

ACCIDENTS INVESTIGATION BRANCH  
Department of Trade and Industry

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**Douglas DC3 PH-MOA**  
**Report on the accident at Southend**  
**Airport, on 3 June 1971**

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LONDON: HER MAJESTY'S STATIONERY OFFICE  
1973

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List of Civil Aircraft Accident Reports issued by AIB in 1972 and 1973

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14/72	Piper Cherokee Arrow PA 28R-200 D—EHBR at Saron, Carmarthenshire, May 1971	November 1972
15/72	BEA Vanguard G—APEC at Aarsele, Belgium, October 1971	December 1972
1/73	Douglas DC 3 PH—MOA at Southend Airport, June 1971	February 1973

Department of Trade and Industry  
Accidents Investigation Branch  
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22 November 1972

*The Rt Honourable Peter Walker MBE MP  
Secretary of State for Trade and Industry*

Sir,

I have the honour to submit the report by Mr G M Kelly, an Inspector of Accidents, on the circumstances of the accident to Douglas DC 3 PH-MOA which occurred at Southend Airport on 3 June 1971.

I have the honour to be  
Sir  
Your obedient Servant

V A M Hunt  
*Chief Inspector of Accidents*



Accidents Investigation Branch  
Civil Accident Report No EW/C 382

*Aircraft:* Douglas DC 3 PH-MOA  
*Engines:* 2 Pratt and Whitney R1830 - 90D  
*Owner and Operator:* Moormanair Ltd  
*Crew:* In Command - Captain W B Merrick - Uninjured  
Supernumerary - Captain J L J Van  
de Meulebroek - Uninjured  
Co-pilot - F/O K J Muns - Uninjured  
Stewardess - I Frese - Uninjured  
*Passengers:* 2 - Slightly  
injured  
30 - Uninjured  
*Place of Accident:* Southend Airport  
*Date and Time:* 3 June 1971 at 0125 hrs

All times in this report are in GMT

## Summary

Following a fall in manifold pressure and the discovery of an oil leak in the starboard engine soon after a night take-off the pilot decided to return to Southend Airport for an emergency landing. In order to avoid an overshoot he used 15° of flap for the landing which resulted in a higher than normal air-speed at touchdown. The aircraft touched down about half-way along the runway in use, overran the paved area and collided with an earth bank. Of the thirty-two passengers and four crew on board the aircraft, two passengers were injured. The aircraft was substantially damaged.

The report concludes that the accident was due to a late touchdown and inappropriate use of the flaps. Insufficient braking efficiency resulted in a higher speed of overrun than would have otherwise occurred.

# 1. Investigation

## 1.1 History of the flight

The aircraft was on an international passenger charter flight from Southend Airport to Amsterdam with thirty-two passengers and four crew.

Soon after take-off, which was made with Captain Van de Meulebroek at the controls in the left hand seat, Captain Merrick noticed a one inch Hg drop in manifold pressure of the starboard (No 2) engine which would not respond either to adjustment of the throttle or to the application of carburettor air heat. Examination by torch from the cockpit window revealed an oil leak near the top of the engine and, after some discussion with the crew, the commander decided to return to Southend. In view of his greater experience on DC3 aircraft Captain Merrick placed himself at the controls in the left hand seat. To avoid overheating of the port engine, the faulty engine was kept running to make use of the available power since there was no other indication of abnormal temperature or pressure.

During the approach (for which he was offered surveillance radar assistance), the commander requested, and was given, a tighter turn in to land because of the worsening condition of the faulty engine. Four miles out on final approach he said he had the runway lights in sight and the radar assistance was discontinued. At this stage the hydraulic pressure was normal, the undercarriage was lowered and 15° flap was selected. The approach and landing were continued visually.

According to the pilots' statements the final approach was made at the normal descent rate and slope and the airspeed, last noted on passing the high intensity approach lights, was 100 knots. The aircraft touched down approximately half-way along the runway and, immediately afterwards, the pilot retracted the flaps in order to provide greater 'bite' for the brakes. The aircraft continued its landing run with no appreciable deceleration and with its tail wheel well clear of the ground. The brakes appeared to the pilots to be ineffective and, as the end of the runway approached, the commander attempted to disengage the tail wheel lock to enable him to turn the aircraft. It slewed some 20° to port before leaving the end of the runway at about 30 knots to collide with, and come to rest on, the grass bank at the edge of the airfield.

When the impact was seen to be inevitable Captain Van de Meulebroek, who was standing between the two pilots, pulled the engine fire wall shut off cocks and the commander switched off the ignition master switch.

There was no fire. Two of the passengers were slightly injured and the aircraft was substantially damaged.

The fire and rescue services had followed the aircraft down the runway and began fire inhibiting operations as soon as it had stopped. The passengers used the normal aircraft airstairs to disembark.

## 1.2 Injuries to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>
Fatal	—	—	—
Non-fatal	—	2	—
None	4	30	—

## 1.3 Damage to aircraft

The aircraft was substantially damaged.

## 1.4 Other damage

Slight damage to airport boundary fence.

## 1.5 Crew information

Captain W B Merrick, aged 25, held a current United States of America (USA) airline transport pilot's licence, with a Netherlands validation, endorsed for command of DC3 aircraft. His most recent certificate of test was dated April 1971 and his last medical examination was on 2 March 1971. At the time of the accident his total flying experience was 4,663 hours of which approximately 1,750 hours were in command of the DC3. He had flown 73 hours during the 28 days preceding the accident and had 39 hours off before reporting for duty in Amsterdam at 0700 hrs on the day preceding the accident. He then operated a flight to Southend, returning to Amsterdam at 1000 hrs. At 1300 hrs he operated a flight from Amsterdam to London Heathrow Airport where he took a rest period from 1500 hrs until 2220 hrs before operating a flight from London Heathrow to Southend Airport at 2330 hrs. This flight was followed by the flight that terminated in the accident.

Captain J L J Van de Meulebroek, aged 39, held a current USA airline transport pilot's licence, with a Netherlands validation, endorsed for command of DC3 aircraft. His certificate of test was dated March 1971 and his last medical examination was on 6 January 1971. At the time of the accident his total flying experience was 3,247 hours of which 230 hours were on the DC3 aircraft as captain and co-pilot. He had flown 77 hours during the 28 days preceding the accident and had 5 days off before reporting for duty at 0700 hrs in Amsterdam on the day before the accident. Thereafter his activities were the same as Captain Merrick.

First Officer K J Muns, aged 29, held a current USA commercial pilot's licence with a Netherlands validation, endorsed for command of DC3 aircraft under VFR conditions only. His last medical examination was on 5 February 1971 and at the time of the accident, his total flying experience was 1,604 hours of which 125 hours were on the DC3 aircraft as captain and co-pilot. He had flown 25 hours during the last 28 days and had 39 hours off duty before joining Captains Merrick and Van de Meulebroek at 0700 hrs on the day preceding the accident.

## 1.6 Aircraft information

The aircraft was constructed in 1944 by the Douglas Aircraft Corporation and had completed a total of approximately 6,372 hours flying up to the time of the accident. The certificate of airworthiness had last been renewed on 18 December 1970 and the last Check 2 inspection was carried out at 6,226 hours and recorded on 7 April 1971. It was equipped with 32 passenger seats and two pilots' seats, all with lap straps. According to the logbooks the engines were overhauled by Malta Aviation Co Ltd and installed in PH-MOA during October 1969, when the aircraft was overhauled by them. The last entry in the engine logbooks, dated 22 February 1971, showed a total running time of 104 hours. It is estimated that the total running time up to the time of the accident was 400 hours.

- 1.6.1 In addition to its standard equipment the aircraft carried a 5 gallon drum of de-icer fluid and a 5 litre plastic container of hydraulic fluid, both of which were stowed loose on the floor of the flight deck.

### *Loading*

Examination of the aircraft load sheet showed it to be inaccurate. A re-calculation of the aircraft loading based on the most accurate information that could be obtained, gave the following figures:

Basic aircraft weight	8851 kgs
Additional equipment	100 kgs
Total fuel	1700 kgs
Total (Operating weight)	10651 kgs
Traffic Load (32 Passengers @ 77 kgs)	2464 kgs
Total (Ramp weight)	13115 kgs
Less Fuel used for taxiing	30 kgs
Calculated take-off weight	13085 kgs
Maximum authorised	12750 kgs
Therefore overload on take-off	335 kgs

The centre of gravity has been calculated as being within the authorised limits.

- Note: 1 The fuel consumption during the flight was calculated to have been approximately 325 kgs giving an aircraft weight at the time of the accident of 12,760 kgs.
- Note: 2 The estimated fuel consumption for the flight to Amsterdam was 550 kgs and this would have given a landing weight for the arrival at Amsterdam of 12,534 kgs. The maximum authorised landing weight is 12,200 kgs.



Note: 3 The standard passenger weights given in Moormanair's *Operations Manual*, which were 75 kgs for males and 65 kgs for females, were used when the loadsheet was prepared for the flight in which the accident occurred. Although these figures are coincident with those laid down in the United Kingdom regulations for this class of flight, they are not in accordance with the Netherlands regulations where a basic standard passenger weight of 77 kgs, (as used in the re-calculation), is specified for all classes. At the lighter weights the loadsheet totals given above, and the overloads, would have been 84 kgs less.

Note: 4 A total of 32 passengers, as stated on the passenger list, is the most accurate estimate of the traffic load that can be made. Another aircraft with an associated passenger load was scheduled to leave Southend Airport at the same time as PH-MOA, bound for the same destination, and the combined passenger loads for the two aircraft, (estimated to be approximately 80 persons), were released from the departure hall together. The passengers were not counted as they embarked on each of the two aircraft.

### 1.7 Meteorological information

The landing conditions reported at Southend at the time of the accident were:

Wind	020° estimated speed of 8 knots
Visibility	8 km
Cloud	7/8 Stratus 800 feet 8/8 Stratus 1,000 feet
Temperature	12°C
Runway	Dry

The anemograph at Southend Airport was not operating at the time of the accident. A reading of the Shoeburyness Meteorological Office anemograph at the time gave a surface wind of 360°/10 knots.

The landing was made in darkness, six days before the full moon.

### 1.8 Aids to navigation

The aircraft was vectored on to its final approach by surveillance radar. A radar talkdown was offered to the commander but he said he had the runway in sight and radar assistance was discontinued.

### 1.9 Communications

Communications with Southend on 119.7 MHz and 128.95 MHz were normal.

## **1.10 Aerodrome and ground facilities**

Runway 06 at Southend Airport was 1,605 metres (5,266 feet) long and 37 metres (121 feet) wide with a displaced threshold of 174 metres (571 feet) at the approach end. The runway was surfaced with a granite friction course with 91 metres (300 feet) of asphalt at either end and was dry at the time of the accident. There was an overall slope downwards in the 06 direction of 12 feet which was more pronounced in the first half of the runway, the slope over the last 750 metres (2,500 feet), being practically negligible. The high intensity approach, threshold and runway lights and the visual approach slope indicator system (VASIS) were all in operation and serviceable. Immediately beyond the overrun end of Runway 06 was a Lytag arrester installation and a trip wire to cut off the power supply to the adjacent railway. There was also an earth bank approximately 2.1 metres (7 feet) high protecting the railway along the adjoining section of the aerodrome boundary.

## **1.11 Flight recorder**

Not required and none fitted.

## **1.12 Examination of the scene of the accident and the aircraft**

Inspection of the runway after the accident revealed no trace of oil or any deposit that might have reduced the adhesion of aircraft tyres. It was not possible to determine from tyre marks on the runway where the aircraft first touched down and the only tyre marks that could be related to PH-MOA began about 120 metres (400 feet) from the overshoot end of the runway. Marks of both main wheel tyres were identified and appear to have been made by the sideways scrubbing of the tyres as the aircraft swung to port and ran off the runway at an angle of about 20° to the runway heading. No indications of severe braking or skidding were found. Deep ruts had been made by the wheels in the soft ground beyond the runway edge, up the side and over the top of the grass bank on the airport boundary where the aircraft had come to rest with its centre section resting on top of the bank. As a result of the swing it had missed both the Lytag arrester installation and the trip wire.

Examination of the aircraft revealed that the port side landing gear had collapsed, No 1 engine mounting had broken and both propellers and the wing centre section were damaged. The pitot head mast and associated tubing were also disrupted which precluded a check on the air data system but both air-speed indicators were undamaged and a check calibration showed them to be well within the required tolerances.

Examination of the shoe-type, hydraulically operated brake assemblies revealed that the linings of the starboard outer brake were worn down to the rivets on one shoe and below the rivets on the other and one of the linings was cracked completely through its centre. The starboard inner brake linings were partially worn and one shoe was found to be cracked at its centre flange. The linings of the port brakes were satisfactory but all the brake drums were convex and showed signs of lateral cracking. There was no

evidence of overheating. The starboard undercarriage assembly, wheels and tyres were covered with oil but there was no evidence of oil contamination of the brakes themselves. The hydraulic lines of the port undercarriage had been disrupted in the accident and it was not possible to check the functioning of the system. Both tyres were in good condition.

The malfunction of No 2 engine was caused by a split in No 12 cylinder barrel which passed vertically down between the valve gear and through the sparking plug hole. No obvious metallurgical defect of the cylinder was found to account for the split which was of a type normally associated with over-stressing due to prolonged operation at high manifold pressure.

### 1.13 Fire

There was no fire.

### 1.14 Survival aspects

The accident was survivable. As soon as the aircraft had come to rest the aircraft airstairs were extended and the passengers disembarked. Two passengers were slightly injured in the accident.

### 1.15 Operations manual and performance aspects

#### 1.15.1 *Emergency procedures and handling techniques*

Emergency procedures were dealt with in the company's *Operations Manual* and Section 5(c) dealt specifically with the procedure to be adopted when landing with one engine inoperative. Amongst other provisions it was recommended that the approach should be made 'a little higher than usual and maintaining a speed of 110 mph (99 knots) until it is certain that the aircraft will get into the field'. There was also a note recommending that 'during single engine landings the propeller of the failed engine [should] be feathered only if the engine is entirely useless. If the engine can be operated at reduced power, even though a drop in oil pressure, or engine roughness, is present, operate the engine at reduced power during landing'.

In the pilot's handling notes of the aircraft, under the section headed 'Approach and landing with one engine inoperative', it was recommended that, 'Lowering of the flaps beyond the initial 25 percent (15°) should be delayed until it is quite certain that the end of the runway will be reached without having to apply more power'. Contradictory recommendations concerning the retraction of the flaps after landing appeared in the same volume where, under 'Normal procedures', it was recommended that 'In moderate wind or calm conditions the flaps should not be raised as they will act as an air brake. However, if it is desired to make a short stop, raising the flaps will reduce the residual lift of the mainplanes and therefore give tyre grip on the runways when braking'. In the same section it was also recommended that in calm conditions and with full flap extended, the final approach should be flown at a speed of 80 to 85 knots. It should be noted in this connection that the stalling speed of the aircraft with 25 percent of flap is approximately 6 knots greater than with full flap.

### 1.15.2 Performance data available in the Operations Manual

The performance criteria for this aircraft, contained in the manufacturer's *Operating Instructions* issued 15 May 1948 and revised 15 January 1949, 1 January 1950 and November 1951, do not conform to the performance standards for modern transport aircraft in force at the time of the accident. The only landing performance chart in these instructions was limited to a maximum landing weight of 26,900 lb (12,202 kgs) and the use of 45° (full) flap. This chart indicates that, at this weight and flap setting in the circumstances otherwise prevailing at the time of the accident, the aircraft would have required a landing distance of 700 metres (2,350 feet) from a height of 50 feet. Extrapolation for the actual landing weight at the time of the accident, which was 28,130 lb (12,760 kgs), gave a landing distance required of approximately 780 metres (2,600 feet) with 45° of flap. It was not possible to extract any information from this chart for a landing with less than full flap or to cover the situation when the flaps are retracted during the landing run.

## 1.16 Tests and research

### 1.16.1 Landing run calculations

Under standard landing conditions, (maximum authorised landing weight with full flap, still air and standard atmosphere), the *Flight Manual* gave a landing distance required of 588 metres (1,960 feet) using the normal operating techniques. This distance can be broken down into an estimated air distance of 270 metres (900 feet) and a landing run of 318 metres (1,060 feet) which, by calculation, gave a mean deceleration during the ground run of 0.2g.

Using the same mean deceleration, at a landing weight of 12,760 kgs and using 15° of flap, the landing run would be 597 metres (1,992 feet) at 90 knots touchdown speed (Vtd) extending to 797 metres (2,657 feet) at 105 knots Vtd.

Without wheel braking the respective distances were calculated to be 1,706 metres (5,689 feet) at 90 knots Vtd and 1,993 metres (6,644 feet) at 105 knots Vtd.

### 1.16.2 Flight tests

Flight tests were conducted by the Netherlands authorities to measure the landing performance of a DC3 aircraft. The results were corrected to take into account the circumstances of the accident at PH-MOA and showed that:

- (i) The landing run from a touchdown at 102 knots was 2,400 metres (7,900 feet) without brakes and 1,300 metres (4,360 feet) with brakes and
- (ii) From 95 knots Vtd the landing run was 2,000 metres (6,600 feet) without brakes and 1,000 metres (3,300 feet) with brakes.



## 2. Analysis and Conclusions

### 2.1 Analysis

Faced with a loss of power in his starboard engine soon after take-off, the commander decided to return to Southend and land at the earliest possible moment and to keep the defective starboard engine operating for as long as possible to avoid overheating of the port engine. This decision was consistent with the recommendations contained in the operations manual.

During his visual final approach the pilot took effective steps to prevent the aircraft getting too low or too slow and it was for this reason that he restricted the flap setting to 15°. However, as he passed the point beyond which an undershoot was no longer a likelihood, the required measures to avoid an overrun were not taken and the aircraft was not prepared for a landing with full flap at minimum speed with the result that it used up almost half the runway before it touched down. Furthermore, by retracting the partial flaps he had used for landing immediately after touchdown, the pilot lost the associated aerodynamic braking which might have been of benefit to him. For most of its ground roll the aircraft was running on its main wheels with its tail wheel clear of the ground. This attitude may have been indicative of fierce braking but no braking marks were found on the runway and examination of the brakes revealed no indication of overheating.

Although calculations, using the lowest touchdown speed compatible with the evidence, show that it should have been possible to stop the aircraft in the 760 metres (2,500 feet) remaining, the flight tests indicate that it would have overrun the remaining runway distance even if the brakes had been working at their maximum efficiency. The wheel brakes were worn to the extent that their efficiency may have been impaired and oil on the starboard tyre may have reduced its adhesion. Although these adverse factors were not contributory to the accident, they may have led to a higher speed of overrun than would otherwise have been the case.

In view of the prevailing conditions – a defective engine, a heavily loaded aircraft and night – the pilot may have been operating under considerable mental stress; but the skill and care required to complete the flight safely should not have been beyond the capabilities of an experienced air transport captain.

The significance of the engine failure as a contributory cause of the accident has been disregarded as it occurred at a non-critical time in the flight.

## 2.2 Conclusions

### (a) Findings

- (i) The documentation of the aircraft was not in order.
- (ii) The number of persons on board was in excess of the number for which seating capacity and safety belts were provided, and the aircraft weight at take-off was 335 kgs in excess of the authorised maximum.
- (iii) The crew were properly licensed.
- (iv) Following an engine failure in the air, the aircraft made an emergency landing at Southend Airport at a weight 560 kgs in excess of its regulated landing weight.
- (v) The approach and landing was made with 15° of flap extended; full flap was not used.
- (vi) Touchdown occurred approximately half way down the runway.
- (vii) The aircraft's wheel brakes were worn to the extent that their efficiency would have been impaired and oil may have reduced the grip of the starboard tyre.
- (viii) The aircraft overran the paved area and collided with an earth bank on the aerodrome boundary.

### (b) Cause

The accident was due to a late touchdown and inappropriate use of the flaps. Insufficient braking efficiency resulted in a higher speed of overrun than would have otherwise occurred.

G M Kelly  
*Inspector of Accidents*

Accidents Investigation Branch  
Department of Trade and Industry  
November 1972