

Department of Trade

ACCIDENTS INVESTIGATION BRANCH

---

**Piper PA28 Series 180 (Cherokee) G-AVSB  
Report on the accident at Denham Aerodrome,  
Buckinghamshire on 10 June 1975**

---

LONDON  
HER MAJESTY'S STATIONERY OFFICE

---

# List of Aircraft Accident Reports issued by AIB in 1976

<i>No.</i>	<i>Short title</i>	<i>Date of Publication</i>
1/76	Sikorsky S-Blackhawk N671SA at Farnborough, Hampshire, England September 1974	April 1976
2/76	Hughes 269C Helicopter G-BABN at Beech Farm, Nr Barnby Moor, Notts January 1975	April 1976
3/76	Hot Air Balloon G-BCCG at Saltley Trading Estate, Birmingham October 1974	June 1976
4/76	Handley Page Dart Herald 203 G-BBXJ at Jersey Airport, Channel Islands December 1974	<i>(forthcoming)</i>
5/76	Aero Commander 680 G-ASHI near Rochester City Airport	June 1976
6/76	Douglas DC6B. OO-VGB at Southend Municipal Airport, Essex October 1974	May 1976
7/76	Cessna 310 G-APTK at Norwich Airport, Norfolk October 1974	May 1976
8/76	Turkish Airlines DC-10 TC-JAV in the Ermenonville Forest, France March 1974	June 1976
9/76	Piper PA series 235 G-BCAK at Wootton, Nr Woodstock, Oxfordshire June 1975	July 1976
10/76	Piper PA Model - 140 G-AVLA south of Biggin Hill Aerodrome, Kent May 1975	August 1976
11/76	Wessex 60 Series 1 G-ATSC in the North Sea, northeast of the River Humber estuary March 1976	<i>(forthcoming)</i>

Department of Trade  
Accidents Investigation Branch  
Shell Mex House  
Strand  
London WC2R 0DP

10 August 1976

*The Rt Honourable Edmund Dell MP*  
*Secretary of State for Trade*

Sir

I have the honour to submit the report by Mr G C Wilkinson, an Inspector of Accidents, on the circumstances of the accident to Piper PA-28, Series 180, G-AVSB which occurred at Denham Aerodrome, Buckinghamshire, on 10 June 1975.

I have the honour to be  
Sir  
Your obedient Servant

W H Tench  
*Chief Inspector of Accidents*



Accidents Investigation Branch  
Aircraft Accident Report No. 12/76  
(EW/C525)

*Aircraft :* Piper PA-28 Series 180 (Cherokee) G-AVSB  
*Engine:* One Lycoming O-360 - A4A  
*Registered owner  
and operator:* White House Garage Ashford Ltd  
*Crew:* Pilot - uninjured  
*Passenger:* Uninjured  
*Place of Accident:* Denham Aerodrome, Buckinghamshire  
51° 33' 10" N 00° 30' 50" W  
*Date and Time:* 10 June 1975 at approximately 14.06 hrs  
All times in this report are GMT

## Summary

Approximately four minutes after take-off from Denham there was a significant loss of engine power which necessitated an emergency landing. The aircraft overran the aerodrome and was substantially damaged. The pilot and his passenger were unhurt. There was no fire.

It is concluded that the accident was caused by kerosene being placed in a petrol supply at Denham aerodrome from which the aircraft was subsequently refuelled. The significant loss of engine power had been caused by detonation and overheating as a result of the engine running on the contaminated fuel.

# 1. Investigation

## 1.1 History of the flight

The aircraft was making a private flight in Visual Meteorological Conditions (VMC) from Denham to Lasham.

Shortly before the flight, after the aircraft had been refuelled, the pilot carried out a visual check for water contamination of the fuel but found nothing amiss. At approximately 1355 hrs he taxied the aircraft to the holding point for the grass runway in use 07, then completed a satisfactory power check which included a momentary application of full throttle. The take-off at about 1358 hrs, which appeared normal to the pilot and his passenger, was made with 25° flap extended and with about 2,500 engine rpm. When airborne the flaps were retracted, the electric fuel pump was switched off and the aircraft was climbed at an Indicated Airspeed (IAS) of 80 mph towards the east. At a height of about 350 feet above aerodrome level (aal) the engine was throttled back and the aircraft was levelled off for a short time while the pilot called London (Heathrow) Director on RTF 119.9 MHz and requested a Special Visual Flight Rules (VFR) clearance through the London Control Zone to Lasham. While awaiting instructions from the London Controller, the pilot initiated a turn to the left, applied full throttle to resume the climb and about this time heard a slight 'knocking' coming from the engine. The turn to the left was continued on to a southwesterly heading and the aircraft had reached a position north of Denham before the London Controller requested the pilot to route his flight via the Denham Free Lane and around the outside of the London Control Zone. In compliance with this request the pilot made a turn to the right onto a northwesterly heading. During the turn he heard the 'knocking' noise from the engine increase in intensity and noted falling oil pressure and rising oil temperature indications. When on a northwesterly heading at a position approximately 3 miles northwest of Denham, at a height of about 500 feet aal the pilot saw the engine speed had fallen to 2,000 rpm with the throttle fully open and that the rate of climb was considerably reduced. He attempted unsuccessfully to regain engine rpm by switching on the electric fuel pump for some seconds and then endeavoured to reduce the 'distress' noises from the engine by partially closing the throttle. As a result the aircraft descended rapidly to a height of about 350 feet aal and the IAS started to fall below 80 mph before the throttle was again fully opened. The pilot then made a turn to the right onto a southerly heading during which the aircraft descended further to a height of about 250 feet aal and the IAS dropped to 60 mph before he saw Denham in the latter part of the turn approximately 2½ miles ahead. He positioned the aircraft for a direct approach to grass runway 19, then informed Denham on RTF 123.5 MHz that he would make an emergency landing on that runway. His RTF call was answered by a qualified flying instructor based at Denham who was airborne at the time. The flying instructor advised all aircraft operating on the Denham RTF to remain clear of the aerodrome, ascertained the nature of the emergency from the pilot and asked if the aerodrome fire service should be alerted but was answered in the negative.

During the approach the pilot noticed that the engine speed had fallen to 1,800 rpm. In the final part of the approach he saw that the stall warning light was illuminated and attempted to restore engine power by switching on the electric fuel pump and changing the cockpit fuel selector to the left tank as the aircraft neared the boundary fence. The engine then produced a short but considerable burst of power and the aircraft climbed to some extent before the pilot closed the throttle and extended the flaps.

The aircraft touched down approximately half way along grass runway 19 at a speed which although undetermined appeared excessive both to the pilot and to a flying instructor who had watched the approach. The pilot turned off the battery master switch and the cockpit fuel selector during the landing run when despite heavy brake applications

he saw the aircraft would overrun the aerodrome. He then applied left rudder and attempted to broadside the aircraft into the aerodrome boundary fence. It skidded to the right knocked down part of the boundary fence and continued onto an adjoining golf course. When the aircraft had come to rest the engine continued to run for approximately 25 seconds after being shut down.

There was no fire. The pilot and his passenger were unhurt.

## 1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	—	—	—
Non-fatal	—	—	—
None	1	1	

## 1.3 Damage to aircraft

The aircraft was substantially damaged.

## 1.4 Other damage

A 35 foot section of a low wooden cleft pale fence on the southern boundary of the aerodrome was knocked down.

## 1.5 Crew information

Pilot:	Male, aged 48
Licence:	Private Pilots Licence (PPL) valid until 22 March 1977
RTF Licence:	Restricted VHF only
IMC rating:	Valid until 30 May 1976
Night rating:	Issued 6 April 1967
Aircraft rating:	Group 'A'
Total flying experience:	553 hours
Flying hours in command on type:	397 hours
Flying hours in last 28 days:	11 hours 10 minutes
Medical certificate:	Last medical examination 4 June 1975. Valid until 30 June 1976.

## 1.6 Aircraft information

### 1.6.1 Construction

The Piper PA-28-180 (Cherokee) is a four seat, low wing, single engine monoplane of metal construction with a fixed tricycle undercarriage. Dual control wheels and rudder pedals are fitted. Hydraulically operated disc brakes fitted to the main landing gear wheels can be actuated from a hand lever in the cockpit or by foot pedals when as in G-AVSB these are fitted as an optional extra. The nosewheel is steerable by the use of the rudder pedals.

The Lycoming O-360-A4A four cylinder engine drives a two-bladed fixed pitch metal propeller. The aircraft Type Certificate No. 2A13 contains the following limitations.

Propeller limits:	Static rpm at maximum permissible throttle setting not over 2,450 not under 2,275.
-------------------	------------------------------------------------------------------------------------------

Engine limits:	For all operations, 2,700 rpm.
----------------	--------------------------------

Two tanks of equal capacity, located one in each wing provide storage for a total of 41.6 imperial gallons (imp/gal) of fuel. The cockpit fuel selector enables either tank to be used in any condition of flight. The engine driven fuel pump may be augmented by an auxiliary electric fuel pump. The aircraft flight manual states 'the electric fuel pump must be on for both take-off and landing and specifies the minimum grade of fuel to be used as 91/96 octane. As fuel of this octane rating is no longer produced Aviation Gasolene (Avgas) 100L is approved as an acceptable alternative by the engine manufacturer.

### 1.6.2 General information and maintenance

G-AVSB was constructed in the United States of America in 1967 and was subsequently exported to the United Kingdom. It was placed on the United Kingdom Register on 24 July 1967 and at the time of the accident was registered in the name of White House Garage Ashford Ltd. The Certificate of Airworthiness (C of A) in the General Purpose Category had been renewed on 6 June 1973 and was valid until 5 June 1975. It had therefore ceased to be current at the time of the accident and consequently the aircraft was overdue for a C of A renewal inspection (Check 4) in accordance with the approved maintenance schedule under which it had been operated. Since the last C of A inspection the aircraft had flown 104 hours 05 minutes out of a total flying time of 711 hours 40 minutes. The engine had run 711 hours 50 minutes since new. On 8 June 1975 the aircraft made two uneventful flights with a total duration of 3 hours 05 minutes.

On the afternoon of 10 June 1975 the aircraft was refuelled from 'No. 4' bulk storage tank at Denham. A total of 30 imp/gal was uplifted into the aircraft tanks which prior to refuelling contained unequal but undetermined quantities of Avgas 100L. As far as can be ascertained the aircraft tanks contained a total of about 40 imp/gal of fuel on departure from Denham.

### 1.6.3 Weight and balance

The aircraft weight at take-off was less than the maximum certificated take-off weight. At take-off it was calculated that the C of G was on the forward limit of the specified C of G range.



## 1.7 Meteorological information

The weather at the time of the accident was good. A witness located on the aerodrome estimated the visibility as more than 10 kilometres, the wind as northeasterly 8 to 10 knots with no cloud.

An estimate of the conditions prevailing at Denham for the period 1400 hours to 1410 hours was obtained from the Meteorological Office and contained the following information.

Surface wind	040° 10 to 12 knots
Cloud:	Nil
Visibility:	In excess of 10 kilometres
QNH	1,019 millibars

The accident occurred in daylight.

## 1.8 Aids to navigation

Not applicable

## 1.9 Communications

Denham is located within the London Control Zone but is exempt from a requirement to provide an Air Traffic Control service. However information on the aerodrome contained in the United Kingdom Air Pilot, AGA Section, Pages 3-9 indicated that it was not available to aircraft unable to communicate on the Air/Ground frequency 123.5 MHz.

The aeronautical ground radio station may provide advisory information to aircraft using Denham. The station was operated on 123.5 MHz the frequency promulgated in the United Kingdom Air Pilot, Comm Section although the schedule to the radio licence had not been amended and still showed the operating frequency as 122.45 MHz. The radio licence required that the station be operated by authorised persons. No such persons were on duty at the time of the accident.

The aircraft made RTF contact with Denham on 123.5 MHz and with London (Heathrow) Director on 119.9 MHz during the flight. The latter frequency was recorded on tape for the relevant period. There were no facilities for recording RTF communications at Denham. Satisfactory RTF communications were maintained with the aircraft throughout the flight. Shortly before the accident the pilot informed Denham of his intention to land in emergency on grass runway 19. He was answered by a qualified flying instructor airborne from Denham at the time.

## 1.10 Aerodrome and ground facilities

### 1.10.1 Aerodrome

Denham Aerodrome which has an elevation of 249 feet above mean sea level (amsl) is licenced as an aerodrome by the Civil Aviation Authority. The aerodrome surface is grass with two runways 07/25 and 01/19. The latter runway was unmarked and had a landing distance available of 371 metres. The aerodrome is bounded by a low wooden cleft pale fence.

## 1.10.2 *Ground facilities*

### 1.10.2.1 Fuel storage installations

There were two fuel storage installations, one located on the north side of the aerodrome the other on the south. Each installation comprised two underground tanks. The number of each tank was clearly marked on the manhole cover above the pit containing its dip and fill pipes. Two Petroleum Spirit Licences, one for each installation were issued in the name of the aerodrome licensee. Since 7 May 1975 stocks of aviation kerosene (JET A-1 with AL38 additive) had been stored in the tanks located on the north side of the aerodrome (numbers 2 and 3) and stocks of aviation petrol (Avgas 100L) had been stored in the tanks on the south side (numbers 1 and 4).

Tanks Nos 2 and 3 on the north side of the aerodrome each had a capacity of 1,000 imp/gal. Premises adjacent to the installation were occupied by employees of a company, a tenant of the aerodrome licensee.

Of the two tanks which comprised the installation on the south side of the aerodrome No. 1 had a capacity of 1,000 imp/gal and No. 4 a capacity of 2,000 imp/gal. The fuel from the tanks was dispensed via a common EMC fuelling pump and its attached flexible hose located in front of No. 1 tank. As in the case of Nos 2 and 3 tanks either or both tanks could be isolated from the EMC pump. Both the EMC pump and its filter were labelled clearly Avgas 100L. A metal tag similarly designated was fixed to a pipe in the pit containing the combined dip and fill pipe of No. 4 tank. Three warning notices were displayed at the installation. Only the notice mounted on the front of a small building at the rear of No. 1 tank contained in part the words 'Petroleum Spirit, Highly Inflammable'. The wording was partially obscured by corrosion. Office premises adjacent to the installation were occupied in part by a company, the main user of Avgas 100L at the aerodrome. Although a tenant of the aerodrome licensee this latter company was not associated with the company on the north side of the aerodrome.

### 1.10.2.2 Ordering of aviation fuel

A tacit agreement existed between the aerodrome licensee and the two tenant companies whereby each company would order when necessary that grade of aviation fuel contained in the bulk storage installation adjacent to its premises. The companies ordered the different grades of fuel independently of each other and when doing so did not advise the supplier to which bulk storage the delivery should be made.

On 4 June 1975 2,000 imp/gal of JET A-1 with AL38 additive was ordered by telephone from a fuel company on behalf of the licensee at Denham. This order was placed by an employee of the tenant company on the north side of the aerodrome. On the same day an order for 2,000 imp/gal of Avgas 100L was placed by telephone with the same fuel company, on behalf of the licensee at Denham by an official of the tenant company on the south side of the aerodrome.

Because stocks of Avgas 100L at Denham were running low, the official made two further telephone calls to the fuel company on 7 and 9 June 1975 concerning the order for this product. He requested delivery at the earliest possible date and has stated that on 9 June 1975 the fuel company advised him the order for Avgas 100L would be delivered on 10 June 1975. No record can be found by the fuel company of a specific delivery date being passed to Denham for the order of Avgas 100L. The orders for the two different grades of aviation fuel placed on behalf of the licensee at Denham were correctly processed by the supplier. The first order supplied was that for Jet A-1 with AL38 additive which was dispatched to Denham on 10 June 1975.

#### 1.10.3 *Delivery vehicle and driver*

A fuel company sub-contractors tank-wagon with a relief driver were used to deliver the fuel which was part of an overall consignment of JET A-1 with AL38 additive carried in the vehicle and contained in two of its five integral tanks. A metal grade label approximately 2 inches by 2 inches in size with the letters AV TUR was located in a bracket above each of the integral tank outlet pipes on the near side of the vehicle below the guard rail. Unless their position was known the labels were not readily visible. No other notices indicating the grade of fuel were attached to the vehicle.

The driver had no previous experience in the handling and delivery of aviation fuels to aerodromes. He had however delivered Petroleum Spirit to road filling stations and as a result knew he should collect a certificate (see Appendix) from the consignee when delivering such fuel. In addition at the time he delivered the aviation fuel to Denham he knew that Avgas 100L was the designator for 100 octane aviation petrol. He was unaware that there were two bulk fuel storage installations at Denham and after difficulty in locating the aerodrome arrived at the fuel installation on the south side early on the afternoon of 10 June 1975.

#### 1.10.4 *Delivery and acceptance of fuel into storage at Denham*

Deliveries of Avgas 100L were normally accepted into storage on the south side by an employee of the aerodrome licensee who on this occasion was absent on holiday. No firm arrangements had been made for other persons to accept delivery in his absence. On arrival at Denham the delivery driver contacted the tenant company official who had ordered the Avgas 100L and showed him the delivery note which indicated that 2,000 imp/gal of JET A-1 with AL38 additive were being delivered. However the driver was not asked and did not specify the grade of fuel contained in the tank-wagon. At the time of the fuel delivery No. 4 tank contained about 50 imp/gal of Avgas 100L and No. 1 tank contained about 30 imp/gal of the same grade of fuel. 1,100 imp/gal of JET A-1 with AL38 additive and 900 imp/gal of the same grade of fuel were discharged in error into No. 4 and No. 1 tanks respectively. The official subsequently signed the delivery note.

The official has stated that he did not normally accept deliveries of aviation petrol into the storage tanks, but had an idea in his mind that some certificate (see Appendix) should be presented to or collected by the delivery driver. He had not noticed the grade labels located in the brackets above the outlet pipes of the tank-wagon and when signing the delivery note had not looked to see the grade of fuel specified.

The delivery driver has stated that he did not notice the grade labels attached to the EMC fuelling pump and its filter or to the pipe in the pit containing the combined dip and fill pipe of No. 4 tank.

#### 1.10.5 *Refuelling of aircraft*

Fuel from the storage tanks located on the south side of Denham Aerodrome was dispensed directly into aircraft tanks via the EMC fuelling pump and hose. After the aviation kerosene had been discharged in error into No. 4 and No. 1 storage tanks, G-AVSB was refuelled with the mixture from No. 4 tank by the passenger in the presence of the pilot who subsequently carried out a visual check for water contamination of the fuel. Samples of fuel drawn from both of the aircraft tanks via the drain points appeared to be the same colour as Avgas 100L and he did not detect the presence of aviation kerosene by smell then or later when he drained fuel from the engine strainer through his fingers. Two other aircraft based at Denham were also supplied with the contaminated fuel. One of the aircraft was flown on the same day shortly after the accident to G-AVSB. This aircraft suffered a significant loss of engine power after take-off but landed successfully. The pilot heard the engine mis-firing and 'knocking' and felt it vibrating when

airborne. Before landing he advised other aircraft at Denham on RTF not to attempt to take-off if they had refuelled at the aerodrome. The RTF message alerted personnel at the aerodrome and the contamination of the bulk fuel tanks was discovered. Both aircraft were subsequently grounded pending cleaning of the engines and the fuel systems. In addition an inspection of the engine of the aircraft which had suffered the loss of power was made.

#### **1.11 Flight recorder**

Not required and not fitted.

#### **1.12 Wreckage**

Examination of surface marks made by its wheels during the landing run showed that the aircraft had skidded to the right on a track of 188°M for approximately 100 yards while yawed some 30° to the left and had struck the aerodrome boundary fence. It knocked down part of the fence and continued onto an adjoining golf course for some 80 yards before coming to rest on a heading of 060°M shortly after the left wing had struck a small sapling and its supporting wooden post.

The aircraft suffered substantial damage as a result of the impact with the boundary fence and the sapling. There were numerous dents, some substantial, on both wing leading edges and isolated dents on the leading edge of the tailplane. Both flaps were damaged and the rudder was slightly distorted at its base. The engine cowling and the three fibre glass wheel fairings were damaged.

There was no evidence of any pre-accident damage to the aircraft or its flying controls. The wheel brakes operated satisfactorily when tested after the accident.

The four engine cylinder barrels showed signs of over heating between the cooling fins and the crank-case attachment flanges particularly on their forward sides. The paint on the lower cooling fins was blistered. Most of the sparking plugs had a matt black 'sooted' appearance and the No. 3 cylinder upper plug had a blue coloration on its centre electrode. A strip examination of the engine revealed thermal discolouration on each of the 4 connecting rods. It is considered that the significant loss of engine power resulted from detonation and overheating caused by the engine running on fuel of a lower octane value than the minimum required.

#### **1.13 Medical and pathological information**

The pilot and his passenger were unhurt.

#### **1.14 Fire**

There was no fire.

#### **1.15 Survival**

Although the aerodrome boundary fence gave way readily when struck by the aircraft it is probable that the pilot and the passenger were saved from injury at this time as both had their seat lapstraps fastened during the flight and these restraints remained intact. The accident was survivable.



## 1.16 Tests and research

### 1.16.1 Fuel

Fuel samples were taken from the aircraft, No. 1 and No. 4 bulk storage tanks at Denham. The samples were submitted for analysis with the results tabulated below.

<i>Source of fuel</i>	<i>Colour</i>	<i>Approx % Avgas 100L</i>	<i>Approx % JET A-1</i>	<i>Approx octane rating</i>
(a) Aircraft left tank	Green	60	40	78
(b) Aircraft right tank	Green	40	60	63
(c) No. 1 bulk storage tank	Pale Green	5	95	Not deter- mined
(d) No. 4 bulk storage tank	Pale Green	5	95	Not deter- mined

Avgas 100L is the civil designation used for aviation gasoline meeting the Ministry of Defence specification D. Eng. R.D. 2485 (Issue 7). As a result of the analysis it was found that all the fuel samples failed to comply with the specification for distillation and engine rating. The non-compliance was due to the presence of aviation kerosene.

### 1.16.2 Engine overheating

Hardness tests carried out on all four pistons showed evidence of softening of the piston crown centres consistent with engine overheating.

## 1.17 Other information

### 1.17.1 Detonation

Detonation may occur in spark ignition internal combustion piston engines when a lower grade of fuel than that specified is used. It results from the spontaneous combustion of the air/fuel mixture when the pressure in the combustion chambers rises to a value higher than that which the octane rating of the fuel can tolerate. The detonation can usually be heard as a 'knock' and the accompanying abnormal temperatures and pressures within the combustion chamber can lead to loss of power and mechanical damage to the engine.

### 1.17.2 Petroleum-spirit

The following interpretation is contained in the Petroleum (Consolidation) Act 1928, Section 23:

“‘Petroleum-Spirit’ means such petroleum as when tested in the manner set forth in Part II of the Second Schedule to this Act gives off an inflammable vapour at a temperature of less than seventy-three degrees fahrenheit (+73°F).’

When so tested Aviation Kerosene gives off an inflammable vapour at a temperature of not less than +100°F. However Avgas 100L gives off an inflammable vapour at a temperature of -40°F approximately.

- 1.17.3 The Petroleum-Spirit (Conveyance by Road) Regulations, 1957 Regulation 16 contains the provisions relating to the transfer of petroleum-spirit from a carrying tank into a storage tank and reads in part as follows:

- ‘16 (5) Before delivery of petroleum-spirit into a storage tank is begun, the licensee shall secure that some competent person who is not the driver of, or any other person employed to be in attendance on, the vehicle from which the delivery is to be made, is in charge of the storage tank for the purposes of the delivery.
- 16 (7) Before delivery into any storage tank is begun the person in charge thereof shall on each of two copies of a certificate in the form specified in the Second Schedule to these Regulations in the first column opposite thereto enter the quantity and grade of petroleum-spirit which is to be delivered into that tank, and the person attending the vehicle from which the delivery of petroleum-spirit into the tank is to be made shall not begin delivery until the person appearing to him to be in charge of that tank has in his presence signed his name on each of the said two copies in the third column opposite to the number of that tank in the first column.
- 16 (10) The person in charge of a storage tank for the purposes of a delivery of petroleum-spirit into that tank shall give a copy of the certificate on which entries have been made in accordance with paragraph (7) of this Regulation in connection with that delivery to the person attending the vehicle from which the delivery is made and that copy shall be kept by the employer of the last-mentioned person for a period of not less than six months after the delivery, and the other copy of the said certificate shall be kept by the licensee for the like period.’

A copy of the Certificate referred to in Regulation 16 (7) and 16 (10) is shown in the Appendix.

- 1.17.4 The licence issued by the Local Authority for the keeping of petroleum-spirit at Denham Aerodrome was granted subject to conditions which state in part:

‘22 Notices.

Notices to the satisfaction of the Licensing Authority shall be conspicuously displayed in such of the following forms, or wording to a similar effect, as may be appropriate. The notices required under paragraphs “a” and “b” of this condition shall be in 2 in. letters and that required under paragraph “c” not less than 1 in. letters. In either case the lettering shall be in plain block red characters on a white background.

- a. where petroleum spirit is dispensed by means of pumps, in the vicinity of the pumps (and the tanks and filling points when they are in a position removed from the pumps) - “Petroleum Spirit - Highly Flammable - No Smoking - Switch Off Engine”.
- b. where petroleum spirit is stored above ground, on the store and near any place where petroleum spirit is dispensed - “Petroleum Spirit - Highly Flammable - No Smoking”.
- c. adjacent to the emergency switch - “Petrol Pumps - Switch Off Here”.

The licensee shall bring to the notice of all concerned the provisions of No. 16 of The Petroleum Spirit (Conveyance by Road) Regulations, 1957 (S.I. 1957, No. 191) which relates to the precautions which have to be observed in delivering petroleum spirit from a tank wagon or tank trailer into a storage tank.’

- 1.17.5 There is no specific legislation related to aviation fuel storage at aerodromes to ensure quality control of such fuel.
- 1.17.6 On arrival at Denham the tank wagon driver showed a delivery note to the official who accepted the fuel consignment. The delivery note was pre-printed with provision made for indicating delivery of one or more of seven aviation products, three fuels and four lubricants. It contained, *inter alia*, a number of boxed divisions. The consignors brand names of the seven products were printed in columnar form in one of the divisions and the grade of each of two aviation kerosenes was printed next to its brand name on the appropriate line in the adjoining column. Additional columns used to indicate the method of packing and quantity of product being supplied were completed prior to delivery. The delivery note given to the official who accepted the fuel at Denham contained written entries which showed that 2,000 imp/gal of JET A-1 with AL38 additive were being delivered in bulk.

## 2. Analysis and Conclusions

### 2.1 Analysis

The accident occurred when the aircraft overran the aerodrome during an emergency landing made because of a significant loss of engine power after take-off. Examination of the wreckage revealed no pre-crash defect in the aircraft, its flying control or other systems apart from indications of engine overheating. It is considered that the significant loss of engine power and the abnormal engine indications observed by the pilot during the flight were caused by detonation and overheating. Throughout the flight the engine had been running on contaminated fuel the octane value of which was lower than the minimum specification it required. This analysis is therefore concerned with how the contaminated fuel came to be in the aircraft and its effect on engine operation.

- 2.1.1 Stocks of JET A-1 with AL38 additive and of Avgas 100L were stored at Denham in separate bulk installations located respectively on the north and south sides of the aerodrome. Each tenant company ordered on behalf of the aerodrome licensee when necessary the grade of fuel stored in that installation adjacent to its premises. By coincidence, on the same day, and unknown to one another, each tenant company ordered fuel from the same supplier. One ordered JET A-1 with AL38 additive, the other Avgas 100L. The quantity of fuel ordered in each case was the same. However the supplier was not informed to which of the bulk installations a specific order should be delivered. In the circumstances the lack of this information proved crucial as it started a sequence of events which led to the accident.

Both orders were correctly processed by the supplier but as it happened the one for JET A-1 with AL38 additive was the first to be delivered. Following a standard procedure a fuel company sub-contractor's vehicle and driver were used to deliver the fuel.

The driver employed on this occasion had no previous experience of delivering aviation fuels to aerodromes. He was unaware that two separate bulk fuel storage installations were in use at Denham and fortuitously arrived at the one on the south side of the aerodrome where Avgas 100L was stored. Only one of the three warning notices displayed in the vicinity of this installation contained in part the words 'Petroleum Spirit Highly Inflammable'. It is not known if the driver saw this notice but had he done so it is considered unlikely that this would have alerted him to the error in the fuel delivery as the wording it contained was not readily readable because of corrosion. However Avgas 100L fuel grade labels were affixed to the common EMC fuelling pump, its attached filter, and a pipe in the pit containing the combined dip and fill pipe of No 4 storage tank, and the driver knew that Avgas 100L was the designator for 100 octane aviation petrol. He did not notice any of the grade labels. His failure to notice the one in the pit containing the combined dip and fill pipe of No 4 tank, the first tank to be replenished is inexplicable. Had he noticed this label it is probable the fuel contamination would have been avoided.

The only indicators on the delivery vehicle showing that it contained aviation kerosene were grade labels located in the vicinity of the outlet delivery pipes. Their location was such that they were not readily visible unless positively looked for and on this occasion were not seen by the person accepting the fuel delivery. It is possible that additional grade labels prominently displayed on the body of the vehicle might have alerted the person accepting delivery to the fact that the fuel supplied was not the grade he was expecting before it was discharged into No 4 and No 1 tanks.



The procedure for accepting aviation petrol into bulk storage at Denham on this occasion is considered to have been unsatisfactory. The Petroleum-Spirit (Conveyance by Road) Regulations 1957 require in part that a competent person be secured by the licence holder to accept Petroleum-Spirit (which by definition includes Avgas 100L) into storage tanks and that such a person complies with Regulation 16(7) and 16(10) in regard to the 'Form of Certificate'. In this respect there is considerable doubt about the competence of the person, who in absence of the licence holder's employee, accepted delivery of the fuel on this occasion. As he had received no instructions on the procedure to be followed he was in part unaware of the regulations in regard to the 'Form of Certificate' and therefore did not comply with them. Had he done so it is possible that the delivery driver from his experience of delivering petroleum-spirit to road filling stations would have queried the grade of fuel being supplied. Moreover he signed the delivery note given to him by the delivery driver without looking at its contents. However as he was expecting a delivery of Avgas 100L and was unaware that a similar quantity of JET A-1 with AL38 additive had also been ordered this might have contributed to his readiness to accept the incoming delivery.

After the contamination had occurred at Denham G-AVSB was refuelled with the mixed product from No 4 tank via the common EMC fuelling pump and its attached hose. Fuel samples were then drawn from both tanks of the aircraft via the drain-points by the pilot prior to the accident flight to check for water or other contamination. Both samples appeared to be the same colour as Avgas 100L and no smell of aviation kerosene was evident to him either from these samples or subsequently when he drained fuel from the engine strainer through his fingers. This underlines the fact that once Avgas 100L has been contaminated with aviation kerosene and depending on the severity of the contamination its presence is not easily detectable whether by colour or smell.

- 2.1.2 At the time of the accident flight the C of A had ceased to be current and consequently the aircraft was overdue for a C of A renewal inspection. However this is not considered to be a causal factor in the accident.

The significant loss of engine power which occurred during the flight is considered to have been caused by detonation and overheating as a result of the engine running on the contaminated fuel. There is little doubt that the slight 'knocking' noise heard by the pilot at an early stage in the flight was the first tangible indication of detonation. Subsequently the detonation became pronounced and was accompanied by indications of engine distress and a significant loss of power. After unsuccessful attempts to restore power and alleviate distress noises from the engine the pilot attempted to land in emergency on Runway 19 at Denham which was downwind. At a very late stage in the approach he changed fuel tank selections and switched on the electric fuel pump in a further attempt to restore engine power. These actions produced a short burst of power from the engine most probably because the line from the tank to the engine contained some uncontaminated fuel. However the burst of power frustrated the pilot's attempt to achieve a satisfactory emergency landing as the touchdown was made further along the runway and at a higher speed than intended. Because of this and possibly in combination with the tailwind he was unable to prevent the aircraft overrunning the aerodrome boundary.

As it happened the lack of RTF communication between the aircraft and Denham at the time was not contributory to the accident. It is somewhat incongruous that no authorised

persons were on duty to man the aeronautical ground station despite the information contained in the United Kingdom Air Pilot to the effect that the aerodrome was not available to aircraft unable to communicate with this facility.

## 2.2 Conclusions

### (a) Findings

- (i) The pilot was properly licensed and experienced to carry out the flight.
- (ii) The aircraft Certificate of Airworthiness had ceased to be current 5 days before the accident flight.
- (iii) As the Certificate of Airworthiness had ceased to be current the requirements of the approved maintenance schedule to which the aircraft was operated had not been complied with.
- (iv) Approximately four minutes after take-off the engine sustained a significant loss of engine power accompanied by detonation and overheating which necessitated an emergency landing.
- (v) The pilot attempted to carry out the landing on Runway 19 at Denham which was downwind.
- (vi) At a late stage in the approach the pilot changed fuel tank selections and switched on the electric fuel pump in an attempt to restore engine power.
- (vii) It is probable that the short burst of engine power which ensued was produced by some uncontaminated fuel in the line from the tank to the engine.
- (viii) The burst of engine power frustrated the pilot's attempt to achieve a satisfactory emergency landing as the aircraft touched down further along the runway and at a higher speed than was intended.
- (ix) Because of the reduced runway distance available and possibly in combination with the tailwind the pilot was unable to prevent the aircraft overrunning the aerodrome.
- (x) Analysis of the fuel in the aircraft right tank from which the engine was supplied for the greater part of the flight showed that it consisted of approximately 40 per cent Avgas 100L and 60 per cent JET A-1 with AL38 additive and that it had an octane rating of 63.
- (xi) Analysis of the fuel in the aircraft left tank which the pilot selected at a late stage in the approach showed that it consisted of approximately 60 per cent Avgas 100L and 40 per cent JET A-1 with AL38 additive and that it had an octane rating of 78.
- (xii) Analysis of the fuel in No. 4 storage tank at Denham Aerodrome showed that it consisted of approximately 5 per cent Avgas 100L and 95 per cent JET A-1 with AL38 additive. Its octane rating was not determined.
- (xiii) Shortly before the accident flight 30 imp/gal of the mixture from No. 4 storage tank at Denham Aerodrome was uplifted into the aircraft tanks. The quantity of fuel supplied to each individual tank could not be determined.

- (xiv) The pilot carried out checks for contamination of the fuel in the aircraft after it had been refuelled but found nothing amiss.
- (xv) Prior to the refuelling of the aircraft 1,100 imp/gal of JET A-1 with AL38 additive had been discharged in error into No. 4 storage tank at Denham Aerodrome which still contained approximately 50 imp/gal of Avgas 100L.
- (xvi) After the JET A-1 with AL38 additive had been discharged into No. 4 storage tank 900 imp/gal of the same grade of fuel was discharged in error into No. 1 storage tank at Denham Aerodrome which still contained approximately 30 imp/gal of Avgas 100L.
- (xvii) It is probable that the fuel contamination would have been averted had the delivery driver noticed the grade label located near the dip and fill pipe of No. 4 storage tank.
- (xviii) The Petroleum-Spirit Licensee at Denham Aerodrome did not provide an adequate organisation to supervise the acceptance of fuel deliveries.
- (xix) The significant loss of engine power during the short flight was caused by detonation and overheating which resulted from the engine being run on unsuitable fuel.

(b) *Cause*

The accident was caused by kerosene being placed in a petrol supply at Denham Aerodrome. The aircraft, which had been refuelled with the mixture suffered a significant loss of engine power after take-off. This led to an emergency landing during which the aircraft overran the aerodrome. The loss of engine power was caused by detonation and overheating due to the engine being run on contaminated fuel.

### 3. Recommendations

It is recommended that

- (1) Deliveries of aviation fuels to aerodrome should only be made by drivers suitably trained and experienced.
- (2) Mandatory procedures should be introduced governing the handling, storage and quality control of aviation fuels at aerodromes.
- (3) When aviation fuel deliveries are made to aerodromes the grade of product being supplied should be self evident from the associated documentation.
- (4) Consideration be given to the provision of selective couplings to ensure that incorrect grades of aviation fuel cannot be discharged into bulk storage tanks at aerodromes.

G C Wilkinson  
Inspector of Accidents

Accidents Investigation Branch  
Department of Trade

August 1976