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AIRCRAFT ACCIDENT DIGEST
NO. 2

Prepared in the Air Navigation Bureau
and published by authority of the Secretary General

INTERNATIONAL
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FOREWORD

The Accident Investigation Division of the Air Navigation Commission 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 first summary was issued in October 1946 (List No. 1, Doc 2177, AIG/56) entitled "Consolidated List of publications and documents relating to Aircraft Accident Investigation Reports and Procedures, 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 and extremely useful 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 in future to produce the material in the form of an information circular entitled "Aircraft Accident Digest".

The first ICAO information circular entitled "Aircraft Accident Digest, No. 1" (ICAO Circular 18-AN/15) was issued in June 1951, this is, therefore, the second issue under the new title. It is hoped that States will co-operate to the fullest extent their national laws permit 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, accident investigation presenting one of the knottiest problems of standardization in international civil aviation for this very reason. 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 only in this way that this most fertile field for international co-operation can be effectively exploited. The measure of interest which this publication has aroused, and the salutary effects which the vital intelligence it imparts has had in informing everyone concerned before they have all individually experienced the disastrous possibilities inherent in the various situations explored within its covers, amply demonstrate the possibilities of ultimate achievement when <u>every</u> accident is investigated with the greatest thoroughness and the findings disclosed with complete frankness.

The ICAO Manual of Aircraft Investigation is a valuable guide to securing the information required for accident prevention measures and, whether available facilities and resources permit of the fullest investigation or not, if it is followed to the greatest practicable extent, uniformity of findings and usefulness of the Digest will be enhanced. Briefly, the intelligence required in order to be useful must include:

1) Aircraft Type;

2) State of Registry;

3) Date and Place of Accident;

4) Résumé of the Accident;

5) Result of the Technical Investigation;

6) Conclusions and Recommendations (if any).

Any restriction upon reproduction in the Digest seriously impairs of course the usefulness of any report, 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.

Highlights of this issue are, first, the continued preponderance of accidents attributed to pilot error and the large proportion which occur during take-off and landing. With the continued improvement in en-route aids and airworthiness this state of affairs is to be expected, for the human is the weakest link in the chain of operations and the take-off and landing, the most hazardous. However, examination of the contributory factors of these accidents suggest that carelessness, poor technique due to lack of training or experience and negligence are the principle factors involved. Considerable improvement can therefore still be made by better training and constant vigilance on the part of everyone concerned. Accident No. 12 is a typical example of the above. Many others will be obvious to the reader.

Secondly, Part 4 contains a Report of the enquiry into the relative responsibilities of the captain of an aircraft, the operator and the aerodrome authority in deciding whether an aircraft can safely land at, or take off from, an aerodrome in bad weather conditions. This should be of interest to all those engaged in finding a solution to this hazard which ranks high as a potential cause of accidents. As a result of this report the United Kingdom is engaged in practical research for determining "slant visibility" and "runway visibility" from the ground. A special meeting will be held by ICAO this year to consider this problem in all its aspects.

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PART I.- SUMMARIES OF AIRCRAFT ACCIDENT REPORTS

No. 1

American Airlines DC-6 Aircraft, N-90705, propeller blade failure, near Eagle, Colorado on 21 August 1950. CAB Accident Investigation Report, No. 1-0109. Released 12 June, 1951

Circumstances

The aircraft en route from Los Angeles, California, to Chicago, Illinois, carrying 54 passengers, and a crew of 5, incurred a propeller blade failure at 21,000 feet altitude when in the vicinity of Eagle, Colorado, and the resulting unbalance tore loose the engine which fell from the aircraft. A portion of the blade pierced and depressurized the cabin. A safe emergency landing was made at Stapleton Airport, Denver, Colorado. One passenger died (presumably from heart failure) and five passengers and one stewardess sustained minor injuries. The aircraft was extensively damaged.

Investigation and Evidence

Inspection of the aircraft structure revealed a nearly vertical slit 36 inches long by 2 inches wide through the ice-striker plate on the right side of the fuselage, caused by the jettisoned portion of the propeller blade striking the fuselage edgewise. A large irregular opening on the top of the fuselage starting almost in line laterally with the slit, and extending back along the top and both upper sides of the fuselage for about 12 to 14 feet was attributed to the jettisoned portion of blade leaving the fuselage flatwise, and to the sudden violent out-rush of air as the cabin pressure escaped through the hole, subsequent peeling, bending and tearing of protruding parts being due to the high speed of the aircraft itself. No damage was evident on either surface of both wings nor on the empennage, although small pieces of sound proofing material had adhered to the edge of the left stabilizer.

Within the fuselage the left forward bunk was missing and the right forward bunk was distorted, and partly out of the large opening in the top of the fuselage. Signs of distortion caused by rapid decompression were visible elsewhere, bulkheads, surfaces, doors, ceilings and floors bulging in varying degree, in the direction that air behind those surfaces would flow to escape.

Examination of No. 3 engine nacelle showed that the engine broke away from the aircraft at the mount ring. Vibration isolators Nos. 1, 2, 5 and 6 had separated at their cup threads. Sections of the mount ring between No. 1 and No. 6 and from No. 3 to No. 4 vibration isolators were broken out. All fluid lines, electrical conduits and controls which had been attached to the engine had separated. The outboard upper, middle and lower accessory cowl panels, oil cooler scoop and front fairing were missing. The electrical circuits for No. 3 propeller checked to the point of separation, showed no irregularity and the propeller synchronizer checked normally when functionally tested.

The No. 3 engine, retrieved from a position some 84 miles west of Stapleton Field, although severely damaged by impact with the ground, was disassembled, and its internal condition determined with reasonable accuracy. No failure of any part was found although some significant wear appeared in both dynamic dampers. The outer portion of the failed blade some 48" long was retrieved and examined together with the 25" long shank end which remained with the engine. The break was observed to be substantially at right angles, and gouges were found, plainly evident, on the inner side of the flat (rear) surface at the place of failure.

The failure was analyzed and found to be caused by a fatigue fracture which originated at one of several defects which were points of stress concentration on the inside surface of the flat side of the blade. These defects, which occurred prior to heat treatment and painting on the inside of the blade, appeared to have resulted from a gouging or galling action due to rubbing against another surface such as a mandrel.[1] Two of the parallel and longitudinal gouges found, were located and spaced closely corresponding to the location and spacing of Allen head set screws which serve to lock in position the cam adjustments of a side mandrel.

At the time the subject blade was manufactured, it was subjected to a number of tests and inspections. One such inspection was by means of x-ray photographs. Examination of the manufacturer's original x-ray negatives revealed faint marks indicating internal defects, corresponding in size, location and spacing to the gouges evident on the failed blade and to the location and spacing of the Allen head set screws of the center mandrel.[2]

Probable Cause

The probable cause of this accident was the internal gouging of a propeller blade during the manufacturing process which resulted in a fatigue fracture and subsequent failure during flight.

1) In the fabrication of this blade (a hollow steel model) the two surfaces are formed and shaped separately and then welded together. During the welding the two parts are positioned by a mandrel within the blade controlling the distance between the two surfaces. This mandrel has extendable side mandrels controlling the weld locations. The entire device is rigid in use but is necessarily made collapsible so that it may subsequently be withdrawn from the relatively small opening in the shank end of the blade. The positioning of the side mandrels is by means of two cam adjustments in the center mandrel. These cams are locked in position by Allen head set screws.

2) Immediately following the accident the blade manufacturer instituted a thorough re-examination of all blades in service. This re-examination included a tightening of inspection procedures including x-ray photographs and closer tolerance specifications for the evaluation of any indicated defects.

ICAO Ref: AR/138

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No. 2

Trans-World Airlines, Lockheed Constellation aircraft, N-6004C, crashed during emergency landing 52 miles N.W. Farouk Airport, Cairo, on 31 August 1950. CAB Accident Investigation Report No. 1-0114. Released: 15 June 1951.

Circumstances

Aircraft N-6004C departed from Cairo en route for Rome carrying 48 passengers and 7 crew members. Approximately 67 miles from Cairo, No. 3 engine failed, precipitating an outbreak of fire. The aircraft turned back as if intending to land at Cairo, but the fire rapidly increased, causing the burning engine to fall free. Fire continued in the right wing and an attempted night landing on the desert resulted in destruction of the aircraft and death of all passengers and crew.

Investigation and Evidence

The aircraft struck while under control and nearly level laterally, with the right wing slightly depressed, and in a slight nose-down attitude, suggesting that there had been no flare-out as the aircraft approached the ground. Contact with the ground was made with the landing gear and flaps retracted.

The aircraft was severely damaged on initial impact and almost completely disintegrated before its forward speed was checked, debris being scattered over an area stretching fan-wise for about 700 feet. Autopsies performed on the bodies of both the captain and the co-pilot disclosed that neither had breathed flame or hot gas indicating that there was no fire in the cockpit prior to the crash.

Examination of the aircraft's entire control system, electrical system and radio equipment disclosed no failure, malfunctioning or arcing prior to impact, with the exception of the probable loss of aileron boost. Examination of engines Nos. 1, 2 and 4 revealed no evidence of malfunctioning.

The emergency fuel shut-off valve for No. 3 engine was in the closed position. The engine itself was found some 3-1/2 miles from the impact site. The point of severance from the aircraft was at the nacelle barrel attaching points flush with the firewall. Inspection of No. 3 propeller revealed no evidence of failure in flight. Between the main wreckage and No. 3 engine, many pieces of molten metal from the top surface of the wings in the general vicinity of and behind No. 3 engine were recovered.

Examination of No. 3 engine revealed that the main failure was the rear master rod bearing, and as a result of the engine's continued operation thereafter, the rear crank pin overheated and collapsed. The bearing failure and the crank pin collapse progressed until there was an inch difference in the diameters of the two, which permitted the effective piston stroke to increase until the pistons were striking valves and cylinder heads, whereupon all rear articulated rods and the rear master rod failed. This general failure caused much external damage at the rear row of cylinders and the crankcase. As the rear master and articulated rods sliced through the walls of the rear cylinders, the mating sections of the rear crankcase were appreciably displaced. This in turn distorted and displaced the inter-zone baffle, commonly known as the fire seal. Damage to this baffle was sufficient to destroy its function as a means of preventing the spread of fire.

Throughout the engine various bearing surfaces showed considerable operational damage as evidenced by metal pick-up, metal displacement and heat discoloration, a condition unquestionably caused by lack of lubrication. This condition also indicates that the engine continued to rotate for some time after the failure of the rear master rod bearing, which resulted in a loss of oil pressure, and lubrication, throughout the engine.

From analysis of the fire pattern it was determined that the flailing of broken master or articulated rods at the mating sections of the crankcase in the plane of the rear row of cylinders actually cut away a section of the crankcase, which destroyed the effectiveness of the interzone baffle lying immediately aft. The general breakage was such that more than one line carrying inflammable fluid was severed and lubricating oil and oil fumes from the crankcase were liberated profusely, resulting in fire.

[1]The fire was relatively light in Zone No. 1 but so severe in Zone No. 2 that it melted the adjoining dural structure rearward of the firewall, in Zone No. 3, allowing the engine to fall free. The fire then continued through Zone 3 and the adjacent wing structure, leaving aft of the rear spar through the top skin of the wing. The result was that numerous parts of the secondary wing structure also burned free and fell accounting for the general line of small molten and burned pieces found between No. 3 engine and the main wreckage.

The subject engine (No. 3) had not reached its first overhaul period. It had been operated approximately 1,100 hours since installation when new, and the specified overhaul period for this model of engine is 1,200 hours. At the time of the accident the engine oil had not been changed but merely added to as required, which was company procedure and accepted good practice at that time. Analysis of maintenance records and flight logs disclosed that some 18 hours previous to the accident while the subject aircraft was en route from Cairo to Bombay, No.3 engine experienced a temporary unusually high difference of approximately 40°C between the temperature of oil to the engine and oil from the engine. However, this was not considered by the operator to be indicative of potential trouble inasmuch as the carrier itself had arbitrarily set a differential of 45°C as a safe spread.

There would appear to be three possibilities as to what may have initiated the failure of the master rod bearing. In the first instance, although No. 9 piston showed signs of burning similar to a failed piston it appeared that piston failure did not initiate the failure of the master rod bearing. Secondly, there is the possibility of internal damage occurring at the time of the unusually high oil temperature difference which was logged approximately 18 hours before the accident. This unquestionably indicated some abnormality in the operation of the engine. It is possible that a balancer seized thereby causing the high oil temperature and that the subsequent stripping of the balancer's pinions rendered the balancer inoperative

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[1]Zone No. 1 - The entire region forward of the baffle (annular disc made of a fireproof material) which surrounds the rear accessory section of the engine at a point immediately aft of the rear row of cylinders and extends radially to the cowling.

Zone No. 2 - Comprises the entire region aft of the baffle mentioned in Zone 1 back to a firewall. Both the baffle and the firewall are of fireproof material, and there is fireproof material enclosing Zone 2 circumferentially.

Zone No. 3 - The entire region aft of the firewall and including the rest of the nacelle.

allowing the oil temperature difference to return to normal. Metallic parts from the failed balancer and its pinions could have been introduced into the lubricating oil system and carried to the rear master rod bearing, thus initiating the failure of that bearing.

The third possibility concerns the accumulation of sludge found within the crank pins of this engine. It has been determined that such an accumulation is not dangerous providing the sludge remains solid and does not break away. Sludge normally does remain solidified, although, under certain conditions it may shift or break up and thus obstruct oil flow to a master rod bearing. There have been a number of master rod bearing failures attributed to just such an occurrence. Because the engine had been in operation for 1,100 hours there must remain the distinct possibility that sludge obstruction of oil flow was the primary cause of the failure of the master rod bearing.

Probable Cause

The probable cause of this accident was the failure of the rear row master rod bearing causing an uncontrolled fire which precipitated a crash landing.

Notes.-

1.- As a result of this accident and previous failures of master rod bearings in the model 749C18BD1 engine, the following corrective measures have been taken:

a) The practice of no oil changes between engine overhaul has been discontinued. Oil is now being changed at periods not exceeding 400 hours.

b) Fine mesh main oil screens are now being service tested. It is believed that some contaminants now being carried into the engine lubricating system will be screened out.

c) Longer master rod bearing oil feed tubes are currently being installed as an interim remedy until a new type crank pin sludge plug now under development is installed.

d) A crank pin sludge plug is under development which is expected to reduce effectively crank pin sludge accumulation to the point that it is of no consequence.

e) A centrifuge, independent of the engine, for the separation of sludge from the oil is being developed as a long range project.

f) Discontinuation of the practice of oil dilution in all similar engines, regardless of climate.

2.- The carrier issued to all pilots and flight engineers the following information:

"It is pretty generally known that typical symptoms of the early stages of a master rod bearing failure are high oil temperature and low oil pressure, these two abnormal indications starting early in the failure and becoming continually more pronounced as the failure progresses. The explanation for these typical symptoms is simple and direct.

As the bearing failure commences the clearance between the bearing surface and the crank pin journal increases rapidly thus permitting a much greater rate of oil flow through the engine. Since the oil pumping capacity of most engines is not far above the value required for normal conditions in the engine, this increased oil flow will rapidly be indicated by a drop in oil pressure. Inasmuch as the heat rejected to the oil is largely a function of the oil circulation, the greater the flow the greater the amount of heat the oil will absorb. If the oil cooling capacity of the installation has only a slight margin above normal requirements the above condition will lead to a rapid increase in oil temperature.

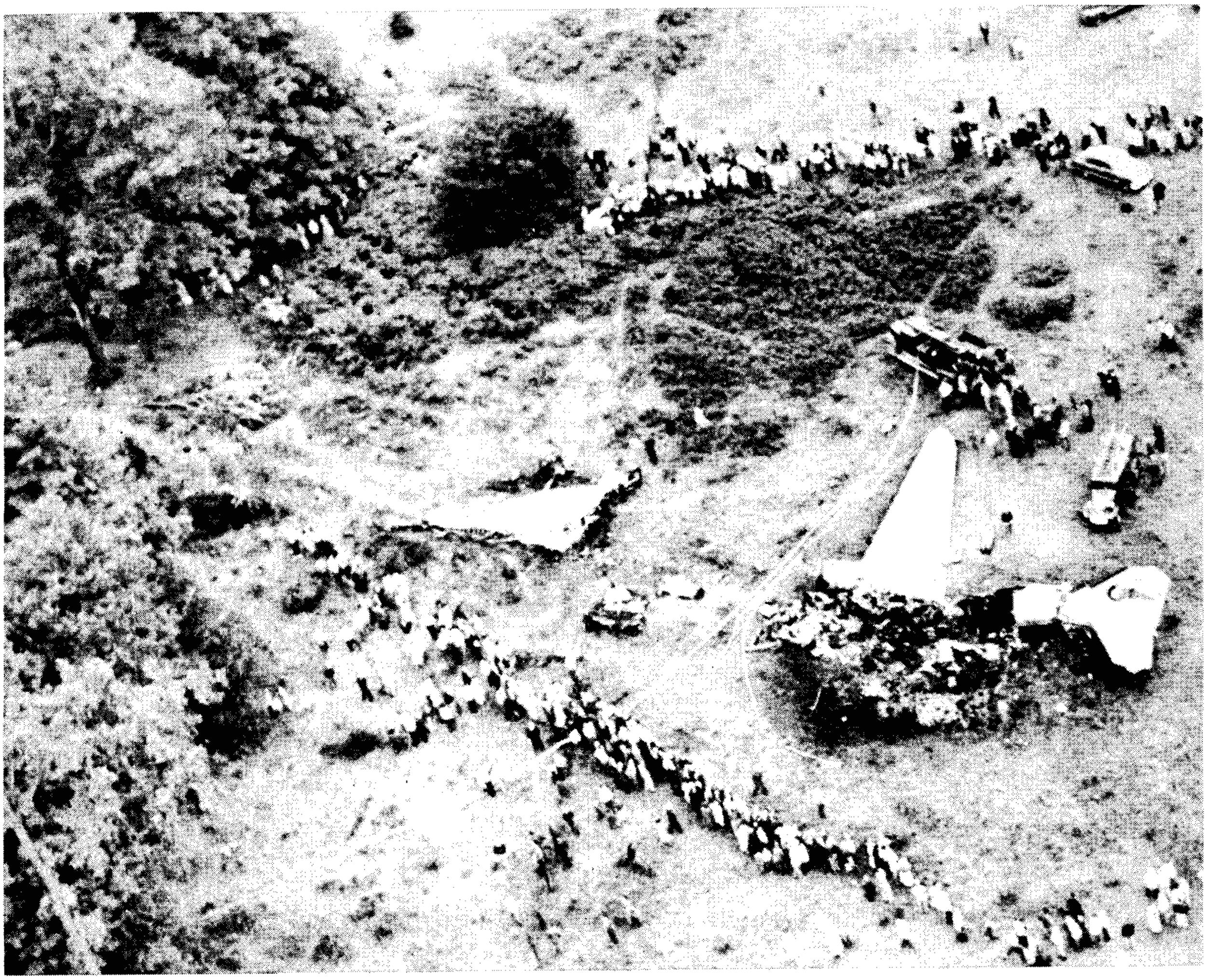
In the CI8BD series engine the manufacturer has finally developed an installation with extremely generous oil pumping capacity and oil cooling capacity. This design feature naturally eliminates many oil temperature and pressure problems resulting from marginal installations. However, by applying the reasoning in the preceding paragraph it is evident that the earlier steps of a master rod bearing failure will not be nearly so marked in terms of decrease in oil pressure and increase in oil temperature as they will be in a more marginal design. Inasmuch as TWA and other operators have in recent months experienced a number of BD master rod bearing failures which were permitted to advance in flight to such a degree that the engines were badly mutilated, it seems desirable to remind all flight crews of the above facts and to urge their constant alertness to detect the first unmistakable signs of decreasing oil pressure and increasing oil temperature in these engines. When these symptoms are observed the engine should be feathered. A review of six such failures in TWA's and in other carriers' operation during the past few months shows that the failures all occurred during climb, that the symptoms were recognized for an average of 12 minutes before feathering took place, and that in every case considerable damage resulted to the power section of the engine, not to mention the attendant hazard of total destruction of the power plant before feathering was accomplished.

Because of the very marginal oil flow and cooling capacity of the BA engine plus the much greater experience of domestic flight crews with master rod bearing failures these precautions are not so specifically applicable to the BA engine. Experience has shown that a very marked drop in oil pressure and rise in oil temperature will always precede a master rod bearing failure and flight crews have generally responded promptly (with but a few isolated exceptions). Minor abnormalities in oil pressure and temperature on this engine may well be a direct result of the marginal design rather than an indication of bearing failure."

ICAO Ref: AR/136

No. 3

Robinson Airlines Corp., DC-3 aircraft N-18936, crashed 1-1/2 miles S.E. of Oneida Airport, Utica, New York, on 4 September 1950. CAB Accident Investigation Report No. 1-0106. Released 23 May 1951



Wide World Photo

Circumstances

Aircraft N-18936 took off from Oneida Airport, Utica, en route for Newark, New Jersey carrying 20 passengers and a crew of 3. Approximately

3,000 feet from take-off, parts were observed to fall from the left engine and the aircraft was seen to make a shallow turn to the left, slowly losing altitude until it struck a grove of trees 1,5 miles S.E. of the airport. Sixteen of the occupants were fatally injured and seven seriously injured. The aircraft was completely destroyed.

Investigation and Evidence

During the descent through the trees, the left wing separated from the fuselage, and the left engine broke free from its engine mount. The right wing and engine remained attached to the fuselage. The tail section separated at impact. Fuel from the ruptured centre section tanks spilled over the forward part of the fuselage and was probably ignited by severed electrical wiring in the radio compartment. Examination of the cockpit control quadrant revealed the left engine propeller control in the full high pitch position, and the right engine propeller control in the full high pitch position, both throttles fully forward, and both mixture controls in automatic rich. With the exception of the left engine and left engine cowling, there was no evidence of structural failure of any components of the aircraft's structure or remaining engine.

Examination of the left engine and propeller disclosed that the propeller was in the full feathered position, and that the entire engine cowling and No. 9 cylinder had separated and fallen from the engine during flight approximately 3,200 feet from the point of take-off. When disassembled it was found that the inside of the crank case main section was badly mutilated as a result of the movement of broken parts. The primary cause of the loss of power of the left engine was due to the cracking of the No. 1 piston pin. The failure occurred in the inside diameter and approximately midway longitudinally of the piston pin. The inside diameter of the pin was not case hardened or carburized and was, therefore, more susceptible to fatigue.[1] When the piston pin cracked, it began a rocking motion which imposed excessive loads on the master rod and piston pin bushing. The pin then separated from the master rod and broke into several pieces.

Following separation of the pin, the master rod began a whipping motion in the area of the Nos. 1, 2, and 9 cylinders which resulted in pushing

1) Since the accident, Robinson Airlines has installed carburized piston pins in all of its aircraft which will tend to prevent this type of failure.

the No. 9 cylinder away from the crank case which broke the engine cowling retaining cables. As a result, the No. 9 cylinder and engine cowling separated completely from the engine. The most reasonable explanation as to why the aircraft did not maintain single engine flight, and lost altitude, is that the right engine was not developing the rated take-off horsepower because the propeller was set in the high pitch position. No evidence is available as to when or why the right propeller was set in the high pitch position, but conceivably it could have been done inadvertently at the time of the emergency and the condition not recognized in time to take the necessary corrective action.

Probable Cause

The probable cause of the accident was the failure of the left engine shortly after take-off, coupled with increased drag due to loss of the left engine cowling, and reduced power output of the right engine resulting from the high pitch position of the right propeller.

Fire Aspect of Accident

The Westmoreland Fire Dept., (2 miles away) was despatched to the scene and arrived within 4 or 5 minutes with their one 500 GPM pumper. The only water available was the truck's booster tank and a well about 1/2 mile away. They could do little toward extinguishing the advanced fire and upon their arrival all occupants who might have escaped had done so. The airport did not have major emergency aircraft fire-fighting equipment available. (Extract from NFPA, Special Aircraft Bulletin, Series 1951, No. 7)

ICAO Ref: AR/135

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No. 4

Eastern Air Lines: Lockheed Constellation (749A-79) aircraft N-104A, landing gear failure at Imeson Airport, Jacksonville, Florida, on 10 October 1950. CAB Accident Investigation Report, No. 1-0144. Released 17 July 1951

Circumstances

The aircraft was en route from Miami, Florida to Newark, New Jersey, via Jacksonville, Florida, carrying 23 passengers and a crew of 3. On final approach to land at Imeson Airport, Jacksonville, the landing gear was extended but the landing gear warning lights in the cockpit indicated that the left main landing gear was not in the down and locked position. Accordingly, the approach was discontinued and the landing gear retracted.

Circling east of the airport the landing gear was again extended but the warning lights still indicated that the left main landing gear was not in the locked position. The aircraft was then flown at a low altitude past the control tower, at which time it appeared to the tower personnel that both landing gears were fully extended.

Since the warning lights in the cockpit still indicated that the left main landing gear was not locked down, an attempt was made to extend the gear by the use of the emergency hydraulic system. The landing gear lever was placed in the down position and the hydraulic hand pump selector to the gear position. The hand pump was then actuated for approximately three to five minutes and then abandoned since no pressure resistance was felt on the pump handle.

The aircraft made a second low flight past the tower, at which time a company mechanic advised that both landing gears appeared to be fully extended. The warning lights still indicated that the landing gear was not locked down but since darkness was approaching it was decided to land immediately.

A normal approach was made and the landing accomplished on the right side of the runway. Immediately following landing, the left main gear was observed to slowly retract and the aircraft swerved to the left coming to rest some 3,600 feet from the approach end and 50 feet to the left of the 7,200 feet runway. There were no casualities.

Investigation and Evidence

The aircraft came to a stop resting on the left wing flaps, the No. 1 engine nacelle, the nose landing gear, the aft under section of the fuselage, and the left lower fin and rudder.

The right main landing gear was under the right wing having sheared off at the securing fulcrum fitting just below the attachment lug, following retraction of the left main landing gear. There was no evidence of any malfunctioning or failure to the right main landing gear prior to the landing. The left main landing gear was undamaged and in the retracted position in the wheel well.

The left wing sustained minor damage confined to the wing flaps and wing tip. Damage to the empennage was minor, consisting of distortion and wrinkling of the under surfaces. The right wing sustained substantial damage, having ruptured inboard of and adjacent to No. 3 engine nacelle, when the right main landing gear failed in a rearward, inboard and upward direction. All engines and propellers were intact although the propeller blades were bent rearward. The nose gear was intact and in the down and locked position.

Examination of the left main landing gear mechanism disclosed that the down lock down line had failed at its point of attachment to the down lock release cylinder which allowed hydraulic fluid to escape, and resulted in a loss of secondary hydraulic system pressure and fluid. Because of this, it was impossible to lock the left main landing gear in the down position by secondary hydraulic system pressure.

The down lock down line and its fittings were removed from the aircraft for further examination. The line was 52S aluminum alloy[1] approximately 20 inches long, with single flares at each end fitted with coupling nuts and sleeves. When the line failed at the down lock release cylinder, it slid through the sleeve leaving the coupling nut and sleeve still attached to the cylinder. The separation occurred at the outer lip of the flare approximately 3/64 of an inch from the end of the tubing. The outer lip of the flare was found inside the coupling nut and when the line separated the sleeve lost its grip on the tube and hydraulic pressure pushed the tubing through the sleeve.

It was evident from the markings on the line that the sleeve had cut through the flared end of the tube, due to excessive torquing of the coupling nut. Eastern Air lines had not established a torque value for this coupling nut, although the manufacturer had specified a torque value and recommended that a torque wrench be used for its installation.

Functional tests of the hydraulic system revealed that although the left main landing gear would not lock in the down position by the secondary hydraulic system pressure, it would fully extend and lock when the emergency hydraulic system was operated. It required 181 cycles of the hydraulic hand pump before the gear locked in the down position, and it was only on the last 8 strokes that there was back pressure on the hydraulic hand pump. The initial lack of back pressure is normal until the main landing gear actuating cylinders have been filled with hydraulic fluid, and to fill these cylinders it takes practically all of the required strokes of the hand pump.

The CAA Approved Airplane Operating Manual (a copy of which was in the aircraft) states that about 245 full strokes are required over 2-1/2-3 minutes to extend and lock all gears.

The Eastern Airlines Flight Engineers Manual, the only company manual carried, states that main struts will drop of their own weight with assistance of air drag after pressure from hand pump has unlocked the uplatches. Nose strut must be pumped down against the air drag, requiring about 245 full strokes of pump lever during approximately 2-1/2 minutes.

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1) As a result of this accident the carrier has replaced all 52S lines with lines made of Everdur, which having higher strength, are capable of withstanding without failure, repeated torquing at maximum service value without the use of torque wrenches.

In the Flight Engineers Manual, there is an inference not contained in the Aircraft Operating Manual, that the main gear will fall and lock in the down position. However, it was determined that while the main landing gear will drop of its own weight when the up locks have been released, it will not always lock in the down position. Furthermore, a full stroke was not defined in either manual, that is, whether it is a cycle or a half cycle. The captain described it as a full stroke in one direction, the first officer interpreting it as a cycle.

No attempt was made by the crew to check the normal operation of the hand pump, which could have been done by placing the emergency selector valve to the brake position and operating the hand pump. This would have indicated that the pump was operating, and that fluid was in the emergency tank. Furthermore, neither of the crew members observed the fluid level in the emergency tank when the hand pump was being operated. If the emergency system had been functioning normally, the fluid level in the emergency tank would have dropped below the sight gauge. This lack of familiarity was due primarily to inadequate training.[1)]

Probable Cause

The probable cause of the accident was the unsuccessful attempt of the crew to lock the landing gear manually, due to lack of training in the operation of the emergency hydraulic system.

1) Since the accident, the company has distributed to all its flight crews specific information on the hydraulic system of the Constellation type aircraft, with particular emphasis on the operation of the emergency hydraulic system. The company has also made it mandatory that each Constellation crew physically extend the landing gear with the emergency system. Moreover, the company has made it mandatory that during each six-month check every Lockhead Constellation crew perform a manual extension of the landing gear by the use of the emergency system. In addition to the co-pilot performing this function on each six-month check, it is required that the captain move to the co-pilot's seat and go through the procedure also.

ICAO Ref: AR/143

No. 5

British European Airways Corp., Dakota aircraft G-AGIW, crashed at Marsh Lane, London on 17 October 1950, MCA Civil Aircraft Accident Report MCAP 93.

Circumstances

Aircraft G-AGIW departed under IFR conditions from Northolt Airport en route for Renfrew Airport, Glasgow, carrying 24 passengers and a crew of 5 (one supernumerary). Engine trouble was encountered almost immediately after take-off and two minutes later the starboard engine was stopped and the propeller feathered. The aircraft unable to gain or even maintain height, struck some beech trees, dived almost vertically into the ground, bounced forward, turned over and caught fire. All occupants save the steward lost their lives. The aircraft was destroyed.

Investigation and Evidence

At the time the aircraft took-off from Northolt Airport, Instrument Flight Rules were in force and the meteorological conditions were: wind-10/11 knots (240-260); visibility-about 2,000 yards; weather-drizzle; cloud-8/8 ths. at 400 feet.

It was established that at take-off the left-hand or Captain's seat was occupied by the First Officer, and the right-hand or 1st Officer's seat by the Captain. Nothing suggests that there was an exchange of these positions during flight. It was ascertained that the duties of the two pilots as laid down in the prescribed drills and procedures follow the seat and not the man. That is to say the occupant of the left-hand seat "flies the aircraft" and carries out all the actions allocated in the drills to the Captain, while his neighbour, even though he be the Captain of the aircraft, carries out those allocated to the First Officer. Nevertheless, the Captain still remains in command and even when occupying the right-hand seat is responsible for seeing that the occupant of the left-hand seat carries out the drills for the seat and generally flies the aircraft in a proper manner.[1)]

Those on the ground at the airport itself, barely saw the aircraft take-off owing to the bad surface visibility, and no witness or documentary record speaks of the undercarriage having been raised. It is believed, however, that the undercarriage was raised at the normal moment since the aircraft gained 400' to 500' in height in what would be the expected time for a Dakota following the usual procedures. An emergency must, however, have arisen while the undercarriage was being raised, resulting in the starboard engine being stopped. Presumably at this stage, action was taken to lower the undercarriage with the intention of completing a left-hand circuit and making an immediate visual landing on runway 26. Thereafter either because sight of the airport was lost or because it was preferred to rely on GCA, the full left-hand circuit was never made, the aircraft continuing to fly in the downwind direction.

It is considered that in view of the emergency which had presented itself and the uncertainty as to whether it would be better to maintain a continuous visual look-out or to rely on instruments and ground aids, both pilots forgot the position of the undercarriage and made no effort to retract it a second time.

The Captain notified the Aerodrome Control Officer by R/T of the stopping of his starboard engine, and to quote the written record in the log "Request immediate landing and GCA assistance we are downwind on runway 26." Shortly afterwards the aircraft announced it was on a course of 060° and fixed its position as over Harrow-on-the-Hill Church Steeple. Immediately afterwards, the aircraft was picked up on the GCA screen and told to continue on 060°. The last message received from the aircraft was the acknowledgment of that instruction. Shortly afterwards the GCA Director asked the aircraft for its altitude and a little later called for a turn to the right on to 260°, which order was several times repeated, but within about a minute of the first order to turn right, the aircraft disappeared from the GCA Director's vision and soon thereafter crashed.

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1) The Court recommended that close study should be given by all concerned with safety in flight, to the problem of establishing a code of discipline so drafted and so enforced as to eliminate any possibility of uncertainty as to who is to take executive decisions in emergency.

It is believed that with the undercarriage down, the aircraft flying on one engine could not gain and would hardly maintain height. In all probability the pilots, sensing an increasing sluggishness, felt that initiation of a turn off the course to which they had committed themselves and to which they had been told from the ground to adhere, would lead to complete loss of control, accordingly the aircraft continued on the same heading until just prior to the crash when for some unexplained reason it was observed to turn right.

There were no witnesses to the crash but a careful examination of the debris in the general area of the accident shows that the port wing struck some beech trees at a height of 46 feet above the ground, and was torn away just outboard of the engine nacelle, coming to rest on the roof of a building. The aircraft then dived vertically into the ground, and after bouncing forward turned over onto its back and was almost immediately afterwards largely consumed by fire. It was not found possible to time the messages which passed between the aircraft and the airport owing to defects in the monitoring and recording systems in use at the time, and to the omission or unreliability of times against many of the messages recorded in the Radio Officer's Log. Evidence was received that it was the duty of BEA Captains to provide left-hand seat flying experience to First Officers while en route on services when conditions were suitable. Conditions would not be suitable when resort must be had to instrument flying almost immediately after take-off, as was the case in this instance. Evidence was given that in the six months preceding the accident the First Officer had completed 48 hours on Dakotas as second pilot, against 303 hours on Rapides as first pilot. His Air Transport Pilot's licence had expired on 12th October 1950 without the necessary steps to secure its renewas having been taken, although it was his duty and responsibility to take such steps. On September 1950 he was subjected to a BEA check described by the examining officer as an instrument rating check of the same standard but larger in scope than the check called for by the Statutory Regulations.[1)]

1) The Court recommended that a review be made of training arrangements so as to free the curriculum from complications or limitations arising out of presence of passengers. It was observed that the First Officer's last single-engine landing was in December 1949, it being stated that at "the 1st check he did he was unable to do any single engine flying because it was all done in passenger aircraft." At the same time it was asserted that an engine failure on take-off and a single-engined landing ought according to BEA's training syllabus to be practised twice a year, and it is, of course, obvious that asymmetric power tests cannot be undertaken during passenger flights.

By his employers standards, the First Officer failed to pass this test.[1] In view of the First Officer's failure, the examining officer recommended that he be given further instrument training on the Link, and that he should memorize his drills and procedures before being re-examined in two or three weeks time. In actual fact, owing to the incidence of the Link Training Officer's period of leave, the First Officer never had the recommended training nor was he ever re-examined.

The fact that in the left-hand seat was a pilot, the greater part of whose recent experience with BEA was on "Rapide" aircraft which have non-retractable undercarriages, and whose mastery of the drills and procedures appropriate to Dakotas had recently been questioned, may well explain why the undercarriage was not managed as would ordinarily be expected. The condition of the starboard propeller showed that it was not rotating at the time of the crash, indicating that it had been feathered. The blades of the port propeller were distorted towards the tips and spiral score marks on its dome indicated that it was rotating when it struck the ground. Inspection of the undercarriage indicated that it was locked down at the moment of the crash.

Examination of the port engine failed to reveal any failure or malfunctioning with the exception of the sparking plugs. The amount and extent of the lead deposits found on the insulators indicated that they were not new when fitted and that the only cleaning process to which they had been subjected was a process of sandblasting in the assembled state, which had not removed the deposit from the insulators except at the tip. The deposits on the insulators had glazed indicating that they had been running at a sufficient temperature to fuse. Erosion of the electrodes as a result of excessive sand blasting was observed on some of the plugs, in some cases to such an extent as to render them unfit for further service. Up to six plugs were not gas-tight at the gland.

1) Extract from original report: "The Court recommended that severely practical notice should be taken of failures in any sort of check or test to which pilots are subjected by their own employers. That an operator should impose tests over and above the requirements of statutory authority postulates a jealousy on his part for the maintenance of standards of his own and is to be commended. But if those superior standards are realistically and effectively to be safeguarded and the commendation justly earned, an operator must not hesitate to suspend and relegate to a further course of training any officer who fails in such a test, notwithstanding that the officer's qualifications in terms of the requirements of the general law is unimpeached."

Evidence submitted on the condition of the sparking plugs from the port engine, indicated that at some time they had been running hot enought to cause fusion of the deposits. While such deposits remain molten the insulation resistance in the plugs affected would "fall like a stone", placing on the magneto involved an intolerable load and so leading to a misfire or misfires. The cooling of any given cylinder consequent upon a series of misfires would permit the molten deposit on the insulators to re-solidify, thereby restoring the insulation resistance thus permitting the plug to fire. The result of such a cycle of fusing and re-solidifying might cause irregular running of the engine with consequent loss of power.[1] Examination of the starboard engine showed unequivocally that the front and rear master rod bearing had failed. It is likely that the rear bearing (nearest to oil feed) failed first and that the front bearing, thereby starved of its proper lubrication, rapidly followed. An exhaustive metallurgical study of the bearings could only describe the probable sequence of the breakdown without pointing to a cause.

Examination of the passenger compartment revealed that all the forward facing passenger seats, stressed to withstand a deceleration in the line of flight of 6g, had either torn away from their fastenings to the floor, or had torn parts of the floor away with them and had been thrown into the fore-end of the compartment in a confused heap of twisted metal.[2]

Probable Cause

The accident cannot be ascribed to any one cause. Its explanation must be sought for in a number of coincident factors none of which standing alone would have been sufficient to bring about the disaster.

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1) The Court recommended that a more satisfactory method of cleaning the type of plug used in this instance (i.e. a plug with a cylindrical, as distinct from a conical, insulator, and able readily to be "split") should be adopted.

2) The United Kingdom had already decided to recommend to ICAO the adoption of rearward-facing seats for passenger aircraft. A recommendation was added, however, that rearward-facing seats should be stressed to withstand the deceleration reasonably to be expected in an air crash. A further recommendation was made for the immediate start towards educating the public to such an innovation as rearward-facing seats by the use of suitable advertising media.

The first and preponderant cause among those which contributed to the accident was the failure of the master rod bearings of the starboard engine. This failure could not have been foreseen or guarded against by any greater exercise of vigilance that could reasonably have been required of the operators and their staff.

The secondary causes are harder to assess and evaluate. Among them are or may be:-

a) The failure of pilots to make an immediate visual landing upon realizing that they must stop the starboard engine.

b) The failure of the pilots to make use of SBA [although equipment was carried in the aircraft. SBA would not have been subject in this instance to the disadvantages of GCA ("presence of a mass of permanent echoes which obscure on the visual display returns from aircraft within the irregularity bounded area of sky covered by those echoes[1]")].

c) The failure of the pilots, having elected to make use of GCA, to retract the undercarriage while flying away from the airport over the distance necessary to bring their aircraft under the effective control of GCA and thereafter.

d) The glazing of the lead deposits on the sparking plugs of the port engine while under conditions of high power-output leading to ignition trouble and so to a loss of power sufficient to destroy the ability of the aircraft to maintain level flight.

e) The necessity for taking drastic action with the controls to avoid the steeple of Harrow-on-the-Hill Church, and the high ground beyond, at a time when there was but a marginal reserve of power for maintaining level flight.

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1) The effect of this is that at all practicable heights an aircraft cannot be picked up by GCA until it is between four and five miles away from the scanner.

ICAO Ref: AR/137

No. 6

British European Airways Corp., Viking Aircraft G-AHPN, struck runway at London Airport during Fog on 31 October 1950.
MCA Civil Aircraft Accident Report, MCAP 95

Circumstances

The aircraft en route from Le Bourget, Paris, to Northolt, London, carrying 26 passengers and a crew of 4, encountered adverse weather conditions and diverted to London Airport, where an approach-to-land was made under GCA. Shortly after completing the GCA approach to break-off point, the pilot announced that he intended to overshoot. Five seconds later the aircraft struck the runway and crashed, resulting in the destruction of the aircraft and the death of 28 occupants.

Investigation and Evidence

Before departure from Le Bourget, the Captain was informed of the weather conditions prevailing in the London Area, and was given the following landing forecasts which had been broadcast at 1721 and 1718 hours respectively:

> Northolt (1800 - 2400 hrs.) Visibility 1,100 yds.; smoke haze cloud 8/8ths at 600 ft.; risk at 2000 hrs. of 440 yds. visibility in fog with sky invisible and cloud 8/8th at 400 ft.
>
> London Airport (1800 - 2400 hrs.) As for Northolt except that the item in regard to cloud was "no cloud".

The aircraft departed from Le Bourget at 1839 hours with endurance of 4-3/4 hours for an estimated flight of 1 hour 24 minutes. On the flight plan London Airport, Blackbushe, Cormeilles and Orly, were designated as the alternates to Northolt Airport.

At 1925 hours, the aircraft reported to Air Traffic Control Centre, Uxbridge, as flying at 4,500 feet with E.T.A. Gravesend beacon 1938 hours.

Immediately afterwards the Uxbridge Controller instructed the aircraft to maintain altitude at 4,500 feet and stated that the meteorological observations for Northold at 1914 hours were: visibility 50 yds., surface wind - calm, sky obscured - fog. In acknowledging this, the Captain said that he would proceed to London Airport or Blackbushe and requested clearance to London Airport via Gravesend, which was granted.

At 1928 hours Uxbridge informed the aircraft that visibility at London Airport at 1920 hours was 40 yds. and at Blackbushe at 1925 hours, 1,000 yds. The Captain acknowledged this message and said he would continue to London Airport and if it was not possible to land he would advise diversion to Blackbushe and if that was not possible, to Hurn. At 1930 he was given the visibility at 1925 hours at Hurn as 1,000 yds.

At 1932, ATC Uxbridge gave the aircraft permission to enter the London Control Zone at Gravesend Beacon at 4,000feet altitude. At 1936 Uxbridge reported visibility to the aircraft as follows: Blackbushe at 1934 - 1,000 yds.; London Airport at 1935 - 40 yds.; Hurn at 1932 - 500 yds. The Captain replied asking for the latest available meteorological observation at Manston. At 1939 he was informed that visibility at Manston at 1930 hours was 1,500 yds., to which he replied that if it was not possible to land at Blackbushe or London he would divert to Manston. This was acknowledged and he was instructed to establish communication with London Approach Control.

It is to be observed that at this stage the aircraft was quite close both to Blackbushe and Manston, and that the reported visibility at both was ample for safety, whereas the Captain had twice been told in the last 11 minutes that at London Airport visibility was down to 40 yds., which (as will clearly appear later) was much below any minima in which it was permissible for him to land. At 1940 the pilot told London Approach Control that he was approaching Gravesend at 4,000 feet and was diverting to London Airport. He was given London's weather in these terms "The surface wind is calm, the visibility is 40 yards, the runway visibility is 50 yards, thick fog, sky obscured, the runway in use is 28". The Captain at 1941 reported over Gravesend at 4,000 feet and London Approach Control said that they understood the pilot would have a look at London and then Blackbushe and Manston. At 1942 London Approach Control told the pilot he was cleared for the field, to maintain 4,000 feet and stand by for the London Director (Director of the GCA System, London Airport).

The London Director asked whether the pilot wished to carry out a ground controlled approach. He replied that he did. The aircraft was accordingly identified and told that it was clear to descend to 1,500 feet and that this would be a straight-in approach for a landing on runway 28.[1] The approach continued in a normal way. The pilot was reminded that the break-off height for runway 28, was 140 feet.[2] He asked whether the Calvert lighting (system of lights along approach path) was switched on and was informed that all the lighting was on 100 per cent. At 1949 the aircraft was transferred to the talk-down controller. At 1951 with 6 miles to go, the pilot was told he was on the glide path, that his heading was good, that the visibility was now 30 yards with no lights (runway lights) visible. At 1953 with 1-1/2 mile to go, he was again reminded "visual check" (by which he would have understood "break-off point") was at 140 feet. Later he was told that he was 400 yards from the end of the runway.

At London Airport break-off point, 140 feet, and 400 yards from the runway for all practical purposes coincide, thus when the Captain was told he was 400 yards from the end of the runway, he was then at break-off point. After reaching break-off point the aircraft was observed in the radar scopes to start to rise above the glide path which was taken to indicate that the pilot intended to overshoot and was beginning to do so. Accordingly the controller did not give the usual final instructions "look ahead for landing". It cannot be said that this omission contributed to the accident, but it would have been better to have given it.[3]

At 1954 hours the pilot said that he was overshooting. Up to that moment the talk-down controller had been speaking, giving the usual guidance afforded to pilots carrying out overshoot procedure, but it is impossible to say with certainty when overshoot action actually began. A few seconds later with undercarriage retracted, the aircraft struck the runway, skidded 140 feet damaging its propellers, became airborne again and came down about 3000 feet further on. The aircraft's starboard wing was torn off as the aircraft skidded across the runway and across a disused runway, coming to rest alongside a pile of drain-pipes where it burst into flames. The fog at the moment of the accident was so dense that the crash was heard but not seen and the fire engines, though ready, took five to ten minutes to find and reach the scene.

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1) The aircraft is brought down in a descent, in this case, at an angle of 3 degrees, to a point 400 yards from the threshold of the runway known as the break-off point.

2) Break-off point represents a height predetermined for the particular airport, here 140 feet, beyond which the aircraft ought not to approach unless the pilot can complete the approach and landing by visual means.

3) Arrangements brought into force since the inquiry ensure that the pilot will in future be left in no doubt that the talk-down has finished.

It is considered that this accident would have been avoided if the pilot had not brought his aircraft down as low as he did in spite of the information several times supplied to him that the meteorological visibility, as measured on the ground was as low as 40 or 50 yards. It is further considered that such an accident is unlikely to occur again if it is made an offence for a pilot to come down so low when visibility reported from the ground is considerably lower than the prescribed minimum.

Nevertheless to conclude that the accident would not have happened if the pilot had not come down so low in such conditions, is a very different thing from deciding that the pilot was in breach of regulations or instructions in taking the course he did; nor does it necessarily follow that he was imprudent in so doing.

The only relevant statutory requirements[1)] in force in October 1950, state that:

> "The aircraft shall not, unless compelled by accident or other unavoidable cause, continue its approach to landing at any aerodrome beyond a point at which the limits of the aerodrome meteorological minima for landing at that aerodrome as specified in the said manual[2)] .... would be infringed." ("Aerodrome meteorological minima" means minimum heights of cloud and minimum values of visibility defined for the purposes of determining the usability of an aerodrome either for take-off or landing).

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1) The Court of Inquiry recommended that the statutory requirements be amended so as to prohibit an aircraft from continuing its approach to land at an aerodrome in circumstances in which the weather reported from the ground is below the operator's minima by a certain percentage (this does not rule out fixing a minimum height and minimum runway visibility, or runway visual range without reference to percentages if that is more convenient). It was suggested that something of the order of 70 per cent would be reasonable and effective.

2) The manual referred to is the Operator's Manual provided by the operator, in this case BEA, for the use and guidance of the members of the operating crew.

In the BEA Manual [1], the minimum height of cloud base specified for London Airport was 200 feet and the minimum visibility 600 yards. The effect, therefore of the statutory requirements was that the aircraft should not continue its approach to land at London Airport beyond a point at which these limits for landing at that aerodrome would be infringed.

Several questions were debated at the inquiry on the construction of the statutory requirements. It was urged on the one hand that an approach to land does not begin until break-off height is reached, and on the other hand that an approach to land begins at least as soon as the aircraft begins its last straight down approach, some 8 - 11 miles away from the point of touch down. It was agreed that the latter is the true view.

Next it was contended that there could be no infringement of the minima unless there was an actual landing and that the pilot was in any case entitled under the regulation to come down to break-off height. In respect of this it was decided that if the pilot went down below 200 feet without breaking cloud, he would be infringing the cloud base minimum. Equally if he went on flying at any point below 200 feet with a visibility of less than 600 yards he would be infringing the visibility minimum.

An additional question was debated, namely, whether the aerodrome meteorological minima in relation to values of visibility, meant visibility measured on the ground by the Meteorological Officers there, or the visibility of the pilot from his cockpit sometimes referred to in the inquiry as "slant visibility". It was agreed that the minima referred to in the regulation are minima as measured from the cockpit and not on the ground.

A further complication stemmed from the fact that the BEA Operator's Manual did not impose the specified minima as absolute or unqualified minima. The instructions in the manual contained a provision which permitted interpretation or "interpolation". Weather minima for airports, it was said, had been laid down as a combination of cloud height and visibility which, when considered together, form the limiting weather conditions. It was accordingly provided that the Captain should assess the existing conditions as given by the combination of the two factors and decide whether the differences produced better or worse conditions. He was in effect entitled to treat a case

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1) The Court of Inquiry recommended that clarity and simplicity should be introduced into those paragraphs of the Operator's Manual which specify the minima.

in which one factor was below the minimum but the other above as a case in which the combined conditions might not be regarded as worse than the limit laid down.[1)]

Yet another factor must be taken into account before deciding whether the pilot was in breach of the regulation. There was undoubtedly radiation fog on the ground at the time of the accident, extending up to 40 or 100 feet and may have reached up to 200 feet though this is doubtful. It is considered that fog cannot be equated with cloud for the purpose of ascertaining the cloud base minimum. It may well have been therefore, that when the pilot had come down to 200 feet he was clear of cloud and remained clear down to 140 feet when he reached break-off height, though there was fog below him. Accordingly though the descent from 200 to 140 feet may have involved a breach of the regulation, such a breach, if established, could hardly involve a reflection on the Captain since in coming down to break-off height he was not infringing the instructions of BEA as both he and they understood them. On the basis of the preceding paragraphs it cannot be said that the Captain was in breach of the relevant regulations, although it is considered that his coming down was pointless, imprudent and hazardous.

Probable Cause

Although it cannot be established with certainty, the probable explanation of the known facts may be that the Captain deliberately came down below break-off point and then, at 100 feet or less, came into fog which abruptly reduced the visibility of the runway lights and that then and not till then he started overshoot procedure with fatal results.

1) This provision has since been cancelled by BEA.

ICAO Ref: AR/152

No. 7

Northwest Airlines, Inc., Martin 202 aircraft, N93040 crashed 2-1/2 miles east of the Butte, Montana, Airport on 7 November 1950. CAB Accident Investigation Report No. 1-0125 Released 22 June 1951

Circumstances

The aircraft was en route from Helena, Montana, to Butte, Montana, carrying 17 passengers and a crew of four. The pilot failed to follow the carrier's prescribed No. 2 Instrument Approach procedure to the Butte Airport and the aircraft struck a mountain at about the 8,250 foot level. The aircraft was destroyed, and all the passengers and crew were killed.

Investigation and Evidence

The flight plan specified an altitude of 10,500 feet MSL under IFR via Amber Airway No. 2 to the Whitehall (Montana) Range Station and from there to the Butte Airport via Red Airway No. 2. Following take-off the aircraft was flown in a climbing right turn so that it passed approximately over the Helena Radio Range Station as it headed South towards the Whitehall Range Station. At 0814 the aircraft notified Butte that it was over Whitehall (Range Station) at 0811 and starting descent. Butte acknowledged this message, gave the flight the station altimeter setting of 29.27, advised that the wind was South, calm, and that the Weather Bureau advised that the ceiling was lower to the East and North and better to the South and Southwest. The aircraft replied that it had vertical visibility at 10,500 feet. This was the last radio contact with the flight.

It was determined that at approximately 0815 the aircraft struck the eastern slope of a ridge about 30 feet below its crest, at an altitude of about 8,250 feet MSL. Distribution and spread of the wreckage indicated that the aircraft struck while about level longitudinally. First impact was with trees with the left wing, followed by the nose section and right wing striking rimrock solidly. The angle of the propeller blades on both engines was found in the forward pitch position. It was determined by the evidence found that power was being developed by both engines at the time of impact with the ground. There was no indication of fire prior to impact. There was no evidence of structural failure or power interruption prior to the accident.

With regard to weather, a weak cold front extending across N.W.Montana was moving S.E. At the time of the accident this front had not passed Butte, although it had progressed further South both to the East and West of Butte. This front was not very active and precipitation was occurring mainly in the Helena-Butte area where air was being lifted over the mountains. The Captain was at all times kept fully informed of the weather situation. At the time the flight reported it was over Whitehall, the weather there was ceiling estimated 4,000, overcast, visibility 30 miles, wind W.S.W. 10, altimeter 29.96, storming in mountains on all quadrants.

The Northwest Airlines' flight manual prescribes the instrument approach procedure for landing at Butte. This procedure requires that an aircraft approaching Butte from the East shall pass over the Whitehall Range Station and then proceed out the west leg of the Whitehall Range on a course of 275 degrees magnetic and, while on this leg of the range, shall pass over and receive a signal from the Homestake Fan Marker which is 13 miles from the Whitehall Range. The fan marker shall be crossed at an altitude of 9,500 feet MSL and 140 mph IAS whereupon descent to the authorized minimum of 8,050 feet MSL may be started on the same course of 275 degrees magnetic for the Butte Airport. Exhaustive tests and check flights confirmed that both the Whitehall Radio Range and Homestake Fan Marker were functioning normally.

From the testimony of witnesses it would appear that the flight came southbound down the north leg of the Whitehall Range as it should have done and then turned right on approximately the correct heading for Butte while still some 3 miles short of the range station. If this theory is accepted, the flight nearly paralleled the west leg of the Whitehall Range and would definitely have passed appreciably to the North of where it would have received the visual signal of the Homestake Fan Marker. The aircraft may or may not, depending upon how the control was set, have received the aural indication of the fan marker. The direction of flight at the time of impact was estimated to be 309 degrees true or 290 degrees magnetic.

It is believed that the final few miles prior to the crash were flown visually under conditions of intermittent and alternating instrument and visual flight and appreciably to the right (north) side of both the west leg of the Whitehall Range leg and the Homestake Fan Marker and that the aircraft struck the ridge during a local snow storm.

The investigation concluded that the Captain demonstrated a lack of flight discipline by deviating from the prescribed instrument approach procedure to Butte; that had he followed such prescribed procedures the accident would not have occurred.

Probable Cause

The probable cause of this accident was the failure of the Captain to conduct the flight in accordance with the prescribed approach procedure.

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Note.- As a result of this and subsequent accident involving Northwest Airlines, the CAA took the following action:

1. Required higher ceiling and visibility minima[1] for Northwest Airlines' operations on both domestic and international routes.

2. Required the establishment of a concentrated pilot training program for all pilots.

3. Required a comprehensive inspection of all company aircraft.

4. Restricted operations to 225 miles for 4-engine aircraft, and 150 for 2-engine aircraft unless an airport having the higher weather minima was available within such distances.

5. Restricted flight schedules to allow sufficient time to accomplish necessary maintenance.

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1) It is the Administration's intention to alter the minimum downward as the operator demonstrates ability to complete the pilot training program and the aircraft inspection program.

ICAO Ref: AR/148

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No. 8

Monarch Air Service, C-46D aircraft, N-79982, crashed on take-off from Midway Airport, Chicago, Illinois, 4 January 1951. CAB Accident Investigation Report No. 1-0002. Released 22 October 1951.

Circumstances

The aircraft was cleared to proceed from Midway Airport, Chicago to Newark, N. J. carrying 45 passengers and a crew of 3. The Captain started his take-off by advancing the throttles to approximately 45 inches manifold pressure and 2,700 rpm after which the co-pilot further advanced the throttles to a manifold pressure of 47 inches. The aircraft became air borne aproximately half-way down the 5,730 ft. runway. At the Captain's command to raise the landing gear the co-pilot moved the handle into the retract position noticing simultaneously that the aircraft was turning to the left and that the air speed indicator was reading 85 mph. Seeing the left wing down and with but a few feet of altitude, the co-pilot realized an emergency existed and immediately applied emergency take-off power - 55 inches manifold pressure. The C-46 however, still turning, struck several small aircraft, a fence, a railroad embankment and came to rest beyond the embankment about 1-1/2 mile West of the airport on a heading of 250 degrees. A fire developed immediately but all passengers and crew were evacuated before it assumed major proportions. The aircraft was destroyed.

Investigation and Evidence

Detailed examination after the accident revealed no evidence of structural failure of any component of the aircraft prior to impact. A tear-down examination of both engines disclosed no evidence of mechanical malfunctioning or failure. Evidence indicated that the propellers were in low pitch. Maintenance records for the aircraft were reviewed and reflected that the aircraft was airworthy at the time of take-off.

It was determined that the total aircraft weight at the time of take-off was approximately 46,000 lbs. which was 1,100 lbs. in excess of the authorized gross weight. Investigation further revealed that the take-off was made using less than the recommended power which according to the CAA required Aeroplane Flight Manual, gives 52 inches and 2,700 rpm as the approved power settings for take-off. The co-pilot stated that the aircraft was airborne and that the landing gear was in the process of being retracted when the indicated air speed was approximately 85 mph. In this respect, it was established that the recommended break ground speed of this type of aircraft is 105 mph and the power-on stalling speed with flaps and gear up is 92 mph when the aircraft is loaded to its maximum authorized gross weight.

Probable Cause

The probable cause of this accident was loss of control of the aircraft due to faulty piloting technique and overloading of the aircraft.

ICAO Ref: AR/156

No. 9

Dove aircraft ZS-DDW disintegrated in the air above Ixopo, Natal on 12 January 1951.
Union of South Africa Aircraft Accident Report No. 3/51

Circumstances

At 1430 hours the aircraft with 10 passengers and a crew of 2 took off from Margate to fly to the Rand Airport, Germiston, via Ladysmith. The weather at the time of take-off was overcast with intermittent drizzle - cloud base about 1,000 feet above the airfield which is near sea level - wind southerly, strength 20 - 25 knots - the weather inland in the direction of flight appeared to be dark rain clouds. The pilot did not receive a meteorological report for the flight before take-off. On this particular flight a call-sign from the aircraft was received by the operator at Durban Airfield at 1444 hours, but the signal was weak and because of another aircraft in the circuit area, wireless contact was lost altogether.

At about 1450 hours, people on the ground near Ixopo saw pieces of aircraft fall from cloud. The aircraft had disintegrated in the air (on course and at a place 49 miles from Margate) and all the occupants were fatally injured.

Investigation and Evidence

The wreckage was distributed over an area of 1,200 yards long by 350 yards wide. Both engines and propellers, port mainplane, rear fuselage, tail planes and elevators had broken away in flight. The engines had broken under down and side loads, the port wing under upload and the empennage by twisting. No technical defects were found. The pilot had about 5900 hours total flying experience of which about 350 hours were on Dove aircraft. His record revealed a serious lack of recent blind flying practice. The aircraft was overloaded by 300 lbs. The pilot did not obtain a meteorological report for the flight before take-off. The flight was of a scheduled nature.

Probable Cause

The probable cause of the accident was:

Either:

a) i) Whilst flying in substantially level flight, but momentarily port wing down, the aircraft was subjected to a very severe gust. As a result the weakened engine mounting structure in the port wing gave way, the engine momentarily moving by its inertia towards the right (inwards) relative to the aircraft. It then swung over to the outside and in doing so the propeller cut into the port wing causing severe damage. This damage associated with the conditions at the time caused the wing to collapse.

ii) The aircraft whipped violently over to the left and downwards resulting in the almost immediate collapse of the tail structure and causing the starboard engine to come out. The propeller of this engine damaged the starboard wing during its motion away from the aircraft.

iii) The rear end of the fuselage broke away during the violent twisting motion resulting from the failure of the port wing.

Or:

b) Although there would appear to be no very fundamental arguments against the foregoing conception of the cause of the accident, certain members of the Board consider that it does not explain, without somewhat conjectural assumptions, the distribution of the aircraft parts as found on the ground. It also neglects evidence which tends to show that the aeroplane broke up during recovery from a dive. They consider it more probable that it did so, since it explains more naturally and directly the ground distribution of the aircraft parts. The effect of coming out of a dive would cause both engines to swing to starboard, and tend to cause the whole aircraft to do likewise. If, as a result of this as verified by its ground position, the starboard engine came out first, the effect of this would be that the starboard wing would rise sharply and the port wing correspondingly fall. Some of the port engine supports, being already fractured and weakened by the initial movement towards the starboard side, would then give way due to the weight of the engine now acting in a direction downwards and outwards along the now steeply dipping port wing. Any resulting impact between engine and wing, such as occurred, would accentuate the effect of the gyroscopic torque induced by dive recovery conditions, tending to cause the port wing to break away as it did.

ICAO Ref: AR/167

No. 10

National Airlines Inc., DC-4 aircraft, N-74685, crashed and burned following an overshot landing at Philadelphia International Airport, Philadelphia, Pennsylvania, on 14 January 1951, CAB Accident Investigation Report No. 1-0008 Released 26 October 1951

A survivor of a National Airlines plane wreck, at International Airport, Philadelphia, Pa., Jan. 14, clambers from the ditch seconds after the blazing plane came to a stop on a road adjoining the airport. Another person is dimly visible in the doorway of the plane's cabin as fire, fed by high-octane gasoline, spreads from the front of the ship. This picture was taken by an amateur photographer near the spot as the plane crashed. (Wide World Photo).

Circumstances

The aircraft was en route from Newark, New Jersey, to Philadelphia International Airport, Philadelphia, carrying 25 passengers and a crew of 3.

After touching down on the runway, at Philadelphia, the aircraft continued straight ahead, passed beyond the end of the runway, and crashed into a ditch at the east boundary of the airport. Fire immediately followed. Seven of the twenty-eight occupants did not evacuate the aircraft, and were fatally burned. The airport fire-fighting equipment was dispatched immediately to the scene, but efforts to extinguish the fire and rescue the remaining occupants were unsuccessful.

Investigation and Evidence

At 1354 the local weather communicated to the flight by Philadelphia Approach Control was: precipitation, ceiling 500 feet, sky obscured, visibility 1-1/4 mile, snow and smoke, wind south-southwest at two miles per hour. At 1408, the flight reported over the outer marker, inbound, and stated that it was at 1,600 feet and descending. A clearance was immediately issued to land on Runway 9, and the wind was given as south-southwest at three miles per hour. The flight was advised that the glide path was inoperative; that the frequency of the ILS localizer was 110.3 mc; that a 2,000-foot extension to the west end of the runway was under construction, and that braking action on Runway 9 was poor-to-fair. According to tower personnel this transmission was acknowledged. The crew, however, stated that they did not receive it.

On its approach past the middle marker to the airport, the aircraft was observed beneath the overcast, directly over the intersection of Runways 4/22 and 9/27, which is located approximately 1,200 feet east of the threshold of Runway 9. Thereafter, at 1413, it was seen to descend steeply, flare out for a landing in a normal manner, and float a considerable distance before making contact with the runway.

Investigation disclosed that the aircraft traveled a distance of 243 feet from the end of the runway before striking the ditch. During this portion of the ground roll it struck and damaged a flood-light attached to a concrete stanchion. When the aircraft struck the ditch a large portion of fence was torn down and the aircraft came to rest with its nose resting on an adjoining road. The rear section of the fuselage remained suspended with the sill of the main cabin door six to eight feet above the east bank of the ditch. Fire originated in the vicinity of the No. 2 and No. 3 engine nacelles and rapidly spread rearward, substantially destroying a large portion of the aircraft.

The nose wheel assembly was separated from its fastenings by the impact, and the nose gear strut was severed just above the fork. Both of the main landing gear struts were bent rearward and had pulled loose from their respective fittings on the main spar. The main landing gear wheels and brake assemblies were subsequently removed, tested and found capable of normal operation.

All four engines were badly damaged. The nacelle and a propeller blade of the No. 1 engine were damaged by contact with the flood-light. The blades of all propellers were bent rearward, and it was determined that little or no power was being developed at the time of impact. There was no evidence of mechanical malfunctioning of either the aircraft or engines prior to the accident.

Wheel marks showed that initial contact was made by the aircraft's main landing gear wheels 3,140 feet down the runway and that the nose wheel touched down 528 feet further on. The remaining distances of surfaced runway from these observed touch-down points were 2,140 and 1,612 feet respectively. There was evidence that the tires had slid in several places.

Information in the company's Operations Manual for DC-4's, a copy of which was on board the aircraft, indicate that the landing distance required to come to a full stop from a 50-foot height on a dry runway is 2,550 feet. Also, that under unsuitable runway conditions (wet, or icy, etc.) or with malfunctioning brakes, a total runway length of 4,250 feet is required. The Captain testified that only 1,550 feet is required to stop a DC-4 on a dry runway. The Douglas DC-4 Manual specifies 1,936 feet as the distance required to bring a DC-4 to a full stop from point of touchdown, when there is normal braking action and a dry paved surface is used. In the event of wet or slippery runways the distance required is stated as varying between 3,650 and 5,283 feet.

Runway 9/27 is 5,280 feet long and is the ILS runway. It is surfaced with a black tar-like composition, and a large portion of the east end is covered with fine gravel. At the time of the accident the runway was also covered with approximately 3/4 inch of wet snow. Two rows of high-intensity runway (Bartow) lights were on, and the selector switch was at the position of highest intensity. Portable green threshold lights with yellow cone-like bases, divided the main 5,280-foot runway from the 2,000-foot extension under construction at the approach end. A row of red neon approach lights extended westwards 1,500 feet from the threshold of Runway 9/27. The tower operator could but assume that these lights were on since they are activated by an automatic device. The flight crew stated that they did not see the approach lights.

The Captain stated that he did not receive the final radio transmission from the tower (advising that the glide path was inoperative, etc.). This was found difficult to understand since it was established (by means of automatic recorder in the tower) that it was transmitted as stated, and since all other messages to the flight were received and acknowledged.

The Captain further stated that he purposely made a normal but slightly high approach to avoid possible landing hazards, that he intended to land within the first third of the runway and that there were no obstructions to his vision. After touchdown he considered there was sufficient distance remaining within which to stop and therefore he did not attempt to go round again. As soon as the nose wheel made contact with the runway, he began applying brakes. Although there seemed to be adequate brake pressure there was apparently no effective brake action. When approximately 1,000 feet from the end of the runway the emergency air brakes were applied with no apparent retardation.

The crew said that an external fire and another between the pilot's compartment and the main cabin door started immediately after impact. The engine switches and electrical system switches, etc., were not turned off and the intercommunication system between the pilot's compartment and the main cabin was not used.

The pilot's experience as Captain on DC-4 aircraft was approximately 22 hours mostly gained in 1947. A review of the pilot training given to the Captain prior to the accident indicated that he received 24 hours of ground school training and passing grades on 6 hours and 30 minutes of DC-4 flight training. He was also given a company route check between Jacksonville and Newark by the assistant chief pilot the day before the accident and rated as satisfactory. As a consequence of this accident the company reviewed its training program with particular emphasis to emergency "pull up" procedures.

Probable Cause

The probable cause of this accident was the Captain's error in judgement in landing the aircraft too far down the slippery runway instead of executing a missed approach procedure.

Fire Aspect of Accident

The airport based fire unit responding, a specially designed FWD foam crash truck manned by four firemen, reached the proximity of the accident scene within one minute of the alarm, according to fire department estimates. Foam was applied through the 1-1/2 inch hose lines on the truck (no turret being available) as soon as the 500 E.P.M. fire pump could be activated through a power take-off from the vehicle engine (probably within 30 seconds additional time). This fire equipment response was as prompt as could be expected but the ditch prevented manoeuvring the 28,000 lbs. vehicle into the most advantageous position for rescue work. (Extract from NFPA, Special Aircraft Bulletin, Series 1951, No. 1).

ICAO Ref.: AR/157

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No. 11

ALITALIA, Savoie Marchetti, 95B aircraft, I-DALO, crashed 8 kilometres north of Civitavecchia, Italy on 17 January 1951

Circumstances

The aircraft departed from Le Bourget, Paris at 1016 hours en route for Ciampino, Rome, carrying 12 passengers and a crew of 5. At 1436 the aircraft reported that it was directly above the Civitavecchia beacon at an altitude of 6,500 feet. Immediately afterwards the aircraft was observed in flames and descending rapidly, following which it violently struck the ground. Four of the crew and nine passengers were killed outright (one of the surviving passengers died six days later) and the aircraft was destroyed.

Investigation and Evidence

Examination of the wreckage revealed that the left wing, the tip of which was first to strike the ground, was completely shattered, parts being found scattered over a 40 metre stretch of ground. The left wing tip which had broken off near the last rib was found intact but bearing numerous traces of electric discharges which had caused the metal to melt. Traces of molten metal were more evident near rib No. 56 on the two upper longitudinal plate-lightening discharges. Other minor traces of fusion were found on and near the upper plate opposite rib No. 58 and on part of the left wing aileron. The fabric covering of some pieces of the wing was burned.

Examination of the air-screws indicated that at the moment of impact the engines were running at reduced speed; no traces of fire were discernible on the engines. The right wing was completely destroyed by fire. The controls of engines 3 and 4 were in the "stop" position, but the levers for feathering the propellers did not appear to have been operated; the fuel switches for all four engines were approximately at the "wide-open" position, while those for the propellers were set at minimum pitch. No appreciable degree of magnetism was found present in the fuselage. The wire antenna was found still unwound.

Statements from survivors and the record of radio communications between the aircraft and Rome Area control confirm that the flight which was carried out partly IFR and partly VFR was normal until the time of the accident, except for a slight turbulence which half an hour prior to the accident had prompted the captain to order the passengers to fasten their belts. Following transmission of its last acknowledged message at 1436 hours the aircraft must have descended very rapidly with the urgent intention of finding a suitable place for an emergency landing.

Investigation revealed that following receipt of the aircraft's message at 1436 hours on frequency 122.1 Mc/s, ATC authorized the aircraft to change over to 118.1 Mc/s as the approach frequency of 119.1 Mc/s was not reliable. Immediately thereafter the aircraft attempted to establish R/T contact with Ciampino control tower on 118.1 Mc/s but the call was scarcely audible. At or about the same moment the aircraft called Area control twice on 122.1 Mc/s, however, Area control failed to establish contact and, therefore, concluded that the aircraft's radio had failed. This assumption on the part of Area control was strengthened by the fact that the aircraft failed to reply to the numerous calls initiated by Area control, Approach control, the Tower and DF services. It appears logical to assume that the last two calls from the aircraft were not routine calls but were prompted by the necessity of reporting the occurrence of trouble on board. The fact that no further contact with the aircraft was established following these two last calls leads one to believe that the trouble experienced by the aircraft had rendered the radio unserviceable.

A study of the weather situation prevailing at the time of the accident revealed that the area in which the accident occurred was experiencing a pre-frontal edge of a cold occlusion of moderate intensity which was moving in an easterly direction. Freezing level was at approximately 1,200 metres, the wind direction was south with speed 14 knots. At 1,400 hours weather reports indicated a total cloud amount of 8/8 stratocumulus in the area, with low cloud 6/8 - 8/8 stratocumulus, fractocumulus and nimbostratus, the base of low cloud varying between 450 and 750 metres. At this time there was light or moderate rain present. One hour later the cloud amount was 8/8 with the base of low cloud down to 450 - 600 metres with rain continuing to fall.

In view of the rapid change which takes place in cloud amount with this type of weather situation it was not found possible to accurately determine the number and thickness of layers of cloud which were present in the area at the time of the accident. It is reasonable, however, to assume that there were several cloud layers in the area; that the base of the first layer fluctuated between 450 and 750 metres with top from 1,500 - 1,600 metres;

that the base of a second layer was about 2,000 metres with top from 3,000 - 3,200 metres and that this second layer at times merged with the first. Visibility at the time of the accident was between 500 and 1,000 metres. In addition, the steward stated that the aircraft was flying through hail 15 minutes prior to the accident.

It was determined from evidence and from statements made by survivors and ground witnesses that the crash must have occurred at 1440 hours and that prior to the crash the aircraft was on fire. Furthermore, in view of the wooden construction of the wings it was decided that the outbreak of fire could not have taken place more than three or four minutes before the aircraft struck the ground. A violent electrical discharge in the area is known to have taken place some three or four minutes prior to the crash. Traces of this electrical discharge were found on the railroad tracks about 1½ kilometres from the scene of the accident and on the wing of the aircraft itself.

From the evidence available it would appear that the following sequence of events took place: a sudden occurrence of fire between the two port engines followed by intense flames; explosion and bursting of part of the plywood covering; breakdown of radio communications; change in engine speed; rapid descent for an emergency landing; execution of a heavy bank to the left and finally impact with the ground.

In all probability the electrical discharge in the atmosphere either directly set the aircraft on fire when passing through it, or indirectly originated the fire by producing a strong inductive charge with consequent discharges or sparks. With regard to the explosion of the wing covering and subsequent conflagration either of the following two explanations are possible:

1) The occurrence of an electrical discharge between two cloud layers or between clouds and the ground when passing through the wing of the aircraft ignited and exploded a mixture of air and petrol fumes inside the wing sections or in a fuel tank.

2) Ignition of a mixture of air and petrol fumes in one of the wing sections produced by a spark originating near a break in the bonding system resulting from heavy electrostatic voltages.

In respect of the second explanation mentioned above it was noted that following previous cases of electrical discharges to aircraft of the same type (four cases had previously been recorded), the "Registro Italiano

Aeronautico" took measures to improve the bonding generally and the outer lightning protective frame in particular. Following a similar type of accident which occurred to the subject aircraft on 17 May 1949 (part of the plywood covering of the right wing tip was blown off), the duraluminum outer frames of the wings were replaced by ones of copper extended to the edges of the wings, to provide greater conductivity and to facilitate welding. This lightning protective frame was in good order when last inspected on 19 December 1950. No evidence of fused metal was observed on the frame conductors, and of the many copper strips recovered only those near the tips of the wings showed signs of molten metal. In view of the foregoing and since it was extremely difficult to check whether there was any break in the bonding or not, the possibility that there may have been some gap in the lightning protective system which in itself would explain the origin of the sparks and fire cannot be excluded.

Probable Cause

The probable cause of the accident was fire in flight, due to lightning striking the wing frame of the aircraft and igniting a mixture of air and petrol fumes in one of the wing panels or fuel tanks.

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Note.- As a result of this accident the Board of Investigation recommended the temporary withdrawal of all mixed construction type aircraft, pending thorough examination and modification of their bonding systems as necessary.

ICAO Ref: AR/164

No. 12

Avro Anson V aircraft CF-EKJ crashed on take-off from Yellowknife, N. W. T. on 6 February 1951, whilst engaged on a charter flight. Dept. of Transport, Air Services Branch, Civil Aviation Division. Report No. 51-4.

Circumstances

The aircraft with one passenger and pilot attempted to take off from Yellowknife, N. W. T., to carry goods on a non-scheduled chartered flight to Fort Rae and the Martin Lake area. During the take-off the aircraft failed to rise sufficiently to avoid striking buildings in the Yellowknife Settlement and crashed, killing both the pilot and passenger simultaneously, and destroying the aircraft.

Investigation and Evidence

At the time of the accident the weather was clear with unlimited visibility, the temperature was -26°F, and the wind was from a north westerly direction at approximately 5 - 10 mph. The direction of take-off was approximately 192°T, thereby giving a small tailwind component. The pilot held a valid Public Transport Pilot's Licence and had accumulated approximately 3,820 hours of flying time. At the time of the accident the certificate of airworthiness of the aircraft was valid, although there is a possibility that a previous wheels-up landing may have caused damage to the supercharger gears. Examination of these gears revealed that they had failed but it was not possible to establish whether the failure had occurred before or during the crash. Investigation revealed that the aircraft was overloaded to the extent of at least 1,400 lbs. This situation was aggravated by a 6-day accumulation of frost and snow which on the instructions of the pilot had not been removed, thus further decreasing the performance of the aircraft.

Probable Cause

The probable cause of the accident was the failure of the aircraft to gain height, due to being overloaded, covered with a 6-day accumulation of frost and snow, and having taken off partly downwind. It was not possible to determine whether or not there was a power failure in one or both engines.

ICAO Ref: AR/141

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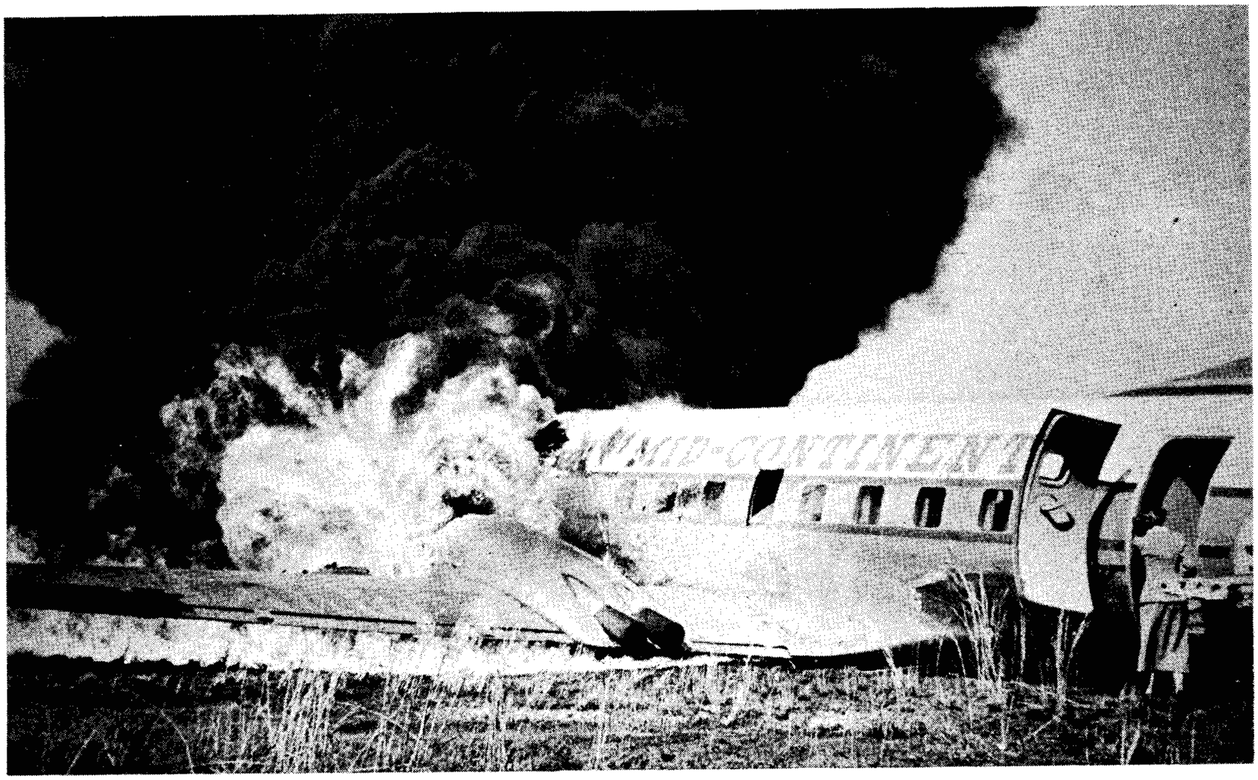
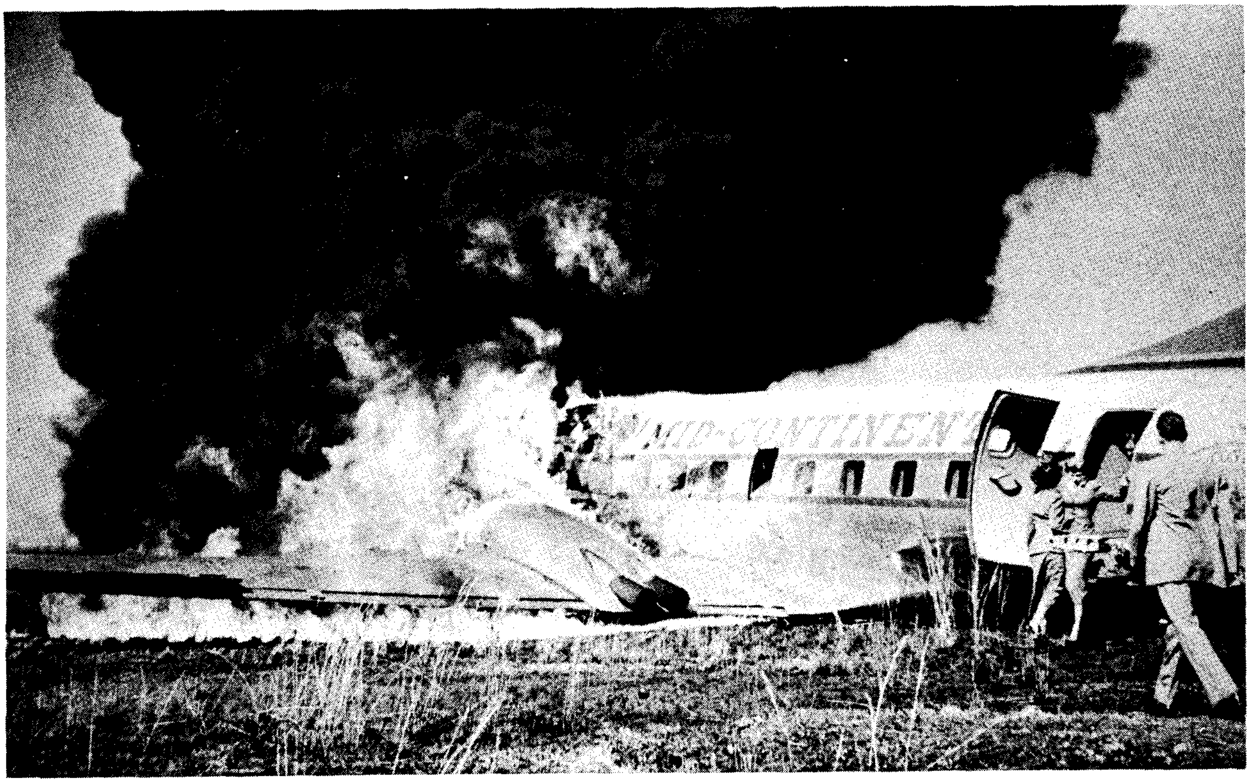
No. 13

Mid-continent Airlines Inc., Convair 240 aircraft, N-90664, crashed following take-off from Tulsa Municipal Airport, Tulsa, Oklahoma on 27 February 1951.
CAB Accident Investigation Report No. 1-0012.
Released 23 November 1951

The very unusual photographs published herein, rather than words, can best describe the significant fire factors of this accident.



(Chester Sharp - Courtesy Tulsa Tribune)



(Photo by Chester Sharp)

(Photo by Chester Sharp)

(Photo by Chester Sharp; Courtesy Tulsa Tribune)

(Photo by Lee F. Gillette; Courtesy Tulsa Tribune)

Circumstances

The aircraft took off from Tulsa with 29 passengers and a crew of 4. Prior to take-off, the engines were run up and the pre-flight check accomplished using a check list. All items checked satisfactorily, with the exception that the left engine torque meter pressure indicator was abnormally low. Flaps were positioned at 24 degrees for take-off. The take-off roll was started on Runway 12, and the signal devices in the cockpit indicated that the automatic feathering unit and the anti-detonation injection unit were functioning.

During the take-off roll, the co-pilot called out the indicated air speed. The aircraft became airborne at 124 mph or slightly higher. The landing gear was immediately retracted and the air speed was then observed to be 145 mph. At this time, at an altitude estimated to be not over 50 feet, the left propeller was observed to feather and immediately thereafter to rotate slowly.

Both engine controls were left at the take-off setting, and a single-engine climb was initiated. The air speed decreased to approximately 124 mph during the climb to a maximum altitude of approximately 150 feet. At this point since it was doubtful if the airspeed could be maintained, the aircraft was levelled off and a shallow turn was made to avoid flying over a building. As the airport started turning at an approximate air speed of 122 mph the Captain (according to the co-pilot) gave the command to retract the flaps from the 24-degree position to the 12-degree position which was immediately acted upon.

While in the left turn, the aircraft was observed to lose altitude steadily until it struck a grove of trees at a point approximately 17 feet above the ground, after which it slid on to the ground on the underside of the fuselage. All passengers and crew were evacuated safely and in an orderly manner. The aircraft was destroyed by fire.

Investigation and Evidence

The aircraft made contact with the ground on a heading of 30 degrees, slid 540 feet and turned anti-clockwise to a heading of approximately 310 degrees as it came to rest. Both fuel tanks ruptured, and the fire that followed consumed all of the fuselage forward of the tail section. The right wing and part of the centre section were torn from the aircraft by impact with a tree and were subsequently destroyed by fire. Investigation failed to reveal any evidence which would indicate a failure or malfunction of any of the flight controls or their mechanisms. There was no evidence of any structural failure of any of the components of the aircraft prior to the accident, with the exception of the torque piston assemblies in the engine nose section. A review of the maintenance records of the aircraft indicated that it should have been airworthy at the time of take-off.

A damage survey of both engines indicated that they could be operated after minor repairs. These repairs were accomplished and the engines run in a test cell. The right engine operated satisfactorily at full power. When the left engine was run, it was found that the torque boost and torque pressures were abnormally low, and as the oil temperatures increased these pressures decreased. After 10 minutes of operation, the engine was stopped and the nose section removed. It was found that the torque meter piston and the ballend assembly in the No. 5 position had failed. The ballend had broken adjacent to the flange, and the ballend and slipper bearings were out of position. Also four of the remaining five torque meter pistons were cracked or broken in varying degrees.

These failures resulted in a decrease in torque boost and torque pressures due to excess oil flow past the torque indicator pistons. They were progressive failures as indicated by the decreasing pressure reading of the left engine torque meter prior to the accident. Although the failures did not affect the operation of the engine, they did cause a sufficient decrease in torque pressure to actuate the auto-feathering system which feathered the left propeller. Since the left engine controls remained at take-off power settings after the propeller feathered and the ignition switch remained on, the engine continued to operate. Operation of the engine following feathering was erratic due to upset carburettor metering and unequal mixture distribution to the cylinders. Since the propeller governor senses only rpm it caused the propeller to move out of the full feathered position due to normal governor action. This latter action also contributed to the continued rotation of the propeller following its feathering operation.

Flight tests conducted under conditions comparable to those existing at the time of the accident indicated that this type of aircraft is able to maintain altitude in a shallow turn at an air speed of 124 mph with one engine developing take-off power, the other engine wind-milling at 1,000 rpm, and the flaps set at 24 degrees. Since reduction in the flap deflection decreases lift, it is apparent that increased air speeds are necessary to maintain altitude with lesser flap deflections. Conversely, if the air speed is held at 124 mph while the flap deflection is reduced from 24 degrees, as it was in this instance, it is apparent from the test results that the aircraft will lose altitude. These tests also indicated that if the turn had not been made the aircraft would have continued to climb. The testimony of the Captain and co-pilot differs as to the location of the aircraft when the flaps were retracted. However, a preponderance of the testimony disclosed that the aircraft lost altitude at the beginning of the left turn, it is therefore reasonable to conclude that the flaps were retracted at this time. Although the co-pilot stated that the flaps were retracted to the 12-degree position and that thereafter the flap control switch was not touched, examination of the flap worm gear mechanism showed that the flaps were in the "up" or "near up" position at impact. Impact forces could not alter the position of the flap worm gear mechanism, accordingly it must be concluded that although the co-pilot believed he retracted the flaps to the 12-degree position only, he must have raised them to the nearly fully retracted position.

A review of the company's approved Convair 240 training program revealed that pilots were required to complete a transition course incorporating all pertinent operational procedures applicable to the aircraft. This included flights under emergency procedures of simulated single-engine operation following take-off. The program also included indoctrination of speeds and flap settings for the best climb configuration of the aircraft under certain load conditions. Both the Captain and co-pilot had satisfactorily completed this course.

Probable Cause

The probable cause of the accident was retraction of the flaps from the take-off setting at a critical air speed, following failure of the left engine torque meter assembly.

Note 1.- As a result of this accident the CAB recommended to the CAA that the following procedure be established by operators of equipment which incorporates automatic feathering unless the automatic feathering feature is disarmed and not used:

a) In the event of abnormal BMEP indication it be mandatory that prior to take-off, the cause of the difficulty be positively isolated to either the engine torque meter system or to that portion of the system outside of the engine.

b) If the difficulty is in the system outside of the engine, the flight be continued to a terminal station where the necessary repairs be made; flight time under these conditions to be kept at an absolute minimum.

c) If the difficulty is found to be in the engine-nose section, corrective measures be taken prior to another take-off.

Note 2.- Since the accident, the engine manufacturer has issued the following Service Bulletin (No. 212 dated 8 May 1951).

"In order to provide increased durability, the torque meter pistons in the torque meter piston and ballend assemblies have been progressively improved as follows:

1) shot peening on the forward side of the web;

2) increased cross sectional area at the junction between the web and journal;

3) large fillet radii between the web and journal.

It is recommended that, at overhaul of subject engines, only the torque meter piston and ballend assemblies having the above improvements be used ...."

ICAO Ref: AR/162

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No. 14

Dove aircraft ZS-BTM, crashed outside boundary
of Baragwanath Airfield,
South Africa on 28 February 1951
Union of S. Africa Aircraft
Accident Report No. 10/51

Circumstances

The aircraft with two commercial licensed pilots as sole occupants took off from Baragwanath Airfield for the purpose of pilot familiarization with the aircraft. After a short period of single-engined flying with the starboard propeller feathered, two landings and take-offs were performed successfully. During the approach for the third landing with the landing gear extended and locked and with flaps in the 60-degree position, a noise was heard on the port side. The pilots associated the noise with the undercarriage and decided to go round again with 85 - 90 mph IAS, the throttles were opened with the propellers set in fine pitch. There was no response from the port engine. Height was being lost so the undercarriage lever was placed in the up position and the port propeller feathered. The ASI fell to 70 - 80 mph. The flaps were raised to 20 degrees and the aircraft sank and yawed to the left. Shortly after clearing some trees, the aircraft stalled and struck the ground with the starboard engine under full power.

Investigation and Evidence

The aircraft struck the ground port wing first, and then swung completely round. There was fuel in the tanks but the aircraft did not catch fire. The starboard propeller was under power and the port propeller was feathered at the time of impact. The aircraft was not overloaded but the C.G. was just forward of the forward limit. All damage was consistent with impact except that of the port engine. A large hole was found on the top cover on its starboard side just behind the rear lifting eye and also holes on the port and starboard sides of the engine. No. 6 vibration damper assembly was not in position on the crankshaft. The rear piston of the crankshaft and crank case disc was considerably damaged due to hammering of some foreign body within the case. Marks indicated that a solid body had lodged at the camshaft rear bearing and this had forced the entire camshaft back until the cam followers were completely off the cam. This would have caused complete power failure of the engine. Markings on No. 6 main bearing web of the crank case indicated that some rotating object, probably the vibration damper assembly had been rubbing against it. One of the damper rings was found in the starboard rear corner of the crankcase and showed signs of hammering. The vibration damper roller was recovered. The headed end was broken into a number of pieces and about half of the threaded portion of the special bolt which screws into it was still in position. The bolt had unscrewed about half an inch and had then broken off at the end of the roller. This bolt is normally peened over onto the headed end of the roller to prevent unscrewing, however, the peening had not been effective in this case. The head of the special bolt was rescrewed within the engine. It had fractured half an inch from the head and the shank showed signs of heavy working such as could be caused by the heavy damper rings operating thereon instead of the roller. Both pilots had more than 5,000 hours flying experience.

Probable Cause

The probable cause of the accident was failure of the port engine caused by the vibration damper bolt partially unscrewing from the roller until the rear damper ring was operating on the bolt shank which eventually failed under excessive loading.

ICAO Ref: AR/169

No. 15

Mid-continent Airlines, Inc., DC-3 aircraft, N-199228, crashed during landing approach to Sioux City Airport, Iowa on 2 March 1951. CAB Accident Investigation Report No. 1-0010 Released 27 September 1951

Circumstances

The aircraft was en route from Omaha, Nebraska to Sioux City, Iowa, carrying 21 passengers and a crew of 4. During an attempt to land in marginal weather conditions the Captain permitted the air speed to fall below that necessary to maintain flight, thereby causing the aircraft to stall when at a low altitude and thus crash. Sixteen occupants, including the pilots, were killed, the remaining 9 being injured. The aircraft was completely destroyed by the crash and the fire which followed.

Investigation and Evidence

The aircraft reported over the Sloan Fan Marker, 11.9 miles S-SE of the approach end of Runway 35 at the Sioux City Airport and was immediately cleared for a "straight-in" approach and landing on Runway 35. The weather information was given as: precipitation, ceiling 500 feet, sky obscured, visibility one mile in light snow showers, and wind from the East at 14 miles per hour. Following receipt of this information the aircraft requested permission to land to the SE on Runway 13 and received clearance to do so. A few minutes later the aircraft reported that it was in contact over the SE corner of the field and was cleared to land. Shortly thereafter, it was sighted approximately over the intersection of Runways 4/22 and 17/35 on an E-SE heading. A left climbing turn to the North was then made and the pilot was advised that he was cleared to land on either Runway 17 or Runway 13, but that he would encounter a 90-degree cross-wind if he elected to land on Runway 17. All transmissions to the flight were acknowledged. The aircraft was not further observed, and crashed about 600 feet north and west of the approach end of Runway 17. Fire developed immediately.

The aircraft structure was largely consumed by fire and it was not possible to determine the extent of impact damage to the fuselage and seat structure. The remains of the left wing panel showed that the resultant forces of the impact had traversed along a line approximately parallel to the lateral axis of the aircraft. Both engines and propellers were thrown free of the aircraft upon contact with the ground. The landing gear and wing flaps were in the down position. No evidence was found which indicated malfunction or mechanical failure prior to the accident.

Analysis of weather data indicated a condition of little or no icing, particularly in the northern half of the route, Omaha to Sioux City. It is possible, however, that a light deposit of ice accumulated during the first half of the flight. The latest forecast available to the flight before departure from Omaha indicated that Sioux City would have a ceiling of 1,500 feet and visibility of 2 miles upon arrival. Weather conditions deteriorated, faster than was expected, however; the ceiling was 500 feet and visibility was reported as being one mile, immediately before the landing approach was made. The Company's minima for a daylight approach at Sioux City are 500 feet and one mile.

It is believed that the first approach to Runway 13 was abandoned and a second approach, to Runway 17 was being attempted by the pilot through visual reference to the ground. The landing gear and flaps were found in the down position; it is, therefore, evident that the pilot intended to make a landing rather than execute a missed approach procedure. The flight from Omaha to Sioux City was conducted in weather which was marginal enough to suggest that light ice formation may have been a factor in this accident. Some ice was observed on the wings by survivors at the time of the crash and on the vertical fin by a ground witness who arrived at the scene shortly thereafter. However, other witnesses stated that they observed none. Visibility from the cockpit could possibly have been reduced by windshield ice and an accumulation of wet snow. Ice accumulation would not have been critical for normal flight operations, but, under a condition of low air speed in a turn, might have been a factor in causing the aircraft to stall at a slightly higher than normal air speed.

Probable Cause

The probable cause of this accident was a stall during a left turn too close to the ground to effect recovery.

ICAO Ref: AR/150

No. 16

Lancashire Aircraft Corp., Ltd., Halifax C8 aircraft, AJZY, crashed near Bovington Airport on 8 March 1951. MCA Civil Aircraft Accident Report MCAP 94

Circumstances

The aircraft was en route from Torslanda airport, Gothenburg, to Bovington Airport, with a crew of 4 and carrying 174 frozen reindeer carcases. On entering the Bovington area the Captain elected to use SBA for the let-down. The last instruction given to the aircraft by the Bovington controller was to descend to 2,000 feet and to report when over the SBA main beacon; no such report was made. The aircraft was seen 6 miles SW of Bovington flying at a low altitude, and a few seconds later it struck the ground. The crew were killed instantly, fire broke out and the aircraft was totally destroyed.

Investigation and Evidence

The weather situation at Bovington Airport at the time in question was wind - 060°, 20 kts; visibility - 3,000 yards; intermittent slight rain; clouds - 7/8 + at 500 feet, 8/8 stratus and strato-cumulus, base 700 to 1,000 feet above M.S.L.; tops 3,500 to 5,000 feet above M.S.L.; QNH - 999.1 mbs; QFE 980.5 mbs; the surface air temperature was approximately 39°F. and the freezing level 1,500 to 2,000 feet above M.S.L. From this height up to the cloud top, temperatures were between freezing point and about 27°F. Conditions were, therefore, favourable for ice formation, and the cloud formation was such that slight rime would have been expected generally, with moderate clear ice at times.

An inspection of the wreckage in situ showed that the aircraft had struck the ground while descending in what was probably the commencement of a steep right-hand spiral. Examination revealed nothing to suggest that any pre-crash failure or malfunctioning had occurred. The condition of the propellers indicated that they were turning under some degree of power at the moment of impact. It was ascertained that no de-icing equipment was installed on the propellers.

Probable Cause

There was insufficient evidence to determine the probable cause of the accident, however the possibility that ice formation was a contributory factor cannot be entirely dismissed.

ICAO Ref: AR/145

No. 17

Northwest Airlines, Inc., DC-4, aircraft, N-95426, landed in deep snow adjacent to runway at Minneapolis - St. Paul International Airport on 18 March 1951. CAB Accident Investigation Report No. 1-0011. Released 30 August 1951

Circumstances

The aircraft was en-route from Fargo, North Dakota to Minneapolis - St. Paul Airport, carrying 14 passengers and a crew of 4. On arrival over Minneapolis-St. Paul the pilot started an ILS straight-in approach to Runway 29-left, but in the vicinity of the middle marker he abandoned the instrument approach and continued VFR to the landing. The runway and runway lights were partially obscured by snow and the aircraft landed in deep snow adjacent to Runway 29-left. No casualties were incurred. The aircraft was substantially damaged.

Investigation and Evidence

The weather at Minneapolis-St. Paul at the time of landing was - precipitation ceiling 1,500 feet, sky obscured, visibility one mile variable, light snow, blowing snow, wind N-NW at 15 mph, altimeter 2971; visibility variable 3/4 to 1-1/4 mile. The Captain was kept fully informed of the weather.

The pilot stated that shortly before arrival over the middle marker, he had the airport and the approach light system in sight, but could not distinguish the runway from the airport area due to the snow. The Captain elected to abandon the ILS approach and to continue the descent visually as the aircraft was properly aligned with the runway at the time.

Investigation revealed that the aircraft touched down in snow 4-5 feet deep approximately 600 feet NW of the Runway and came to rest 874 feet NW of the threshold and 96 feet to the right of the runway. Inspection of the pilot's control compartment indicated that all the aircraft's controls were in their correct positions. No evidence of malfunctioning of the aircraft or any of its components prior to the accident was found. The SE half of Runway 29-left, on the day the accident occurred, was covered with 8 to 10 inches of fresh snow, which made recognition of the approach end of the runway extremely difficult. The NW end of the runway had been plowed and the runway lights in this area were clearly visible to aircraft on the ground in that vicinity. However, under the poor visibility conditions which existed, this partial clearance was of no assistance to aircraft attempting to land at the opposite end.

Bartow runway lights, placed 200 feet apart longitudinally, 27 feet from the edges of the runway, and illuminated at maximum intensity (180,000 candle power) marked the right and left sides of the runway. Nevertheless, the Captain saw no lights burning at any time during the approach and landing.

Runway 29-left was also provided with an approach lighting system which is a component of the ILS installation. The system which is located 117 feet to the left of the centre line of Runway 29-left extended, consists of 29 bars (14 feet wide with 5 clear coloured 90,000 candle power lights mounted), spaced about 100 feet apart longitudinally, from a point 200 feet SE of the threshold and extending 3,050 feet SE. The lights are beamed toward the approaching aircraft commensurate with the angle of the glide path and are approximately at the elevation of the runway. Tower personnel testified that the lights were operating at their highest intensity.

The Captain stated that shortly after establishing visual contact and at a low altitude, the approach-light structure was seen to be slightly to the aircraft's right. Shallow right and left turns were therefore made to align with the runway, at which time several flag markers were seen and almost immediatly additional markers were observed to the right of these. The observed flag markers outlined the north edge of the runway and the south end of the taxi-strip, respectively.

Because of the heavy snow conditions prevailing, the runway lights were marked by small red streamers. Bartow lights on the taxi-strip adjacent to and parallel to Runway 29-left were marked in turn by larger obstruction marker flags. The purpose of these flags was to indicate the locations of the lights to avoid damage by snow removal equipment. Due to the varying visibility caused by blowing snow it is probable that the pilot momentarily lost sight of landmarks such as the approach light structure which he was using for guidance, and thereby lost the alignment he had previously established.

This would explain the aircraft's later position to the left of the approach-light structure. Also, the coincidence of seeing the widely spaced flag markers, after the corrective turns were made, may have been sufficient to assure the pilot that his directional corrections had placed him in line with the runway. Under the reduced visibility conditions this false indication of the location of the runway can be understood.

On the other hand in view of the adverse conditions prevailing and the fact that the aircraft was not properly aligned with the runway at its extremely low altitude, the Captain showed poor judgement in not executing a missed approach procedure.

Probable Cause

The probable cause of this accident was the failure of the pilot to identify properly and align the aircraft with the assigned runway due to snow coverage and poor visibility.

ICAO Ref: AR/149

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No. 18

Trans-World Airlines, Inc. Constellation (L-749) Aircraft, N-01202, landed with undercarriage retracted at Sky Harbour Airport, Phoenix, Arizona, on 19 March 1951. CAB Accident Investigation Report No. 1-0023. Released 19 July 1951

Circumstances

The aircraft was en route from Albuquerque, New Mexico, to Phoenix, Arizona, carrying 29 passengers and a crew of 5. The flight was flown by the First Officer from the right seat, with the Captain in the left seat executing the duties of First Officer. The aircraft was cleared to enter the Phoenix traffic pattern and the landing gear was lowered. After turning on to the base leg however, the flight was advised that it was No. 2 to land, whereupon to establish proper time separation, a shallow 360° turn was made and the landing gear was retracted. Upon being cleared No. 1 to land, the Captain moved the landing gear operating lever toward the "gear down" position but made no check to determine if it actually reached that position. The aircraft landed with the gear in the fully retracted and locked position. No casualties were incurred. Damage to the aircraft was confined mainly to propellers, flaps, engine nacelles and the bottom of the fuselage.

Investigation and Evidence

The aircraft came to rest supported by Nos. 2 and 3 engine nacelles, the inboard flaps and the bottom of the fuselage. The blades of all 4 propellers were badly bent or broken, and the lower sections of Nos. 2 and 3 engine nacelles were badly crushed and worn from contact with the runway. All wing flaps, which were in the full down position, were extensively damaged as was the bottom of the fuselage.

The landing gear warning horn did not sound. However, upon moving each throttle back toward its closed position, the horn sounded when the throttles were within approximately 3/8 inch from the fully closed position. The landing gear warning light system indicated all three landing gears to be in the up and locked position. The landing gear operating lever was in the full "down" position.

The aircraft was raised with the aid of air bags and placed on wing and nose jacks. The hydraulic system operating the landing gear was tested with the landing gear lever in the full down position as found, and everything was demonstrated to operate normally. All hydraulic and electrical units which could have in any way contributed to a landing gear malfunctioning were removed and subjected to exhaustive bench tests. No significant variations from the prescribed performance requirements were found.

The landing gear operating lever was in the "up" position when the Captain undertook to comply with the First Officer's "gear down" order. Since investigation revealed that the landing gear never left the up and locked position, it must be presumed that the Captain moved the operating lever only from the "up" to the neutral position, or if beyond that point, not enough to move the selector valve the amount necessary to get effective pressure to the down gear lines. In the light of the foregoing and the fact that during tests the gear functioned normally, it must be concluded that the landing gear operating lever was placed in the full down position after the aircraft was on the ground.

Probable Cause

The probable cause of this accident was the failure of the Captain to place the landing gear operating lever in a full "gear down" position and to make the necessary check to determine its position before the landing was made.

ICAO Ref: AR/144

No. 19

Queen Charlotte Airlines Ltd., Dehavilland DHC-2 aircraft, CF-FHF, crashed during forced landing at Ferrer Point, Vancouver Island, B. C. 24 March 1951, Dept. of Transport, Air Services Branch, Civil Aviation Division, Report No. 51-9

Circumstances

The aircraft was en-route from Chamiss Bay to Tahsis carrying 5 passengers and one pilot. At about the time the flight commenced there was a broken ceiling at approximately 1,500 feet. The flight was therefore made VFR along the coast line. The ceiling and visibility rapidly deteriorated however causing the pilot to decide to turn back and land at a bay at Ferrer Point. Having entered the bay at Ferrer Point and observed that the tide was going out, the pilot decided to land forthwith as he was then too far into the bay to make a turn. The aircraft landed in shallow water and ran onto a sand-bar causing it to turn over on its back. No injuries were incurred but the aircraft was severely damaged.

Investigation and Evidence

The pilot held a valid Public Transport Pilot's Licence and had accumulated a total of some 6350 hours. The aircraft was airworthy for the flight and there was no indication of malfunctioning of the aircraft, engine or controls. Due to the approach of an occlusion, the weather conditions were poor, being generally below VFR limits for Control Areas and occasionally below VFR limits for Flight Information Regions.

Probable Cause

The probable cause of this accident was that the pilot continued VFR into unfavourable weather, thereby being forced to land in shallow water during the course of which the aircraft ran onto a sand-bar and turned over on its back.

ICAO Ref: AR/142

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No. 20

Air Transport (Charter) (C.I) Ltd.,
Dakota aircraft, G-AJVZ; crashed following take-off
near Ringway Airport, Manchester on 27 March 1951,
MCA Civil Aircraft Accident Report MCAP 96

Circumstances

The aircraft was operating a night newspaper service from Ringway Airport, England, to Nutts Corner Airport, Belfast. Following an erratic take-off in conditions of falling snow the aircraft swung to port and failed to gain height. One or both of the engines were heard to cut out a few times and the aircraft struck a tree about half a mile from the end of the runway, dived into the ground and was wrecked. Both pilots were killed.

Investigation and Evidence

Prior to departure the route forecast was carefully explained to the crew. It was made clear that a wide area of precipitation in the form of sleet and snow which lay to the North of Ringway was moving South and would be very near the airfield at the expected time of take-off. Freezing level in the vicinity of this front was expected to fall to 500/1,000 feet. It was pointed out that cloud on and to the North of the front would be frequently "solid" from 400 feet to 9,000-10,000 feet with moderate rime and risk of moderate clear ice at times. Screen temperatures and relative humidities were not asked for or given and it is not a statutory or an international requirement to show these on a route forecast.

The Captain supervised the loading of the aircraft and on its completion, removed the external locks which he placed inside the fuselage. The Captain did not request or take any action to clear snow from the wings. The aircraft taxied out to the threshold of the runway and the sound of the engines being run up was heard. The tower notified the Captain "You are clear to take-off. There is a slight risk of ice on the runway" which message was acknowledged.

For take-off the landing lights were switched on. The take-off run appeared to be normal but the aircraft did not become airborne until near the end of the 1,400-yard runway. It then swung to port and failed to gain height in the normal way. During this time one or both of its engines were heard to cut out momentarily several times. It then struck the top of a tree. The noise of the engines ceased and a second or so later came the sound of a crash. A witness who was close to the scene of the crash stated that it was then snowing heavily. No evidence of pre-crash mechanical failure was found, but the carburettor of each engine bore soot deposits suggestive of back-firing due to an incorrect mixture.

The carburettors fitted were the Bendix-Stromberg injection type. For fuel injection an "X" bar fuel discharge nozzle is employed. In this type neither the throttle nor the choke tubes are heated automatically. Each of these carburettors, however, was fitted with a heat control (to combat icing) in the form of an air scoop flap for selecting hot or cold air to the carburettor. This shutter was operated manually from the cockpit, the control being situated to the right of the throttle controls on the engine control pedestal. In addition, each carburettor was fitted with an electrically operated spraying device for injecting alcohol into the throat. Each carburettor was fitted with an intake screen and these screens were distorted in an almost identical manner. Normally the screens are almost flat and the distortion was strongly suggestive of icing or packing with frozen snow since under such a condition supercharger depression would tend to suck the screen inwards. Such icing-up of the screens would have the effect of upsetting the engine performance and causing serious loss of power. No external screens were fitted.

Owing to the extensive damage it was not possible to ascertain the position of the heat control flaps before the crash. The magneto master switch was found in the "OFF" position,

The Dakota Operating Manual issued by Air Transport (Charter) (C.I) Ltd., contained instructions for the operation of the heat controls and of the alcohol spray when the outside air temperature was below -1° C. with, or without precipitation. No mention was made, however, that carburettor icing can take place at outside air temperatures above 0° C. in conditions of high relative humidity.

Attention was drawn to the fact that the atmospheric variables that have the greatest effect on induction system icing are air temperatures and relative humidity. Owing to the temperature drop in the induction system, ice may form in the carburettor or intake when the relative humidity approximates to 100 per cent and the outside air temperature is considerably above 32°F.

Icing becomes more severe when water exists in the form of rain, snow or sleet concurrently with the above conditions. The weather conditions obtaining at the time of take-off, i.e. air temperature 34.2° F., relative humidity 97 per cent and falling snow, were ideal for the rapid formation of ice in the carburettor and blockage by snow freezing on the carburettor intake screens.

It was further noted that when the carburettor heat control is in the hot air position, air is taken from a duct behind the cylinders into which snow cannot enter and the air is sufficiently hot to prevent ice formation although a slight loss of power may occur which must be taken into consideration for take-off.

Probable Cause

The probable cause of this accident was the inability of the aircraft to gain height shortly after becoming airborne, due to loss of engine power caused by ice formation in the carburettor intakes attributable to the Captain's failure to make use of the heat controls. An extended undercarriage and the presence of snow on the wings may have been contributory factors.

ICAO Ref: AR/151

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No. 21

Southwest Airways Company, DC-3 aircraft, N-63439, crashed 14 miles NW of Santa Barbara, California on 6 April 1951. CAB Accident Investigation Report No. 1-0019 released 13 November 1951

Circumstances

The aircraft was en route from Santa Maria, California to Santa Barbara, California carrying 19 passengers and a crew of 3. Two minutes after take-off from Santa Maria the flight radioed its on and off times to and from that station and gave an estimated arrival time of 2039 at Santa Barbara. This was the last radio contact with the flight, and complete search procedures were shortly thereafter placed in effect. The aircraft was located the following morning and was found to have crashed 14 miles northwest of Santa Barbara. All occupants were killed and the aircraft was demolished.

Investigation and Evidence

The aircraft struck the slope of a ridge on a heading of approximately 117°(M). This was ascertained from a sharply defined path of cut and broken bush. The site was approximately 34°31'30"N and 120° 02'W, a point about 3 miles to the right of a straight line between the Santa Maria and Santa Barbara airports, or about 1½ mile to the left of the course between Santa Maria airport and the town of Capitan. At the time of impact the DC-3 was about level longitudinally and the left wing was raised above the horizontal by about 30°. The top of the ridge was only a short distance ahead of, and some 40 feet higher than, the point of initial impact.

General disintegration and fire followed the crash, largely destroying the structure. Examination of the wreckage indicated that there had not been any fire in flight and that there had been no malfunctioning of the aircraft, aircraft's controls, engines or its propellers, prior to impact. From the severely broken and burned wreckage it was nevertheless, possible to deduce with a high degree of probability that, at the time of initial impact, the wing flaps and landing gear were up and the propellers were in the cruising RPM range. One recovered altimeter indicated an altitude of 2,800 feet, and one rate of climb indicator showed zero; other flight instruments gave meaningless indications or were unreadable. All indications were that the aircraft was in controlled cruising flight when it struck.

All navigational aids that could possibly have been involved in this leg of the flight were checked on the day following the accident. Investigation did not reveal any malfunctioning of the aircraft's radio apparatus.

At the time of departure from Santa Maria, the latest weather reports showed an overcast there at 2,400 feet and a visibility of 20 miles with 3,100 feet and 15 miles visibility at Santa Barbara. Forecasts indicated that the flight could expect mostly overcast from Santa Barbara, with cloud bases at 1,800 and 2,000 feet MSL, and scattered to broken clouds with bases at 3,500 feet at Santa Barbara.

Evidence disclosed by investigation indicates that a solid overcast existed between Santa Maria and the general area of the crash site. The flight must have gone on instruments when reaching an altitude between 2,000 and 2,400 feet MSL after leaving Santa Maria because the stratus base there was at that altitude. It is further indicated that the cloud base was on the terrain at the time and place of the crash, and that the top of the stratus layer was at an altitude of about 3,500 feet.

With reference to routes between Santa Maria and Santa Barbara, the company's operations manual set forth three routes, all approved by the Civil Aeronautics Administration. The course being flown by the subject aircraft was entered into the company's operational manual about three weeks before the accident, and was removed from the manual by the carrier, immediately after the accident. However, this course was not in conflict with the pertinent provisions of the Civil Air Regulations inasmuch as it was within 5 miles of one of the approved routes (a route being defined as a strip 10 miles wide). Although the flight was confined to the limits of an approved route, the altitude at which the crash occurred, 2,740 feet, was markedly below the approved night minima of 500 feet on top, and no lower than 4,000 feet, as prescribed in the company's operating specifications and approved by the Civil Aeronautics Administration. In this connection it was noted that the flight plan called for a VFR operation at 4,000 feet altitude between Santa Maria and Santa Barbara and a course of 123°M as far as Capitan. It is possible that the pilot's long familiarity with the route may have led him to believe that he could fly the more direct course, under the overcast, thereby saving a fractional amount of flight time.

Probable Cause

The probable cause of this accident was the failure, for undetermined reasons, to maintain the specified minimum en-route night altitude of 4,000 feet for the route being flown.

ICAO Ref: AR/159

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No. 22

Noorduyn Norseman IV aircraft, CF-DFF, crashed at Cowan Lake, Sask. on 7 April 1951 whilst on a charter flight. Dept. of Transport, Air Services Branch, Civil Aviation Division, Report No. 51-14

Circumstances

The aircraft took off from Cowan Lake, Sask. with six passengers on board. During the take-off and when about to become air borne, the aircraft lurched and the port ski was observed to be hanging free of the undercarriage leg, remaining attached to the aircraft by the rear check cable only. The pilot immediately throttled back and landed the aircraft on the starboard ski. After continuing for 200 - 300 feet the aircraft settled on the port side and turned over on its back. The pilot and passengers escaped with minor injuries. The aircraft was completely consumed by fire.

Investigation and Evidence

Due to snowdrifts and slush the take-off area was rough and made up of layers of water and ice caused by melted snow freezing overnight. The port ski of the aircraft appeared to have broken through the top layer of ice, hit a covered hammock of snow or ice and broke off at the oleo leg piston. The cause of the cabin fire was not determined but it was noted that the engine was operating at the time of the accident and a packet of matches which was being carried by one of the passengers ignited.

Probable Cause

The probable cause of this accident was a forced landing on the starboard ski due to failure of the port oleo leg during take-off.

ICAO Ref: AR/140

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No. 23

Compañía Cubana de Aviación, S. A., DC-4 aircraft, CU-T188, involved in air collision with Navy SNB aircraft No. 39939 at Key West, Florida, on 25 April 1951. CAB Accident Investigation Report, File No. F-104-51 Released 22 October 1951

Circumstances

The DC-4 was en route from Miami, Florida, to Havana, Cuba, carrying 34 passengers and a crew of five. A twin-engined Beechcraft, Navy designation SNB No. 39939 carrying 4 persons, was executing a simulated instrument training flight from the U. S. Naval Air Station, Key West, Florida. The DC-4 on a southerly heading, and the Navy SNB, on a westerly heading, collided at a point over the west side of the U.S. Naval Station, with the result that the Navy aircraft crashed into the water just west of the Naval Station. The Cubana aircraft, however, continued on for some distance before commencing a left bank which became progressively steeper until the aircraft assumed a nose-down attitude. In this attitude, it crashed into the ocean approximately 1.7 miles S. E. from the point of the collision. The collision resulted in the destruction of both aircraft and the death of all occupants.

Investigation and Evidence

Shortly before the collision the DC-4 was observed by ground witnesses to be about one mile north of the center line of the direct Miami - Key West Control Area Extension, at 4,000 feet estimated altitude and on an approximate heading of 223° M. At about the same time and approximately the same altitude, the Navy SNB was observed on the east leg of the Key West Radio Range, approaching the station on a heading of about 250°. Witnesses saw the two aircraft collide approximately 1.6 mile west of the Range Station and just north of the on-course signal. From the testimony of witnesses, it would appear that the collision occurred while the DC-4 was in a gentle left bank or had just levelled out on the new Havana heading of 197° M.

It was established that one portion of the instrument training flight, on which the Navy SNB was engaged, required a flight inbound on the east leg of the Key West Radio Range on a heading of 250° M. It is assumed that such an approach was being made at the time of the collision.

Among the recovered portions of both aircraft, sufficient evidence was found to establish the position of the aircraft relative to each other at the moment of initial impact. The right propeller of the SNB had deep gouges on the leading edge of both blades. The section of the DC-4 left wing recovered with the SNB wreckage showed evidence of having been cut by a revolving object at wing stations 588½ and 540½, the cutting action being from the front to the rear of the wing and parallel to the longitudinal axis of the DC-4. The cut on the DC-4 left wing at station 588½, which was made by one blade of the right propeller of the SNB, was the first contact between the two aircraft. The cut in the DC-4 left wing at station 540½ by the second blade of the SNB right propeller, and the contact of the tip and leading edge of the DC-4 left wing with the right side of the SNB fuselage, followed almost simultaneously. There was evidence of subsequent impact between the two aircraft; however, the damage was of such a nature that it was not possible to determine any sequence of events. The SNB propeller cuts in the DC-4 left wing indicated that the angle between the longitudinal axis of the two aircraft at the moment of impact was approximately 110°.

The DC-4 aircraft and crew were currently certificated by the Cuban Civil Aeronautics Administration, and the flight was properly dispatched from Miami on an IFR Flight Plan. The weather in the Key West area at the time of the accident was clear and unlimited. The flight of each aircraft was routine and according to plan up to the time of collision.

Probable Cause

The probable cause of this accident was the failure of the crews of both aircraft to maintain sufficient vigilance under VFR conditions to prevent a collision.

ICAO Ref: AR/154

No. 24

United Airlines, Inc., DC-3 aircraft, N-16088, crashed and burned 2.6 miles E. - S.E. of Baer Field, Fort Wayne, Indiana, on 28 April 1951. CAB Accident Investigation Report No. 1-0024, Released 22 October 1951

Circumstances

The aircraft was en route from Cleveland, Ohio, to Baer Field, Fort Wayne, carrying 8 passengers and a crew of three. The aircraft reported when nineteen miles N.E. of Baer Field and was advised that Runway 22 was the runway in use and that the wind was five to ten mph from the S.W. Because of thunderstorm activity in the area, three other aircraft were requesting instructions to land at approximately the time the subject aircraft was making its approach.

At the time the four aircraft were approaching Baer Field, the subject aircraft was number four to land in the traffic pattern immediately behind a TWA aircraft. When these two aircraft were approximately 1 and 2-1/2 miles, respectively, from the approach end of Runway 22, the wind at the airport shifted to W-NW and increased in velocity from 5-10 mph to 40 mph. Both aircraft were advised by the tower of the sudden change of wind direction and increased velocity, and a landing on Runway 27, which was more nearly into wind, was suggested. On receiving this message the two aircraft immediately turned to the left to align with this runway.

When these aircraft were east of the airport the wind increased to 60-65 mph with gusts to 85 mph and a heavy rainfall began, accompanied by lightning and severe static. The aircraft were quickly advised of the weather change but, due to the sudden decrease in visibility, neither aircraft was seen again by the tower. The subject aircraft immediately advised that it was heading East. This was closely followed by a message from the TWA aircraft that it was "pulling out".

At 1932 an orange-coloured flash was seen to the E-SE. from the tower. It was later determined that the subject aircraft had crashed in a field 2.6 miles E-SE of the airport. The eleven occupants were killed and the aircraft was demolished. The TWA aircraft proceeded safely to Toledo.

Investigation and Evidence

Investigation disclosed that the subject aircraft was flying on an approximate heading of 120 degrees when it struck the ground and that at the time of impact it was in a near level attitude with the left wing slightly low. Initial ground contact was made by the aircraft's left wing tip. Wreckage was strewn over the ground for a distance of 720 feet and the main wreckage came to rest in a wooded area several hundred feet distant from the point of initial impact. A detailed examination of the wreckage revealed no evidence of fire, structural failure, or mechanical malfunctioning of any part of the aircraft or its components prior to impact. The damage pattern to all propeller blades in the form of compound bends, severe nicks and gouges in the leading edges near the tips, together with the blade angle-positions, indicated that considerable power was being produced by both engines when impact occurred.

All instruments in the pilot's cockpit were so damaged as to be unreadable. The aircraft's records were examined and these indicated that the aircraft was airworthy.

The "Trip Weather Analysis" (a form prepared by the crew before departure) indicated that scattered cumulus and thunderstorms were expected South of the course to Fort Wayne. Also, that a squall line extending in a north-south direction was moving eastward across Illinois and Indiana at an estimated speed of 35 mph and was expected to be in the vicinity of South Bend on the flight's arrival there.

The U.S. Weather Bureau first forecast the movement of the squall line to be at the rate of 30 mph. At 1713, an hour before it was forecast to arrive there, the squall line reached Chicago. The Weather Bureau then amended its forecast to indicate the forward movement of the storm to be 40 mph and reported severe turbulence in the storm area over northern Illinois. A Chicago special weather sequence report at 1719, reported a thunderstorm accompanied by heavy hail and wind from the North-Northwest at 42 mph with gusts to 57 mph. At 1831, the storm reached South Bend and was reported as being heavy with small hail and wind from the W-NW at 35 mph with gusts to 55 mph.

Several tornadoes were reported along the squall line, three were plotted as beginning near the Indiana-Ohio State border and extending eastward. One of these tornadoes, in its formative stage, was a short distance east of the scene of the accident. No evidence of tornado damage could be found along the flight path of the subject aircraft. Large hailstones were reported falling near the scene of the accident, however, it was determined that hail did not fall in this area until after the crash occurred.

Neither the company meteorologist nor the Weather Bureau anticipated the rapid movement of the storm or its severity in the Fort Wayne area. Investigation revealed that the storm progressed along Northern Indiana at a rate averaging in excess of 60 mph instead of the 40 mph previously forecast. It took approximately five minutes, only, for the storm to arrive over Baer Field after it had been reported as being 10 miles distant. This indicated that the location of the storm was inaccurately reported since, to travel this distance in the time given, the storm would have moved at a rate far in excess of its known speed.

The pilot of the TWA aircraft stated that when he was approaching the airport and was advised of the accelerated wind with gusts to 85 mph, he immediately executed a left turn and proceeded to Toledo, experiencing little or no turbulence during this portion of the flight. It was noted that the TWA aircraft turned immediately ahead of and avoided the approaching storm, but that the subject aircraft was caught in the storm during the turn. The few seconds in time and the short distance separating the TWA aircraft from the subject aircraft meant the difference between flying through reasonably stable air and severe down drafts and turbulence.

It is known that a down draft is composed of cool relatively dense air, and it is logical to assume that practically all initial down drafts descend to the ground, then start fanning out, proceeding ahead of the storm by means of horizontal flow. Thereafter, down drafts in new cloud developments along the forward edge of the storm lose most of their downward velocity before reaching the ground. It is for that reason that a plane caught in a down draft usually can recover before being carried dangerously close to the ground.

In the case of the squall line at Fort Wayne the propagation of the storm was so rapid on the forward side that it resulted in an increased movement of the squall line amounting to 30 mph or so. As a consequence, the fanning out process never had time to form an outflow ahead of the storm and new down drafts descended to the ground because of the lack of the cushioning effect.

Although there was evidence to indicate that a tornado was in its initial stage of development near the scene of the accident, it is unlikely that it caused the aircraft to crash. The forces which accompany even an incipient tornado would be different in character from those which forced this aircraft to the ground. Had such forces been associated with this accident it is extremely doubtful that lateral control of the aircraft could have been maintained. The testimony of witnesses who saw the aircraft in flight does not indicate loss of lateral control and since the aircraft struck the ground in a near level attitude and with power on, it can reasonably be assumed that a severe down draft was encountered on the edge of the storm from which there was insufficient altitude to recover. Down drafts of such magnitude are frequently a part of a line squall development but do not usually occur so close to the ground.

Probable Cause

The probable cause of the accident was the severe down draft encountered which caused the aircraft to strike the ground in a near level attitude.

ICAO Ref: AR/158

No. 25

National Airlines Inc., DC-6 aircraft, N-90896, premature contact with ground on approach to a landing at Newark Airport, New Jersey on 21 May 1951. CAB Accident Investigation Report No. 1-0052. Released 7 November 1951.

Circumstances

The aircraft was en route from Richmond, Virginia, to Newark, New Jersey, carrying 22 passengers and a crew of 4. While making an ILS approach to a landing on Runway 6 of the Newark Airport, premature contact was made with the ground in a swamp, 1,800 feet short of the runway. Full power was applied almost simultaneously with the contact, as a result of which the aircraft again became airborne, and the landing was completed on the airport to the left of Runway 6.

Moderate damage to the aircraft was sustained when a pipe supporting a GCA reflector was struck during the landing. No injuries were experienced by any of the passengers or members of the crew.

Investigation and Evidence

Investigation revealed that the gross weight at take-off with 2,400 gallons of fuel, was 77,160 pounds. This weight was well within the allowable gross of 81,400 pounds and was properly distributed with respect to the aircraft's centre of gravity.

It was ascertained that the aircraft reported over New Brunswick Intersection and was given clearance by Newark Approach Control for a straight-in approach to Runway 6. Approach Control advised that GCA would be issuing advisories on the 110.3 megacycle localizer frequency. An instrument approach was made using ILS, and was monitored by the GCA operator in the Newark Airport Tower. A landing was completed on the Newark Airport, 110 feet to the left and 1,200 feet from the approach end of Runway 6. The aircraft was in a tail-low attitude as it touched down.

Almost simultaneously with touchdown, the outer edge of the left stabilizer struck a 2-inch steel pipe standing 85 inches high. The pipe, which supported a GCA reflector, was struck 58 inches above the ground and impact resulted in shearing off approximately three feet of the elevator and a small section of the stabilizer. Large quantities of swamp mud and reeds were found on the wheels, landing gear, and underside of the aircraft. The right flap was bent up slightly at a point near the fuselage, the left sense antenna was torn loose, and other minor damage was sustained. It was later determined that a premature touchdown had been made 1,800 feet short of the approach end of the runway, in the swamp adjacent to the airport.

The weather conditions at Newark Airport were furnished to the flight by Newark Approach Control shortly before passing New Brunswick, New Jersey. This information was: ceiling 300 feet indefinite, overcast, visibility three-fourths mile, fog, smoke, wind east-southeast at ten to fifteen miles per hour, and altimeter setting 29.90 inches (National Airlines minima for an instrument approach at Newark Airport are 200 feet and one-half mile). During the approach and continuing until after the accident, the weather there underwent no change. No aircraft icing was involved during the flight, nor was there turbulence of any importance.

The Captain stated that the flight from Richmond which was conducted under instrument conditions was uneventful until the ILS approach was made at the destination. The SW leg of the Newark range was contacted at about New Brunswick. Only small corrections were necessary to obtain a correct heading on the ILS localizer. The glide path was intercepted and landing check lists were completed.

On reaching Linden, about 6 miles from Newark Airport, the GCA operator began issuing advisories to the flight on 110.3 megacycles. The operator had advised the flight as follows: "Transmit 118.3". According to the Captain, this instruction was misinterpreted by him to mean that GCA would transmit on 118.3 megacycles, rather than the usual 110.3 megacycles. Due to this apparent misunderstanding, GCA advisories were not utilized by the crew to check the accuracy of the approach, although the approach was monitored by GCA for approximately the last six miles. GCA had no knowledge that the flight was not receiving the information. The ILS approach was apparently normal until the flight reached a point about two miles from intended touchdown. A transcription of the GCA advisories verified this. The aircraft was slightly to the left on the glide path at times, but deviations were not abnormal. At a point one mile from touchdown, the transcription showed the flight low on the glide path and to the left. The operator stated that the aircraft disappeared from the elevation scope between the middle marker and the runway. It remained in view, however, on the azimuth scope.

The Captain advised that the cross-pointer indicators reflected a normal ILS approach throughout, including the period when passing over the middle marker, located 0.61 of a mile from the approach end of Runway 6. The glide path is 230 feet above the ground at this point; the Captain said that altitude was approximately 240 feet and indicated air speed about 135 miles per hour at the middle marker. The air speed was not observed to deviate from this figure at any later time by the Captain, co-pilot, or flight engineer.

The co-pilot had been instructed to seek visual reference to the ground, and advised the Captain that the approach lights could be seen to the right just as they passed over the middle marker. The runway lights were on full brilliance, setting number 5, as were the centreline approach lights and their flasher units. The Captain said that he then levelled the aircraft off at 200 feet by rearward pressure on the elevator control almost simultaneously with receipt of this information from the co-pilot, and looked out to check the position of the approach lights. He further advised that the glide was being maintained at a descent of approximately 550 feet per minute, with 20 to 21 inches of manifold pressure, landing gear down and 30 degrees of flaps. No additional power was applied at this time. The Captain saw the approach lights well to the right and stated he elected to execute a missed-approach procedure. Immediately returning his attention to flight by instruments, he applied full power and almost instantaneously the aircraft made forceful contact with the ground.

The co-pilot stated that he saw the ground coming up rapidly and that he, as well as the Captain, applied full rearward pressure to the elevator control just as the aircraft struck. Almost simultaneously with this action, he had reached over to push the throttles forward, but power was being applied by the Captain. The aircraft immediately became airborne and a tail-low landing was made within the boundaries of the airport within the next few seconds.

Six ILS approaches were made at Newark Airport between 1230 and 0945 by scheduled aircraft. Their pilots stated that all elements of the ILS were functioning normally and that GCA information was accurate. In addition, fifteen ILS approaches were made by pilots of another airline about two hours after the incident. These approaches were made as a research project and were conducted independently of the accident. They were monitored by GCA and all ground components of the ILS system functioned normally throughout.

Records revealed no previous malfunctioning of pertinent aircraft components. Test approaches were made in it by reference to instruments and no abnormalities in either the airborne or ground equipment were found.

The Captain was unable to furnish any reason for the cause of the accident other than possible altimeter lag or errors in the instrument. Investigation showed the altimeters were on the correct setting; according to testimony, the settings were checked during the approach upon receipt of information from Newark Approach Control.

Probable Cause

The probable cause of this accident was faulty judgment and improper piloting technique on the part of the Captain while executing an ILS approach, resulting in forceful contact with the ground prior to reaching the airport.

ICAO Ref: AR/161

No. 26

Dove DH 104 aircraft, ZS-DFC, wheels-up landing at Rand Airport, Germistown, Tvl., on 9 June 1951, Union of South Africa Accident Report No. 33/51

Circumstances

The aircraft with pilot and seven passengers was returning to Rand Airport at the end of a scheduled flight. The pilot operated the undercarriage selector lever to extend the undercarriage prior to landing. The starboard wheel and nose wheel extended and locked in the down position but the port wheel remained retracted. The undercarriage emergency system was operated without success and the pilot tried to extend the port leg by pulling out sharply from a dive but with no success. After circling the airfield for about an hour and twenty minutes the pilot retracted the complete undercarriage and landed the aircraft on its underside.

Investigation and Evidence

The aircraft was jacked up and the normal retraction system operated. It was found that the starboard and nose wheel extended fully and locked down, but when the port wheel leg up lock mechanism was released to the unlocked position the port wheel did not extend. On selecting up, the starboard and nose wheel retracted and locked, and the port leg went back into the locked position.

Inspection of the port leg retraction and extension mechanism revealed that the screw for the adjustment of the upper and lower links of the radius rod had broken immediately above the surface of the locknut. Inspection of the fractured faces of the screw suggested that an adjustment of the screws had been made without loosening the lock nut. Metallurgical examination of the fractures further showed that initial fracture took place as a result of the application of a torsional load and that such a load could only have been applied by attempting to adjust the screw without loosening the lock nut. The material of the screw was up to specification.

Probable Cause

The probable cause of the accident was fracture of the adjustment screw of the port undercarriage leg in torsion, during adjustment by maintenance personnel who had neglected to unloosen the lock nut before the adjustment was made.

Due to the fracture of this screw the upper and lower radius rod links were able to break in the wrong direction when extending, and so jammed the mechanism.

ICAO Ref: AR/171

No. 27

United UH-12 Helicopter, CF-GKJ, crashed near Table Mountain, B.C. on 14 June 1951. Department of Transport Air Services Branch, Civil Aviation Division. Report No. 51-19

Circumstances

The Helicopter took off from Table Mountain on a return trip to its base. After climbing into wind to approximately 50 feet, the aircraft turned to the left, downwind, and flew over the ledge parallel to the face of the mountain. The aircraft was not observed to crash, but it was subsequently found in an inverted position, the crash having killed the pilot.

Investigation and Evidence

Another pilot who was operating a helicopter between the same points and at approximately the same time found that the wind conditions shortly after the accident were so turbulent that a landing on Table Mountain was impossible. It was estimated that the wind speed was 40 mph. An observer stated that the wind was sometimes so strong that he had to lean against it to maintain his balance.

There was no evidence of malfunctioning of the aircraft or engine.

Probable Cause

The probable cause of this accident was loss of control due to extreme turbulence and the aircraft turning downwind at an elevation of 4,900 feet in a 40 mph wind.

ICAO Ref: AR/146

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No. 28

Pan-American World Airways Inc., Lockheed Constellation L-049 aircraft, N-88846, crashed en route 54 miles NE of Roberts Field, Liberia, 21 June 1951. CAB Accident Investigation Report No. 1-0053. Released 5/12/51

Circumstances

The aircraft was en route from Accra Gold Coast to Roberts Field, Monrovia, Liberia carrying 31 passengers and a crew of 9. At 0057 the aircraft reported its position over Abidjan and gave ETA Cape Palmas at 0156. At 0156 the aircraft reported over Cape Palmas at 16,500 feet MSL on instruments and gave ETA Roberts Field at 0246. At 0220 the aircraft requested clearance to descend. Roberts Field radio cleared the flight to descend to 3,000 feet and advised that at 0225 the Roberts Field tower would establish contact on VHF.

A clear two-way contact was made at 0225 on 118.1 Mc/s. at which time the tower gave the flight the local weather and altimeter setting to descend IFR over Roberts Field range station and indicated that runway 05 was in use. At 0237 the aircraft was again given local weather for Roberts Field: cloud base estimated 1,000 feet, broken, a light drizzle and haze, visibility 3 miles. At 0241 the local wind was given as W-WNW variable at 7 mph, all of these messages were acknowledged.

At 0255, 9 minutes after its ETA at Roberts Field, the aircraft was heard calling on VHF (118.1 Mc/s.). The tower replied repeating the call three times. Since there was no acknowledgement the tower switched to 3270 kc/s. and requested the aircraft to give its current position. There was no reply to this call. Immediately thereafter the Roberts Field high frequency radio-telephone facility established contact advising the aircraft that they were unable to read it on 118.1 Mc/s. and that it should reply to the tower's call on 3270 kc/s. This message was acknowledged at 0301. At 0305 the aircraft again contacted Roberts Field on 3270 kc/s., advising that the Dakar radio beacon was interfering with the Roberts Field radio beacon and that they would "be back in 15 minutes". The tower advised the aircraft that Dakar would be requested to turn off its beacon (turned off at 0410) and this message was acknowledged. At 0315 the aircraft again called Roberts Field and the latter transmitted the latest weather. The flight did not acknowledge this transmission on 3270 Kc/s. but called Roberts Field on 118.1 Mc/s. Roberts Field replied on 118.1 Mc/s. but received no acknowledgment. This incomplete contact at 0315 was the last transmission received from the aircraft.

At 0410 emergency procedures were initiated and at 0515 an alert notice was dispatched to appropriate stations that the aircraft was still unreported and that aerial search would begin at daylight. During the day of June 22 aerial search was conducted but was not succesful in locating the missing aircraft. On the morning of June 23 an inhabitant of the village of Sanoye notified the authorities that an aircraft had crashed into the side of a hill 2.4 miles west of his village and that all occupants on board had been killed.

Investigation and Evidence

Investigation revealed that the aircraft struck at high speed in a laterally level and slightly descending attitude at an elevation of 1,050 feet MSL, with the wing flaps, landing gear, and landing lights in the retracted position. The wreckage was distributed about a line running 178° magnetic from the point of impact. All major components were found at the scene, and no evidence was found to indicate that any part had become detached prior to impact. An intense flash fire over the entire area of wreckage distribution and several localized fires followed impact, but there was no evidence of any inflight fire.

The propeller dome settings indicated that all four engines were producing approximately the same amount of power. The cockpit instruments recovered were too severely damaged to give any reliable indications of their readings when the crash occurred. Statements of eyewitnesses and stopped watches which had been worn by occupants of the aircraft indicated the time of impact as approximately 0325. At this time the aircraft had about eight hours of fuel remaining, having departed Accra with over eleven hours of fuel aboard.

A thorough review of maintenance records for the aircraft reflected no irregularities and indicated that the aircraft was airworthy when it departed Accra.

The weather at Roberts Field, available at Accra before the flight's departure, was ceiling 3,500 to 5,000 feet and visibility better than 5 miles. At Cape Palmas the flight should have been in the clear at its assigned cruising altitude of 16,500 feet, with outside temperature about 31° and wind about 80° at 20 knots. In the vicinity of longitude 10° to 11° W, a rather extensive cumulo-nimbus development appears to have existed, with the heaviest rain east northeast of Roberts Field. It is probable that the flight flew into this cumulo-nimbus development, resulting in bad static and heavy rain.

In the vicinity of the crash, the flight was east of the line of storms but the cloud bases were probably down to near the hilltops. Witnesses who heard the aircraft flying northerly, and then saw it flying low on a southerly heading just prior to the crash, stated that the night was dark but no rain was falling, although there had been heavy rain earlier in the evening.

It was determined that the minimum en-route altitude from Cape Palmas to Roberts Field, when not more than 5 miles either side of a direct route, is 4,500 feet; when outside these limits, the minimum altitude is 6,500 feet. There are no radio-navigational aids along the route, and prior to arriving within effective reception range of the Roberts Field aids, (R.R. 50 miles; R. Bn. 75 miles) the only means by which a flight can determine its position under instrument conditions is dead reckoning or a celestial fix.

There were no reported malfunctions of the navigational aids at Roberts Field during the time the aircraft was within range, with the exception of the reported interference of the Dakar beacon, operating on 403 kc/s. No aircraft was heard passing over or near Roberts Field during the time the aircraft was expected to arrive, although competent personnel were waiting and listening for it, and the flight gave no position report of any kind except the statement, "will be back in 15 minutes". From this it must be concluded that the flight not only failed to overhead the range station, but also never reached the general area of Roberts Field.

In the absence of any indications of mechanical trouble, there is no logical explanation for the captain's action in descending without having positive knowledge of the flight's position. It must be concluded, therefore, that he made this descent with the mistaken belief the flight's position was such that he could safely descend below the prescribed minimum altitude. There was no known necessity for immediate descent as the flight still had ample fuel to proceed to either of its alternates, Accra or Dakar, and weather at both remained above minima during the time the flight might have arrived at either point.

Probable Cause

The probable cause of this accident was the action of the Captain in descending below his en-route minimum altitude without positive identification of the flight's position.

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Note.- As a consequence of this accident, Pan American World Airways made a change in operating procedures and issued the following instructions to all personnel concerned with African flights:

> Until further notice minimum instrument approach altitude Roberts Field 8,000 feet. Aircraft will lose altitude by three minute shuttles on the southwest Roberts Field range leg reporting each one thousand feet, procedure turn, and range overhead.
>
> Instrument approach shall start from range overhead with visual and aural "Z" marker indications and be executed in accordance with manual procedure with aircraft reporting inbound procedure turn, low cone, field not in sight or missed approach.

As a result of a survey of the navigational facilities at Roberts Field by the Civil Aeronautics Administration subsequent to the accident, Pan American World Airways' operations into Roberts Field were restricted to VFR day operations only. Improvements made in the Roberts Field facilities however resulted in this restriction being removed to the extent that PAWA was authorized to return to the original operations specifications, except that all night operations are to be in accordance with IFR rules.

ICAO Ref: AR/163

No. 29

Luscombe 8F aircraft, CF-FGP crashed following take-off at Ganges Island Harbour, B.C. on 30th June 1951. whilst on a charter flight. Dept of Transport Air Services Branch, Civil Aviation Division. Report No. 51-20

Circumstances

The aircraft took off from Ganges Island Harbour, B.C. with one passenger, on a charter flight. After climbing to between 100 and 250 feet A.S.L. and immediately following a shallow right-hand turn the aircraft stalled. The pilot was unable to regain control before the aircraft struck the water. No casualties were incurred. The aircraft was not recovered.

Investigation and Evidence

The weather conditions were, wind-calm, sea-smooth, visibility-good. There was no indication of malfunctioning of the aircraft or engine. It was determined that due to the calm conditions existing at the time, three unsuccessful take-off attempts had been made prior to the actual take-off.

Probable Cause

The probable cause of this accident was the failure to recover from a stall at low altitude.

ICAO Ref: AR/147

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No. 30

Republic RC-3 aircraft, CF-EJF, crashed during approach to land at Tahtsa Lake, B.C. on 10 July 1951 whilst engaged on a Charter flight Dept. of Transport, Air Services Branch, Civil Aviation Division, Report No. 21-33

Circumstances

The aircraft took off from Burns Lake, B.C. bound for Tahtsa Lake, B.C., with a cargo of freight and one passenger. On arrival at Tahtsa Lake, a steep approach to land was made, the pilot starting the round-out at an estimated height of fifty feet above the water. After two slight alterations of course, the aircraft struck the water and overturned. The aircraft was destroyed and the occupants received minor injuries.

Investigation and Evidence

The pilot held a valid Commercial Pilot licence and had accumulated a total of 385 hours of flying time of which approximately 60 hours had been acquired on Republic RC-3 type of aircraft. The aircraft and engine were airworthy for the flight and there was no evidence of malfunctioning of the airframe, engine or controls. The weather was good but the surface of the water at Tahtsa Lake was smooth and glassy.

Probable Cause

The probable cause of this accident was the failure of the pilot to level off properly, due to glassy water conditions, as a consequence of which the aircraft struck the water and overturned.

ICAO Ref: AR/155

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No. 31

Air Navigation and Trading Company, DH-89A aircraft, G-ALXJ, struck cliff and crashed at Skeirrip near Laxey Head, Isle of Man on 10 July 1951. MCA civil aircraft accident report MCAP 97

Circumstances

The aircraft was on a charter flight carrying newspapers from Blackpool, England to Jurby, Isle of Man. When approaching the Isle of Man in bad visibility it brushed the side of a cliff and crashed into the sea. Only small fragments of the aircraft were recovered. The pilot, the sole occupant is missing believed killed. There was no evidence of fire.

Investigation and Evidence

The aircraft was known to have flown to the Isle of Man and back on the day prior to the accident. No faults were reported. The loading of the aircraft was determined to be within the prescribed limits and the documentation of the aircraft was in order. The pilot had held a B licence periodically since 1928 and was said to have a total of 10,000 hours flying, about 6,000 hours of which were in Rapide aircraft. He was granted a commercial pilot's licence in October 1950 which was valid until November 1951. It was ascertained that the pilot failed his instrument flight test five times in 1950 and did not hold an instrument rating. In July 1949 he obtained a General Flight Radio Telephony Operator's Licence (Temporary) which was valid until March 1950. The pilot had not since renewed this licence.

Actual weather reports from Ronaldsway and Jurby and from a pilot who flew the route at the time indicate that below the parallel through Ramsay, the Isle of Man was obscured by low stratus which extended 20 miles beyond the eastern seaboard. Witnesses near the scene of the accident said that it was very foggy. The cliffs near the scene of the accident were almost certainly covered by clouds at the time. It was ascertained that the pilot was at all times fully informed of the existing weather situation.

Investigation revealed that immediately after becoming airborne the pilot informed Blackpool approach control by R/T that he was on course for Jurby and not Ronaldsway which was the intended destination. At 0604 hours he reported to Blackpool Approach Control that he was flying at 2,500 VFR and at 0611 hours, that he was flying VFR abeam the Morecambe Bay light. At 0629 hours he informed Ronaldsway Approach Control by R/T that his destination was Jurby with E.T.A. 0645 hours and asked if Ronaldsway Homer was working. In reply Ronaldsway Homer gave him a QTE of 070°. The pilot requested a QDM instead, which was given as 262° and acknowledged. This was his last communication with any station.

Investigation of the cliff at Skeirrip showed that the aircraft had struck the ground a glancing blow 255 ft. above sea level while on a heading of 270° M. The port lower wing tip had struck a sharp-edged rock protruding through the heather and bracken-covered surface and had been torn off together with the outer end of the port aileron. These were found lying near by. There were traces of silver and red dope and shreds of fabric adhering to the rock. The port propeller and port wheel had cut off the heads of the bracken for a distance of 5 yards straight up the cliff indicating that the aircraft was in a climbing attitude of about 50° at the moment of impact. Except for a chip off a second stone in the immediate vicinity no other mark was visible. The wreckage recovered by the Coast Guard and life boat services was the shattered escape hatch and part of the cabin roof. Although all the recovered pieces came from a Rapide type aircraft none could be identified as part of G-ALXJ. A week later, however, a piece of the fuselage flooring was picked up on the beach at Port Mooar near Maughold Head, which was definitely established to have come from the subject aircraft.

Probable Cause

The probable cause of this accident was the failure of the pilot to avoid rising ground when flying at a low altitude in bad visibility.

ICAO Ref: AR/160

PART II

List of Laws and Regulations of the Contracting States containing provisions relating to "Aircraft Accident Investigation".

ARGENTINA

1943	Feb. 3	Decreto 142.074: Normas para las comunicaciones a efectuarse en ocasión de registrarse accidentes o descensos forzosos en el extranjero.
1948	Set. 30	Resolución 1800/48: Normas para la remisión de datos e informaciones sobre accidentes de aviación.
	Nov. 16	Resolución 2117/48: Normas referentes a informaciones sobre accidentes y percances de aviación.
1949	Junio 4	Orden del Día 120/49: Normas para la investigación de accidentes de aviación.

AUSTRALIA

1947	Aug. 6	Air Navigation Regulations, 1947, S.R. No. 112 - Part XVI. (Regulations made under the Air Navigation Act 1920-1947).

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).

CANADA

1951	May 24	The Air Regulations P.C. 2575: Part VIII - Sec. 3- Accidents and Boarding Inquiry (8.3.1 - 8.3.2.2.).

CEYLON

1950	March 29	Air Navigation Act, No. 15/1950 Part I, Air Navigation; Sec. 12. Power to provide for investigation into accidents.

CHINA

1946		Regulations covering accident investigation of civil aircraft.

COLOMBIA

1936	Dec. 18	Law No. 196: Accidents and insurance of technical personnel of civil aviation.
1948	March	Manual of Regulations - Part IV, Sec. I, 40.13.0: Accidents.

COSTA RICA

1949	Oct. 18	Ley de Aviación Civil - Parte I. Título Primero, Cap. 2, Sec. 8: Accidentes (Art. 45-47).

CZECHOSLOVAKIA

1947		Decree of Ministry of Interior on accident investigation (No. 1600/1947).

DENMARK

1920	Sept. 11	Air Navigation Regulations. Par. 22 - Notifications in case of certain aircraft accidents.

EGYPT

1939	January	Departmental Regulations issued by Civil Aviation Department including "Investigation of Accidents".

EGYPT (Contd.)

1951		Notice to Airmen No. 5A/1951: Instructions to be followed in the event of "Flight Accidents".

EL SALVADOR

1950		Ley de Aeronáutica: Cap. V.- Accidentes y Emergencias (Art. 73-89).

FRANCE

1937	Avril 28	Décret relatif à la déclaration des accidents d'aviation. (Bulletin de Renseignements CINA 780/3.).

GREECE

1932	July 8	Decree relating to rules for prevention of air navigation accidents.

GUATEMALA

1949	Marzo	Decreto Núm. 563: Ley de Aviación Civil. Capítulo X - De los siniestros aeronáuticos, (Art. 116-121).

HONDURAS

1950	Marzo 14	Decreto Núm. 121: Ley de Aeronáutica: Cap. IV. Sec. Cuarta - Accidentes y Emergencias (Art. 70-88).

HONG KONG

Air Navigation Regulations of 1932.

INDIA

1934	Aug. 19	The Indian Aircraft Act, 1934 (corrected up to 1 November 1950) - Sec. 7: Powers of Governor General in Council to make rules for investigation of accidents.
1937	March 23	The Indian Aircraft Rules, 1937 (as corrected up to 1 November 1950) - Part X: Investigation of Accidents (Art. 68-77).

IRAQ

1939	August 6	Air Navigation Law No. 41/1939: Article 5 (h).

IRELAND

1928		The Air Navigation (Investigation of Accidents) Regulations No. 21.
1936		Air Navigation and Transport Act, No. 40. Part VII, Section 60: Investigation of Accidents. (This Act was amended in 1942 (No. 10) and 1946 (No. 23).)
1943		Air Navigation Regulations (Investigation of accidents) (Amendment - 1933 - No. 288 to Regulation No. 21 of 1928).

ITALY

1925	Jan. 11	Decree Law No. 356: Rules for Air Navigation - Chap. VII.
1942	April 21	Navigation Code, Second Part - Air Navigation. Book I, Title VIII - Investigation of Accidents (Art. 826-833).

LEBANON

1949	Jan. 11	Aviation Law: Chap. III. Flying., Sub. Chap. 2. Landing of aircraft (Art. 39).

MEXICO

1949	Dec. 27	Civil Aviation Law (replacing Book IV of Law concerning General Lines of Communications, Aerial Communications, 1940); Chap. XIV. Accidents, Search and Rescue (Art. 358-361).
1950	Oct. 18	Reglamento para Búsqueda y Salvamento e Investigación de Accidentes Aéreos (en vigor a partir del 1/1/51).

NETHERLANDS

1936	Sept. 10	Act regulating the Investigation of Accidents to Civil Aircraft (Aeronautical Disasters Act S. 522 as amended on 31 December 1937, S. 527).
	Sept. 22	Order for the application of paras. 8 and 9 of Art. 1 and of par. 5 of Art. 32 of the Aeronautical Disasters Act (S. 579).
	Sept. 22	Order for the application of par. 2 of Art. 6 of the Aeronautical Disasters Act. (S. 579A).
1937	Jan. 14	Decree of Ministry of Water Works regarding Art. VI of the Law of aviation accidents.
	Oct. 19	Decree of the Minister of Water Works regarding landing of civil aircraft outside the designated area, and accidents.

NEW ZEALAND

1933	July 1	Air Navigation Regulations, 1933, as amended to 1951. (Amendment No. 19 of 16/5/51 - Reg. 36 and 37 are replaced by new Regulations.) Arts. 35 to 44 - Investigation of accidents.
1948	Aug. 26	The Civil Aviation Act, 1948. Article 8 - Power to provide for investigation of accidents.

NORWAY

1923	Dec. 7	Civil Aeronautics Act, as amended up to March 11, 1949 - Chapter II, Par. 46.
		Royal Resolution - Regulations on aviation enacted by the Department of Defence, 15 October 1932 and 11 December 1936, in accordance with the Civil Aeronautics Act of 7 December 1923 and the Royal Resolution of 22 April 1932 as amended up to 1947. VIII - Aircraft Accidents.

PAKISTAN

1934	Aug. 19	The Indian Aircraft Act, 1934, No. XXII (as adopted by Pakistan and amended up to 1951) - Par. 7: Powers of Governor General in Council to make rules for investigation of accidents.
1937	March 23	The Indian Aircraft Rules, 1937 (as adopted by Pakistan and amended up to 1951) - Part X: Investigation of accidents.

PHILIPPINES

1936	Nov. 22	Commonwealth Act No. 168. Chapter IV - Powers and Duties of the Director (Sec. 6 (g)) Investigation of Accidents.
1946	May 9	Civil Aviation Regulations - Chapter XVI: Aircraft Accident Investigations.

PORTUGAL

1927	April 27	Decree No. 13:537 Air Navigation Regulations - Chapter VIII.

SPAIN

1948	March 12	Decree relating to investigation of civil aircraft accidents.

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 1946). Par. 28 - is relating to Notification of aircraft accidents.

SWITZERLAND

1948	Dec. 21	Air Navigation Law - First Part, Title I - Chap. II: Articles 22-26.
1950	Juin 5	Règlement d'exécution de la loi sur la navigation aérienne (entrée en vigueur le 15 juin 1950): XIV. Accidents d'aéronefs (Arts. 129-137).

TUNISIA

1930	June 1	Air Navigation (Accidents).

UNION OF SOUTH AFRICA

1923	May 21	Aviation Act. No. 16 - Article 10: Investigation of Accidents.
1949	Dec. 30	The Air Navigation Regulations, No. 4307, 1950 (came into operation on the 1st. January 1950) as amended by Schedules of Amendment No. 1023/1950; Amendment (No. 2) No. 1275/1950 and Amendment (No. 3) No. 2608/1950, chapter 29. Investigation of Accidents (Reg. 29.1 - 29.7).

UNITED KINGDOM

1938		The Aircraft (Wreck and Salvage) Order No. 136.
1949		The Air Navigation Order, 1949 (S.I. No. 49), as amended by S.I. No. 563, 1950 and S.I. No. 319, 1951: Art. 68 - Application of accident regulations to aircraft belonging to or employed in the service of His Majesty.

UNITED KINGDOM (Contd.)

1949	Nov. 24	The Civil Aviation Act, 1949 (12 & 13 Geo. 6. Ch. 67): Part II - Section 10 - Investigation of Accidents.
1951		The Civil Aviation (Investigation of Accidents) Regulations, S.I. No. 563. Came into operation on 1/10/51.

UNITED KINGDOM COLONIES

Section 10 of Part II - Investigation of Accidents of the Civil Aviation Act, 1949 (12 & 13 Geo. 6. Ch. 57) applies to the undermentioned Colonies by virtue of the Colonial Air Navigation (Application of Acts) Order, 1937.

Aden (Colony and Protectorate)
Bahamas
Barbados
Basutoland
Bechuanaland Protectorate
Bermuda
British Guiana
British Honduras
British Solomon Islands Protectorate
Cyprus
Falkland Islands and Dependencies
Fiji
Gambia (Colony and Protectorate)
Gibraltar
Gilbert and Ellice Islands Colony
Gold Coast -
- a) Colony
- b) Ashanti
- c) Northern Territories
- d) Togoland under British Mandate.

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.

UNITED KINGDOM COLONIES (Contd.)

Malta
Mauritius
Nigeria
a) Colony
b) Protectorate
c) Cameroons under British Mandate.
North Borneo
Northern Rhodesia
Nyasaland Protectorate
St. Helena and Ascension
Sarawak
Settlements of Penang and Malacca
Seychelles
Sierra Leone (Colony and Protectorate)
Singapore
Somaliland Protectorate
Swaziland
Tanganyika Territory
Trinidad and Tobago
Uganda Protectorate
Windward Islands
Dominica
Grenada
St. Lucia
St. Vicent.
Zanzibar Protectorate.

BRITISH GUIANA

1938	March 15	Air Navigation (Investigation of Accidents) Regulations (S.R.O. 1939, No. 41).

GAMBIA

1937	Nov. 15	Air Navigation (Investigation of Accidents) Regulations, No. 17/1937.

GOLD COAST

1937	Feb. 17	Aircraft (Accident) Regulations, No. 5 of 1937.

HONG KONG

1932	Jan. 15	Air Navigation Directions (No. 1) (G.N. 31/32).

KENYA

1928	June 22	Air Navigation (Accident) Regulations.

MALTA

1938	March 22	Air Navigation (Investigation of Accidents) Regulations. (G.N. 131/38).

NIGERIA

1936	Oct. 7	Aircraft (Accident) Regulations, No. 33/36.

NORTHERN RHODESIA

1948		The Air Navigation (Accident) Regulations (G.N. 171/48).

SIERRA LEONE

1938	June 13	Aircraft (Accident) Rules (No. 17/1938).

SINGAPORE

1938	May 27	Air Navigation (Investigation of Accidents) Regulations (G.N. 1582/38).

TANGANYIKA

1933	June 30	Air Navigation (Investigation of Accidents) Regulations. (G.N. 91/33).

TRINIDAD

1940	Oct. 26	Air Navigation (Investigation of Accidents) Regulations 1940 (revoking Air Navigation Regulations (Accidents), 1931) as amended on 16 August 1948, G.N. 139/48.
1948		Air Navigation (Investigation of Accidents) (Amendment) Regulations 1948 (G.N. No. 139/48).

ZANZIBAR

1937	Sept. 4	Investigation of Accidents Regulations (G.N. 41/37).

UNITED STATES OF AMERICA

1938		Civil Aeronautics Act - Title VII (Air Safety).
1947	Nov. 20	Civil Aeronautics Board: Organizational Regulations Part 302 - Description of Functions: Course and Method by which functions are channeled: Scope and contents of documents: Part 302.1.(b) (4); Part 302.2. Functions of Offices and Bureaux: (d) (2) The Accident Investigation Division (3) The Accident Analysis Division.
1949	May 1	Civil Air Regulations - Part 62. Notice and Reports of Aircraft Accidents and missing Aircraft.
1950	Sept. 15	Economic Regulations - Part 303 - Rules of Practice in aircraft accident inquiries.

UNITED STATES OF AMERICA (Contd.)

1950	Sept. 15	Economic Regulations - Part 311 - Disclosure of aircraft investigation information.

YUGOSLAVIA

1949	June 1	Decree relating to air navigation: IV, Art. 28 - Investigation of Accidents.

PART III

MISCELLANEOUS PUBLICATIONS AND REPORTS

ACCIDENT STATISTICS

AUSTRALIA

Statistical Analysis of Civil Aircraft Accidents and Casualties 1949. Department of Civil Aviation.

Summary of Accident and Incident Reports March 1950-August 1950. Department of Civil Aviation.

Summary of Accident and Incident Reports September 1950-February 1951. Department of Civil Aviation.

CANADA

Annual Report on Aircraft Accidents 1950, Department of Transport, Air Service Branch, Civil Aviation Division, Ottawa.

INDIA

A Survey of the Accidents to Indian Registered Aircraft in the year ended 31 December 1950, Ministry of Communications, Civil Aviation Department.

NETHERLANDS

Summary of the Accidents and of the Primary Causes of Accidents with Netherlands Aircraft, 1946-1950 inclusive. Department of Civil Aviation.

NORWAY

Norwegian Aviation Statistics 1950 (Luftfartsstatistikk, Norge 1950).

SWEDEN

Swedish Aviation Statistics 1950 (Driftsstatistik för civil luftfart 1950, Luftfartsinspektionen Kungl. Luftfartsstyrelsen).

SWITZERLAND

Rapports et renseignements statistiques sur les accidents d'aéronefs utilisés en service commercial, du 1er octobre 1947 au 31 mars 1949.

UNITED KINGDOM

A survey of Accidents to Aircraft of the United Kingdom in the year ended 31 December 1949. Ministry of Civil Aviation, Publication 89.

UNITED STATES OF AMERICA

A Statistical Analysis of Accidents in Instructional Non-air Carrier Operations (1950). Accident Analysis Division, C.A.B.

A Statistical Analysis of Non-commercial Non-air Carrier Accidents (1950). Accident Analysis Division, C.A.B.

A Statistical Analysis of Commercial Non-air Carrier Accidents (1950). Accident Analysis Division, C.A.B.

A Statistical Analysis of Public Flying and Miscellaneous Non-air Carrier Accidents (1950). Accident Analysis Division, C.A.B.

Accidents in U.S. Scheduled Air Carrier Passenger Operations (1st Three Quarters 1950 and 1949. Accident Analysis Division, C.A.B.).

Accidents in U.S. Scheduled Air Carrier Passenger Operations (Calendar Years 1950 and 1949). Accident Analysis Division, C.A.B.

Non-air Carrier Accident Trend Report (1st One Thousand 1951). Accident Analysis Division, C.A.B.

Non-air Carrier Accident Trend Report (1st Two Thousand 1951). Accident Analysis Division, C.A.B.

Non-air Carrier Accident Trend Report (1st Three Thousand 1951). Accident Analysis Division, C.A.B.

Résumé of U.S. Air Carrier Accidents (1950). Bureau of Safety Investigation, C.A.B.

UNION OF SOUTH AFRICA

Aircraft Accident Review 1949. Department of Transport, Division of Civil Aviation.

RESEARCH

UNITED KINGDOM

Advances in Aircraft Structural Design by G.T.R. Hill, M.C., M.Sc., F.R.Ae.S.

Safer Seating by W.E. Hick.

Combustion of Hydrocarbon Mists by C.B. Davies.

Safety and Civil Aircraft by W. Tye, O.B.E., F.R.Ae.S.

The Icing Problem by S.S. Schoetzel.

UNITED STATES OF AMERICA

Safety in Flight by Jordanoff Assen.

Research and Development to promote Safety in Aviation by Dr. T.P. Wright.

Crash Research from the Point of View of Cabin Design by Hugh De Haven.

Designs for Survival by Beech Aircraft Corporation.

Observations on Flight Safety by Jerome Lederer.

Infusion of Safety into Aeronautical Engineering Curricula by Jerome Lederer.

Comparative Significance of Transport Safety Statistics by Rudolph Modley.

Safety Survey of Pacific Coast Aviation Industry by W.L. Lewis.

Some Special Aspects of Air Transport Safety by C.M. Christenson.

Recent Developments in the Field of Landing Speed Reduction and Hovering Aircraft by D.H. Kaplan.

A study of Serious and Fatal Accident Records during 1939 and 1940. M.S. Civil Aeronautics Administration.

Evaluation of Flight Fire Protection Means for Inaccessible Aircraft Baggage compartments by L.A. Asadourian, Civil Aeronautics Administration.

The Development of the CAA-NRC Flight Recorder, U.S. Civil Aeronautics Administration.

A study of the Semi-annual Instrument Check for Airline Pilots, U.S. Civil Aeronautics Administration.

The effect of various noise levels on performance of three mental tasks. U.S. Navy, Special Devices Centre.

Exploratory Studies, The Relation between 'Uncertainty' and Vocal Intensity. U.S. Navy, Special Devices Centre.

ACCIDENT PREVENTION BULLETINS

UNITED STATES OF AMERICA

Information Accident Releases (Series 1951) Nos. 11-13 inclusive. Crash Injury Research, Cornell University Medical College N.Y.

Accident Prevention Bulletins (Series 1951) Nos. 1-6 inclusive. The Danish and Florence Guggenheim Aviation Safety Centre at Cornell University.

Fire News (1951) Monthly; Bulletins (1951) Nos. 56A-79; Special Aircraft Accident Bulletins (1951) Nos. 1-12; Special Airport Fire Bulletins (1951) Nos. 1-5. National Fire Protection Association International, Committee on Aviation and Airport Fire Protection.

Accident Prevention Bulletins (Series 1951) Nos. 1-30. Flight Safety Foundation.

MISCELLANEOUS EXTRACTS RE ACCIDENT PREVENTION

Expansion of Gasoline

Like most things, gasoline expands with rising temperature. Remember this when refueling ground equipment. Do not fill tanks brim full, particularly when the equipment may stand several hours before being used. Ten gallons of gasoline in a tank filled with cool fuel may expand as much as a quart if left standing in the sun. Overflowing gasoline is not only wasteful, but a fire hazard. Leave a little room for expansion.

Itinerant Pilot and Busy Control Tower

Pat and Mike worked in a large machine shop. One day, Pat was oiling a huge fly wheel. It must have been twenty-five feet in diameter .... tremendous. Someone called his name and Pat looked away. In that instant, his sleeve caught in the wheel and he was whipped off his feet. Round and round he whirled, while Mike stood by, speechless, frozen with horror. Suddenly he jumped into action and pulled the switch. The wheel slowly stopped. Mike rushed over to Pat and said, "Speak to me, Pat, speak to me!" - "Why should I?" groaned Pat. "I passed you a dozen times and you didn't speak to me!"

Blowing Snow

Falling snow does tricks with visibility. Snow may fall at a moderate angle at some distance above the ground so that a pilot has the entire airfield in view as he comes in for a landing. As he approaches the ground, however, the pilot enters an area where the snow is no longer falling, but is being blown along parallel to the ground. This layer of air has a much heavier concentration of snowflakes, and the pilot may find himself in zero-zero visibility.

Snow showers may also cause sudden changes in visibility. It is smart for the pilot to pull up and go around again if he loses contact with the ground, even though he may be almost down. If the pilot loses contact with the ground, conditions could be no worse on a second or third try, and the chances are he can hit a period of improved visibility and come in safely the second time.

Fire in the Air

The best fire fighting for aeroplanes is preventive maintenance. Fuel lines and ignition systems should be inspected frequently and be kept in the best of condition. Most fires in flight result from poor maintenance or from careless disposal of matches and cigarettes by smokers.

Bug-killing poisons

Flight Safety Foundation is warning crop dusters that as little as .012 of a gram (a fraction of the weight of a penny postcard) is a fatal dose of organic - phosphate insecticide. Predominant symptoms of this kind of poisoning are: excessive saliva and tear formation, perspiration, nausea, vomiting, diarrhea, etc.. Antidote is atropine. Call a doctor. Extreme care is recommended in handling such bug-killing poisons, even when they are only in commercial concentration.

It's mostly attitude

The idea that "it can't happen to me" causes most accidents. The pilot who has never had an accident begins to feel that he is immune and that he can take a chance now and then.

The accident repeater feels that his accidents are the other fellow's fault or that he is unlucky. The truth is that he may be first plain lazy and won't take the trouble to follow the rules which experience has shown to be necessary. Others are in a hurry or would rather think about last night's date, or just don't think.

Ignorance may cause accidents when a pilot or mechanic is afraid or ashamed to ask an old timer for advice. Maybe they feel belittled to admit that someone else might know more than they do.

It's a good idea to sit down and make a list of all the things that you need to do to be an alert pilot. Check up on your proficiency, your tendency to daydream in flight, and how carefully you make preflight checks. Don't be an accident going somewhere to happen!

Design Notes

Maintenance and operating requirements should be consistent with average human effort, ability and attitude (If a bolt CAN be installed in reverse, it is only a matter of time before it WILL be).

Design to encounter with safety the effects of natural phenomena.

Design to give occupants reasonable assurance of protection in accidents considered to be survivable.

Training Notes

Eternal vigilance is the price of safety.

Old man gravity works 24 hours a day, every day.

Learn from the mistakes of others, you won't live long enough to make them yourself.

Properly trained employees and good supervision are a team that can make operations safe.

VISIBILITY AND WINDSHIELD WIPERS - BY AN AIRLINE PILOT

"No one seems to have given much thought to rain and its effect on visibility, and this is growing more and more important as the airliners begin to land faster and faster. A VFR clearance in even light rain is ridiculous.

"It is interesting to note that if the airplane's speed doubles, landing in a rain, the windshield hits twice as much rain and hits it four times as hard.

"You know, the observer in the tower will look across the field to some object and he will officially report that the visibility is two miles. I wonder what he would report if someone turned a fire hose on his window!

"In most of our air transports the low visibility is buit in. We have a fancy obscurational device called the windshield wiper. When you use one of them in a rain all you can see is your finish. There also is no system for cleaning the interfaces. The rubber blades sit out in the sun and weather and are subject to extreme variations of temperature. The rubber goes bad in a few days. Some of our blades have not been replaced since the ships were put into service.

"I came in last night with my ship - it is easier to come in with it than without it, although while Airways Traffic Control was holding me at 9,000 feet in the — excuse the word please — 'belly' of a thunderstorm, there were times when I thought that the airliner was going to abandon me — I came in last night for a landing in a rain and abuckin' for the air was rough. I turned on the windshield wiper and all it did was to spread the splashes. The runway was black and wet and so invisible anyway, but the runway lights gleamed up brightly. As a result of the changing refractions of the sheets of water on the windshield, the runway lights jumped and danced and bobbled about. The co-pilot and the flight engineer could see nothing ahead. Me, I'm cockeyed and I can bring witnesses. I have a good 90 degrees angle of vision. Fortunately, our runway, the first part of it, lay along the loading platform with all its lights, and so, to make a long story short, I steered for the jumble of prancing runway lights by the use of my right eye and I judged how to level out by what seeped into the corner of my left eye ....." (Reproduced by courtesy of Flight Safety Foundation).

PART IV

LANDING AND TAKING-OFF OF AIRCRAFT IN BAD WEATHER

(Secretariat Note:- The following reprint of the United Kingdom Report "Landing and Taking-Off of Aircraft in Bad Weather" and the comments on this Report, by the Ministry of Civil Aviation, United Kingdom, are reproduced for information only and do not necessarily represent the views of ICAO in any of the matters quoted.)

The Ministry of Civil Aviation, United Kingdom, has kindly permitted reproduction of the "Brabazon Report" in this Circular and has provided the following statement:

"In November, 1950, the Ministry of Civil Aviation in the United Kingdom invited Lord Brabazon of Tara, to undertake an inquiry into the relevant responsibilities of the captain of an aircraft, the operator and the aerodrome authority in deciding whether an aircraft can safely land at, or take-off from, an aerodrome in bad weather conditions. Lord Brabazon was pleased to accept this invitation and the report of his inquiry is reproduced herein.

The Ministry stated in the House of Lords on 13th February 1951 that the Government accepted the report in principle, including the main recommendation that the operator and not the State should continue to be responsible for establishing weather minima to be observed by pilots of aircraft landing at and taking off from aerodromes.

The Ministry of Civil Aviation has subsequently completed a more detailed examination of the Report which has resulted in the following:

(a) Acceptance of the recommendations in the Report in paragraphs:

4(a)(i)(ii)(iii)
4(b)(i)(ii)
4(d)(i)(iii)(iv)
4(e)
4(f)

(b) The measurement of Runway Visual Range is being undertaken at the majority of aerodromes in the United Kingdom and the information is being passed to pilots. After some further experience which is necessary to ensure that this gives a reasonably accurate measurement of the visibility the pilot will experience when landing, it is our intention to require the operator to state his weather minima in terms of Runway Visual Range and Critical Height.

(c) The recommendation that all operators' weather minima should be officially approved by the Ministry has not been accepted as such a step would only be considered necessary if we had reason to believe that U.K. operators were not adequately fulfilling their responsibilities in laying down suitable minima.

(d) Operators will not be required to state circling minima in terms of ceiling and Runway Visual Range, they may do so if they wish, but a technical study has shown that circling minima can be adequately covered in terms of critical height and Runway Visual Range.

(e) Other details are still under examination."

LANDING AND TAKING-OFF
OF AIRCRAFT
IN BAD WEATHER

being the Report

of the Inquiry into the relative responsibilities of the

captain of an aircraft, the operator and the

aerodrome authority in deciding whether

an aircraft can safely land at, or

take-off from, an aerodrome in

bad weather conditions

Presented by the Minister of Civil Aviation to Parliament
by Command of His Majesty
February 1951

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CONTENTS

APPENDICES

REPORT

To the Right Honourable LORD PAKENHAM,
Minister of Civil Aviation.

MR LORD MINISTER,

I have the honour to present the following report on the subject which you invited me to examine.

INTRODUCTION

1. The terms of reference of the inquiry which you asked me to undertake were to examine the relative reponsibilities of the captain of an aircraft, the operator and the aerodrome authority in deciding whether an aircraft can safely land at, or take-off from, an aerodrome in bad weather conditions.

2. In my examination of this matter, I turned for help and guidance to my fellow members of the Air Safety Board - Air Chief Marshal Sir Frederick Bowhill, Professor A.A. Hall, Dr. L. Bairstow and Air Commodore F.R. Banks - for whose wisdom and general knowledge on all air problems I have a very profound respect. In addition, I invited Captain Alderson to be with us. A distinguished pilot of BOAC and a member of the Air Registration Board, he was indeed a very agreeable ally in my task. I am indeed grateful for the patient consideration involving long hours that they have given to the subject under review and am gratified that unanimously they subscribe to the report I have the honour to submit to you.

3. I have held ten meetings and have obtained information and heard expressions of opinion from both national and international organisations, including the airline Corporations, charter companies, the International Civil Aviation Organisation, the International Air Transport Association, the British Air Line Pilots Association, the Guild of Air Pilots

and Air Navigators of the British Empire, the Association of Supervisory Staffs Executives and Technicians, the Ministry of Civil Aviation, the Air Ministry Meteorological Office, and the Ministry of Supply. These organisations and witnesses are listed in Appendix A.

SUMMARY OF CONCLUSIONS

4. The following is a summary of my main conclusions:

(a) (i) In no circumstances should an aerodrome be closed against emergency (paragraph 10).

(ii) Where a runway is unserviceable, e.g. due to a temporary obstruction, the aerodrome authority should inform pilots that the runway is closed (paragraph 29).

(iii) Where the aerodrome authority is unable to provide the safety and rescue services notified as being available, pilots should be informed of the situation and the reasons for it (paragraph 30).

(b) (i) Arrangements should be made for the measurement of "runway visual range"* at aerodromes in the United Kingdom when visibility falls below one nautical mile (paragraph 22).

(ii) By day, the runway lighting system should be switched on when visibility falls below one nautical mile or at higher visibilities when requested by a pilot (paragraph 20).

(iii) Contracting States to the International Civil Aviation Organisation should be invited to take parallel action (paragraph 23).

(c) (i) The existing procedure by which the operator of aircraft registered in the United Kingdom is held responsible for the establishment of weather minima should be retained but such minima should be subject to State approval (paragraphs 31 and 33).

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* "Runway visual range" is defined as the distance at which a pilot can differentiate between the runway and the adjacent surface area.

(ii) The operator of aircraft not registered in the United Kingdom but which operate to United Kingdom aerodromes should be required to have his minima approved by his State authority and notified to your Department (paragraph 33).

(d) (i) When a precision or runway approach aid is utilised, weather minima should be stated in terms of "critical height"* and runway visual range (paragraph 25).

(ii) In the case of an approach on which the aircraft requires to circle visually, minima should be prescribed in terms of "ceiling"** visibility and runway visual range (paragraph 25).

(iii) For take-off, minima should be stated in terms of runway visual range and, as necessary, ceiling (paragraph 26).

(iv) The operator of a non-scheduled service should conform to the general procedure outlined at (i), (ii) and (iii) above, in so far as it is practicable (paragraph 34).

(v) Contracting States to the International Civil Aviation Organisation should be invited to arrange that their operators state minima in like terms (paragraph 27).

(e) The operator should continue to be held responsible for ensuring that his pilots abide by the minima established. It is extremely important that he also take all practicable steps to assure pilots that a diversion will not be held to indicate a lack of professional ability (paragraphs 36 and 37).

(f) No change should be made to the existing provision by which the State can take action in the event of a violation of minima. The system proposed will permit this power to be used more effectively and, in this regard, the aerodrome authority should report to the Ministry any take-off or landing made below the runway visual range minimum for the company concerned (paragraph 36).

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* "Critical Height" is defined as the height below which it would be impracticable to carry out an overshoot with adequate terrain clearance.

** "Ceiling" is defined as the height of the base of the lowest cloud covering more than half the sky.

5. Emerging out of my inquiries, I add certain recommendations which I feel would be helpful towards further safety. As they are outside my immediate terms of reference, I append them under separate head:

(a) A Fido equipment should be available as an emergency aid at one aerodrome in the United Kingdom and there should also be available, at that aerodrome, a comprehensive system of aids to instrument approach. Manston Aerodrome, the site of the existing Fido installation, is at present deficient in this latter respect (paragraph 15).

(b) Action to install daylight runway markings should be expedited (paragraph 20).

(c) Further trials of runway lighting installations should also be expedited (paragraph 24).

GENERAL APPROACH

Analysis of the Problem

6. During the last decade, and particularly during the war years, the development and use of both airborne and ground aids to facilitate the navigation of aircraft has meant that the dangers of en route flight in instrument conditions are no longer critical. Although comparable progress has been made in the technique of safe instrument approaches, no equipment or combination of equipments is yet available which meets the requirements of safe instrument landing. Similar considerations apply to instrument take-off but the limiting weather conditions in this case are of a lower order. However, certain minimum weather conditions must prevail in each case if a reasonable standard of safety is to be achieved.

Definition of Weather Minima

7. Meteorological minima are defined by the International Civil Aviation Organisation and in paragraph 13 of Article 17 of the Air Navigation Order, 1949, as amended, as "the minimum heights of cloud base and minimum values of visibility prescribed for the purpose of determining the usability of an aerodrome either for take-off or landing". Normally, separate values are given for each, the latter value being the higher. Throughout this report, I propose to use the term "weather minima" instead of "meteorological minima".

The Factors Governing Determination

8. The object of weather minima is to achieve safety for aircraft operating into or out of aerodromes by relating aircraft performance in its broadest sense to weather conditions. The need for some form of limitation upon operations is unanimously agreed but the exact degree of restriction and the authority who should be held primarily responsible has not been finally resolved internationally. Although the responsibility of the operator for the supervision and safety of his operations is recognised, the State cannot disregard the onus which rests upon it for the general conduct of aviation in and over its territory and of its national operators overseas.

9. The difficulty of reaching a generally acceptable solution is further complicated by the number and nature of the factors involved and the impracticability of translating the effect of each into an exact numerical value. The experience of different agencies (e.g. the State and the operator) must be utilised in evaluating the factors in so far as it is possible so to do. The broad criteria which, when combined, form the yardstick upon which weather minima must be based are:-

(a) Performance of the aircraft,

(b) Instrument flying proficiency of the pilot,

(c) Characteristics of the aerodrome including surrounding topography,

(d) Approach or take-off aids used (e.g. radio and/or lights).

CURRENT CONCEPTS OF WEATHER MINIMA

The International Standards

10. The imposition of weather minima has been the subject of discussion by the Operations Division of the International Civil Aviation Organisation and the resulting recommendations have been incorporated as standards in Annex 6 to the Convention on International Civil Aviation "Operation of Aircraft on Scheduled International Air Services" which became effective on the 1st January, 1950. Since the adoption of this Annex, certain amendments to the standards have been recommended by the 3rd session of the Division. As these amendments have now been adopted by the Council of ICAO, they have been incorporated in the excerpt from the international standards

listed at Appendix B. In short, the international standards require an operator to establish weather minima and to list these minima in his Operations Manual. At the same time they neither require, nor deny the right of, a State to establish minima for the aerodromes under its authority, but, in circumstances where a State establishes such limitations, the minima established by an operator must not be lower than these values except where approved by the State. A further standard requires a State to maintain an aerodrome and its facilities continuously available for flight operations irrespective of weather conditions. The purpose of this standard is to provide for the aircraft which, being in emergency, must be permitted to attempt a landing although, by so doing, its weather minima, however established, will be infringed. This is a principle which has my entire support.

11. The standards contained in Appendix B are applicable to International Scheduled Services. Although an equivalent standard of safety is required of non-scheduled services, ICAO has taken account of the impracticability of operators of such services establishing weather minima for all aerodromes which they may use. The inherent fluidity of non-scheduled operations has been recognised by the Organisation and operators are accordingly made responsible for stating in their Operations Manuals the principles upon which weather minima should be based. Before proceeding on a flight, it is a pilot's duty, with due regard to these principles, to evaluate minima for the aerodromes into and out of which he intends to operate. This constitutes the only difference between the standards for international scheduled services and those proposed for non-scheduled services.

United Kingdom Practice

12. In order to give effect to the standards contained in Annex 6 to the Convention on International Civil Aviation, and in anticipation of the introduction of parallel requirements for non-scheduled operations, certain additions were introduced on the 15th April, 1950 to the then existing code of legislation by the Air Navigation (Amendment) Order, 1950. The further provisions specifically dealing with weather minima are listed in Appendix C. I am informed that United Kingdom policy tends to stress the rights, and therefore the duties, of the operator for weather minima and this is indicated in the requirements which have been established. At present, the United Kingdom does not establish weather minima for its aerodromes, but places a responsibility upon its operators so to do. However, although these limitations are not subject to State approval, the provisions are so written that they are infringed where a violation of minima occurs. It is to be noted that the requirements are only effective in so far as operators of aircraft registered in the United Kingdom are concerned. This practice gives

effect to the view held by the United Kingdom that the State of Registry of a company, rather than the State overflown, should be held responsible for its safety standards.

Practices of other States

13. The lack of international agreement as to the division of responsibility between the State and the operator for the establishment of weather minima indicated that there would be value in studying the practices adopted by other States. A comparison of certain of these national policies, all of which are in conformity with the international standards, is given in summarised form under three main heads at Appendix D. Examination of this information demonstrates that the current practice of the United Kingdom by which the operator is held primarily responsible is at one extreme, that of the majority of States who themselves accept major responsibility is at the other, with that of a few States falling somewhere between. Moreover, it may be concluded from the evidence I have heard that none of these concepts has been adopted without some national disagreement and all are still subject to opposition.

DURATION OF PROBLEM

14. The need to establish, and ensure compliance with, weather minima arises from the fact that there is no aid or combination of aids as yet in use which will permit a landing or take-off to be carried out safely by instruments alone. Moreover, the information which I have received from witnesses indicates that the safe landing or take-off of civil aircraft as a normal practice in such conditions will be impracticable for many years to come. It is, of course, possible to cause a temporary improvement in conditions by the use of Fido and so permit an aircraft to make a safe landing. However, the present capital and high running cost of such an installation precludes its use as an aid at all aerodromes.

Fido

15. I feel I should here place on record the opinions which were expressed to me on the subject of Fido. There was general agreement that a Fido equipment should be available as an emergency aid at some aerodrome in the United Kingdom and that this aerodrome should be equipped with modern aids to instrument approach. Manston Aerodrome, the site of the

current installation, is to some extent deficient in this latter respect. I agree that it is essential to have the necessary aids to instrument approach installed at an aerodrome where Fido is available if the service provided by the equipment is to be utilised to the full.

TERMS IN WHICH WEATHER MINIMA SHOULD BE STATED

Weaknesses of the Present System

16. In accordance with statutory requirements, weather minima are defined by British operators in terms of cloud base and visibility. In the case of cloud base, an immediate difficulty arises in that there is no indication as to the cloud amount which should be used as a basis. The Meteorological Office, in accordance with international agreement, reports the amount of cloud coverage in terms of eighths and certain operators relate the cloud height which they establish as minimum to eight-eighths, i.e. complete cloud coverage. The view can therefore be taken that any cloud below the minimum height stated can be ignored provided it is broken cloud. In practice, however, pilots judge conditions on an approach to landing purely by reference to the slant range they can see ahead of them, a factor which is not directly related to the amount of cloud.

17. The difficulty which is present in respect of the cloud height minimum factor is of little significance in comparison with that which arises as regards visibility. The Meteorological Office, again in accordance with international agreement, defines visibility as the distance at which a fairly large dark object can be recognised for what it is when seen against the horizon sky as background. By night, the measurement is made by reference to lights of known candlepower and from the information obtained an equivalent daylight visibility is calculated, i.e. the visibility which would exist in the same conditions by day. Instructions are given as to the time at which these measurements are to be taken and these are promulgated in paragraph 4.6 Part II - Meteorology of the Air Pilot. In brief, the meteorological officer is held responsible for supplying hourly or half-hourly weather reports to Air Traffic Control for subsequent transmission to aircraft and additionally, in low visibilities, for intermediate reports where significant changes occur.

18. It is essential in low visibilities that a pilot be given accurate information of the weather conditions which will prevail during his take-off or approach and landing, but it is in these very conditions that

meteorological measurements may be at variance with a pilot's assessment. Two main characteristics of fog are its variability in time and space and this is particularly true while improvement or deterioration is taking place. Any significant change in the density of fog which may occur over a short period is provided for by the instructions referred to in the previous paragraph. But, in general, those dependent upon place of observation have not similarly been taken into account.

Runway Visibility

19. Runway visibility might well be defined as the visibility observed from the approach end of the runway where it is measured in accordance with current meteorological standards. Thus, where observations of meteorological and runway visibility are made simultaneously, any difference in the respective values obtained will be due solely to the differing points of observation. Although information of the runway visibility would be of more assistance to the pilot than meteorological visibility, it is still not what he wants to know. I have, however, considered it necessary to make reference to these visibilities as, in the evidence placed before me, some confusion appeared to exist in differentiating between them and runway visual range to which I refer below.

Runway Visual Range

20. A pilot wishes to know the distance at which he will be able to differentiate between the runway and the strip surrounding it. I propose to call this distance "Runway Visual Range". By day, in the absence of daylight runway markings and runway lights, such visual range would normally be less than the runway visibility. Where effective daylight runway markings were available or where the runway lights were switched on, the runway visual range would approximate to the runway visibility. I am advised that no specific instructions have been issued as to the visibility below which the runway lights should be switched on by day. In the light of evidence placed before me, I consider that they should be illuminated whenever visibility falls below one nautical mile or at higher visibilities if requested by a pilot. I further consider that action to install daylight runway markings should be expedited since, in certain weather conditions, they afford a greater runway visual range than is provided by lights. At night, the runway visual range would be obtained by reference to the runway lights.

21. It would be wrong to suggest that there has been a lack of knowledge of the weaknesses to which I have referred or that the Meteorological Office has failed to meet requirements placed upon it. In the

particular case of runway visual range, your Air Safety Board, in December, 1948, invited the Meteorological Office to carry out trials with a view to deciding how pilots could best be provided with accurate information of visibility. These have been proceeding at London Airport. Certain difficulties existed in giving full effect to the Air Safety Board's request but provision was made for the measurement of runway visibility, as an experimental measure, when visibility fell below one nautical mile. Pilots were so informed in Information Circular No. 48 of the year 1949. As to daylight runway markings, trials have taken place at Hurn Airport under the direction of your Department. They are now being put down at London Airport in accordance with an Air Safety Board recommendation.

22. From the evidence placed before me, it is clear that all operators and pilots place the greatest importance on the introduction of an accurate runway visual range measurement. I fully support this view and have reached the conclusion that, when visibility falls below one nautical mile, provision should be made at all airports for the measurement and subsequent promulgation of this information to pilots - in the light of experience, it may, of course, be possible to introduce this procedure at a lower visibility criterion. The measurement should be made from the approach-end of the runway in use by reference to the runway lights. I make this recommendation notwithstanding the fact that there still exists a difference of opinion as to whether the height of the observer might introduce noticeable variations in the value measured. I accept the view, however, that trials might well be carried out to determine the importance of having an observer at a height equivalent to that of an average cockpit, but such trials should not be permitted to interfere with speedy implementation of my main conclusion. At runway visual ranges in excess of approximately 1 000 yards, it is extremely difficult to differentiate between successive lights in a row but, in such conditions, which are not dangerously critical, I consider that the observer should, in the light of experience, be able to give a sufficiently accurate evaluation.

23. Several of the witnesses who placed great stress on the need to have a reliable runway visual range measurement were representatives of the International Air Transport Association, an association which is unanimous on this subject. I mention this fact since runway visual range is a value which should be available to pilots not only at aerodromes in the United Kingdom but also, in so far as British operators are concerned, at International aerodromes in other States. It appears necessary, therefore, to initiate action through the International Civil Aviation Organisation with the aim of encouraging other contracting States to introduce a similar practice.

Approach and Runway Lighting

24. The purpose of informing a pilot of the runway visual range when low visibility exists is to acquaint him with conditions along the runway which, even on his approach, he may not be able to judge for himself. In low dense fogs, in particular, it is possible for a pilot to be encouraged to attempt a landing by virtue of the adequate visual reference provided by high intensity approach lights, yet the ground visibility be so low as to make a landing hazardous. These facts point to the conclusion that these weather conditions are the most dangerous a pilot can experience in a landing operation. I have been advised that the visual pattern provided by the approach lights at London Airport in low visibility is much superior to that provided by the runway lights. I am further informed by the technical experts that the guidance pattern afforded to pilots by the runway lights may be of the order of 1/30 of that provided by the approach lights when visibility is poor. Thus on the final and critical stage of a landing a pilot, in changing his visual reference from the approach to the runway lights, may find himself with inadequate guidance. This fact is realised, and I understand that further trials of runway lighting are scheduled to take place. I consider that these trials should be expedited.

The Recommended System

25. I have dealt in the immediate preceding paragraphs with the weaknesses in the present method of defining weather minima and of the lack of relationship between the information reported and that which the pilot desires to know. Just as it is necessary to report weather conditions in realistic terms, it is equally important to define weather minima in like terms. However, the form in which weather minima for landing is expressed has to be varied according to the method of approach being used by a pilot. In the case of an approach using an aid which gives azimuth, and possibly elevation information, a pilot's ability to land will be dependent upon the visibility which he has and can maintain in the direction of the runway from a critical height, and the visibility which he has along the runway during the rounding-out, hold-off and landing phase. Thus the three terms in which weather minima should be stated are critical height, critical height visibility, and runway visual range. Critical height might well be defined as that height below which it would be impracticable to carry out an over-shoot with adequate terrain clearance. It would accordingly be determined on the basis of the efficiency of the radio facility used, the upstanding obstructions in the approach and overshoot paths, the performance of the aircraft, and the instrument flying proficiency of the pilot. A pilot should not descend below this height unless he is in visual reference to the ground or the approach lights, has sufficient visibility to continue an approach with safety and, in particular, has adequate runway visual range in order to effect a safe

landing. Of the three terms mentioned, I find that only the critical height and the runway visual range should be given numerical value. There is little point in evaluating the visibility that a pilot will require from critical height since there is as yet no method of measuring from the ground what it will be, nor has a pilot a yardstick by which he can make a simple judgment as to the relationship between the conditions he experiences and the minimum laid down. In the case of an approach on which the aircraft, on arrival at the aerodrome, requires to circle visually, minima should be prescribed as ceiling, visibility and runway visual range and the minimum weather conditions so chosen will, with the exception of the latter, require to be better than those for a straight-in approach.

26. For take-off, weather minima should be expressed in terms of runway visual range and, as necessary, ceiling. Throughout this report, I use the term "ceiling" as defining the height of the base of the lowest cloud covering more than half the sky.

27. There would appear to be value in inviting each contracting State to the International Civil Aviation Organisation to require its operators to establish weather minima in the same terms as are described in the two preceding paragraphs. This action could be taken simultaneously with that which I have already proposed at paragraph 23.

RESPONSIBILITY FOR ESTABLISHING WEATHER MINIMA

The Three Possible Authorities

28. There are three main parties who might well be held responsible for the evaluation of weather minima; namely the State, the operator, or the pilot. It might be argued that the State has a responsibility for ensuring that an overall standard of safety is maintained over its territory and by its national operators over foreign territory. As it has already established safety standards in respect of airworthiness and various operational matters, and since weather minima is an operational problem, it would appear to follow that the State might logically be held responsible for the establishment of weather limitations. Furthermore the State is, in a sense, an "operator" by virtue of the fact that it is responsible for the provision and administration of aerodromes and for the efficiency of ground facilities. It is, therefore, the authority best able to judge the stage at which bad weather conditions place an unacceptable limitation on the satisfactory operation of the facilities it provides. On the other hand, the

airline company is directly responsible, with due regard to its national regulations, for establishing the level of safety to be achieved in its operations and, since weather minima is a fundamental factor in this matter, it is reasonable for it to evaluate the limits which should apply. Finally, the view might well be taken that no matter how comprehensive and intricate a system of pilot licensing and periodic training is introduced, there will always be noticeable variations in professional ability and therefore, for a certain standard of safety, the severity of weather limitations must necessarily vary from individual to individual. Thus, the only method by which a fixed standard of safety can be achieved would be obtained by placing complete reliance on individual pilots. Further support for this proposal might be advanced on the grounds that the general responsibility for deciding whether to land or to take off is one which is placed upon the pilot.

The State

29. Any proposal to place responsibility on the State for the establishment of weather minima is strongly opposed both by pilots' associations and operators. Neither is it advocated by your Department, although a proposal has been made that it would be reasonable for the State to close aerodromes at a weather limit below which any attempt to land or to take off might well be disastrous. Such a system, of course, still envisages that operators would lay down weather minima above these limits. Although the view was put to me that there need be no danger of the weather limits at which the State closes the aerodrome being regarded as the effective weather minima, it appears to me that there would most certainly be a tendency amongst pilots to take the view that when an aerodrome was open it was safe to attempt to land. This fact is of paramount importance, for although a minority of accidents would have been prevented by closing aerodromes at the low limits envisaged in the above proposal, a larger proportion have, in fact, occurred in conditions above these values. In the end, therefore, adoption of the proposal would, in my opinion, result in an increase, rather than a decrease, in the number of accidents. Moreover, I feel that your Department would be open to serious criticism on the grounds that, although a procedure to close aerodromes was in force, they nevertheless remained open in weather conditions which were accepted as dangerous by experienced opinion. I have given this proposal to close aerodromes most detailed consideration and find myself unable to accept it. I would, however, explain that I am not opposed to the aerodrome authority having the power to close a runway in certain circumstances such as in the event of a temporary obstruction.

30. In principle, I have come to the conclusion that it would be undesirable for the State to establish minima of any character. I would

add, however, that a pilot should always be warned if, for some reason, the aerodrome facilities, notified as being available, are either not functioning or are unable to work efficiently, where this information would appear to affect a pilot's decision. Action of this nature is currently taken, for example, in circumstances where radio aids become unserviceable or are liable to errors but is not applied generally, e.g. in the case of the fire service.

The Operator or the Pilot

31. There remains the question of whether the operator should establish minima or whether the pilot should be left to use his discretion. I received no evidence in support of the latter alternative and it was notable that the British Air Line Pilots Association did not advocate its adoption. I agree that it would be wrong to leave the decision entirely to the pilot. Not only would it place an unwarrantable burden upon him but it would also initiate a practice already proven dangerous. For instance, there is evidence that take-off and landing accidents have occurred which have revealed pilot error as a factor. I should like to say at once that I do not believe that any trained airline pilot consciously compromises safety but I do consider that, on psychological grounds, a number of pilots are influenced into attempting a landing in dangerous conditions. There would accordingly appear to be a need for some overriding control and I am satisfied that this should remain an operator's responsibility. I therefore confirm that the existing procedure by which operators are held responsible for the evaluation of minima is the most desirable of the alternatives.

PROCEDURE TO BE ADOPTED

The Need for Additional Safeguards

32. It may be said that experience has shown that accidents do take place under a system by which operators are required to lay down minima. We must benefit from this experience by taking additional safeguards. Certain safeguards have already been mentioned where I have recommended the measurement of runway visual range and a change in the terms in which weather minima are defined. Nevertheless, I believe further precautions are still necessary.

State Approval of Minima

33. By current practice, operators are required to lay down weather minima and by paragraph 11 of Article 17 of the Air Navigation Order, 1949, as amended, it is provided that where the minima are infringed the aircraft is in default. Such a regulation has no safety value where a company's minima are placed at a dangerously low level. Although the view might be taken that the survival of an airline depends upon its safety record and that inadequate company minima might therefore be dismissed as a source of weakness, there is evidence, nevertheless, that such minima have existed. I consider, therefore, that the State should hold itself responsible for the approval of minima. I realise that a strong case can be made against this proposal on the grounds that the argument that the operator is the only authority capable of taking account of all factors governing the evaluation of weather minima, is equally one that militates against State approval. I recognise the force of this argument but, after careful consideration of the evidence, am satisfied that the State is not so divorced from a practical understanding of the considerations as is often suggested. In fact, the State has taken action in the past to invite operators to review minima which were considered rather low and, in every case, its advice has resulted in minima being raised in value. Approval of minima should, of course, be a responsibility of the State of Registry and I take the view, therefore, that those foreign companies which operate into aerodromes in the United Kingdom should be required to have their minima approved by their State authority and notified to your Department.

34. There must be one exception to the procedure which I have recommended above. In the case of the operator of non-scheduled services, the fluidity of his operations has been recognised in the existing statutory requirements by providing that minima be established only for those aerodromes used frequently. For other aerodromes, the pilot is held responsible for evaluating a minima based on principles laid down by his company. I consider that this waiver must continue to be effective but I would recommend that the non-scheduled operator be invited to establish minima in respect of as many aerodromes to which he may operate as it is practicable so to do. Such minima would, of course, be subject to State approval.

ACTION TO PREVENT INFRINGEMENT

The Benefits of the Recommended System

35. From information obtained from accident reports it would appear that a number of accidents have occurred in weather conditions below

the minima laid down by the company concerned - certain companies had established minima prior to the introduction of the statutory requirements. Where violations of minima may have taken place, it has always been difficult for the operator to discipline his pilots or for the State to take legal proceedings owing to the discrepancies which were known to exist between the reported conditions and those which a pilot might experience. With the introduction of minima giving visibility in terms of runway visual range, and with due regard to the fact that both operators and pilots have indicated agreement that such a value would give an accurate assessment of the visibility a pilot would experience, it will be a simpler task to judge whether future minima have been infringed in this particular respect.

Action by the Operator and by the State

36. I paid particular attention to the various suggestions made as to the method by which compliance with minima might be ensured. Proposals have been made that the operator, who must be held responsible for the discipline of his pilots, is the right and proper authority. In this regard, the Association of Supervisory Staffs Executives and Technicians submitted that a company flight dispatch system incorporating the use of flight operations officers would make a useful contribution to safety. Such officers would be company employees stationed at the various aerodromes to which the company's aircraft operated and would be responsible for advising company pilots whether to land or divert. Though this system has advantages, I make no specific recommendation since a decision whether to employ such a system must be made in the light of wider considerations than weather minima alone. On the other hand, there has been support for additional action by the State. It was suggested that the aerodrome authority be given powers to refuse clearance to land, except in emergency, or to take off when the reported runway visual range fell below the minimum established by the operator. After due consideration, I have come to the conclusion that the operator should be held responsible for requiring his pilots to abide by the minima established and that, in so doing, he should issue clear instructions that a pilot is not to attempt to land where the weather conditions he experiences are below minima. It must be realised that it is impracticable both to define weather minima and to measure runway visual range with absolute precision. Moreover the runway visual range may vary within limits over a short period. I consider it necessary, therefore, to permit a limited degree of discretion to pilots where the runway visual range reported is below their minimum. However, they should be instructed that, where the runway visual range is a certain percentage below that laid down as minimum, even a trial approach is not permitted. It is, of course, essential that the State should retain the right by statute to prosecute where the aircraft infringes its minima and I am convinced that, if my conclusions are adopted, these powers can be more effectively used. In this regard it would appear necessary to circulate

relevant operators' minima to the aerodrome authority so that any take-off or landing made below the runway visual range minimum may be reported.

37. I believe that one further step is necessary. Although there is no known instance of a company placing pressure on a pilot to land at his aerodrome of intended destination when conditions were below minima rather than diverting, it has been indicated to me that the procedure adopted by certain companies when diversions do take place may have just this effect. These companies require a pilot who carries out a diversion to submit a report to his headquarters. I well realise that there may be reasons why such a report is necessary, but it often transpires that a pilot believes that this action indicates that his professional capabilities are in question. A natural corollary to this attitude is that he is averse to diverting in conditions that are marginal - no doubt he may already be influenced for personal and other reasons by the inconvenience of a diversion. Every step must be taken by companies to rid the pilot of this outlook. It would appear to me that, as a general principle, companies should insist most strongly on reports from pilots who land at their intended destination below established minima. This is particularly important since there is an implied, if unintended, slur on the ability of a company pilot who diverts in conditions comparable to those in which another lands safely, though the decision of the former might well be the correct one.

GENERAL CONCLUSION

38. I am convinced that the system which I have proposed can make a valuable contribution towards aircraft safety provided it is made to work efficiently by the wholehearted co-operation of the operator and pilots.

ACKNOWLEDGMENTS

39. You made my task easier indeed by appointing Mr. D.C. Clark to act as Secretary. His personality and comprehensive knowledge kept us always "down the runway" and I am immensely grateful for his help.

I have the honour to be,

Your obedient Servant,

BRABAZON of TARA.

D.C. Clark, Secretary.
18th January, 1951.

APPENDIX "A"

List of Witnesses from whom Oral Evidence was Received

Sir George Cribbett, K.B.E., C.M.G.	Deputy Secretary, Ministry of Civil Aviation
A.S. Le Maitre, Esq., C.B., M.C.	Controller of Ground Services Ministry of Civil Aviation
A.H. Wilson, Esq., C.B., C.B.E.	Under Secretary Ground, Ministry of Civil Aviation
Air Commodore W.E.G. Mann, C.B.E., D.F.C., R.A.F. (ret.).	Director General of Navigational Services, Ministry of Civil Aviation
Group Captain J.B. Veal, A.F.C.	Director of Operations, Safety and Training, Ministry of Civil Aviation
W.M. Hargreaves, Esq.	Director of Navigational Services (Aerodromes), Ministry of Civil Aviation
A.C. Carter, Esq., D.F.C.	Deputy Director of Control and Navigation (Operations), Ministry of Civil Aviation.
D.F. Peel, Esq.	Deputy Director of Operations and Safety, Ministry of Civil Aviation
Air Vice Marshal S.P. Simpson, C.B., C.B.E., M.C., R.A.F. (ret.).	Divisional Controller, London and South Eastern Division, Ministry of Civil Aviation
Air Marshal Sir John H. D'Albiac, K.B.E., C.B., D.S.O., R.A.F. (ret.).	Aerodrome Commandant, London Airport, Ministry of Civil Aviation
Air Commodore Vernon S. Brown, C.B., O.B.E., R.A.F. (ret.).	Chief Inspector of Accidents, Ministry of Civil Aviation
P.G. Tweedie, Esq. O.B.E.	Deputy Chief Inspector of Accidents, Ministry of Civil Aviation

J. Durward, Esq.	Deputy Director of Meteorological Office (S), Air Ministry
E.S. Calvert Esq., B.Sc.	Royal Aeronautical Establishment, Ministry of Supply
Lord Douglas of Kirtleside, G.C.B., M.C., D.F.C.	British European Airways Corporation
Captain J.W.G. James, O.B.E.	British European Airways Corporation
Captain W. Baillie	British European Airways Corporation
Captain A.S. Wilcockson, O.B.E.	British Overseas Airways Corporation
E. Rylands, Esq.	British Air Charter Association
Captain H.J. Cormack	British Air Charter Association
Captain A. Upton	British Air Line Pilots' Association
Captain J. Woodman	British Air Line Pilots' Association
Captain F. Ormonroyd	British Air Line Pilots' Association
R. Ashton, Esq.	Guild of Air Pilots and Air Navigators of the British Empire
Flight Lieutenant F.R. Leatherdale, D.F.C.	Guild of Air Pilots and Air Navigators of the British Empire
Captain N.C. Green, D.S.O., D.F.C.	Guild of Air Pilots and Air Navigators of the British Empire
Major J.L.B.H. Cordes	Guild of Air Pilots and Air Navigators of the British Empire
D.C. Jenkins, Esq.	Association of Supervisory Staffs Executives and Technicians
R.D. Cooling, Esq.	Association of Supervisory Staffs Executives and Technicians
J.B. Levien, Esq.	Association of Supervisory Staffs Executives and Technicians
D.F. Newham, Esq.	Association of Supervisory Staffs Executives and Technicians

S. Krejcik, Esq.	International Air Transport Association
Captain P.A.J. Dils	International Air Transport Association
D.C. Rustom, Esq.	International Air Transport Association
K.H. Gibney, Esq.	International Air Transport Association

List of Witnesses from whom Written Evidence was Obtained

Sir Frederick Tymms, K.C.I.E., M.C.	United Kingdom Representative on the Council of ICAO
Air Marshal D. Colyer, C.B., D.F.C., R.A.F. (ret.).	Civil Air Attaché, Paris
Group Captain C. Clarkson, A.F.C.	Civil Air Attaché, Washington
Wing Commander G.M. Macintosh, O.B.E., R.A.F. (ret.).	Director General of Navigational Services Planning Group
Air Commodore D.F. Lucking, R.A.F. (ret.).	Chief Civil Representative at Ministry of Supply, Ministry of Civil Aviation

APPENDIX "B"

International Standards on Weather Minima and Flight Supervision - Excerpts from Annex 6 as amended

Meteorological Minima

Chapter 3.
Amendment to Annex 6.

"Subject to the published hours of operation and conditions of use, an aerodrome and its facilities shall be kept continuously available for flight operations irrespective of weather conditions."

Chapter 3.
Amendment to Annex 6.

"The Operator shall establish the meteorological minima to be used at each aerodrome at which he intends to operate and shall list these minima in his Operations Manual."

Chapter 3.
Annex 6.

"A flight to be conducted in accordance with Visual Flight Rules shall not be commenced unless current meteorological reports or a combination of current reports and forecasts indicate that the meteorological conditions along the route or that part of the route to be flown under Visual Flight Rules are, and will continue to be, such as to make it possible for the flight to be conducted in accordance with Visual Flight Rules."

Chapter 3.
Amendment to Annex 6.

"A flight to be conducted in accordance with Instrument Flight Rules shall not be commenced unless the available meteorological information indicates that meteorological conditions at at least one aerodrome specified in the flight plan will, at the expected time of arrival, be at or above the aerodrome meteorological minima listed in the Operations Manual for that aerodrome when used as an alternate."

Chapter 3. Amendment to Annex 6.	"The meteorological minima for an aerodrome as contained in the Operations Manual shall not be lower than any that may be established by the State in which the aerodrome is located, except when specifically approved by that State."
Chapter 3. Amendment to Annex 6.	"Except in case of emergency, an aircraft shall not continue its approach-to-landing at any aerodrome beyond a point at which the meteorological minima specified for that aerodrome in the Operations Manual would be infringed."

Flight Supervision

Chapter 2. Amendment to Annex 6.	"An operator or his designated representative shall have responsibility for operational control."
Chapter 3. Annex 6.	"An operator shall establish and maintain a method of supervision of flight operations. The method shall be approved by the State of Registry."

APPENDIX "C"

Provisions of the Air Navigation Order, 1949, as amended, in respect of Weather Minima and which are applicable to Public Transport Aircraft registered in the United Kingdom

Article 17 (4)

"The operator shall provide for the use and guidance of the members of the operating crew an Operations Manual containing such particulars as may be prescribed, such further information as to the conduct of flying operations as will enable them to become fully acquainted with the nature of such operations and clearly outlining the duties and responsibilities of each of them, and the particulars referred to in paragraph (7) of this Article."

Article 17 (7)

"(a) As to any flight to be made by the aircraft on a scheduled journey, the operator shall establish aerodrome meteorological minima for each aerodrome of intended destination and any alternate aerodrome on the route of such a flight and shall specify such minima in the said Manual:

Provided that no such minima for any particular aerodrome shall be lower than the aerodrome meteorological minima, if any, for that aerodrome established by the appropriate authority, unless such minima have been specifically approved by or on behalf of that authority.

(b) As to any flight to be made by the aircraft otherwise than on a scheduled journey, the operator shall specify in the said Manual the method by which the aerodrome meteorological minima for each aerodrome of intended destination and any alternate aerodrome on the route of such a flight shall be determined:

Provided that, if any such aerodrome will frequently be used, the operator shall establish such minima for that aerodrome and shall specify such minima in the said Manual."

Article 17 (8)

"When a flight is planned in circumstances where the meteorological information obtained by the person in command of the aircraft which will be engaged therein indicates that Instrument Flight Rules will be in force at the aerodrome of first intended landing, he shall select an alternate aerodrome unless no such aerodrome suitable for use in the circumstances of the case is available."

Article 17 (9)

"Prior to commencing a flight, the person in command of the aircraft which will be engaged therein shall satisfy himself as to the aerodrome meteorological minima for take-off at the aerodrome of departure and for landing at the aerodrome of first intended landing and, if the last foregoing paragraph is applicable with respect to the flight, for landing at an alternate aerodrome selected by him, as specified in the said Manual, or in a case where such minima are not so specified, as determined by him in accordance with the method specified in the said Manual:

Provided that, if such minima for any such aerodrome are so determined, they shall not be lower than the aerodrome meteorological minima, if any, for that aerodrome established by the appropriate authority, unless such minima have been specifically approved by or on behalf of that authority."

Article 17 (10)

"The aircraft shall not commence a flight unless the meteorological information obtained by the person in command thereof indicates that weather conditions at the aerodrome of first landing, or if paragraph (8) of this Article is applicable with respect to the flight, at any alternate aerodrome selected by him will at the estimated time of arrival at that aerodrome be at or above the aerodrome meteorological minima for landing at that aerodrome as specified in the said Manual or, as the case may be, as determined by him in accordance with the provisions of the last foregoing paragraph."

Article 17 (11)

"The aircraft shall not, unless compelled by accident or other unavoidable cause, continue its approach to landing at any aerodrome beyond a point at which the limits of the aerodrome meteorological minima for landing at that aerodrome as specified in the said Manual or, as the case may be, as determined by the person in command thereof in accordance with the provisions of paragraph (9) of this Article would be infringed."

APPENDIX "D"

Policy on Weather Minima Adopted by Other States

In order to clarify the policies adopted by other States, three main questions were put to them. These questions and the replies received are outlined below:

1. Whether the State or any other authority prescribes weather minima for aerodromes in your territory?

AUSTRALIA

"Yes. The Department of Civil Aviation of the Commonwealth Government prescribes weather minima for all aerodromes in Australian territory at which aircraft are permitted to make instrument approaches. These minima are prescribed in Air Navigation Orders Part XII 'Instrument Approach Procedures' issued pursuant to Air Navigation Regulations 159 and 248 and operators must abide by them."

CANADA

"Yes. The Canada Air Pilot, published under authority of the Minister of Transport and compiled and issued by the Surveys and Mapping Branch, Department of Mines and Technical Surveys, Ottawa, prescribes weather minima for aerodromes in Canadian territory. Approval may be given to further reductions in the minima in the case of scheduled operators whose experience over a given route and in the use of available aircraft equipment and facilities warrant such concession. These reduced minima must be included in the operator's Operations Manual approved by the Department of Transport."

DENMARK AND SWEDEN

"Yes. Weather minima for aerodromes within Danish and Swedish territory are prescribed by the State concerned."

FRANCE

"For all aerodromes which may be used in Instrument Flight Rules conditions, the Secretariat General for Civil and Commercial Aviation promulgates ceiling and visibility minima which may differ from one aerodrome to another and which, for a given aerodrome, may vary according to the aid used."

NETHERLANDS

"The State nor any other Authority prescribes weather minima for aerodromes in Netherlands territory."

UNITED STATES OF AMERICA

"Weather minima are prescribed for all aerodromes in U.S. territory pursuant to Section 60.46 of the Civil Air Regulations. The general section of the CAA Flight Information Manual pertaining to 'Standard Instrument Approach Procedures' is followed by specific details according to the facilities being used, i.e., low frequency range procedures, VHF procedures, etc., and as to each airport specific ceiling and visibility minima are set forth."

2. What is the degree of responsibility or restriction placed upon foreign operators (aircraft) on flights to aerodromes in your territory (i.e., pilot's freedom to decide to land)?

AUSTRALIA

"The provisions contained in our reply to question 1 are equally applicable to foreign operators."

CANADA

"The provisions contained in our reply to question 1 are equally applicable to foreign operators."

DENMARK AND SWEDEN

"When weather conditions at an aerodrome within Danish or Swedish territory are below the minima prescribed, foreign aircraft are not permitted to land or attempt to land."

FRANCE

"The provisions contained in our reply to question 1 are equally applicable to foreign operators."

NETHERLANDS

"Foreign operators (aircraft) on flights to aerodromes in the Netherlands are not restricted and do so on their own responsibility."

UNITED STATES OF AMERICA

"The U.S. places restrictions on foreign operators. These are covered first of all in Section 44.2 of the Civil Air Regulations, also by Section 44.6 providing, in part, that all operations within the United States shall be conducted in accordance with the air traffic rules prescribed in Part 60 of the Civil Air Regulations. Therefore, the minima prescribed generally under Section 60.46 as mentioned in reply to question 1 would also apply to all foreign operators unless specific minima had been established for a particular operator in accordance with Section 44.2."

3. The degree of responsibility or restriction placed on your operators (aircraft) on flights to aerodromes either in your territory or foreign territory?

AUSTRALIA

"Australian operators are required to comply with the weather minima in force in Australian territory. On flights over foreign territory, Australian operators must abide by minima set out in their Operations Manual and approved by the Department of Civil Aviation, Australia. They would also, of course, abide by a minima prescribed by the State for the aerodrome to which they are operating if this was higher than the minima approved in the Operations Manual. In practice, co-ordination is effected between the Governments concerned to ensure that such a case does not occur."

CANADA

"Canadian operators are required to comply with the weather minima in force in Canadian territory. On flights beyond Canada they will be subject to such other regulations as may be in force there, but will not be absolved, in the absence of such regulations, from the consequences of the neglect of any precaution that may be required by the ordinary practice of the air or by the special circumstances of the case. In the case of scheduled operators serving points outside Canadian territory under a bilateral air agreement, approval is given for weather minima at each such point in the Operations Manual, provided that in no case will approval be given for minima below those specified by the State in which the aerodrome is situated."

DENMARK AND SWEDEN

"Danish and Swedish operators are required to comply with the weather minima in force in their territory. On flights beyond Denmark and Sweden, the weather minima specified in the relevant Operations Manual must be complied with."

FRANCE

"The French Administrative Authorities allow their operators and pilots complete freedom with regard to approach and landing procedures in other countries but within the regulatory limits laid down by the country concerned."

NETHERLANDS

"Royal Dutch Airlines has provided weather minima for every regular airport and these minima are approved by the Department of Civil Aviation."

UNITED STATES OF AMERICA

"Restrictions on U.S. operators on flights abroad are set forth generally in Section 41.1 of the Civil Air Regulations which again calls for an air carrier operating certificate. Weather minima are prescribed in Section 41.96.b, which provides that aircraft may be dispatched etc., only if it appears that the ceiling and visibility will be at or above the minimum specified when the flight is scheduled to arrive. This specified minimum with respect to a particular aerodrome would be that established in the CAA approved operating certificate, or that specified by the State having jurisdiction over the aerodrome and the operator would be required to conform to whichever requirement was more severe."

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<u>Note</u>.- Copies of this Report may be had from Her Majesty's Stationery Office - London.

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