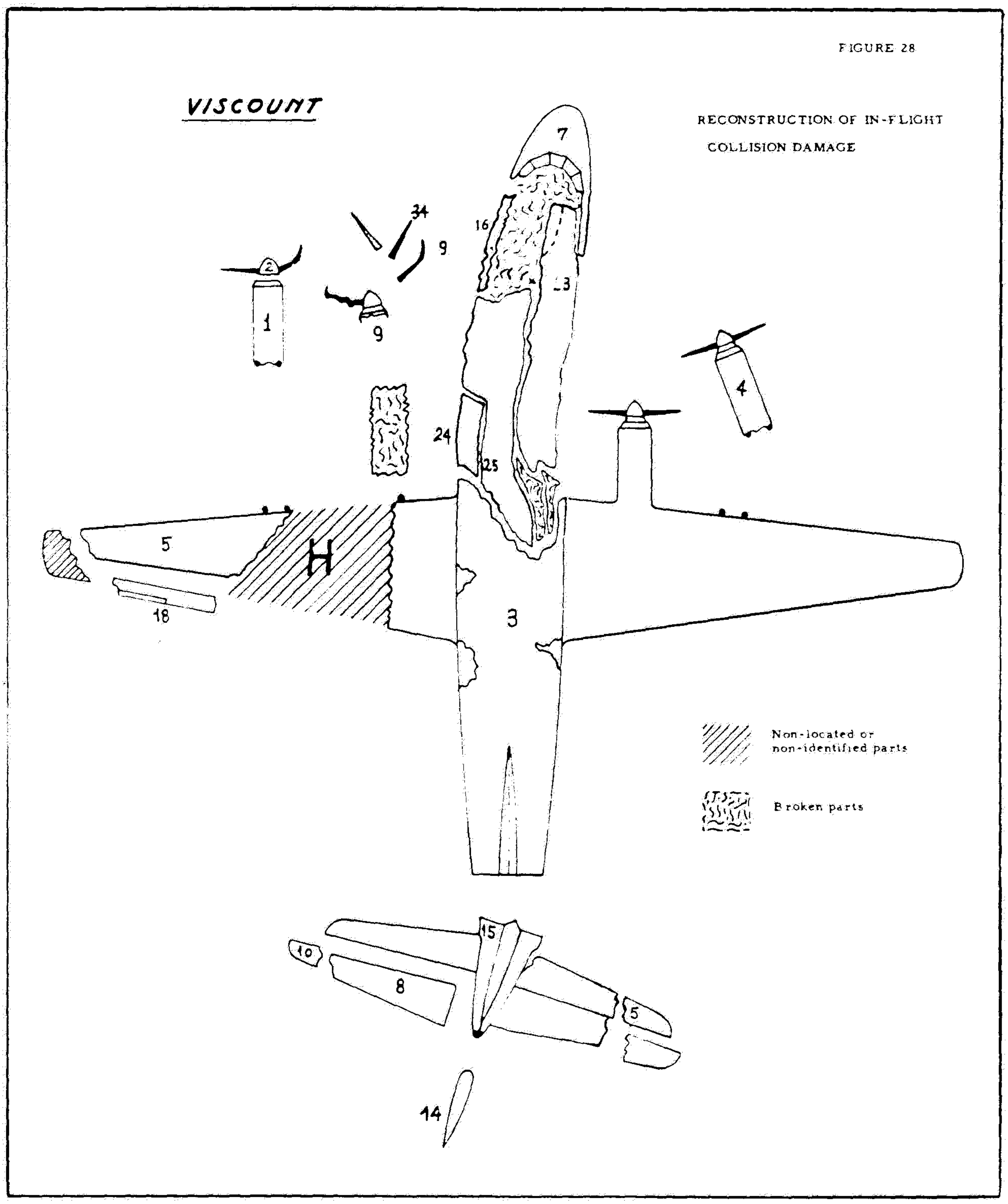


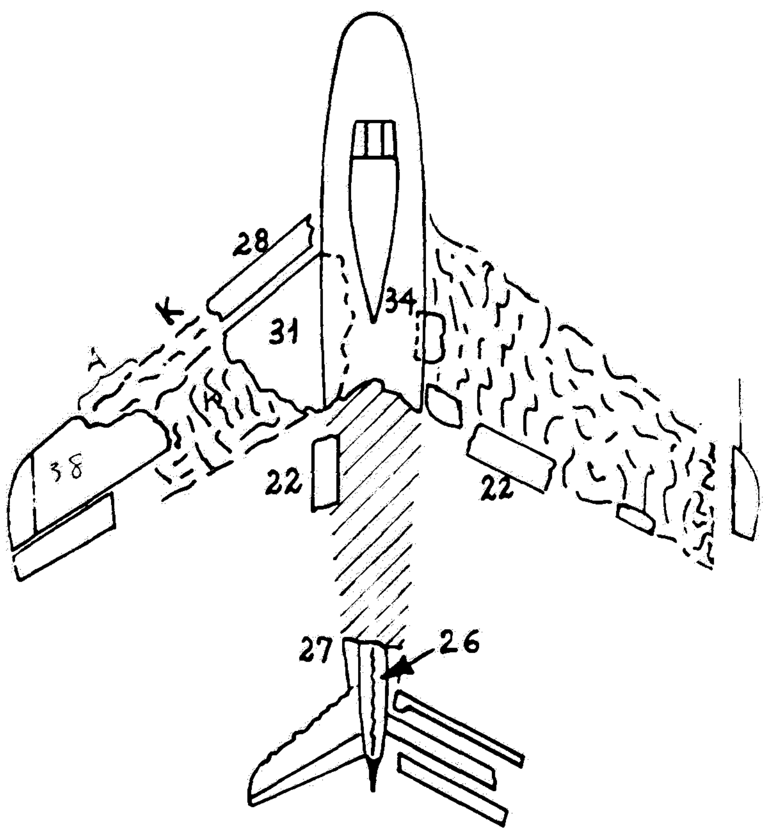
FIGURE 28

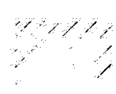
RECONSTRUCTION OF IN-FLIGHT COLLISION DAMAGE

FIGURE 29

F 86 E

RECONSTRUCTION OF IN-FLIGHT COLLISION DAMAGE





Non-located or non-identified parts

Broken parts

The angle, as seen from above, of the longitudinal planes of symmetry of the two aircraft was 45/50°.

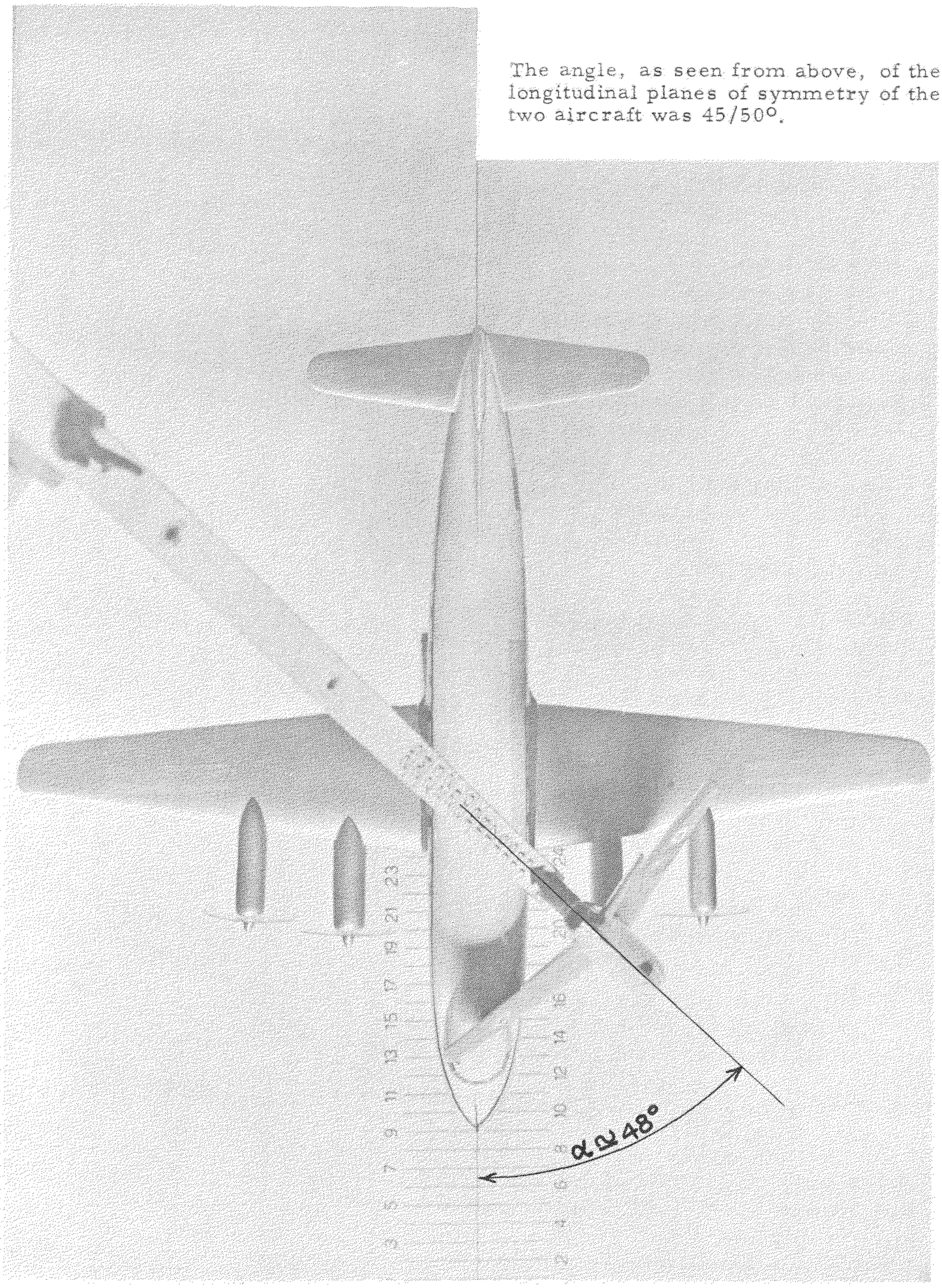
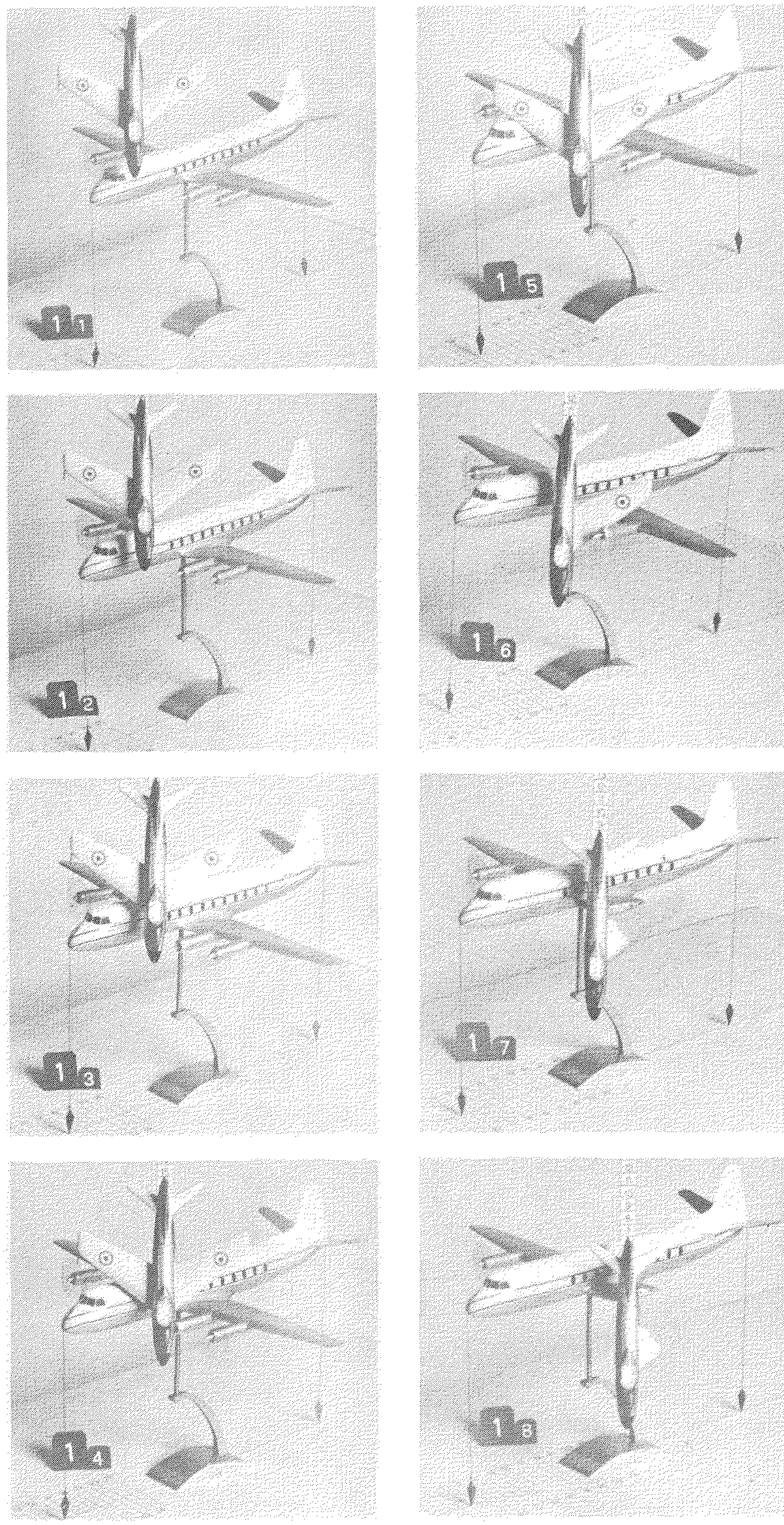


FIGURE 30

FIGURE 31

Reconstruction of the likely sequence of the collision.



No. 51

Compañía Cubana de Aviación, S.A., Vickers Viscount, CU-T 603, accident at Nipe Bay, Cuba on 1 November 1958. Report by the Civil Aviation Commission, Republic of Cuba.

Circumstances

Flight 495, a scheduled flight, departed Miami at 2200 hours en route to Varadero, a distance of about 200 miles, estimating its time of arrival as 2249 hours. It carried 16 passengers and a crew of 4. As there was no news of the flight at 2249 hours, an alert was declared. It was subsequently learned that the aircraft had crashed over 400 miles from Varadero at approximately 0210 hours in Nipe Bay, Central Prestón, Oriente Province, killing all aboard except 3 passengers.

Investigation and Evidence

The aircraft left Miami at 2200 hours with 1 600 U.S. gallons of fuel, total endurance thus being 3.47 hours, giving ample reserve for the intended flight. It was later proved that impact with the water occurred at 0210 hours. Thus, the aircraft had flown 23 minutes beyond the estimated endurance. Even though fuel on board always exceeds the amount required for a given flight, at the time of impact only 8 gallons remained in the tanks.

According to testimony of residents in the accident area, the aircraft circled over the spot a number of times, finally making a wide turn, passing over the town of Antilla in the direction of Prestón Airport, on final approach. It suddenly fell into the bay at about 400 metres from the coastline and 2 km from the airport. The direction of travel was reversed by the force of the impact with the water, and the aircraft travelled about 200 metres, furrowing the muddy bottom, which is at a depth of 2 fathoms.

After salvage the following evidence was found:

The right wing was intact over its entire length, but the left wing tip was not found.

Engines Nos. 3 and 4 were in perfect condition; engine No. 1 was lacking the hub and propeller; the propeller blades on No. 2 were bent backward.

The tail section was completely separated from the fuselage, floating about 80 metres from the rest of the aircraft.

When the cockpit was salvaged intact, it was found that all routine landing operations had been carried out.

The above information indicated that the pilot attempted to raise the aircraft's nose but was too near the water, which the tail hit, parting from the fuselage over a length of about 4 metres.

Probable Cause

The pilot was trying to land at Prestón Airport when the aircraft ran out of fuel on final approach and loss of control followed.

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ICAO Ref: AR/583

No. 52

Yemenite Airlines, DC-3, YE-AAB, accident near Roccatamburo di Poggiodomo, Perugia, Italy, on 3 November 1958. Report released by the Director General of Civil Aviation and Air Transport, Italy.

Circumstances

YE-AAB was on an official government flight from Rome, Italy to Yugoslavia, taking the Under Secretary of Foreign Affairs, Yemen, to Belgrade. Four crew and four passengers were aboard. The flight departed Ciampino Airport (Rome) at 1645Z on an IFR flight plan and was to proceed via Viterbo, Pescara and Split to Belgrade. Due to the fact that the aircraft gave an impossible estimate for its ETA over Viterbo, Ciampino Tower, at 1729Z on its own initiative, notified the aircraft that it was on a bearing of 315°, which indicated that it was to the west of Viterbo. At 1736Z, YE-AAB advised it was over the Viterbo NDB giving its ETA at Pescara as 1817Z. At 1738Z the Tower cleared the aircraft to climb from 8 500 ft to 13 000 ft and requested it to transfer from VHF to HF for further en route navigation messages. The aircraft acknowledged, and this was the last effective radio contact. At approximately 1800Z the aircraft crashed on the western slopes of Monte Porretta at a height of 2 690 ft. All aboard were killed, and the aircraft was destroyed.

Investigation and Evidence

Crew Information

The aircraft carried a pilot-in-command, second pilot, radio operator and flight engineer.

The Yugoslav pilot had a total of 3 165 flying hours by day, 2 125 of which had been on DC-3 type aircraft.

Yugoslav pilots are taken on for 11 month periods of duty with Yemen Airlines. Prior to their being assigned to Yemen Airlines the pilots receive instrument flight checks, link training and medical checks. The Yugoslav Government gives Yemen Airlines a guarantee that these pilots are qualified and holding valid licences. Before commencing duties in Yemen, each pilot is tested by the Chief Pilot of Yemen Airlines with whom he must perform 10 hours of flight with landings at the various airports in Yemen. If the examination is successful, the pilot is issued with a Yemenite commercial licence.

Navigation Aids

All radio aids available along the flight segment Ciampino-Ostia-Viterbo-Pescara were operating efficiently during the flight as was the Viterbo NDB. There were no reports by other aircraft in flight at the same time as YE-AAB of irregular functioning of any radio aids.

Communications

The following frequencies were available to the aircraft: 117.9, 118.1, 119.1 and 121.5. Throughout its flight it used only 117.9 (a military VHF frequency) when in contact with Ciampino Tower. Also, while en route it advised that it could not switch over to Rome Control as it did not have the appropriate frequency - 120.1.

During the time in which the aircraft was in contact, from 1645Z to 1738Z, it made no mention of difficulties or interference in its airborne equipment, nor did it complain about the efficiency of the Ciampino radio facilities.

All HF communications were normal. HF contacts between the aircraft and Pratica di Mare (Ciampino) were made on 6554-6552 Kc/s.

Weather

Actual weather conditions along the route and in the accident area at the time of the crash

Lazio, Tuscany and Umbria generally overcast with stratocumulus base between 1 900 and 1 500 metres and top at 2 700 - 3 000 metres. Higher up medium clouds with base above 4 500 metres. Visibility was generally good and more than 10 km in all directions.

Winds aloft 1 500 metres, 300°, 10 knots.

Temperature +3 degrees C, winds at 3 000 metres from 300°, 15 - 20 kts, temperature minus 3° C. At 5 500 metres winds 300° 25 kts, temperature minus 18°C.

Statements by eye witnesses indicated that in the accident area, situated at approximately 800 metres above mean sea level, the clouds (stratocumulus) were at the 400 - 500 metre level and were shrouding the nearby peaks overlooking the point where the aircraft crashed - Monte Porretta (1 338 metres) and Monte Maggio (1 416 metres).

The actual weather conditions along the route flown were those given to the pilot in the forecast and in the position and weather reports.

The Wreckage - General

The wreckage was scattered along the west slope of Monte Porretta (1 338 metres) in the Central Apennines, southwest of Monte Vettore (2 478 metres), at an elevation of approximately 820 metres. It lay at approximately 300 - 400 metres from the bottom of the valley, which is surrounded by the high peaks of Monte Porretta and Monte Maggio.

The aircraft had crashed on a slope with a 45° incline and many of the parts that had become detached from it (engines, seats, radio equipment) had rolled down the incline. It was deduced from inspection of the wreckage that the aircraft hit the ground with the wings approximately parallel to the ground, the right wing slightly lower than the left. On impact, the longitudinal axis was probably inclined approximately 10° with reference to the plane of the slope.

The wreckage pattern and distribution of parts over the steeply sloping ground indicated the aircraft's forward motion was probably very small at the moment of impact.

From the condition and the position of the fuselage, the airframe and the power plants, it was deduced that the right engine and the front underpart of the fuselage struck the ground first.

The telescoping of the fuselage indicated that the path of the aircraft was inclined with reference to the ground surface, and its displacement towards the left was indicative of a side motion. This was confirmed by the fact that the engines were found to the left of the point of impact and that the rudder, broken off at the root, was folded towards the left.

The fire which broke out and which destroyed most of the wreckage, extended to a large area around the main group of wreckage and was fed by the large amount of fuel in the tanks. Since all other available evidence tended to exclude any outbreak of fire on board before the accident, it was concluded that fire broke out as the result of impact against the ground, probably starting in the right engine which suffered the greatest fire damage.

The few parts that were found of the controls, control links and control surfaces did not provide any evidence of pre-impact damage or malfunction.

It is assumed that the aircraft instruments, navigation aids and radio equipment were operationally efficient up to the last moment. It must be borne in mind that because of the difficult terrain and the position of the aircraft that it may have been impossible to re-establish radio contact on frequency 117.9, regardless of the status of efficiency of the airborne receiver-transmitter equipment.

Brief description of events

1645Z Departed Ciampino

1655 Aircraft reported over OSTIA at 4 000 ft, was cleared to CIVITAVECCHIA, remained on Tower frequency 117.9 m/c (Rome ACC frequency 120.1 m/c was not carried).

1707 Cleared to fly CIVITAVECCHIA to VITERBO at 8 500 ft. Aircraft gave, on request, ETA VITERBO as 1712. As the accuracy of this ETA was suspected by control two requests were made for confirmation.

1712 Aircraft gave revised ETA VITERBO 1717.

1717 Aircraft gave revised ETA VITERBO 1721 and reported flying in "fog" at 8 500 ft. Control then requested and was given confirmation that aircraft was receiving VITERBO Beacon; then further requested aircraft to transmit for bearing.

1729 Aircraft, on request, reported it had not overflown VITERBO. Control gave it a bearing (class B) from Ciampino of 315° and informed the aircraft that bearing of VITERBO from Ciampino was 328°. The aircraft acknowledged and read back.

1733 Control advised aircraft to contact Monte Argentario on 121.5 m/c. Aircraft acknowledged but apparently ignored the advice.

1735 Control asked aircraft for its heading, aircraft replied 020° and reported all well.

1736 Following Control's message - "you are behind time and should have passed VITERBO" - the aircraft reported - "I'll check again, here we are, over VITERBO NDB now. ETA PESCARA 1817."

1738 Control cleared the aircraft to climb to 13 000 ft and to transfer from VHF to HF. The aircraft acknowledged and this was the last effective radio contact. Just before 1800Z witnesses in the accident area heard the normal engine sound of an aircraft flying low on an easterly heading towards Monte Porretta. They observed the lights which were seen to turn and shortly afterwards the aircraft struck the mountainside and burst into flames.

Reconstruction of flight

The brief description of events indicates the confused nature of the flight and the consequent difficulty of reconstructing accurately the track followed by the aircraft. The Commission considered and discussed at length the relative merits of various hypotheses which may briefly be summarized as follows:-

1. The aircraft's radio compass may have been incorrectly tuned to Bibbona NDB (Call sign IO --/———) instead of VITERBO NDB (Call sign IMV --/——/----).

2. The radio compass may have been tuned to Viterbo NDB then with needle heading towards the beacon the selector receiver may have been placed to ANTenna position

during a check of the call sign and subsequently left in that position.

3. The magnetic compass may have been pre-set to 328° for a direct flight from Ciampino to Viterbo, as indicated in the flight plan. The pilot may not have reset when subsequently cleared to Viterbo via Ostia and Civitavecchia.

Two possible tracks of the aircraft after leaving Civitavecchia (1707) are shown in Fig. 32. During the 22 minutes up to the time of the bearing of 315° from Ciampino (at 1729) the aircraft could have covered, on a constant heading, the unbroken line to point A; or, on a zigzag course, the broken line to point A_1. Then, on being given the bearing, the pilot may have turned on to an easterly heading towards the Adriatic coast. In the time remaining before the crash, namely 29 minutes (up to 1758) the aircraft could have covered, assuming a constant heading, the unbroken track A to C on Fig. 32. If, however, a zigzag course was being followed the aircraft may have flown from A_1 to C during this time and have been on a heading of 020° (between A_1 and B_1) when that heading was reported by the pilot to Ciampino at 1736.

The Commission then discussed the possible reasons for the aircraft being at 2 690 ft at the time of the crash despite the fact that it had been cleared to fly at 13 000 ft in order to give adequate clearance over 9 500-foot mountains en route. The descent could have been caused by malfunctioning of the aircraft or icing or alternatively by the voluntary action of the pilot. It was concluded from the evidence that the latter was more probable for one or more of the following reasons.

The pilot may have descended:

a) to rest after a lengthy instrument flight;

b) to make a visual position check;

c) to eliminate icing.

The pilot may have been under the impression, due to confusion with estimated times, that he had crossed the mountains and was over the Adriatic.

The fact that the estimated flight time along the route Ciampino - Pescara was 73 minutes and that the aircraft crashed exactly 73 minutes after take-off appears to be significant, bearing in mind the special psychological situation of the Yemenite crew under the command of a Yugoslav pilot on a flight to Yugoslavia for the purpose of transporting to Belgrade the Under-Secretary of Foreign Affairs of Yemen on an official trip.

The above circumstances may have influenced the pilot in deciding to act on his own initiative without relying on flight control assistance which, although very valuable, nevertheless was somewhat embarrassing for him, since it pointed to serious errors of navigation on his part; therefore, it cannot be excluded that for reasons of personal pride he may have decided to continue to descend below the clouds at the very moment when, according to his flight plan, he should have been in the area of Pescara and therefore convinced (or perhaps even only hoping) to be beyond the Apennines.

Conclusions

The following conclusions were reached by the Board:

Inadequately trained crew

- faulty use of the radio compass, failure to request assistance of D/F facilities, erroneous estimates.

- The pilot-in-command and the crew had an inadequate knowledge of the Italian and English phraseology to be used in ground-air-ground radio communications.

Inadequate preparation for the flight

- erroneous assessment of adverse weather conditions, particularly at the destination airport, bearing in mind the lack of adequate facilities under such conditions;

- errors in compilation of the flight plan - error of approximately 12 minutes in estimated time for the Rome-Viterbo segment;

- inaccurate indication of frequencies available in aircraft - in actual fact, the control frequency of the Rome ACC (120.1 Kc) was not available although it was essential for flight assistance;

- inadequacy of charts covering the area along the route - it appears that there was no chart of Europe on board and the flight guide which was found in the wreckage was out of date.

Probable Cause

The accident was due to faulty conduct of the flight.

Recommendations

The Board made the following recommendations:

1. Aircraft that do not carry all the equipment prescribed by ICAO regulations should not be permitted to depart.

2. Air crews should hold documentary proof of appropriate IFR flight training, such training to be checked periodically as prescribed.

3. Air crews should be sufficiently familiar with the routes to be followed and the countries to be overflown and should have on board a complete and up-to-date supply of charts.

4. Air crews should have an adequate knowledge of the official languages to be used in radio transmission.

5. The competent authorities of the State concerned should issue appropriate regulations for the adoption of restrictive measures in respect of navigating personnel and of carriers who have been the subject of reports or warnings for infractions likely to constitute a hazard to flight safety.

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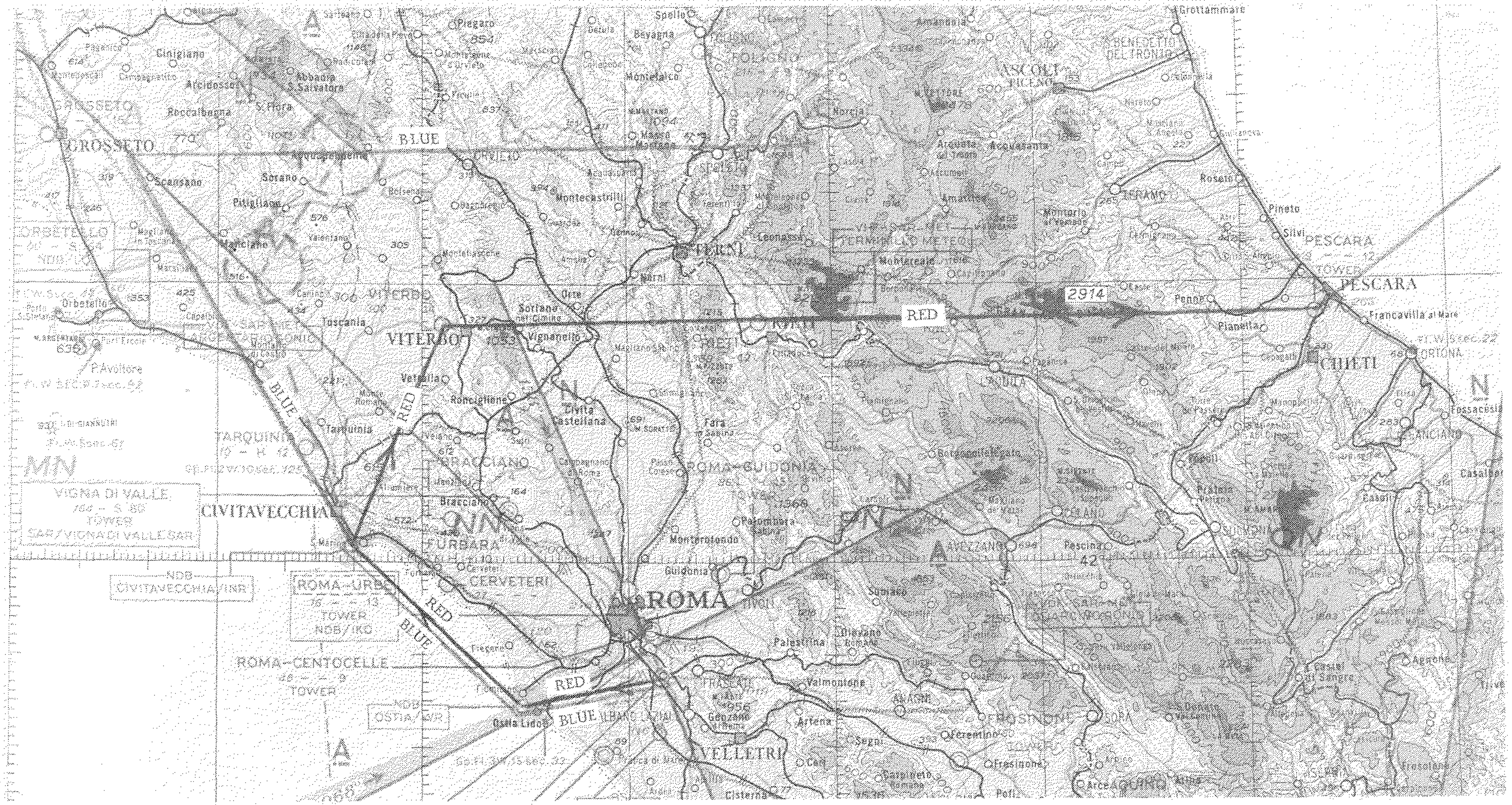
ICAO Ref: AR/582



Yemenite Airlines, DC-3, YE-AAB accident, Perugia, Italy on 3 November 1958

FIGURE 32

—— RED ——	Route which the pilot should have flown
—— BLUE ——	Route which the pilot may have flown (1st hypothesis)
– – – – – – – –	Route which the pilot may have flown (2nd hypothesis)

No. 53

Aero Topografica Ltda., Martin Mariner flying boat, CS-THB, missing since 9 November 1958. Report of the Investigation Commission, released by the Directorate General of Civil Aviation, Portugal.

Circumstances

CS-THB should have departed Cabo Ruivo at 0700 hours for Funchal but due to weather information received it postponed its departure until 1223 hours. On board were 36 passengers and 6 crew. At 1230 the aircraft reported to the Continental Regional Air Navigation Control Centre that it was climbing abeam the Barcarena radiobeacon (LS) and reported again at 1240 to ask for the alteration of the cruising altitude from 8 000 to 6 000 ft. This was approved. At 1247 it sent its first routine message in which it stated that it was estimated that the crossing of the Lisboa Flight Information Region limit would take place at 1407 hours. Normally, the aircraft would only contact Lisbon again to give the exact time of this crossing, however, at 1321 it sent the following message: "QUG Emergency". Nothing further was heard from the aircraft nor was any wreckage found during the search operations which followed.

Investigation and Evidence

The brevity of the message "QUG EMERGENCY" in which QUG means in the international code " I am forced to alight immediately" and the absence of an answer to questions show that there was an abnormal situation on board. The signal "QUG" may also mean, "I will be forced to alight at. . . " when followed by the indication of the place where the alighting will probably take place.

Since this indication was not given, such interpretation cannot be accepted and, therefore, the situation called for an immediate alighting. The fact that the word "EMERGENCY" in plain language followed the "QUG" signal seems to be proof that the radio operator was unaware of the nature of the emergency or was unable to explain it due to a very quick development of the situation.

The sea was high (2 - 2.5 m swell), the pilots had considerable experience with flying boats and they knew the Lisboa-Funchal route very well; all this leads to the conclusion that the pilot-in-command had no other alternative than to try to alight immediately.

The Aircraft

CS-THB was one of the two flying boats with which ARTOP intended to carry out public scheduled services to the Island of Madeira and the second to start these services.

The fuselage of CS-THB was fourteen years old. During this time it had accumulated 2 240 flying hours, 1 134 of which had been since its first complete overhaul. Most of the time it was under a preservation treatment and received in due time the appropriate maintenance. The fuselage was found to be in good condition by TAP's and DGCA's technicians and its hull did not show any signs of corrosion.

The work regarding the conversion of the aircraft into a commercial transport aircraft was directed and carried out by technical personnel and, as far as it was possible to ascertain, did not affect the safety of the aircraft.

One of the engines had a total of 1 369 hours running time, 453 of which were since the last overhaul. The other engine had only 329 hours running time, 50 of which were since the first overhaul. They had, therefore, completed only a fraction of 1 200 hours recommended for an overhaul of this type of engine.

The running time of the two propellers before their coming to Portugal was recorded as being 301 and 1 157 hours. There were gaps in the history of the propellers which prevented the Commission from following their previous life in detail. However, the overhauls and check-ups made at "Oficinas Gerais de Material Aeronáutico" are an assurance that they were in good condition.

Crew information

As of June 1958 the pilot had flown a total of 10 671 hours as aircraft captain, of which 2 700 hours were as Solent flying boat captain. He had been a pilot with Aquila Airways on the Southampton-Lisboa-Funchal line. His piloting ability of Martin Mariner aircraft was checked by an American pilot who was ARTOP's technical adviser and who had 3 918 flying hours in Martin Mariners and a total of over 22 000 flying hours.

In October 1958 the co-pilot had, as captain of aircraft, a total of 3 367 flying hours and was authorized to fly a Solent as co-pilot in which capacity he had 890 flying hours to his credit.

Discussion as to the Cause of the Accident

The stopping of one engine cannot explain by itself the accident. As a matter of fact, in case of one engine failure, the aircraft could have continued its flight with the other, although descending to about 2 400 ft and would certainly have reported this altitude change and the situation.

In the case of a simultaneous stopping of the two engines, the aircraft still had four minutes to reach the sea surface in gliding flight.

The aircraft called the C. R. A. N. Control Centre normally. The operator could not understand clearly the call sign of the aircraft (CS-THB) and asked for a repetition, which was made.

Once the contact was established, CS-THB asked about the quality of its signals. This information was given. It was only then that the emergency message was transmitted with the normal repetition of the QUG signal.

This communication procedure must have taken about two minutes and if the aircraft radio operator did not start the transmission immediately after the emergency situation occurred, he might have had no time for the transmission of further information.

The impossibility of transmitting further information could also have resulted, for instance, from the necessity of disconnecting some electrical circuits or from a failure in the telecommunication equipment.

ARTOP's technical adviser expressed the opinion that the accident might have been the result of some extraordinary fact, such as, for instance, an explosion which made it impossible to glide the aircraft and its breaking into pieces when ditching in the sea. However, if this assumption is to be accepted, the Commission could not explain the entire absence of wreckage during the search operations conducted in the area where the accident presumably occurred.

Having checked the condition of the equipment and the qualifications of the personnel without finding the presumable cause of the aircraft's disappearance, the Commission still considered as probable causes sabotage and route deviation, either voluntary or forced or due to a navigation error. These possibilities had, however, to be overlooked for lack of data for their examination.

Of all these assumptions, the stopping of both engines is perhaps the most likely to have been the immediate cause or the aggravation of an emergency situation. This is, however, a mere assumption which, although plausible, is only supported by the considerations already mentioned of the circumstances concerning the distress messages received.

Probable Cause

The cause of the accident was not determined.

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ICAO Ref: AR/574

No. 54

Aviación y Comercio, S.A., Languedoc M.B.-161, EC-ANR, accident in the Guadarrama Mountains, 4 December 1958. Report released by the Directorate General of Civil Aviation, Spain.

Circumstances

The aircraft took off from Vigo airport at 1540 hours on a scheduled flight to Madrid, with a crew of 5 and 16 passengers on board. The flight was cleared IFR for cruising level 95. At 1605 the flight advised Madrid D. F. station that it had overflown Guinzo de Limia at 1600, in cloud, and estimated the Salamanca JW radio beacon at 1650. At 1654 the aircraft advised Madrid D. F. station that it had overflown Salamanca at 1650 at level 95 and estimated Madrid at 1730 - also that its VHF equipment was out of order, and it was, therefore, requesting Barajas Tower to stand by on 3 023.5 kc/s. At 1710 Madrid control cleared the aircraft to proceed directly to Barajas radio range, maintaining flight level 95. At 1715 Madrid control authorized the aircraft to switch over to 3 023.5 kc/s and to establish contact with Barajas Tower on that frequency. This was the last communication with the aircraft. Between 1715 and 1720 the aircraft crashed and burst into flames on the peak of "La Rodilla de la Mujer Muerta" which is 1 999 metres, approximately 800 m lower than flight level 95. All aboard were killed, and the aircraft was destroyed.

Investigation and Evidence

The Aircraft

At the time of the accident, the aircraft had flown a total of 6 301 hours since its major overhaul, and approximately 1 387 hours since its last 1 500 - hour overhaul. Its Certificate of Airworthiness was valid. The take-off weight from Vigo was 20 720 kg, 2 680 kg less than the maximum permissible.

The Wreckage

The state of the aircraft's wreckage led to the conclusion that the aircraft was functioning normally at the time of the crash. It had struck the mountain slope in a normal flight attitude pitched slightly up and inclined to the left. The impact and the rupture of the tanks started a fire; and, because of the slope (25° - 30°), part of the fuel poured down on to the fuselage, causing its complete destruction.

Meteorological factors

The mountain-wave effect and downdrafts on the lee side.

There was no evidence that these factors could have jeopardized the flight. In spite of uncertainty about the wind data, it cannot be assumed, even under the most unfavourable circumstances, that air flow over the divide of the central system might have reached the force of a 35 kt transversal wind. Even at such a value, however, the aircraft had a sufficient safety margin in the 600 metres at which it was flying over the mountain divide. The sea level pressure was below normal; even so, however, assuming the aircraft was not using QNH, level 95 did in fact correspond to the true altitude of 2 800 metres, as is shown by the upper air observations.

Turbulence

Turbulence was, undoubtedly, present over the mountain divide. At level 95 it would, in general, have been moderate, but short intervals of more severe turbulence might have been encountered when crossing cumuliform clouds.

Nonetheless, taking into account the Languedoc's cruising speed, it is unlikely that such turbulence could seriously have affected the flight's safety.

Icing

At level 95, the air temperature was 3 or 4 degrees below zero. This, together with the prevailing cloud structure, indicates that icing may have been present. The 1 800 hour synoptic weather report for the Cogorros indicated fog with rime. Within the stratiform cloud layers, icing would have been light to moderate, however, within cumuliform clouds, conditions might have been far more dangerous since it is known that the severest forms of icing tend to occur in the upper half of large cumuli congesti, or in clouds just on the point of becoming cumulonimbi - icing in a cumulonimbus proper being far less severe than that occurring before a heavy precipitation which removes most of a cloud's moisture content.

At level 95, had the aircraft penetrated a cumulus congestus, it would have been flying in or very close to the upper half of the cloud mass. At the time of the accident (1715 hours), no heavy precipitation had as yet begun, as is shown by the fact that no snow was found under the wings of the wrecked aircraft, where the ground appeared to be dry. In other words, the accident occurred slightly before the major precipitation phase in the mountains. Thus, it is possible that at the time of the accident the mountain lay under cumuliform cloud formations at the critical stage, which favours severe icing.

Conclusions

The above leads to the conclusion that if the accident was due to meteorological factors, icing would have been the factor most directly responsible. It is assumed that during its flight through innocuous stratiform clouds, the aircraft may have encountered a cumulus congestus where sudden severe icing occurred.

The following may have taken place:

a) a sudden change in the aerodynamic characteristics of the aircraft may have caused stalling without giving the captain time to initiate recovery action;

b) the aircraft may have lost height rapidly, down to a level where the downdrafts over the lee slope swept it into a lower zone of erratic turbulence that sent it out of control;

c) when icing occurred, the captain may, in the belief he had already passed the mountain divide, have decided to fly below the freezing level which, as he knew, was to be found at about 2 200 metres.

It is possible that in assumptions (a) and (b) turbulence within the cumuli may have been a contributing factor.

Under severe icing conditions, the mechanical de-icing equipment is practically inoperative.

About 40 minutes before the accident, the mountain divide was overflown, also at level 95, by a scheduled Santiago-Madrid flight. This aircraft found nothing unusual to report, since light icing and turbulence are the normal accompaniments of winter weather in a low pressure area. This fact however, in no way precludes the possibility that shortly thereafter conditions of severe icing may have prevailed.

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ICAO Ref: AR/606

No. 55

Union Aeromaritime de Transport, DC-6B, F-BGTZ, accident at Salisbury Airport, Southern Rhodesia, on 26 December 1958. Report released by the Federal Department of Civil Aviation, Rhodesia - Nyasaland.

Circumstances

The aircraft was operating U. A. T. scheduled service UT. 736 (Johannesburg-Salisbury-Brazzaville-Nice-Paris). It took off from Salisbury Airport at 1252 hours for Brazzaville and during take-off from runway 24 entered rain. The aircraft climbed to about fifty feet and then began to lose airspeed and height. Although the captain was using full power, had 20° of flap extended and the undercarriage retracted, he was unable to prevent the aircraft sinking back on to the ground. Fire broke out immediately after impact. Of the 7 crew and 63 passengers on the aircraft, 3 of the passengers lost their lives.

Investigation and Evidence

The Wreckage

The first contact with the ground was a gouge mark caused by the tail skid at a point 1 900 ft from the south-west end of runway 24 and 220 ft to the right of the centreline. After impact the aircraft slewed slightly to the left and almost simultaneously numbers 1 and 2 propellers, the under-fuselage cooling air scoop and the number 3 propeller made contact with the ground, followed by number 4 propeller. As the aircraft settled, the under-fuselage and engine nacelles began to break up and the left wing inner flexible fuel cells and the wing root alcohol tank ruptured, and fire broke out. The aircraft continued to slide forward slewing to the left and shedding propellers, pieces of under-fuselage, wing and nacelle structure, but suffering no major break-up. It finally came to rest 1 450 ft from the point of initial impact and had slewed to the left through 135° from its original heading.

Further examination of the wreckage showed the main undercarriage and nose wheel to be in the fully retracted position. The flap and flying control systems were severely damaged but no evidence of pre-crash failure or malfunction could be found. It was impossible to ascertain the flap or control trim settings. All instruments were incinerated and no readings could be obtained.

Detailed examination of the four engines revealed no mechanical defect. The domes of all propellers were removed and it was ascertained that the blade angle of each was in the constant speed range on impact. All engine reduction gear casings and front covers were torn out, still attached to the propellers. From the foregoing evidence, and the extensive damage suffered by the blades of each propeller, it was evident that all were under a high degree of power on impact.

The Aircraft

The aircraft had been correctly maintained and was properly documented. The weight at take-off was 170 lb (77 kg) below the maximum permissible. The centre of gravity was within authorized limits.

The Weather

The captain and crew were briefed at approximately 1155 hours by the duty meteorological officer. The briefing included the information that there would be isolated storms at a distance of 20 to 40 miles from the airport on a true bearing of 300° to 330° which would be approximately along the track to Brazzaville; these storms were shown to the crew on the meteorological radar screen. There was no indication at this time of a storm to the east or southeast of the airport.

At 1240 hours it was observed that a storm was building up to the south-east of the airport and the meteorological officer on duty telephoned the control tower and stated that there might be gusts prior to or at the time of arrival of the storm at the airport.

At 1250 the storm to the southeast had approached the airport and the edge of the curtain of rain was about 1 200 yards to the south of the terminal building.

As the aircraft commenced its take-off, the edge of the rain reached the intersection of the runways, but the north-east end of runway 24 was clear of rain. The aircraft became airborne at about the intersection of the runways and disappeared into heavy rain.

The storm moved across the airport very quickly, estimated by the meteorological observers as between 20 and 30 miles per hour. There was about 5/8 of cloud cover with the sun shining between the cloud patches, which made the storm seem lighter than was in fact the case.

During the short period between the commencement of take-off and the crash (estimated at 45 to 50 seconds) the rain had become so intense that the air traffic control officer in the control tower could not see the aircraft after it had passed the intersection of the runways, and in fact did not see the crashed aircraft until some ten minutes later, even when he knew its position and that it was burning fiercely.

Surface wind speed and direction at Salisbury airport can be assessed from:

a) an anemometer head situated about six feet above ground level and 600 ft to the south-southeast of the control tower, which is connected electrically to dials both in the A. T. C. O. 's console and the meteorological briefing office giving accurate and continuous readings: the former reading is passed by the A. T. C. O. to pilots by radio;

b) an anemometer head situated 44 ft above ground level at Kutsaga Meteorological Station, recording graphically on a paper trace and which is used for record purposes;

c) wind socks close to the ends of each runway giving a visual indication of direction; the speed can be estimated from the attitude of the sock by an experienced pilot.

Whilst all the above can give wind speed and direction at each precise position, they can never act as more than a guide to the wind speed and direction some 40/50 ft above ground level in the vicinity of the runway intersection. However, they indicated in this particular accident rapid changes in both speed and direction prior to and during take-off.

The Accident

The aircraft requested taxy clearance and take-off instructions by radio telephony at 1245 hours. The A. T. C. O. on duty replied that the surface wind was "Northerly at five knots" and the aircraft was cleared to taxy out to runway 06. At 1246 hours this was altered to "use runway 24 to expedite your clearance", and at 1248 hours the A. T. C. O. asked the aircraft to "try and expedite your take-off as this rain appears to be coming across rapidly". At 1250 hours the captain stated that he was ready to take off and clearance was given together with the surface wind as "one four zero degrees at 18 knots". This information was repeated back by the captain in acknowledgment. At 1252 hours the aircraft called over the radio and said "FTZ airborne at 1252". As the A. T. C. O. acknowledged this call the aircraft disappeared from view into heavy rain at about the intersection of the runways. At the time of commencement of take-off the weather conditions were within the minima laid down by the airline for operations at Salisbury Airport.

The captain, first officer and flight engineer confirmed that on entering the rain, the aircraft built up speed normally from V. 2 speed (in this case 111 knots) to about 118/120 knots in the climbing attitude and the wheels retracting. Then the airspeed started a steady and positive decrease and, although all engines were giving maximum power the captain was unable to keep the aircraft airborne and it struck the ground in a slightly tail down attitude 220 ft to the right of the centreline, and 1 900 ft from the southwest end of runway 24. The aircraft came to rest 1 450 ft beyond the point of first impact after sliding along on its under-fuselage in heavy rain, and with the mainplane area burning.

There were no eye witnesses to the actual crash due to the heavy rain and the burning aircraft was not seen until the smoke and flames made it visible to an African Meteorological Observer in the Kutsaga Meteorological Station which is situated about 1 000 ft from the final position of the aircraft.

It is clear that, as the crew stated in evidence that they were quite satisfied with the performance of the aircraft, its power output and the response of the controls, and since nothing in the wreckage could be found to indicate any mechanical defect, there was nothing mechanically wrong at the time of the accident.

Consideration was then given to the following questions:

a) Was the captain justified in attempting a take-off in the weather conditions prevailing, and should he have abandoned the take-off and brought his aircraft to rest on the runway when he reached the highest point of the runway and saw the rain in front of him.

b) Did the A. T. C. O. do all he could to warn the captain by radio telephony of the progress and nature of the storm, including the possible suggestion that the take-off should be delayed, and was he justified in sending the aircraft off on runway 24 instead of 06?

World-wide accepted practice is for the captain to make the final decision regarding the advisibility of the take-off or landing of his aircraft, except when either would endanger other traffic. In other words, the captain is in a far better position to judge the performance and capabilities of his aircraft under a given set of circumstances than is the A. T. C. O. in a control tower. The latter's function is to pass to the captain all the relevant information he has at his disposal.

Changes of wind speed and direction accompanying the onset of a thunderstorm can be violent and unpredictable, and will mómentarily either increase the aircraft's speed through the air, or decrease it according to whether the wind is from ahead or astern of the aircraft. Any decrease of airspeed when the aircraft is flying comparatively slowly (as is the case immediately after take-off) will cause a proportionately large reduction in the lift being generated by the wings, and in this particular case the wind effect acting on the aircraft necessary to cause a loss of airspeed (and therefore lift) was considerably more than that recorded by either anemometer. It is estimated from the information available from the two anemometers and from witnesses' statements, that the aircraft encountered a tailwind component of approximately 40 knots shortly after becoming airborne. As the aircraft was near the ground when it encountered this loss of airspeed and lift, the pilot was unable to prevent it striking the ground before it had time to accelerate out of the tailwind component.

The strength of the actual squall that affected the aircraft is unknown, but it was of sufficient intensity to cause not only the loss of airspeed and lift mentioned earlier, but to carry the aircraft 220 ft to the right of the runway centreline in the short period of about 17 seconds that it was airborne, and to carry most of the debris well to the right of the aircraft's path along the ground.

In addition, the heavy rain falling at the time would carry with it a down-draught of air and the effect on the aircraft of such downdraught cannot be discounted.

The questions posed above were given very careful consideration and it was agreed:

The captain is a very experienced pilot; he has a wide knowledge of the DC-6B and its performance and is familiar with the route Paris-Johannesburg. After his meteorological briefing and what was visible to him of the storm whilst taxying out to take-off, he had no reason to suspect that the storm would affect take-off performance in any way. Further, whilst the aircraft was stationary at the threshold of runway 24, the pilot's line of vision would be at an upward angle due to the profile of the runway and he was unable to see the progress of the storm along the ground until his aircraft had reached the highest point of the runway; by this time he had attained V. 1 speed and was very close to V. 2. When at this point, the captain considered abandoning the take-off when faced with the curtain of rain in front of him, but dismissed it immediately, having regard to the wet state of the runway and the down gradient in front of him: he decided to continue. This decision had to be made very quickly and the captain was satisfied at the time that it was safer to continue than to try and stop: it was considered that his decision to take-off, and then to continue, was justified.

Whilst the aircraft was taxying away from the terminal building prior to take-off, the air traffic control officer was watching the approaching storm. Having considerable experience at Salisbury Airport and of the local weather, he was satisfied that the aircraft, if dispatched on the shorter route to runway 24 instead of runway 06 would have ample time to become safely airborne before the storm reached the runway. In addition, runway 24 gave the pilot a shorter turn after take-off for the direct route to Brazzaville and also kept the aircraft well clear of the gliding operations centred 12 miles to the north of Salisbury. He was aware of the possible effects of thunderstorms on the take-off and landing of large aircraft, but was misled in this instance by the rapidity with which the storm moved across the airport, and by the violence of the changes in wind speed and direction. His failure to appreciate the effects of this particular storm may have been due in some measure to the fact that the sun was shining in areas adjacent to the airport. The appearance of the storm was extremely deceptive. In point of fact, the storm moved across the airport much faster than either the pilot or the A. T. C. O. realized would be the case, and there is no doubt that they both underestimated the violent changes in wind speed and direction that accompanied it. As to whether the aircraft should have been sent out on runway 06, the surface wind speed and direction readings available to the A. T. C. O. prior to the aircraft taxying out were such that it was immaterial which runway was used.

The rapidity with which these conditions developed, and the lack of significant, visible, evidence as a warning of their likely effect on the aircraft, were such that neither the captain nor the A. T. C. O. can fairly be blamed for the accident.

Probable Cause

The aircraft struck the ground shortly after take-off as a result of an uncontrollable loss of airspeed and height due to a sudden squall accompanying the onset of a thunderstorm.

(Further information on the meteorological aspects of this accident is to be found in the article in Part III entitled - "Hazards of Landing and Take-off in the Vicinity of Advancing Thunderstorms". The similarity of the circumstances of this accident and one which occurred at Kano, Nigeria in June 1956 is of interest. The latter accident report is included in ICAO Accident Digest No. 8, Summary No. 21.)

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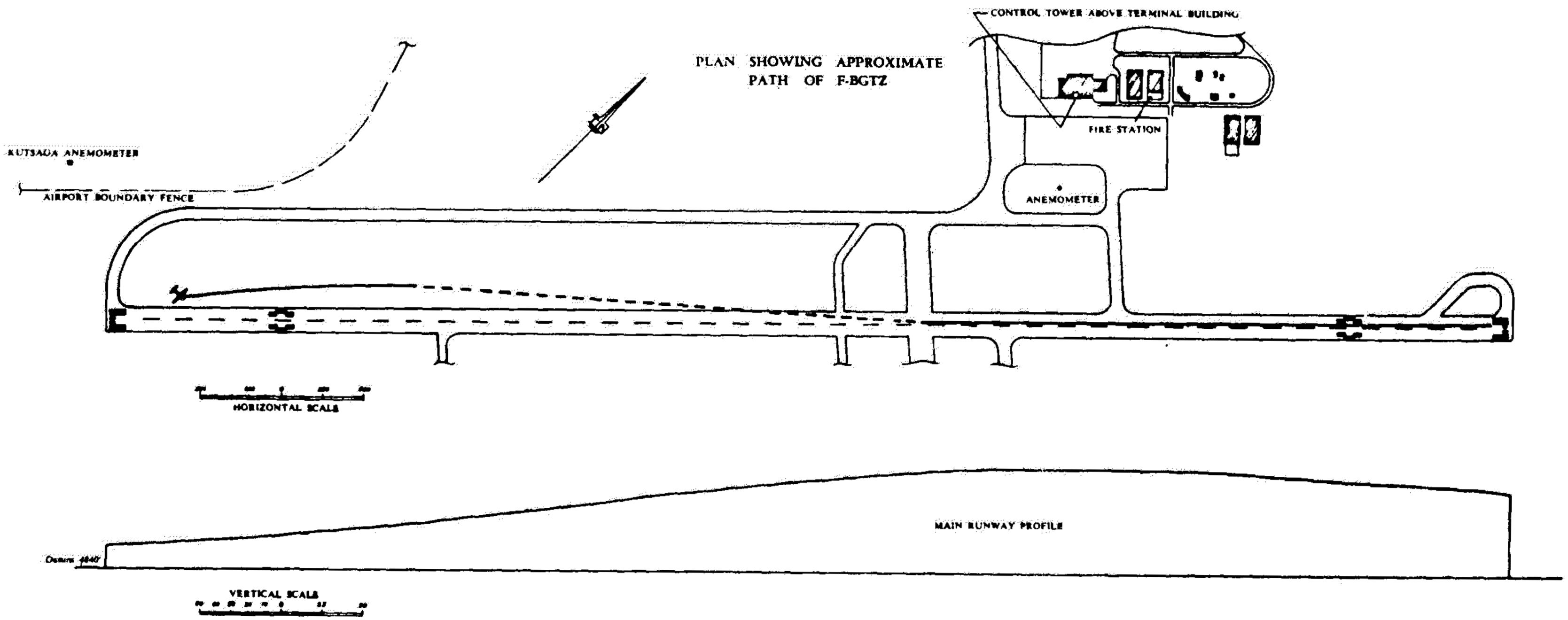
ICAO Ref: AR/587

FIGURE 33


PLAN SHOWING APPROXIMATE PATH OF F-BGTZ
CONTROL TOWER ABOVE TERMINAL BUILDING
FIRE STATION
ANEMOMETER
KUTSAGA ANEMOMETER
AIRPORT BOUNDARY FENCE
HORIZONTAL SCALE
MAIN RUNWAY PROFILE
VERTICAL SCALE

No. 56

Viacão Aérea São Paulo, S.A., Scandia, PP-SQE, fell into the sea at Guanabara Bay, Brazil on 30 December 1958. Accident Report Form Summary as released by the Air Ministry, Brazil, 13 April 1959.

Circumstances

After take-off from SBRJ (Rio de Janeiro) on a flight to SBSP (São Paulo/ Congonhas) the port engine failed unexpectedly at a height of about 50 metres. The pilot applied the emergency procedures, then made a 90-degree left turn. After flying about 500 metres on the new heading, he started another left turn, when the aircraft stalled and fell into the sea, killing 4 crew members and 17 passengers and seriously injuring 16 other passengers.

Probable Cause

The accident was attributed to the pilot's incorrect handling of the controls in flight.

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AIRCRAFT ACCIDENT REPORTS - GENERAL

The following accident reports have been requested by ICAO but were not received by 31 December 1959, the deadline for receipt of material for inclusion in Digest No. 10. If forwarded to ICAO, summaries of these reports will appear, if space permits, in the next edition - No. 11.

Cruzeiro do Sul, Ltda.
C-82
at Val de Cans, Belém, Brazil
16 January 1958

Loide Aéreo Nacional, S.A.
DC-4, PP-LEM
after taking-off from Santos Dumont Airport, Brazil
1 February 1958

PP-AGG
about 10 km from the São Paúlo-Santos road, Brazil
19 February 1958

R.A.I. (Tahiti)
Catalina
at Utoroa Harbour, Raiatea Island, Society Islands
19 February 1958

Misrair Airline
Viking
Menzalah Lake, nr. Port Said, U.A.R.
7 March 1958

Indian Airlines Corporation
Dakota, VT-CYN
16 miles from Katmandu, Nepal
24 March 1958

Transportes Aéreos Orientales
Junkers Ju-52, HC-SND
after taking-off from Quito, Ecuador
8 April 1958

Aviación y Comercio, S.A.
Heron, EC-ANJ
nr. Castelldefells, Spain
14 April 1958

BEA
Dakota, G-AGHP
at Chatenoy, nr. Nemours, France
16 May 1958

SABENA
DC-7C, 00-SFA
nr. Casablanca, Morocco
18 May 1958

Air France
DC-3, F-BHKV
160 km southwest of Algiers
31 May 1958

Aerolíneas Argentinas
DC-6, LV-ADV
forced landing on Ilha Grande Beach 75 miles west of Rio de Janeiro
10 June 1958

Indian Airlines Corporation
Dakota, VT-CYM
at Demra, East Pakistan
9 July 1958

All Nippon Airways Co. Ltd.
DC-3, JA-5045
nr. Shimoda, Japan
12 August 1958

KLM
Super Constellation, PH-LKM
in the Atlantic Ocean
14 August 1958

Collision between two private aircraft
at Yajalón, near the Guatemalan border
26 August 1958

Handley Page, Ltd.
Dart Herald, G-AODE
at Godalming, England
30 August 1958

Flying Tiger Line, Inc.
Super Constellation 1049H, N 6920C
nr. Mt. Oyama, Japan
9 September 1958

Middle East Airlines Co., S.A.
Avro York, OD-ADB
missing between Beirut, Lebanon and London, England
28 September 1958

Air France
Constellation, F-BAZX
nr. Schwechat Airport, Vienna, Austria
24 December 1958

B.O.A.C.
Britannia, G-AOVD
nr. Christchurch, Hampshire, England
24 December 1958

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The following reports on accidents which occurred during 1958 have been received by ICAO but for various reasons have not been summarized:

AUSTRALIA

DH-82
Darwin River, Northern Territory
1 January 1958 (ASD* No. 16-12/58)

Chipmunk
nr. Newcastle, New South Wales
26 March 1958 (ASD No. 16-12/58)

Cessna 180
nr. Murrurundi, New South Wales
27 March 1958 (ASD No. 20-12/59)

Viscount
Brisbane Airport
1 April 1958 (ASD No. 17-3/59)

Piper Tri-Pacer
nr. Belgrave, Victoria
6 June 1958 (ASD No. 17-3/59)

Cessna 182 (ambulance aircraft)
nr. Edungalba, 40 miles SW of Rockhampton
7 June 1958 (ASD No. 17-3/59)

de Havilland Dove
Fitzroy Crossing Aerodrome
August 1958 (ASD No. 17-3/59

DH-82
nr. Dalwallinu, Western Australia
21 August 1958 (ASD No. 20-12/59)

Grunau Baby Sailplane
Caversham, Western Australia
19 October 1958 (ASD No. 19-9/59)

CANADA

Canadian Helicopters Limited
Sikorsky S-55/C Helicopter, CF-JLP
5 miles NW of Big Owl, Ontario
13 February 1958

Department of Transport
Beech D18S, CF-GXU
at Ottawa Airport, Ottawa, Ontario
23 April 1958

RCAF
Comet 5301
nr. Ottawa, Ontario
26 February 1958

Skyway Air Services Ltd.
Grumman TBM-3, CF-IMJ
13 miles east of Hartland, N.B.
12 June 1958

P. and M. Flying Service
Piper PA-20, N 6998K
5 miles northeast of Perth, N.B.
29 June 1958

Leavens Brothers Ltd.
Cessna T-50, CF-BRK
Chute des Passes, P.Q.
11 July 1958

Granduc Mines Ltd.
DHC-2 (Beaver), CF-JFQ
Latitude 49°59'N; Longitude 123°09'W
1 September 1958

Southern Ontario Soaring Association
Laister Kauffmann 10A, 2-seater Glider, CF-ZCH
Brantford Aerodrome, Ontario
5 September 1958

TCA, Viscount, CF-TIB &
(Private) Globe Swift, N 80913
Ottawa Airport, Ontario
6 December 1958

* Aviation Safety Digest

IRELAND

Piper Apache, EI-AJL
River Shannon
15 January 1958

NETHERLANDS

Auster, PH-NGL
nr. Rotterdam
10 May 1958

National Flying School
Piper Cub L-47
nr. Hilversum Airport
25 May 1958

National Aviation School
Tiger Moth, PH-UDM
nr. Oud-Loosdrecht
4 June 1958

collision of two gliders
Skylark II PH 255 &
Prefect Type PH 192
nr. Terlet gliding centre
9 July 1958

Tiger Moth, PH-UDY
at Eelde Airport
20 May 1958

Tiger Moth, PH-UDE
was hauling gliders of the
Noord-Nederlandse Aeroclub "Avio Eelde"
11 June 1958

Terlet Gliding Centre
Sky Glider (34), PH-203
20 May 1958

National Aviation School
Tiger Moth, PH-UFO
at Nieuw Loosdrecht
27 August 1958

Piper Super Cub, PH-NEV
at Melissant
26 June 1958

NEW ZEALAND

DH 82, ZK-AJG
at Thames Aerodrome
19 January 1958

Percival EP9, ZK-BDP
nr. Rangiwahia
19 February 1958

Piper Comanche, ZK-BOO
in the sea off Muriwai Beach,
Auckland
17 October 1958

Auster J. 1B, ZK-BCS
at Le Bon's Bay, Banks Peninsula
13 August 1958

DH 82, ZK-BVK
nr. Kiokio, Auckland Province
8 May 1958

Piper PA 18A, ZK-BFV
at Karetu Downs, Hawarden, North Canterbury
24 January 1958

Piper PA 18A, ZK-BKI
at Wangaehu, Masterton
15 February 1958

DH 82, ZK-ATL
missing nr. Napier
27 September 1958

Wackett, ZK-AUC
at Taupo Aerodrome
8 June 1958

PHILIPPINES

Philippine Air Lines, Inc.
DC-3C, PI-C128
made a forced landing at Refugio Airfield, San Carlos, Negros Occidental
4 July 1958

Feati Flying School
L-4J, PI-C75
at Manila International Airport
5 July 1958

SWITZERLAND

Ryan Navion, NAV-4, 00-ESD
5 miles east of Lausanne
18 January 1958

F-84F "Thunderstreak" (Royal Netherlands Air Force)
west of the village of Wolperwil
18 September 1958

Stinson Voyager 108-2
Urner district (Furka area)
18 May 1958

UNITED STATES

Alaska Coastal Airlines
Lockheed Vega 5C, Seaplane, N 47M
nr. Tenakee, Alaska
15 January 1958

Sikorsky S-58B, helicopter, N 861
crashlanded in the Gulf of Mexico, nr. Grand Isle, Louisiana
1 February 1958

Ayer Lease Plan, Inc.
Lockheed Lodestar, N 300E
nr. Grants, New Mexico
22 March 1958

Piper PA-22, N 2945P
nr. Dover, Delaware
23 September 1958

Petroleum Helicopters, Inc.
Republic Alouette II, helicopter, N 526
in the Gulf of Mexico, near Lake Charles, Louisiana
2 December 1958

Johnson and Johnson
Learstar, N 37500
nr. Woonsocket, Rhode Island
15 December 1958

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Reports on accidents to private aircraft, which have not been summarized, have been received from the following Contracting States:

Australia
Canada
United States

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PART II

AIRCRAFT ACCIDENT STATISTICS 1958

INTRODUCTION

GENERAL COMMENTS

1. This section of the Aircraft Accident Digest No. 10 contains a detailed analysis of the statistics for the year 1958, as well as an historical record of selected data for the years 1925 to 1959 inclusive. Although figures for the years subsequent to 1951 were obtained largely from the ICAO Air Transport Reporting Forms G (Aircraft Accidents) filed by contracting States, other sources had to be used for those countries which have not yet filed the required reporting Form in order to arrive at as complete a picture as possible of accidents in which public aircraft were involved.

2. The statistics shown are the best available to date but are subject to adjustment when more accurate data is forwarded to this Organization on the Forms G (facsimile copy given on pages 259 and 260).

DESCRIPTION OF TABLES

3. Accident data has been recorded under the country in which the airline which suffered an accident is established and not in the country where the accident took place. Data for the years 1955 and 1956 cover the operations of 70 contracting States, members of ICAO at 31 December 1956: the data for the year 1957 covers the operations of 72 States, members of ICAO at 31 December 1957. For the year 1958, the data is for 73 States, members of ICAO at 31 December 1958.

4. Three detailed tables follow for the year 1958. These tables give the following information:

TABLE A Fatality rate by contracting States whose airlines had an accident causing a passenger to be killed on a scheduled flight.

TABLE B Aircraft accident summary by country (73 contracting States of ICAO) of all operators engaged in public air transport.

TABLE C Aircraft accident summary by type of operation and by country.

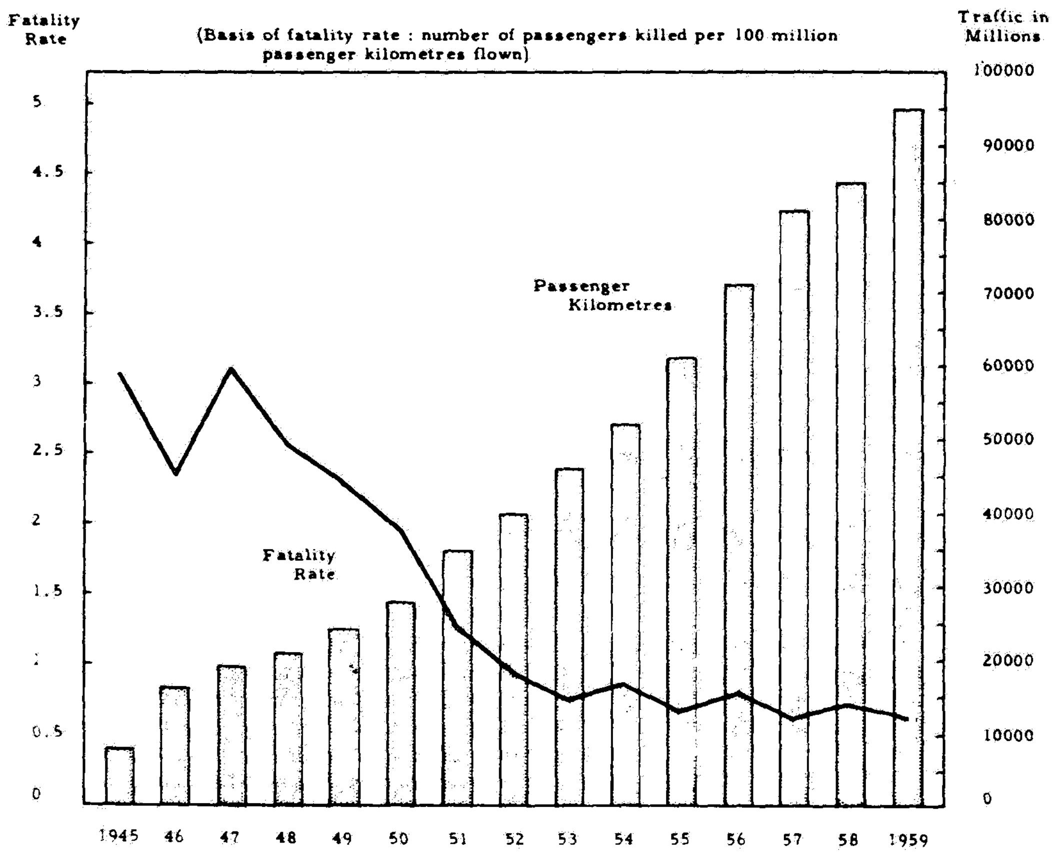
SAFETY RECORD

5. There has been a remarkable downward trend in passenger fatality rates since 1945, indicating a steady improvement in safety of commercial flying over the past fourteen years. Despite the increased speeds, weights and range of the aircraft flown today as compared with over a decade ago, and the increased traffic density on airways, the risk of accident occurrence has lessened over the period largely through technical changes and improvements in proficiency.

6. It is to be noted that all accident data prior to 1952 are to be regarded as the best available data only, because of the fact that accidents were not so widely or fully recorded in those years. With this in mind, if the safety record is extended to compare the pre-war period (1925 - 1939), with the war period (1940 - 1944), and the post-war period (1945 - 1959), it is found that the average fatality rate per 100 million passenger-kilometres has dropped from 12 in the pre-war period, to 3 in the war period, to 2.5 in the first six years after the war, and to 0.76 for the next nine years.

7. From a perusal of the chart and table shown on the following pages, it will be observed that the fatality rate per passenger-kilometre of 0.63 for 1959 is 20% of the 3.09 of 1945, a decrease of 13% from the rate of 0.72 in 1958. For the eighth consecutive year, the 1959 rate has remained at less than one fatality per 100 million passenger-kilometres flown. Although the number of passengers killed on scheduled flights over the period 1952 to 1959 ranged from a low of 356 persons in 1953 to a high of 615 persons in 1958, the extent of the increase in passenger traffic has more than offset the change in the level of passengers killed thereby maintaining the fatality rate below the mark of one.

PASSENGER FATALITY RATE TREND
COMPARED WITH GROWTH IN TRAFFIC
SCHEDULED AIR SERVICES 1945 - 1959



PASSENGER FATALITIES 1925 - 1959

ON

SCHEDULED AIR SERVICES

YEARS	Number of Passengers Killed	Passenger Kilometres Flown (millions)	Fatality Rate per 100 million Pass-Kms.	Millions of Passenger-Kilometres per Fatality
YEARLY AVERAGE				
1925 - 1929	36	130	28	4
1930 - 1934	80	445	18	6
1935 - 1939	133	1 475	9	11
1940 - 1944	114	3 795	3	33
YEAR				
1945	247	8 000	3.09	32
1946	376	16 000	2.35	43
1947	590	19 000	3.11	32
1948	543	21 000	2.59	39
1949	556	24 000	2.32	43
1950	551	28 000	1.97	51
1951	443	35 000	1.27	79
1952	386	40 000	0.97	104
1953	356	46 000	0.77	129
1954	447	52 000	0.86	116
1955	407	61 000	0.67	150
1956	552	71 000	0.78	129
1957	507	81 000	0.63	160
1958	615	85 000	0.72	138
1959 (preliminary)	602	95 000	0.63	158

Exclusions: The People's Republic of China and USSR.

1958

TABLE A

CONTRACTING STATES OF ICAO

PASSENGER FATALITIES OCCURRING ON

SCHEDULED INTERNATIONAL AND DOMESTIC OPERATIONS

YEAR 1958

Description	Country Total of Hours Flown	Number of Fatal Accidents	Number of Passengers Killed	Country Total of Passenger Kilometres	Fatality Rate per 100 Million Pass-Kms.	Millions of Passenger-Kilometres per Fatality
	(thousands)			(millions)		
Total Scheduled Operations						
Belgium	128	1	56	1 198		
Brazil	477+	7	54	2 438+		
Cuba	35+	1	13	275+		
Ecuador	5•	1	29	15•		
France	336	2	23	4 144		
Japan	71	1	30	686		
Mexico	183•	1	38	924•		
Netherlands	178	1	91	1 986		
Pakistan	25	1	17	229		
Portugal	30	1	30	162		
Spain	76	2	30	610		
United Arab Republic	20+	1	4	111+		
United Kingdom	534+	2	58	4 689+		
United States	4 339+	7	125	50 692+		
Venezuela	91	1	17	360		
All other States	2 179	-	-	16 481		
Total	8 707	30	615	85 000	0.72	138
International Scheduled Operations						
Belgium	80	1	56	707		
Cuba	19+	1	13	193+		
Netherlands	172	1	91	1 972		
Pakistan	11	1	17	61		
United Arab Republic	14+	1	4	83+		
United Kingdom	385+	2	58	4 067+		
United States	692+	2	10	9 812+		
Venezuela	24	1	17	127		
All other States	1 291	-	-	12 978		
Total	2 688	10	266	30 000	0.89	113
Domestic Scheduled Operations						
Brazil	437+	7	54	2 032+		
Ecuador	3•	1	29	9•		
France	71	2	23	2 034		
Japan	49	1	30	360		
Mexico	148•	1	38	674•		
Portugal	21	1	30	70		
Spain	49	2	30	324		
United States	3 647+	5	115	40 880+		
All other States	1 594	-	-	8 617		
Total	6 019	20	349	55 000	0.63	158

NOTES:

Accident data have been recorded under the country in which the airline is registered and not in the country where the accident took place.

Under "Total Scheduled Operations" are listed all countries with scheduled airlines which had aircraft accidents resulting in passenger fatalities. These data have been segregated as to those fatalities occurring on a scheduled international flight and/or a scheduled domestic flight.

Source of data: ICAO Air Transport Reporting Forms and outside sources.

\+ Provisional data.
• Estimated data.

CONTRACTING STATES OF ICAO

AIRCRAFT ACCIDENT SUMMARY FOR 1958

OF ALL OPERATORS ENGAGED IN PUBLIC AIR TRANSPORT

1958

TABLE B

Contracting States of ICAO	Number of Accidents		Passenger Injury			Crew Injury			Others Injured		By Operators With an Accident		Hours flown during year by all operators engaged in public air transport
	Total	Fatal	Fatal	Serious	Minor or None	Fatal	Serious	Minor or None	Fatal	Serious	Number of Landings	Hours Flown	
Afghanistan	-												
∅ Argentina	-	-	-	-	-	-	-	-	-	-			
∅ Australia	7	-	-	-	-	-	-	-	-	-			340 257
Austria	-												
Belgium	1	1	56	-	4	9	-	-	-	-			
Bolivia	-												
∅ Brazil	11	9	54	26	113	28	4	6	-	-	172 756	240 719	406 412
Burma	-												
Cambodia	-												
∅ Canada a/	-	-	-	-	-	-	-	-	-	-	-	-	282 877 b/
∅ Ceylon	-	-	-	-	-	-	-	-	-	-			
Chile	-												
∅ China (Taiwan)	-	-	-	-	-	-	-	-	-	-			
Colombia	-												
∅ Costa Rica	1	1	2	-	-	1	-	-	-	-	2 520	[illegible]	[illegible]
Cuba	1	1	13	-	3	4	-	-	-	-			
Czechoslovakia	-												
Denmark	-												
Dominican Republic	-												
Ecuador	1	1	29	-	-	3	-	-	-	-			
El Salvador	-												
∅ Ethiopia	-	-	-	-	-	-	-	-	-	-			
∅ Finland	-	-	-	-	-	-	-	-	-	-			43 861
∅ France c/	13	3	28	16	53	6	3	9	-	3		313 063	360 208
∅ Germany (Fed. Rep)	3	-	-	-	42	-	-	8	-	-			
Ghana	-												
∅ Greece	-	-	-	-	-	-	-	-	-	-			
Guatemala	-												
Haiti	-												
Honduras	-												
Iceland	-												
∅ India	12	3	16	2	-	12	2	-	-	-		129 354	172 606
∅ Indonesia	-	-	-	-	-	-	-	-	-	-			
Iran	-												
Iraq	-												
∅ Ireland	-	-	-	-	-	-	-	-	-	-			
Israel	-												
∅ Italy	-	-	-	-	-	-	-	-	-	-			
∅ Japan	1	1	30	-	-	2	-	-	1	-	*18 263	24 824	71 163
Jordan	-												
Korea	-												
Laos	-												
∅ Lebanon	1	1	-	-	-	3	-	-	-	-		26 005	
Liberia	-												
Libya	-												
Luxembourg	nca	nca	nca										
Malaya	-												
Mexico	1	1	38	-	-	8	-	-	-	-			
Morocco	-												
∅ Netherlands	2	1	91	-	-	8	-	-	-	-	65 841	192 430	
∅ New Zealand	3	-	-	-	62	-	-	4	-	-	49 201	57 252	81 950
Nicaragua	-												
Norway	-												
Pakistan	1	1	17	-	15	4	-	2	-	-			
Paraguay	-												
Peru	-												
∅ Philippines	1	-	-	-	-	-	-	-	-	-			61 367
Poland	-												
∅ Portugal	1	1	30	-	-	6	-	-	-	-	35		32 784
∅ Spain	2	2	30	-	-	7	-	-	-	-	12 495	16 277	78 924
Sudan	-												
∅ Sweden	17	-	-	-	1	-	1	1	-	-	59 980 d/	99 382 d/	153 654
∅ Switzerland	1	1	-	-	-	-	-	-	1	-	572	2 054	98 862
∅ Thailand	1	-	-	-	1/4	-	-	0/5	-	-	10 857	15 208	15 708
∅ Tunisia	-	-	-	-	-	-	-	-	-	-			
∅ Turkey	-	-	-	-	-	-	-	-	-	-			
Un. of S. Africa	-												
United Arab Rep.	1	1	4	-	17	4	-	1	-	-			
∅ United Kingdom f/	(28)	(12)	(124)	(20)	(54)	(32)	(8)	(27)	(5)	(6)			
∅ United States g/	91	15	130	54	1 526	26	9	281	5	1	3 084 572	4 316 094	4 671 639
Uruguay	-	-	-	-	-	-	-	-	-	-			
Venezuela	1	1	17	-	-	6	-	-	-	-			
Vietnam	-	-	-	-	-	-	-	-	-	-			
Total for 73 States	203	57	709	118	1 895	169	27	344	12	10			
TYPE OF OPERATION													
Scheduled International	32	12	266	17	447	50	7	102	-	1			
Scheduled Domestic	95	25	349	81	1 262	76	7	178	6	1			
Non-Scheduled International	19	7	46	18	93	17	-	24	5	5			
Non-Scheduled Domestic	33	8	38	2	93	13	4	22	-	-			
Non-Revenue	24	5	10	-	-	13	9	18	1	3			
Total Operations	203	57	709	118	1 895	169	27	344	12	10			

NOTES:

Source of data: Air Transport Reporting Form G filed by countries indicated with a ∅.
All other country data collected from outside sources.

* Estimated.
nca – No Civil Aviation.
a/ Form G data for scheduled operations only
b/ Data for total operations of all scheduled operations.
c/ Includes one scheduled fatal accident for AAI which was not reported on Form G.
d/ Only the Swedish quota of Scandinavian Airlines System's operations is included.
e/ Includes some hours flown by helicopters whereas landings by the same are excluded.
f/ Data refer to airlines registered in the United Kingdom and its dependencies. Data incomplete for number of landings and hours flown.
g/ Data refer to all public air transport i.e. scheduled U.S., Alaska airlines and irregular air carriers. Data incomplete for number of landings and hours flown.

TABLE C

CONTRACTING STATES OF ICAO AIRCRAFT ACCIDENT SUMMARY FOR 1958 OF ALL OPERATORS ENGAGED IN PUBLIC AIR TRANSPORT BY TYPE OF OPERATION

Type of Operation Contracting States of ICAO	Number of Accidents		Passenger Injury			Crew Injury			Others Injured		By Operators With an Accident	
	Total	Fatal	Fatal	Serious	Minor or None	Fatal	Serious	Minor or None	Fatal	Serious	Number of Landings	Hours Flown
SCHEDULED INTERNATIONAL OPERATIONS												
∅ Australia	1	-	-	-	-	-	-	-	-	-		
Belgium	1	1	56	-	4	9	-	-	-	-		
Cuba	1	1	13	-	3	4	-	-	-	-		
∅ France	3	-	-	-	-	-	2	-	-	-		133 826
∅ Lebanon	1	1	-	-	-	3	-	-	-	-		26 005
∅ Netherlands	2	1	91	-	-	8	-	-	-	-	56 412	172 443
Pakistan	1	1	17	-	15	4	-	2	-	-		
∅ Sweden	1	-	-	-	-	-	-	-	-	-	13 576	59 174
∅ Thailand	1	-	-	-	1/4	-	-	0/5	-	-	3 167	7 713
United Arab Republic	1	1	4	-	17	4	-	1	-	-		
∅ United Kingdom a	6	3	58	6	46	12	1	14	-	1	122 733	318 071
∅ United States b	12	2	10	11	357	-	4	80	-	-	134 278	480 725
Venezuela	1	1	17	-	-	6	-	-	-	-		
Total for 13 States	32	12	266	17	447	50	7	102	-	1		
SCHEDULED DOMESTIC OPERATIONS												
∅ Australia	5	-	-	-	-	-	-	-	-	-	118 451	200 036
∅ Brazil	8	8	54	26	113	25	4	6	-	-		
Ecuador	1	1	29	-	-	3	-	-	-	-		
∅ France c	6	2	23	11	-	6	1	-	-	-		112 947
∅ India	4	1	-	1	-	3	-	-	-	-		86 832
∅ Japan	1	1	30	-	-	2	-	-	1	-	18 263	24 824
Mexico	1	1	38	-	-	8	-	-	-	-		
∅ New Zealand	1	-	-	-	0/62	-	-	0/4	-	-	44 379	52 811
∅ Portugal	1	1	30	-	-	6	-	-	-	-	35	
∅ Spain	2	2	30	-	-	7	-	-	-	-	9 919	12 549
∅ United Kingdom a	4	-	-	-	1	-	-	-	-	-	37 065	34 212
∅ United States b	61	8	115	43	1 086	16	2	168	5	1	2 876 514	3 319 856
Total for 12 States	95	25	349	81	1 262	76	7	178	6	1		
NON-SCHEDULED INTERNATIONAL OPERATIONS												
∅ France	1	1	5	5	53	-	-	7	-	-		465
∅ Germany	2	-	-	-	0/35	-	-	3/3	-	-		
∅ India	5	1	16	1	-	4	-	-	-	-		765
∅ Sweden	2	-	-	-	-	-	-	-	-	-		3 708
∅ Switzerland	1	1	-	-	-	-	-	-	1	-		
∅ United Kingdom a	6	3	21	12	5	9	-	8	4	5	3 746	5 675
∅ United States d	2	1	4	-	-	4	-	3	-	-		
Total for 7 States	19	7	46	18	93	17	-	24	5	5		
NON-SCHEDULED DOMESTIC OPERATIONS												
∅ Costa Rica	1	1	2	-	-	1	-	-	-	-	2 570	1 174
∅ Germany	1	-	-	-	0/7	-	-	0/2	-	-		
∅ India	3	1	-	-	-	5	2	-	-	-		13 543
∅ New Zealand	1	-	-	-	-	-	-	-	-	-	952	713
∅ Philippines	1	-	-	-	-	-	-	-	-	-		
∅ Sweden	9	-	-	-	1	-	1	1	-	-	10 185	11 927
∅ United Kingdom a	6	2	35	2	2	1	1	3	-	-	3 522	2 391
∅ United States	11	4	1	-	83	6	-	16	-	-	5 680 e	11 070 e
Total for 8 States	33	8	38	2	93	13	4	22	-	-		
NON-REVENUE OPERATIONS												
∅ Australia	1	-	-	-	-	-	-	-	-	-	14 749	17 297
∅ Brazil	3	1	-	-	-	3	-	-	-	-		
∅ France	3	-	-	-	-	-	-	2	-	3		13 499
∅ New Zealand	1	-	-	-	-	-	-	-	-	-	80*	42
∅ Sweden	5	-	-	-	-	-	-	-	-	-	16 867	7 308
∅ United Kingdom a	6	4	10	-	-	10	6	2	1	-	10 640	29 164
∅ United States	5	-	-	-	-	-	3	14	-	-	-	28 610 e
Total for 7 States	24	5	10	-	-	13	9	18	1	3		

NOTES: Source of Data: Air Transport Reporting Form G filed by countries indicated with a ∅.
All other country data collected from outside sources.

a Data refer to airlines registered in the United Kingdom and its dependencies. Data incomplete for number of landings and hours flown.
b Data for all scheduled U.S. and Alaska airlines.
c Includes one accident for RAI not reported on Form G.
d Data for all scheduled U.S. and Alaska airlines as well as irregular air carriers.
e Data incomplete for number of landings and hours flown.

FORM G

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AIR TRANSPORT REPORTING FORM

COUNTRY................

AIRCRAFT ACCIDENTS

YEAR ENDED.............

Name of Operator	Type of Operation	Number of Accidents		Passenger Injury			Crew Injury			Others Injured		Number of Landings	Hours Flown
		Total	Fatal	Fatal	Serious	Minor/None	Fatal	Serious	Minor/None	Fatal	Serious		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Scheduled International												
	Scheduled Domestic												
	Non-Scheduled International												
	Non-Scheduled Domestic												
	Non-Revenue Flights												
	Total Operations												
	Scheduled International												
	Scheduled Domestic												
	Non-Scheduled International												
	Non-Scheduled Domestic												
	Non-Revenue Flights												
	Total Operations												
	Scheduled International												
	Scheduled Domestic												
	Non-Scheduled International												
	Non-Scheduled Domestic												
	Non-Revenue Flights												
	Total Operations												
	Scheduled International												
	Scheduled Domestic												
	Non-Scheduled International												
	Non-Scheduled Domestic												
	Non-Revenue Flights												
	Total Operations												

Total hours flown during the year by all operators engaged in public air transport = ...

Remarks:

DOC 7357 - STA/529 - 1/53 The attention of ICAO should be drawn to any unavoidable deviation from the instructions.

INSTRUCTIONS

Reporting Period: This form is to be filed annually by each State in respect of aircraft accidents of operators, registered in the country, which are engaged in public air transport.

Filing Date: This form should be filed not later than 2 months after the end of the year to which it refers.

Notes: 1) Data for individual operators are required only in respect of those operators whose aircraft were involved in an accident - regardless of where the accident took place.
2) The total number of hours flown by all operators (whether involved in accidents or not) should also be inserted in the space provided. The form should be filed giving this information even if there are no accidents to report.

Aircraft Accident means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which:

a) any person suffers death or serious injury as a result of being in or upon the aircraft or by direct contact with the aircraft or anything attached thereto, or
b) the aircraft received substantial damage (Annex 13).

Notes: 1) An accident resulting in only minor injuries or damages need not be reported.
2) A collision between two or more aircraft should be reported separately for each operator involved, and additional details should be provided under 'Remarks'

Type of Operation:
a) 'Scheduled International', 'Scheduled Domestic', 'Non-Scheduled International' and 'Non-Scheduled Domestic' operations relate to flights operated for the purpose of carrying revenue load.
b) 'Non-Revenue Flights' relate to positioning flights, test flights, training flights, etc..
c) Data should be reported in columns 3 to 12 opposite the type of operation in which the aircraft was engaged at the time of the accident.
d) Data should be reported in columns 13 and 14 relating to the total activities of the operator during the year, subdivided into the types of operation indicated.

Passenger Injury: Include the total number of passengers involved, both revenue and non-revenue.

Crew Injury: Include hostesses, stewards and supernumerary crew in addition to flight crew.

Others Injured: Include all persons injured other than those aboard the aircraft.

Number of Landings: If the number of landings cannot be ascertained without difficulty an estimate may be given and a note inserted under 'Remarks' indicating that the figure is an estimate.

Hours Flown: Report to nearest number of whole hours. Indicate under 'Remarks' basis used - such as 'block-to-block', 'wheels off-wheels on', etc..

PART III

Hazards of Landing and Take-off in the Vicinity of Advancing Thunderstorms

by

J. E. Stevens, B. Sc.
Assistant Director of Meteorological Services
Federation of Rhodesia and Nyasaland

The turbulence and powerful updraughts and downdraughts encountered during en route flight through thunderstorms are well known. The hazards of taking-off or landing in the immediate vicinity of an advancing storm can be much more dangerous, but do not seem to be sufficiently widely appreciated. Whereas an aircraft captain in flight might find himself irrevocably committed to a rough passage through cumulonimbus which was obscured, taking-off and landing can almost always be deferred until the comparatively brief critical period of the onset of a thunderstorm has passed.

The object of this note is to describe the dangers of this temporary critical phase as a thunderstorm arrives at an airport.

The United States Government employed a team of very experienced pilots, meteorologists, and other personnel to make a detailed scientific investigation into the characteristics of thunderstorms over Florida and Ohio in 1946 and 1947.

The resultant "Report of the Thunderstorm Project" is a most comprehensive treatise of the processes of the thunderstorm, paying due attention to the nature of wind discontinuity and turbulence at the onset of a thunderstorm. In addition to cumulative pilot and meteorological experience, this authentic report corroborates any generalizations made in this note to supplement or interpolate actual observations made at the time of the occurrence.

In the formative or cumulus stage of the thunderstorm, there is a net updraught carrying moisture up through the cloud which forms drops of water, snow and ice crystals, which increase in size until they become too big to be borne by the updraught. These big crystals and drops then begin to fall and cool the column of air through which they descend. As the column of air becomes cooler, it sinks. The very downward speed of the precipitation drags air with it. Thus the commencement of rain causes a downdraught through the cloud. As the downdraught reaches within a few hundred feet of the ground it is diverted horizontally over the ground and radially outwards. The horizontal and outward flow usually reaches any given point on the ground suddenly, and often the first gust is the greatest experienced during the short gusty period of the onset of the storm. The general pattern is illustrated in Figure 1 to this paper.

The outward flow caused by the downdraught is often a sudden replacement for the inward flow of air under the convective cloud. The change of horizontal wind speeds causes a shear and consequent gustiness.

The shear between the leading edge of the outflowing air undercutting the gentle inflow causes violent turbulence.

The frictional effect of the ground on the outflow also produces turbulence. This turbulence causes violent upward and downward gusts. This effect is sometimes seen in the case of the roll cloud advancing just ahead of the base of an approaching thunderstorm. Sometimes, particularly in the case of the first storms to occur after a dry season, the turbulence is clearly shown by violent upward and downward swirling dust.

Once the leading edge of the outflowing air has passed any point, the gusty winds begin to moderate.

In the case of the accident at Salisbury Airport on 26 December 1958, the Meteorological Officer warned the approach of the thunderstorm and that gusty winds were likely. He did not specify the direction or speed of the gusts, either horizontal or vertical. It is impossible to give this information because the actual gusts are sudden and random.

The evidence stated that a few minutes before the accident there was only about 5/8 of cloud cover with the sun shining between the clouds, which made the approaching storm seem lighter. This common impression is erroneous and dangerously misleading. The initial gusty conditions at the time of arrival of a storm in otherwise fair conditions are usually more violent than in the case of generally rainy weather. This delusion should be well noted.

Although the Meteorological Department could not and would not claim to be able to forecast the exact gust pattern which evolved, nevertheless, they were in no way surprised at the sequence.

The onset and effect of hazardous wind shift on the take-off of F-BGTZ is given in the following sequence:

Figure 2 shows the position at 1245 hours when the aircraft commenced to taxy out. The storm is approaching from the southeast, the anemometer reads a wind of northerly five knots and the anemograph records calm.

Figure 3 shows the position at 1250 hours when the aircraft was ready to take off. The storm has now reached the middle of the runway. Surface winds caused by the downdraught above the falling rain have reached the recording instruments. The anemometer reads 140° at 18 knots and at about that minute the anemograph records a gust of 38 knots from 100/140°.

Figure 4 shows the position at about 1253 hours when the aircraft lost height. Rain has spread further over, there is a heavy curtain of rain over the intersection of the runway. The anemometer reads a surface wind from 160° gusting to 30 knots. The anemograph records about 20 knots from 060/100°.

It will be seen that the aircraft took off in a southwesterly direction, as the storm was approaching from a southeasterly direction. At the time of taxying out, measured surface winds were light. At the time the aircraft was ready to take off the measured winds were beam winds.

At about the time of loss of height, the anemometer which is nearer the northeast end or threshold end of the runway still shows a headwind component, but the anemograph near the southwest end of the runway records a tail component at a height of approximately 44 ft above ground.

It will, therefore, be seen that during the time of take-off a slight head component has suddenly become a tail component at the anemograph, close to the runway end. This would fit in with the captain's report of loss of airspeed.

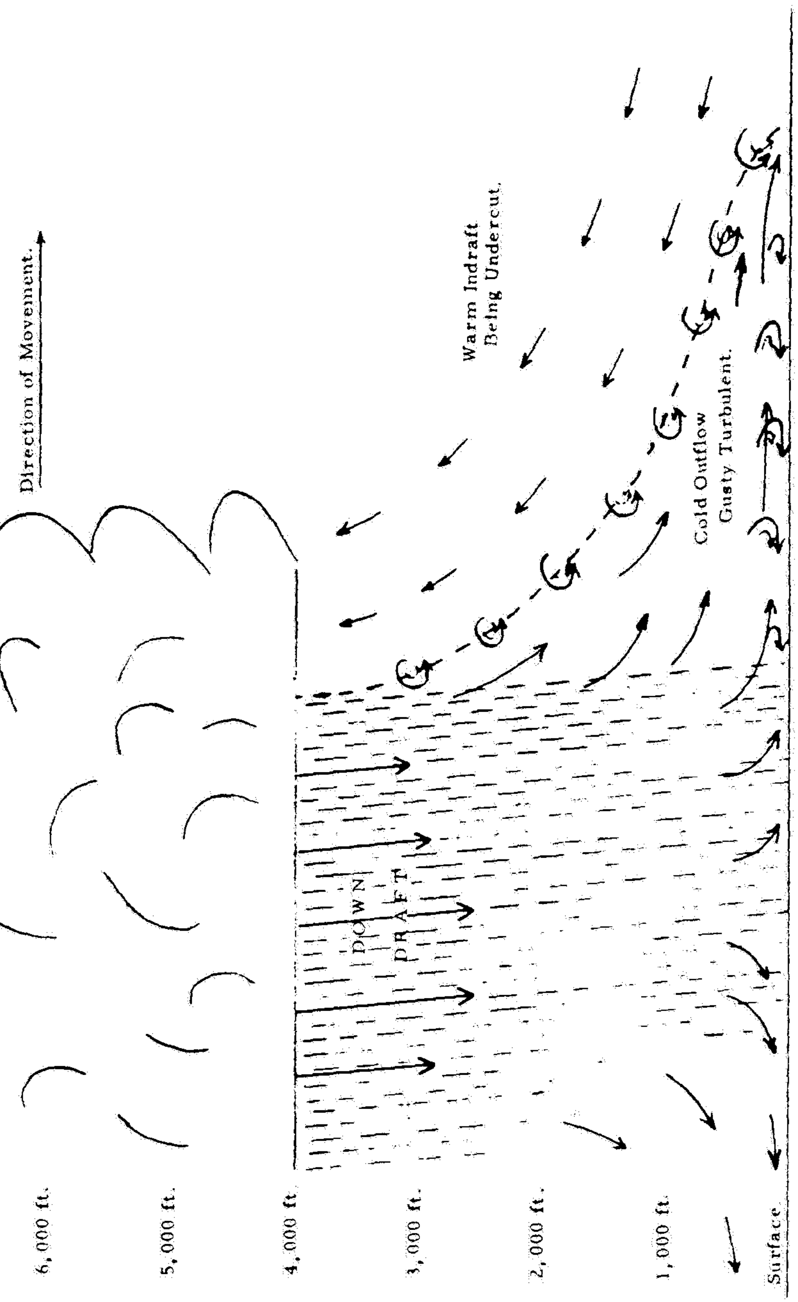
The main points which arise from a consideration of the meteorological factors are, therefore:-

> Bright sunshine before a storm does not indicate that the gusts and turbulence at the time of onset will be slight.
>
> Taking-off or landing just as a thunderstorm reaches the runway may encounter violent wind shifts, gusts and turbulence. An aircraft just above stalling speed could easily be beset with a tail wind and downward gust at the same time.
>
> The critical period usually lasts only a few minutes from the onset. The main gusts in this storm had passed by 1302 hours.

- - - - - - - - - - - -

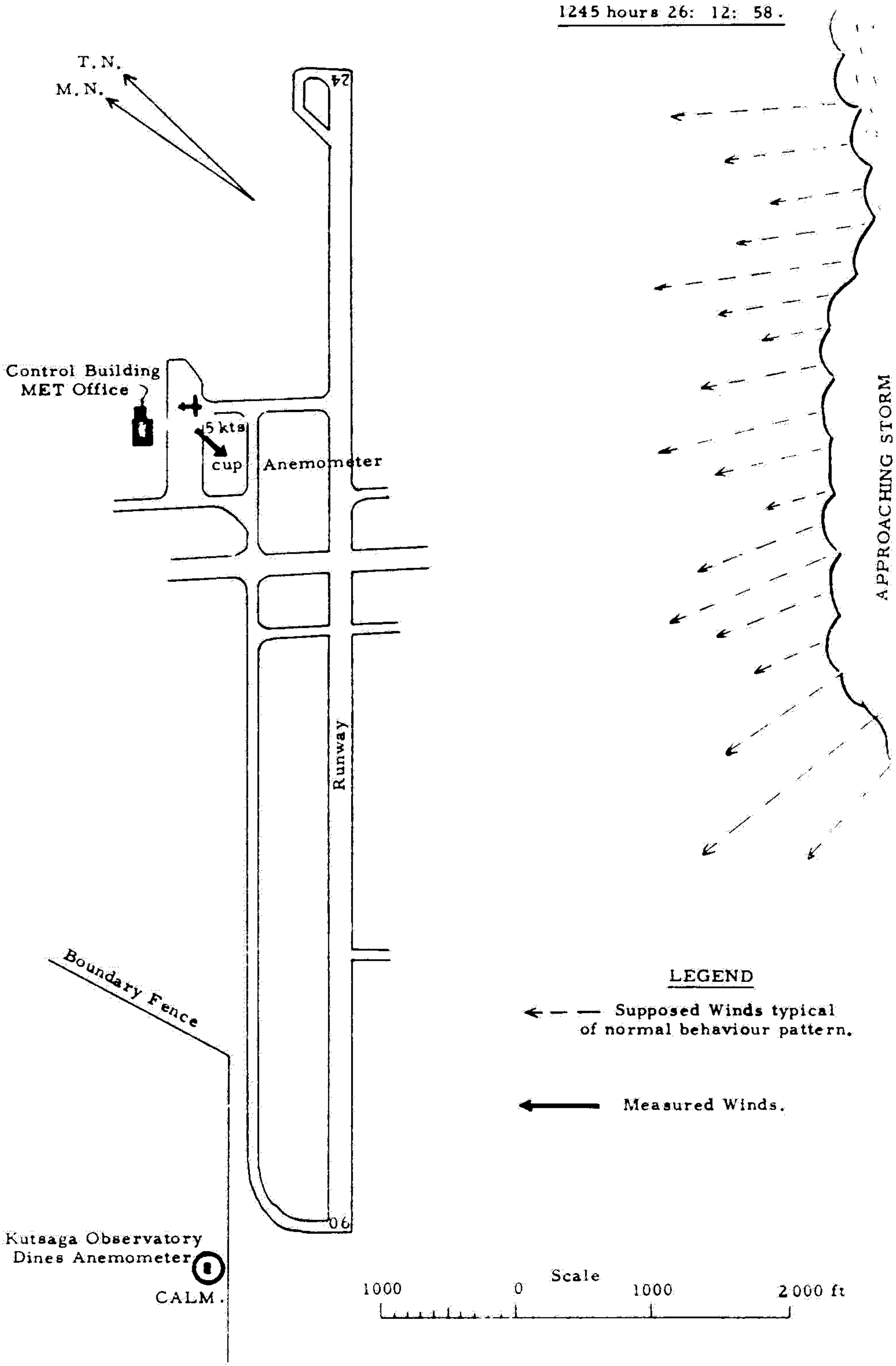
ONSET OF THUNDERSTORM: AIR CURRENTS AND TURBULENCE NEAR SURFACE.

FIGURE 1



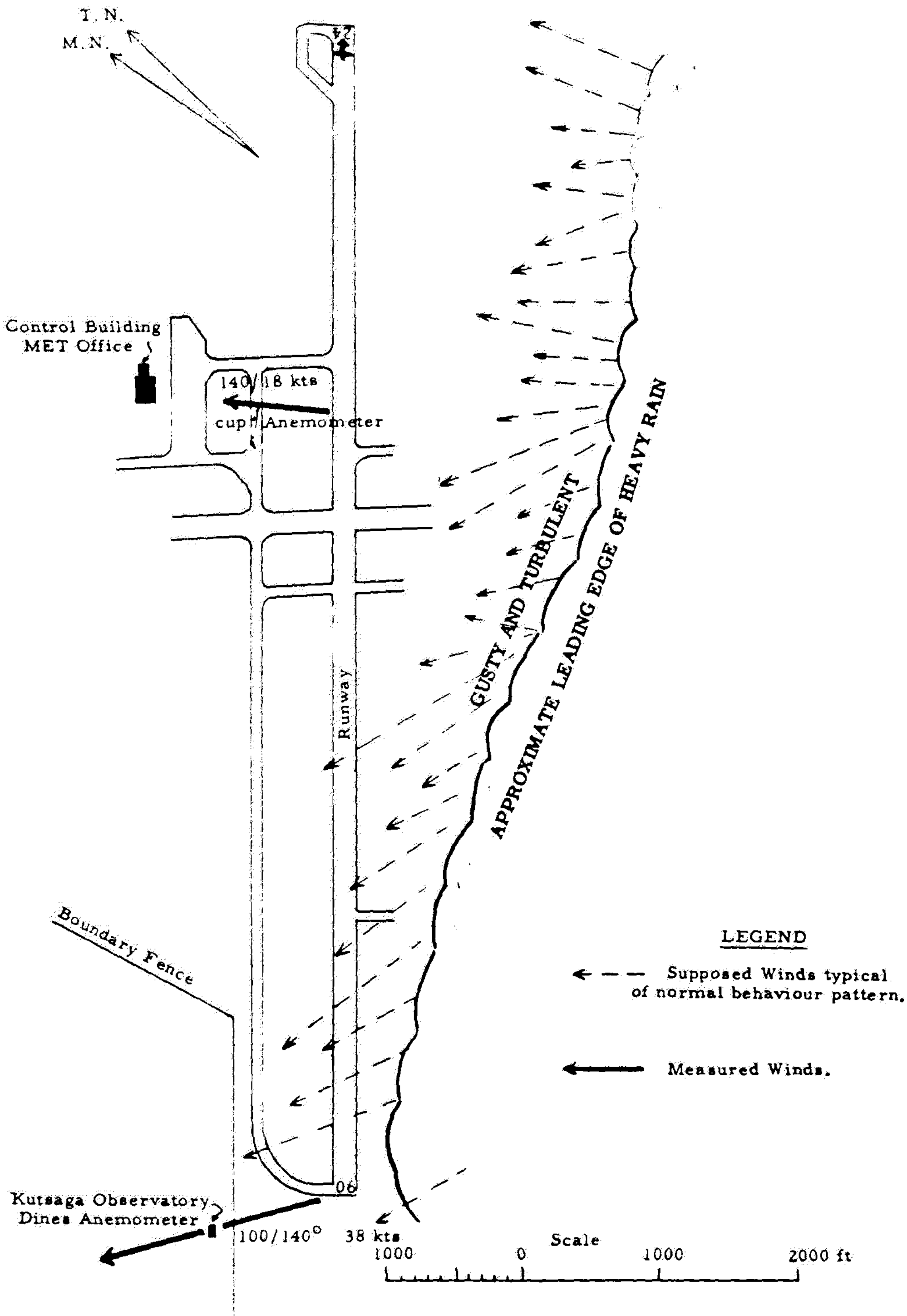
SALISBURY AIRPORT, MAIN RUNWAY FIGURE 2.

1245 hours 26: 12: 58.



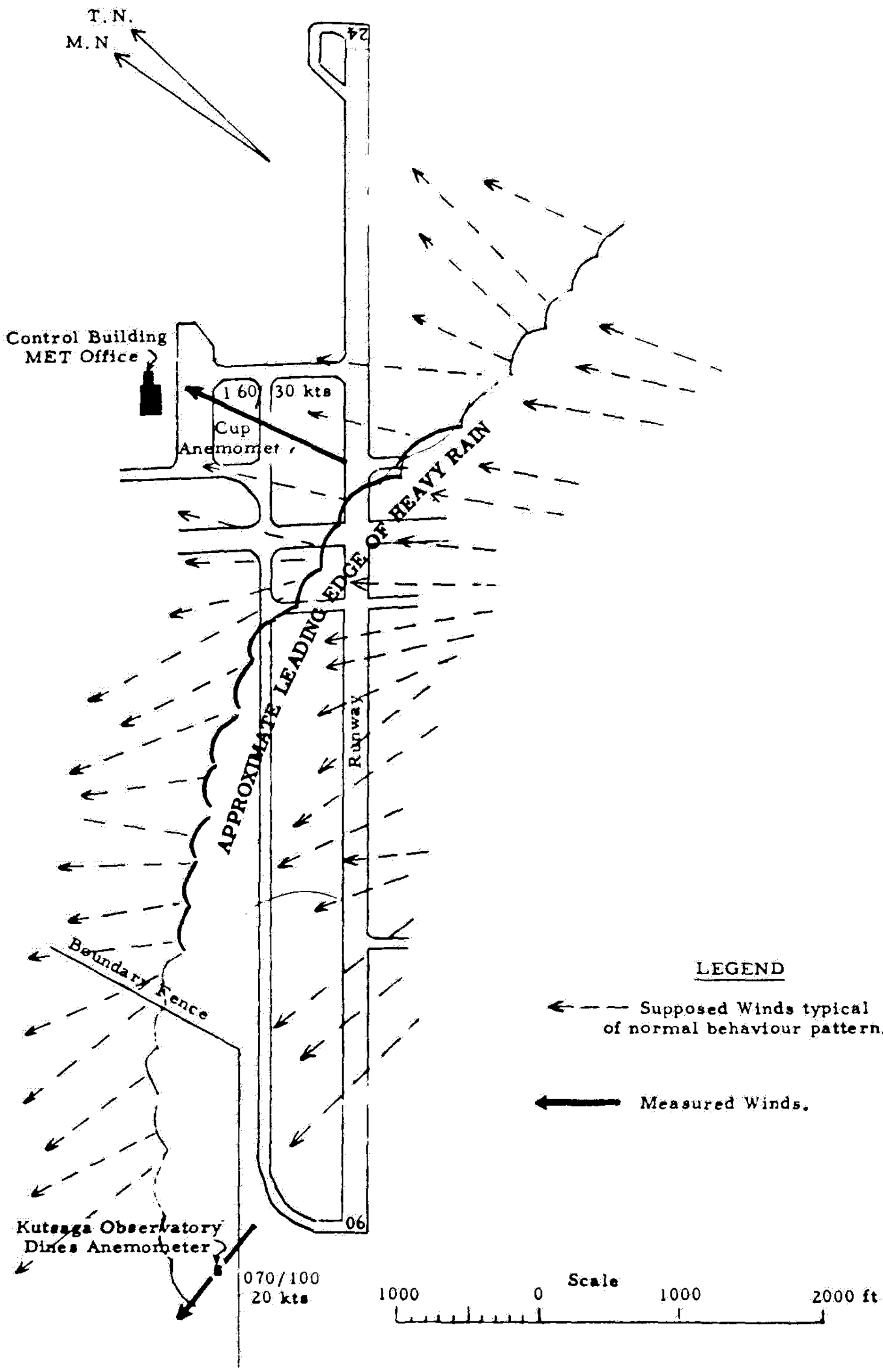
SALISBURY AIRPORT MAIN RUNWAY FIGURE 3.

1250 hours 26: 12: 58.



SALISBURY AIRPORT MAIN RUNWAY. FIGURE 4

1253 hours 26: 12: 58.



LEGEND

Supposed Winds typical of normal behaviour pattern.

Measured Winds.

PART IV

List of Laws and Regulations of the Contracting States containing provisions relating to "Aircraft Accident Investigation"

(Replacing list in Digest No. 9)

ARGENTINA

1952	oct.	9	Resolución Núm. 100 (S.A.C.) - Normas para la investigación de accidentes de aviación civil y directivas generales para la investigación. Ampliada el 8 de enero de 1954.
1954	enero	12	Decreto Núm. 299 - Creación de la Junta de Investigaciones de Accidentes de Aviación y competencia de la Subsecretaría de Aviación Civil y Comando en Jefe de la Fuerza Aérea Argentina en la Investigación de Accidentes civiles y militares respectivamente.
	julio	15	Ley Núm. 14.307 - Código Aeronáutico de la Nación; Título XVIII. - Disposiciones varias (Art. 208).
1957	feb.	19	Normas para investigación de accidentes de aeronaves de propiedad particular.

AUSTRALIA

1947	Aug.	6	The Air Navigation Regulations, S.R. No. 112/1947, as amended up to 4 December, 1958: Part XVI. - Accident Inquiry (Reg. 270-297).

AUSTRIA

1957	Dec.	2	The Federal Air Law, 1957: Part VIII. - D) Investigation of civil aircraft accidents.
1958	March	29	Ordinance No. 68 relating to aircraft accident investigation.

BOLIVIA

1949	junio	18	Procedimiento para el informe de accidentes (Boletín Oficial Núm. 2 - Sec. OP-100).
1950	marzo		Reglas Generales de Operaciones (Provisional): Accidentes de Aeronaves, (02.46-02.52).

BRAZIL

1951	July	24	Portaria No. 280 - Recommendations relating to aircraft accident investigations.

BURMA

1934			The Union of Burma Aircraft Act, 1934 (XXII of 1934): Section 7. - Power of the President of the Union to make rules for investigation of accidents.
1937			The Union of Burma Aircraft Rules, as amended up to 13 March, 1956: Part X. - Investigation of Accidents.
1949	August		Notice to Airmen No. 5/1949 - Aircraft Accident and Incident Investigations.
1957			Notice to Airmen No. 8/57 - Reporting of accidents and incidents involving aircraft.

CANADA

1954	Nov.	23	The Air Regulations, Order in Council P.C. 1954-1821, as amended up to 18 September 1958: Part VIII. - Div. III. - Accidents and Boards of Inquiry.

CEYLON

1950	March	29	Air Navigation Act, No. 15/1950: Part I. - Section 12 - Power to provide for investigation into accidents.
1955	May	4	Civil Air Navigation Regulations: Chap. XVI. - Accident Inquiry (Reg. 260-271).

CHINA (TAIWAN)

1953	Oct.	21	Civil Air Regulations No. 102 - Accident Reporting and Investigation.

COLOMBIA

1948	marzo		Manual de Reglamentos ejecutados por el Decreto Núm. 969 de 14/3/47 y el Decreto Núm. 2669 de 6/8/47: Parte IV - 40.13.0. - Accidentes.

CUBA

1954	dic.	22	Ley-Decreto Núm. 1863 por la cual se crea la Comisión de Aeronáutica Civil, Organización y Facultades: Art. II, 17) Investigación de Accidentes.

CZECHOSLOVAKIA

1947			Decree of Ministry of Interior on accident investigation, No. 1600/47.
1956	Sept.	24	Civil Aviation Law. Para. 45. Investigation of Aircraft Accidents.

DENMARK

1920	Sept.	11	Air Navigation Regulations: Para. 22 - Notifications in case of certain aircraft accidents.

ECUADOR

1954	julio	8	Reglamento de Aeronáutica Civil del Ecuador, Núm. 7: Título II. Parte 8. - Investigaciones y encuestas de accidentes de aviación.

EL SALVADOR

1955	dic.	22	Decreto Núm. 2011 - Ley de Aeronáutica Civil: Cap. XV. - De la Investigación de Accidentes Aéreos (Art. 173-187).

FRANCE

1937	avril	21	Décret relatif à la déclaration des accidents d'aviation.
1953	jan.	3	Instruction interministérielle relative à la coordination de l'Information judiciaire et de l'enquête technique et administrative en cas d'accident survenu à un aéronef français ou étranger sur le territoire de la Métropole et les territoires d'outre-mer.
1957	juin	3	Instruction du Secrétaire d'Etat aux Travaux Publics, aux Transports et au Tourisme n° 300 IGAC/SA, concernant les dispositions à prendre en cas d'irrégularité d'incident ou d'accident d'aviation.

GERMANY (FEDERAL REPUBLIC OF)

1936	Aug.	21	Regulations concerning air navigation, amended as of 21 June, 1955: Sections 65 and 66.

GHANA

1937	Feb.	17	Aircraft (Accident) Regulations, No. 5/1937.

GUATEMALA

1948	oct.	28	Decreto Núm. 563 - Ley de Aviación Civil: Capítulo X. - De los siniestros aeronáuticos (Art. 116-121).

HONDURAS

1957	sept.	3	Decreto Núm. 146 - Ley de Aeronáutica Civil: Título I. - Cap. II. Dirección General de Aeronáutica Civil (Art. 6 xiii) Cap. XIV. Investigación de Accidentes Aéreos.

INDIA

1934	Aug.	19	The Indian Aircraft Act, 1934: Section 7. - Powers of Central Government to make rules for Investigation of Accidents.
1937	March	23	The Indian Aircraft Rules, 1937, as amended up to 12 March 1958: Part X. - Investigation of Accidents (Rules 68-77A).

IRAQ

1939	Aug.	6	The Air Navigation Law No. 41: Article 5 (h).

IRELAND

1936			The Air Navigation and Transport Act, No. 40: Part VII. - Section 60 - Investigation of Accidents. This Act has been amended by Amendment Acts No. 10, 1942; No. 23, 1946; No. 4, 1950.
1957	Feb.	9	The Air Navigation (Investigation of Accidents) Regulations, S.I. No. 19/1957.

ITALY

1925	Jan.	11	Decree Law No. 356 - Rules for Air Navigation: Chapter VII.
1942	April	21	The Navigation Code, approved by Royal Decree No. 327 of 30 March, 1942: Second Part. - Air Navigation - Investigation of Accidents (Art. 826-833).

JAPAN

1952	July	15	Civil Aeronautics Law No. 231, as amended up to 1 April, 1954: Chap. 9 - Article 132. - Investigation of Accidents.

LEBANON

1949	Jan.	11	Aviation Law: Chap. III. - Sub-Chapter 2 - Landing of Aircraft, (Art. 39).

LIBYA

1956			The Civil Aviation Law No. 47: Part VI. - Accident Inquiry (Annex 13).

MALAYA (FEDERATION OF)

1953	Nov.	1	Air Navigation (Investigation of Accidents) Regulations (L.N. 584/53).

MEXICO

1949 dic.	27	Ley de Aviación Civil (Libro IV de la Ley de Vías Generales de Comunicación): Cap. XIV. - De los accidentes y de la búsqueda y salvamento (Art. 358-361).
1950 oct.	18	Reglamento para Búsqueda y Salvamento e Investigación de Accidentes Aéreos (en vigor a partir del 1 de enero de 1951).

NETHERLANDS

1936 Sept.	10	Law - Investigation of Accidents to civil aircraft, amended by Law of 31 December, 1937, (concerns inter alia the greater part of the provisions of Annex 13).
1936 Sept.	22	Royal Decree: Application of paras. 8 and 9 of Article 1 and of para. 5 of Article 32 of the Law dated 10 September, 1936.
Sept.	22	Royal Decree: Application of para. 2 of Article 6 of the Law of 10 September, 1936.

NEW ZEALAND

1948 Aug.	26	The Civil Aviation Act, 1948: Art. 8. - Power to provide for investigation of accidents.
1953 Nov.	11	The Civil Aviation (Investigation of Accidents) Regulations, Serial No. 152/1953, (made in accordance with ICAO Annex 13).

NICARAGUA

1956 mayo	18	Decreto Núm. 176 - Código de Aviación Civil: Título II. - Cap. V. De la Investigación de Accidentes Aéreos.

NORWAY

1923 Dec.	7	Civil Aeronautics Act, as amended up to 17 July 1953: Chapter XI.
		Royal Resolution - Regulations on aviation enacted by the Department of Defence, 15 October 1932, in accordance with the Civil Aeronautics Act of 7 December, 1923, and the Royal Resolution of 22 April 1932, as amended up to 1950: VIII. - Aircraft Accidents.

PAKISTAN

1934 Aug.	19	The Aircraft Act, No. XXII of 1934 (corrected up to 26 October 1950); Para. 7. - Power of Central Government to make rules for investigation of accidents.
1937 March	23	The Aircraft Rules, (corrected up to 24 February, 1956): Part X. - Investigation of Accidents. (Amended on 7 February, 1956).

PARAGUAY

1954	enero	15	Resolución Núm. 54 por la que se establece la definición "Accidentes de Aviación" y las normas a ser cumplidas en tales casos.
1957	sept.	30	Ley Núm. 469 - Código Aeronáutico: Título XVI. - Accidentes Aeronáuticos.

PHILIPPINES

1946	May	9	The Civil Aviation Regulations: Chap. XVI. - Aircraft Accident Investigation.
1952	June	20	The Civil Aeronautics Act of the Philippines, No. 776: Chap. V. - Section 32 - Power and Duties of the Administrator: (11) Investigation of Accidents.

PORTUGAL

1931	Oct.	25	Decree No. 20.062 - Air Navigation Regulations: Chapter VIII.

SPAIN

1948	marzo	12	Decreto del Ministerio del Aire sobre investigación de accidentes y auxilio de aeronaves.

SWEDEN

1928	April	20	Royal Proclamation No. 85 regarding Application of the Decree of 26 May 1922, (No. 383) on Air Navigation. Amended up to 1953 - (Code of Law 42: 1953): Para. 28. - Notification of aircraft accidents.
			Civil Aviation Regulations (BCL) - Operational Regulations (D): Aircraft Accident Inquiry - ICAO Annex 13.
1956	Sept.	21	Regulation No. 68 establishing a commission for the investigation of accidents.

SWITZERLAND

1948	déc.	12	Loi fédérale sur la navigation aérienne (entrée en vigueur le 15 juin 1950): Articles 23-26.
1950	juin	5	Règlement d'exécution de la loi sur la navigation aérienne: XIV. - Accidents d'aéronefs (articles 129-137).

THAILAND

1954	Sept.	1	The Air Navigation Act, (B.E. 2497): Chap. 7. - Accidents (Sections 63 and 64).
1955	June	5	Civil Air Regulations No. 3. - Aircraft Accident Inquiry.

UNION OF SOUTH AFRICA

1923	May	21	The Aviation Act No. 16: Article 10. - Investigation of Accidents.
1950			The Air Navigation Regulations, G.N. 2762/1949, as amended up to 22 June, 1956: Chapter 29. - Investigation of Accidents (Regulations 29.1 - 29.7).

UNITED ARAB REPUBLIC

1941	May	5	Decree - Air Navigation Regulations: Article 10.

UNITED KINGDOM

1949	Nov.	24	The Civil Aviation Act, 1949 (12 and 13 Geo. 6. Ch. 67): Part II. - Section 10 - Investigation of Accidents.
1951	Sept.	5	The Civil Aviation (Investigation of Accidents) Regulations, S.I. No. 1653. Came into operation on 1 October, 1951.
1954	June	24	The Air Navigation Order, S.I. No. 829, as amended up to 31 July, 1958: Part IV. - Article 70 - Application of accident regulations to aircraft belonging to or employed in the service of Her Majesty.
1959	Aug.	6	The Air Navigation (Investigation of combined military and civil air accidents) Regulations, S.I. 195, No. 1388.

UNITED KINGDOM COLONIES

1955

Article 70 of the Colonial Air Navigation Order, 1955, and Section 10 of the Civil Aviation Act, 1949, apply /the latter by virtue of the Colonial Civil Aviation (Application of Act) Order, 1952, as amended/ to the undermentioned Colonies:

Aden (Colony Protectorate)
Bahamas
Barbados
Basutoland
Bechuanaland Protectorate
Bermuda
British Guiana
British Honduras
British Solomon Islands Protectorate
Central and Southern Line Islands - Malden
Starbuck
Vostock
Caroline
Flint

UNITED KINGDOM COLONIES (Cont'd)

Cyprus
Falkland Islands and Dependencies
Fiji
Gambia (Colony and Protectorate)
Gibraltar
Gilbert and Ellice Islands Colony
Hong Kong
Jamaica (including Turks and Caicos Islands and the Cayman Islands)
Kenya (Colony and Protectorate)
Leeward Islands - Antigua
Montserrat
St. Christopher and Nevis
Virgin Islands
Malta
Mauritius
Nigeria - (a) Colony
(b) Protectorate
(c) Cameroons under United Kingdom trusteeship
North Borneo
Federation of Rhodesia and Nyasaland
Southern Rhodesia (self-governing Colony)
St. Helena and Ascension
Sarawak
Seychelles
Sierra Leone (Colony and Protectorate)
Singapore
Somaliland Protectorate
Swaziland
Tanganyika
Trinidad and Tobago
Uganda Protectorate
Windward Islands - Dominica
Grenada
St. Lucia
St. Vincent
Zanzibar Protectorate.

ADEN

1954			The Civil Aviation (Investigation of Accidents) Regulations (G.N. 125/54).

BAHAMAS

1952	Aug.	1	Air Navigation (Investigation of Accidents) Regulations.

BARBADOS

1952	April	29	Air Navigation (Investigation of Accidents) Regulations.

UNITED KINGDOM COLONIES (Cont'd)

BERMUDA

1948 Dec.	18	Air Navigation (Investigation of Accidents) Regulations.

BRITISH GUIANA

1952 Aug.	18	Air Navigation (Investigation of Accidents) Regulations, No. 19/1952.

BRITISH HONDURAS

1953 Dec.	19	Air Navigation (Investigation of Accidents) Regulations, (S.I. 1/1954).

CYPRUS

1952 Nov.	17	Civil Aviation (Investigation of Accidents) Regulations (G.N. 517/1952).

EAST AFRICA

1954 1959		The Civil Aviation (Investigation of Accidents) Regulations.

FIJI

1952 May	1	Civil Aviation (Investigation of Accidents) Regulations (L.N. 90/1952).

GAMBIA

1937 May	1	Air Navigation (Investigation of Accidents) Regulations, (No. 8/37).
Nov.	15	Air Navigation (Investigation of Accidents) Regulations, (No. 2) [No. 17/37].

GIBRALTAR

1952 Jan.	3	Air Navigation (Investigation of Accidents) Regulations, 1952.

HONG KONG

1951		Air Navigation (Investigation of Accidents) Regulations (G.N. A228/51).

JAMAICA

1953 March	24	Air Navigation (Investigation of Accidents) Regulations (G.N. 37/53).

UNITED KINGDOM COLONIES (Cont'd)

LEEWARD ISLANDS

1952	July	31	Civil Aviation (Investigation of Accidents) Regulations (S.R.O. 18/52).

MALTA

1952	Sept.	2	Civil Aviation (Investigation of Accidents) Regulations.

MAURITIUS

1952	Sept.	4	Civil Aviation (Investigation of Accidents) Regulations (G.N. 200/52).

NIGERIA

1953	April	28	Civil Aviation (Investigation of Accidents) Regulations (No. 15/1953).

NORTH BORNEO AND LABUAN

1950	Jan.	6	Air Navigation (Investigation of Accidents) Regulations (S. 8/50).

RHODESIA AND NYASALAND

1954	March	26	The Aviation Act, No. 10/1954: Sec. 13. - Enquiries.
	July	1	The Air Navigation Regulations, 1954: Part 18. - Accidents.

ST. LUCIA

1948	Nov.	27	Air Navigation (Investigation of Accidents) Regulations (S.R.O. No. 40/48).

ST. VINCENT

1953	Jan.	8	Air Navigation (Investigation of Accidents) Regulations (S.R.O. No. 6/53).

SARAWAK

1953			The Air Navigation (Investigation of Accidents) Regulations (G.N. S6/54).

SIERRA LEONE

1953	Dec.	30	Civil Aviation (Investigation of Accidents) Regulations (P.N. 114/53).

UNITED KINGDOM COLONIES (Cont'd)

SINGAPORE

1953	Oct.	1	Civil Aviation (Investigation of Accidents) Regulations (G.N. 301/53).

SOMALILAND

1951	Nov.	7	Civil Aviation (Investigation of Accidents) Regulations (G.N. 48/1951).

TRINIDAD AND TOBAGO

1954	Nov.	23	Air Navigation (Investigation of Accidents) Regulations (G.N. 205/54).

ZANZIBAR

1937	Sept.	4	Air Navigation (Investigation of Accidents) Regulations (G.N. 41/1937).

UNITED STATES OF AMERICA

1950	Sept.	15	Economic Regulations - Part 303 - Rules of practice in aircraft accident investigation hearings, (as issued September 15, 1950, 15 F.R. 6440; revised effective February 15, 1957, 22 F.R. 1026; Part revised by Reg. PR-35, effective March 21, 1959, 24 F.R. 2224).
1950	Sept.	15	Economic Regulations - Part 311 - Disclosure of aircraft accident investigation information.
1955			Economic Regulations - Part 399 - Statements of General Policy, as issued, effective May 25, 1955; Sec. 399.26 - Investigation of Accidents involving foreign aircraft.
1958			Public Notice PN 13 - Request to Administrator of Federal Aviation Agency to investigate certain aircraft accidents for a temporary period, (as issued, effective December 31, 1958, 23 F.R. 10492).
1958	Aug.	23	The Federal Aviation Act: Title I. - Sec. 103.01 Congressional Committee Report; Title III. - Sec. 313 (c) Power to Conduct Hearings and Investigations; Title VII. - Aircraft Accident Investigation.
1959			Safety Investigation Regulations - Part 320 - Notification and Reporting of Aircraft Accidents and Overdue Aircraft (as issued, effective February 28, 1959, 24 F.R. 1508).

UNITED STATES OF AMERICA (Cont'd)

1960		Public Notice PN 14 - Statement of Organization and Delegations of Final Authority (as issued, effective January 8, 1960, 25 F.R. 657, revoking Public Notices PN 11 and 12, effective July 18, 1957 and May 1, 1958): Section 1.2 - Functions of the Civil Aeronautics Board - (c) Safety Activities; Bureau of Safety - Sections 5.1 - 5.8; Sec. 7.2 - Functions of the General Counsel; Sec. 7.3 - Delegated authority of the General Counsel - (A); Sec. 7.4 - Redelegation of authority; Sec. 7.6 - Redelegations of authority to Associate General Counsel, Rules and Legislation.
1952		TITLE 22 - Foreign Relations - Part 102 - Civil Aviation - Subchapter K - Economic, Commercial and Civil Aviation Functions: U.S. Aircraft Accidents Abroad; Foreign Aircraft Accidents Involving U.S. Persons or Property. (As issued in Department Regulations 108.164, effective October 1, 1952, 17 F.R. 8207; Part 102 as republished, effective Decembre 23, 1957, 22 F.R. 10871).

URUGUAY

1955 feb.	2	Decreto Núm. 23.826 - Reglamento para la Investigación de Accidentes de Aviación de Carácter Civil.

VENEZUELA

1955 abril	1	Ley de Aviación Civil: Cap. X. - De los accidentes y de la búsqueda y rescate.

- END -

ICAO TECHNICAL PUBLICATIONS

The following summary gives the status, and also describes in general terms the contents of the various series of technical publications issued by the International Civil Aviation Organization. It does not include specialized publications that do not fall specifically within one of the series, such as the ICAO Aeronautical Chart Catalogue *or the* Meteorological Tables for International Air Navigation.

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES are adopted by the Council in accordance with Articles 54, 37 and 90 of the Convention on International Civil Aviation and are designated, for convenience, as Annexes to the Convention. The uniform application by Contracting States of the specifications comprised in the International Standards is recognized as necessary for the safety or regularity of international air navigation while the uniform application of the specifications in the Recommended Practices is regarded as desirable in the interest of safety, regularity or efficiency of international air navigation. Knowledge of any differences between the national regulations or practices of a State and those established by an International Standard is essential to the safety or regularity of international air navigation. In the event of non-compliance with an International Standard, a State has, in fact, an obligation, under Article 38 of the Convention, to notify the Council of any differences. Knowledge of differences from Recommended Practices may also be important for the safety of air navigation and, although the Convention does not impose any obligation with regard thereto, the Council has invited Contracting States to notify such differences in addition to those relating to International Standards.

PROCEDURES FOR AIR NAVIGATION SERVICES (PANS) are approved by the Council for world-wide application. They comprise, for the most part, operating procedures regarded as not yet having attained a sufficient degree of maturity for adoption as International Standards and Recommended Practices, as well as material of a more permanent character which is considered too detailed for incorporation in an Annex, or is susceptible to frequent amendment, for which the processes of the Convention would be too cumbersome. As in the case of Recommended Practices, the Council has invited Contracting States to notify any differences between their national practices and the PANS when the knowledge of such differences is important for the safety of air navigation.

REGIONAL SUPPLEMENTARY PROCEDURES (SUPPS) have a status similar to that of PANS in that they are approved by the Council, but only for application in the respective regions. They are prepared in consolidated form, since certain of the procedures apply to overlapping regions or are common to two or more regions.

The following publications are prepared by authority of the Secretary General in accordance with the principles and policies approved by the Council.

ICAO FIELD MANUALS derive their status from the International Standards, Recommended Practices and PANS from which they are compiled. They are prepared primarily for the use of personnel engaged in operations in the field, as a service to those Contracting States who do not find it practicable, for various reasons, to prepare them for their own use.

TECHNICAL MANUALS provide guidance and information in amplification of the International Standards, Recommended Practices and PANS, the implementation of which they are designed to facilitate.

AIR NAVIGATION PLANS detail requirements for facilities and services for international air navigation in the respective ICAO Air Navigation Regions. They are prepared on the authority of the Secretary General on the basis of recommendations of regional air navigation meetings and of the Council action thereon. The plans are amended periodically to reflect changes in requirements and in the status of implementation of the recommended facilities and services.

ICAO CIRCULARS make available specialized information of interest to Contracting States. This includes studies on technical subjects as well as texts of Provisional Acceptable Means of Compliance.

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