

Department of Trade

ACCIDENTS INVESTIGATION BRANCH

Cessna 310 G-BCKL

Report on the accident at

Black Hill, Perthshire, Scotland

on 4 March 1976

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Black Hill, Perthshire, Scotland

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

29 March 1977

The Rt Honourable Edmund Dell MP
Secretary of State for Trade

Sir

I have the honour to submit the report by Mr R D Westlake an Inspector of Accidents, on the circumstances of the accident to Cessna 310 G-BCKL which occurred at Black Hill, Perthshire, Scotland on 4 March 1976.

I have the honour to be
Sir
Your obedient Servant

W H Tench
Chief Inspector of Accidents

Accidents Investigation Branch
Aircraft Accident Report No. 2/77
(EW C/553)

Operator: Air Service Training Perth
Aircraft Type: Cessna 310
Model: E310Q
Nationality: United Kingdom
Registration: G-BCKL
Place of Accident: Black Hill, Perthshire, Scotland
Date of Accident: 4 March 1976

All times in this report are GMT

Synopsis

The accident was notified to the Department of Trade by Air Service Training on 4 March 1976. The Accidents Investigation Branch of the Department of Trade carried out an investigation with operations, engineering and human factors groups established under the Inspector-in-charge.

The aircraft was engaged in a training flight at night, with an instructor in charge, and a practice asymmetric circuit was being made with a simulated failure of the left engine. The aircraft was seen in the appropriate position when the 'downwind' call was made and was cleared to 'finals'. Nothing further was heard from the aircraft and the wreckage was eventually found on a hillside 4½ miles northeast of the airfield, 720 feet above airfield level, a position indicative of a wide downwind leg extended by about two miles and with the aircraft about 500 feet below the stipulated circuit height. The aircraft was destroyed and the three occupants were killed; there was no fire.

Evidence from the wreckage was consistent with the declared asymmetric exercise and there was no indication of any emergency nor of any pre-crash defect or malfunction of the aircraft; VHF communication equipment was still serviceable. The crash occurred in almost level flight whilst in a left turn, but no satisfactory reason for the departures from the standard circuit pattern has been established.

1. Factual Information

1.1 History of the flight

G-BCKL was one of a fleet of Cessna 310 aircraft operated by Air Service Training (AST) to provide advanced flying training to the standards required for a Commercial Pilot's Licence and Instrument Rating.

On the evening of 4 March 1976 the aircraft was being used for the night flying training of a student pilot who had completed the syllabus for single-engined aircraft by day and by night and had also completed the twin-engined day flying syllabus including the asymmetric exercises. The instructor and the student, accompanied by a passenger who wished to obtain flying experience, carried out a self-brief after which the instructor authorised exercises compatible with the student's progress. The anticipated time required to complete the detail was 1 hour 30 minutes, and the aircraft was cleared to taxi at 1839 hours. After carrying out about five two-engine 'touch and go' circuits and landings using Runway 22 (see Appendix 1) the instructor intimated to ATC that the next approach was to be made under simulated engine failure conditions. This information was contained in an RTF message from the aircraft reporting 'downwind practice asymmetric' and it is believed that the RTF call was made by the instructor. At that time the Air Traffic Controller saw the lights of an aircraft he considered to be a Cessna 310 in a position consistent with the 'downwind' report, and he cleared it to 'finals'. Shortly afterwards, a second aircraft reported 'downwind', and was given a clearance to 'finals No. 2 Cessna 310 ahead'. At that time the lights of both aircraft were clearly visible from the Control Tower, and were considered to have adequate separation; however the pilots' of the second aircraft stated subsequently that they did not see the one ahead of them. No further radio communication was received from G-BCKL and subsequently, when the pilot of the second aircraft reported 'finals', the Air Traffic Controller was alerted to the possibility of a traffic conflict. This aircraft was instructed to continue its approach and the aircraft's landing lights were used to confirm its position and, in a similar manner, the position of a third aircraft by then also on final approach. During this period and for sometime afterwards repeated radio calls were transmitted to G-BCKL on both Tower and Approach frequencies, but were unanswered.

A total of five aircraft had been disposed in the circuit and the controller, having accounted for the other four, recognised the probability of an emergency and without delay, at 1931 hours, took action to alert the appropriate authorities. All aircraft were recalled and night flying was cancelled except for the duty instructor who carried out airborne searches. Radar assistance was requested from Royal Air Force station Leuchars and search and rescue facilities were requested from the local police and the Royal Air Force.

About five hours later, at 0033 hours on 5 March, a Royal Air Force Mountain Rescue team found the aircraft wreckage on Black Hill, 720 feet above airfield level, and 4½ miles northeast of the airfield. All three occupants had been killed.

Later in the day of 5 March, after hearing of the accident, a witness, who had been at a point about one mile southwest of the accident site at the relevant time, reported that he had seen a twin-engined aircraft, which he described as flying northeast, level, and very low; he then lost sight and sound of it as it turned left and was hidden from view behind trees. This witness was at a point about 100 feet above aerodrome level where the appropriate height for the aircraft to have been was about 1,100 feet above him. So far as is known, this was the only witness who saw the aircraft after the Controller had seen its lights in the 'downwind' position.

The accident occurred at night, with no moon, at approximately 1925 hours in position 56° 28'N 03° 16'W, at an elevation of 1,100 feet.

1.2 Injuries to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>
Fatal	2	1	—
Non-fatal	—	—	—
None	—	—	—

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

There was some minor damage to the open moorland where the aircraft crashed.

1.5 Personnel information

(a) Commander

Male

Age:

45 years

Licence:

Airline Transport Pilot's Licence

Limitations:

Nil

Aircraft ratings:

Cessna 150, 170, 172, 175, 182, 310 and 320 series, Flying Instructor's rating in respect of these types, Instrument rating.

All ratings were valid.

Last medical examination

21 November 1975 assessed fit. This examination included a routine electrocardiograph

Last certificate of test:

On Cessna 310 aircraft, 31 October 1975

Total flying experience:

5,666 hours

Total flying experience in Cessna 310:

440 hours

Total flying in last 28 days:

37 hours 50 minutes

Rest period:

18 hours

Additional information:

Prior to joining Air Service Training in April 1974 as a flying instructor, the commander had served in the Royal Air Force from 1950 to 1974, and from 1957 had held a Qualified Flying Instructor's rating category A2.

He was under treatment for mild hypertension which had been recognised during a medical examination in November 1974. The drug being used to lower his blood pressure was approved by the Civil Aviation Authority.

(b) <i>Student pilot</i>	Male
Age:	20 years
Licence:	Student Pilot's Licence, valid to 16 March 1977
Aircraft ratings:	Flight radio-telephony licence (restricted)
Last medical examination:	7 March 1975
Total flying experience:	69 hours 40 minutes (dual instruction) 140 hours 25 minutes (in command)
Total flying experience on Cessna 310 aircraft:	17 hours 10 minutes (dual instruction) 0 hours 50 minutes (in command)
Total flying hours in last 28 days:	31 hours 50 minutes
Rest period:	18 hours

He had satisfactorily completed the day section of the professional pilot's licence type rating in respect of the Cessna 310 including the asymmetric and emergency manoeuvres sub-sections. The only items in his training records which may have possible relevance are that he was assessed as up to an average standard although rather slow and difficult to communicate with (English was not his mother tongue) and that he had experienced difficulty in maintaining height during instrument flight.

1.6 Aircraft information

G-BCKL was a Cessna, model E310Q aircraft which is a twin-engined low wing mono-plane, powered by two Continental 6-cylinder fuel injected engines driving two-bladed, constant speed, fully feathering, metal propellers. The aircraft was fitted with dual controls, and contained full night flying equipment including an anti-collision beacon. The left hand instrument panel displayed the flight instruments, and the right hand panel the engine instruments. All the flight instruments can be seen from the right hand seat although slip information (ball presentation) is difficult to determine under night lighting conditions from this position.

Certificate of Airworthiness:	In the General Purpose category valid until 15 December 1976.
Certificate of Registration:	The aircraft was registered in the name of Airwork Services Limited on 6 August 1974.
Total airframe hours:	790 hours 20 minutes
Total engine hours:	790 hours 20 minutes
Total hours since last check:	75 hours 10 minutes
Certificate of maintenance:	The aircraft was maintained in accordance with the approved maintenance schedule No. MS/Cessna 310/3. Its last certificate of Release was issued on 6 February 1976 valid for 100 hours prior to a Check II

Prior to flight the aircraft had been refuelled with Avgas 100 to a total of 136 imperial gallons, giving an endurance of 4½ hours.

Maximum total weight authorised: 2,400 kg
Accident weight: 2,220 kg (estimated)
Centre of Gravity limits: 32.0 feet to 43.5 feet aft of datum
Accident Centre of Gravity: 38.9 feet aft of datum (estimated)

1.7 Meteorological information

The area forecast for the period 1600 hours to 2300 hours on 4 March was:

Surface wind: Variable/6 knots
Cloud: 3/8 occasionally 5/8 stratocumulus at 4,000 feet – may disperse later.
Thin layers of altocumulus and cirrus layers over 15,000 feet
Surface visibility: 8-12 kilometres, occasionally 5 kilometres in haze
Weather: Variable cloud, smoke haze thickening at times during the evening.
Temperature + 4^o Celsius at 2,000 feet
Airframe icing: Nil or light

A SIGMET validated at 1730 hours forecast severe turbulence below 8,000 feet over the land area of the Scottish Flight Information Region.

The following weather observation was recorded at Perth aerodrome 2000 hours.

Surface wind: 190/5-10 knots
Visibility: 6,000 metres in smoke haze
Cloud: No cloud visible
QFE: 1007 millibars
QNH: 1021 millibars

Prior to the general commencement of night flying an instructor made a circuit and reported that conditions were suitable for solo flight. There was no indication of significant turbulence but the night was hazy and there was no defined horizon.

1.8 Aids to navigation

1.8.1 *On the ground*

All the navigational aids were serviceable. These comprised a non-directional radio beacon 'PTH', frequency 388 kHz, Very High Frequency Direction Finding (VDF) equipment, and an airfield identification beacon flashing green, 'PH'. At the time of the accident the VDF was not in use because of the distraction of the high frequency noise level which is emitted when it is in operation. Radar assistance may be obtained from RAF Leuchars and when the emergency arose such assistance was requested by the Perth ATC controller; he was advised that there was no evidence of any unaccounted aircraft movement.

1.8.2 *In the aircraft*

The aircraft was equipped with two VHF communication transceivers, two VHF navigation receivers, distance measuring equipment (DME) and a radar transponder. No

unserviceabilities had been recorded in the technical log and post accident examination established the continued serviceability of the VHF communications transceivers.

1.9 Communications

Normal VHF communication had been established on the frequency of 119.8 MHz (Perth Tower) and maintained throughout the flying detail until contact was lost. Although there is no requirement for RTF recording equipment at Perth, the equipment is available and normally used. However, on this occasion there was a failure of the magnetic recorder (Ferrograph, Type YD6BL/CA/R, serial No. 66528). There was no warning indication of this failure which lay in the idler wheel in the drive mechanism between the motor and the tape capstan. Replacement of the wheel restored serviceability but it is not known whether the failure was caused by seizure of the wheel or by possible indentations in its neoprene rim.

1.10 Aerodrome information

The aerodrome is situated approximately 4nm northeast of Perth at an elevation of 399 feet above mean sea level (amsl). The sector to the south, east, and northeast over which the aircraft was flying contains ground significantly above aerodrome level, rising in isolated spots to 1,236 feet amsl. Runway 22, which was the runway in use, is 2,700 feet long and is equipped with low intensity omnidirectional lighting.

1.11 Flight recorder

There was no requirement for a flight recorder, and none was fitted.

1.12 Wreckage and impact information

1.12.1 Accident site

The aircraft had struck the south face of Black Hill at a height of 1,100 feet above mean sea level, about 30 feet below the crest of a ridge leading up to the summit. It had then bounced over the ridge and come to rest inverted, approximately 100 yards from the initial impact point.

Examination of the initial impact area showed that the aircraft had run onto the hill face with some left bank and in a slightly nose-up attitude; the undercarriage was extended and the flaps and landing lights were retracted. The heading at impact was 345° Magnetic and ground cuts made by the left and right propellers were at about 30 inches and 25 inches intervals respectively.

1.12.2 Examination of wreckage

1.12.2.1 Airframe

Examination of the aircraft structure revealed no evidence of any pre-impact failure and the flying controls appeared to have been fully operational until disrupted at impact. Trim settings for the rudder and elevator were established as 65 per cent nose-right rudder trim and 12 per cent nose-up elevator trim. It was not possible to establish aileron trim with any reliability.

Both DC and AC electrical supply had been available up to the moment of impact and the electrically driven attitude instruments had 'frozen' at indications consistent with initial impact parameters. No failures of the radio equipment were revealed and both

communications transceivers were functionally checked and found capable of transmitting and receiving. It was not possible to calibrate the pressure instruments because of damage but the subscales of the two altimeters (both on the left-hand instrument panel) were found set to 1008mb and 1019mb respectively.

1.12.2.2. Engines

Disruption of the teleflex control cables made it impossible to establish information on the pre-crash positions of the engine or propeller control levers but examination of the engines revealed no evidence of any pre-crash mechanical defects. The fuel selectors were set to main tanks and there was evidence of adequate fuel in both main tanks at impact whilst the auxiliary tanks also contained considerable fuel. No obstructions were found in any of the fuel lines and the fuel injection systems of both engines were rig checked and found satisfactory.

1.12.2.3 Propellers

Examination of the propellers revealed that the left propeller had been on the fine pitch stop at impact, whereas the right propeller, though in fine pitch, was well off the fine pitch stop. There was no evidence of pre-impact malfunction of either propeller or its associated governor.

1.12.3 Possible bird strike

A very small number of uncharred downy feathers, subsequently identified as having come from either a blackheaded or common gull, was found in the rear cylinder fins and in the cooling air shroud of the fuel injection metering valve of the right engine. No bird strike deformation, blood or bird tissue was found on any part of the engine, propeller or cowling, nor was any such evidence or other feathers found in the vicinity of the initial impact site.

1.13 Medical and pathological information

Post mortem examination showed that the three occupants had died from severe head injuries. The toxicology showed no significant amounts of alcohol, carbon monoxide, or drugs in either pilot. Histological examination of the commander revealed occasional patches of atheroma in the coronary arteries, the worst area being in the descending branch of the left coronary artery some two inches from the origin where the lumen was reduced to about one third of normal for about one-tenth of an inch. The right coronary artery had an adequate lumen throughout.

The autopsy did not suggest a medical cause for the accident and the hypothesis that cardiac symptoms might have played some part as a distracting factor was assessed as possible but unlikely.

1.14 Fire

There was no fire.

1.15 Survival aspects

The accident was non-survivable.

1.16 Tests and research

Tests were made by an experienced Cessna 310 instructor to clarify a number of points on aircraft performance as follows:

- 1 The simulation of an engine failure and the simulated feathering of the propeller during training exercises was assessed and the accuracy of simulated zero thrust under approximately the same conditions of pressure and temperature as those of the accident was found to be reasonable when rpm was set in accordance with the manufacturer's operating manual.
- 2 With the left engine at this simulated zero thrust setting and whilst maintaining the power on the right engine previously required to maintain the circuit speed of 130 mph, the result of lowering the undercarriage was a speed reduction of about 30 mph. If 130 mph was maintained without additional power a rate of descent of about 500 feet/min resulted.
- 3 With the left engine at the simulated zero thrust setting and the aircraft trimmed for straight and level flight the effect of momentarily fully reducing power on the right engine whilst maintaining the same rudder trim setting was a heading change of 3°/second to the right with an increasing angle of bank.

1.17 Additional information

A map of the aerodrome area including the standard circuit pattern used at AST Perth is shown in Appendix 1. Circuits and landings are normally made under conditions which allow pilots to assume responsibility for safe separation between their aircraft, although it is normal practice for ATC to provide efficient sequencing. Calls on RTF are made at specific reporting points and, in particular, the 'downwind' call is made when the aircraft is abeam of the upwind end of the landing runway. The view from the Control Tower provides adequate surveillance through 360° and it is customary for the controller to make a visual check of an aircraft calling 'downwind' or 'finals'.

The stipulated height of 1,000 feet above aerodrome level for day circuits is increased to 1,200 feet for night circuits. This provides a clearance of about 670 feet over the highest object in the immediate area of the circuit, which is an obelisk almost due south of the airfield. 1,200 feet also provides a clearance of about 400 feet above Kings Seat which is the highest point of the high ground which lies to the northeast of the airfield; the accident site was about one mile from this point, 720 feet above airfield level (see Appendix 1).

It is recognised by the instructor pilots that the aerodrome lighting is not fully adequate for visual positioning except in ideal conditions of visibility and it is therefore common practice to relate to known landmarks. For night circuits to Runway 22 such a landmark is the village of Balbeggie with which the instructor was wholly familiar, having lived there for about three years. Although no system of stopwatch timing is used to regulate actions in the circuit it is emphasised to pupils that when on the downwind leg for Runway 22 it could be hazardous to proceed much northward beyond Balbeggie because of the high ground ahead and therefore the turn onto base leg is initiated shortly after passing abeam that village. The undercarriage is lowered just before the turn which is made in level flight, maintaining 1,200 feet above aerodrome level, and adjusting power as necessary to maintain 120 mph. If there is difficulty in maintaining height at 120 mph the undercarriage may be retracted again. Descent begins only after completing the turn and is made at about 500 feet/min, whilst maintaining 120 mph, to 700 feet above aerodrome level and this is maintained until the turn onto final approach.

2. Analysis

There is no evidence that any pre-crash defect or malfunction of the aircraft its engines, or its flying controls contributed to the cause of the accident. The setting of the rudder trim tab was consistent with asymmetric flight with a failure of the left engine, either actual or simulated. On the basic assumption that the aircraft was flying at about the circuit speed of 120 mph, the propeller evidence is also consistent with the same asymmetric flight condition and with the power and propeller settings employed when simulating the feathering of the left engine. It is true that if the airspeed were appreciably lower than the assumed 120 mph then the propeller evidence would not support the declared asymmetric exercise but in the absence of any evidence of pre-impact damage or malfunction of the propeller governors it is reasonable to accept that the declared asymmetric exercise was still in progress at the time of impact.

About 90 seconds after the 'downwind' RTF call notifying the asymmetric exercise, the aircraft was seen in approximately level flight, still on the northeasterly downwind heading, but low enough to be identified at night as a twin-engined aircraft; there is nothing to suggest that this resulted from a sudden or emergency descent. The aircraft continued in level flight for about one mile further before starting the left turn during which it struck the hillside; it was then 500 feet below the stipulated height for the downwind leg of the circuit. Although both VHF transceivers were found to be still operable after the accident there had not been any RTF call from the aircraft and it is therefore reasonable to conclude that, except possibly in the final few seconds, neither the instructor nor the student had been aware of any emergency or event of sufficient importance to cause them to notify ATC.

There is no evidence to explain the approximately two miles extension of the downwind leg but whatever the cause of that extension and its associated lateral displacement the critical factor was undoubtedly the reduction in height of about 500 feet below the stipulated 1,200 feet circuit height. Although the instructor could be expected to tolerate some inaccuracy in height-keeping from a student at this stage of his training, it is not reasonable to believe that he would knowingly accept such a significant loss as 500 feet when over the high ground in this area of the circuit environs, particularly at night.

If the height reduction was knowingly allowed, and in the absence of any apparent emergency, then it must be presumed that the instructor was certainly unaware of the aircraft's true position. This inference is supported by the lack of any call to ATC since had he realised the magnitude of the downwind extension he would also know that it would seriously disrupt the sequence of the following aircraft in the circuit. A possible, but unsupported, explanation for such unawareness might be considered to lie in an assumed incapacitation of the instructor, perhaps unnoticed by the student. The latter, probably engrossed in his first night asymmetric exercise, might then be assumed to have misjudged his circuit pattern. However, since he had just completed five circuits, all entailing identical height and positioning requirements after the 'downwind' position, any such assumption is certainly questionable.

It must be emphasised that the medical evidence found during this investigation is not strong enough to provide genuine grounds for any such incapacitation. Not only is there no evidence that the instructor had ever reported symptoms of pain attributable to the heart condition disclosed by the post-mortem examination, but there is evidence that during his earlier duties throughout the day of the accident he had appeared to be his 'normal self'. The day's work was not excessive and there is no evidence to suggest the onset of stress or exhaustion sufficient to precipitate any medical incapacity. Whilst, in the circumstances of an accident such as this, the possibility of some form of incapacitation cannot be excluded, the available evidence does not permit it to be offered as

anything more than speculation. Even, if it did occur a further level of speculation would be involved in the assumption that the student persisted in the exercise rather than restoring power to the left engine and thus simplifying any problems which may have arisen.

An alternative to total incapacitation could be some form of preoccupation and there is some evidence on which to base a possible cause for this, though it is by no means convincing. This relates to the possibility of a bird strike (see paragraph 1.12) although there is no evidence to confirm that the bird feathers were the result of an in-flight bird strike rather than something picked up during the final ground impact sequence, or even the result of some occurrence prior to this final flight. If there was such a strike, and if it did occur in the air rather than in the course of the crash sequence, then it certainly does not appear to have affected the aircraft's airworthiness. However, it is possible that the noise or feel of the strike impact could have led to preoccupation during a comprehensive checking of the aircraft, so that the correct position for making the base leg turn was missed and the downwind leg was unwittingly extended. If such bird strike related preoccupation is to be considered as a causal factor then it would have to occur in the period of approximately one minute between 'downwind' call and the correct position for the base leg turn. It is certainly true that for the aircraft to have been at the height seen by the witness one mile beyond the correct turning point the descent from 1,200 feet must have started at or about abeam of that turning point. Although it is conceivable that such preoccupation could lead to the base leg turn not being made at the correct time and even, briefly, to the height loss passing unnoticed, it is straining credulity to believe that the instructor would remain unaware both of the reduced height and the passage of time throughout the continued low level northeasterly flight and thus take no action to remedy the situation.

If it is accepted as more probable that the instructor would be aware of either or both the reduced height and the elapsed time, then the logical deduction is that he was not aware of the aircraft's true position and thought himself to be on base leg; that was the only correct place for the aircraft to have been in more or less level flight at 700 feet with its undercarriage extended. At that height, on base leg, the aircraft should be approaching the turn onto 'finals' and although it is possibly nothing more than coincidence, the time required to reach that position from starting the base leg turn on a wide circuit, the time to descend from 1,200 feet to 700 feet, and the time appropriate to extending the downwind leg to the accident site are all of the order of one minute. An inference that it may be more than coincidence is to be found in the fact that if the pilots had indeed believed themselves to be on base leg then this would also explain the lack of any RTF call, since this would not become due until the turn on 'finals', ie at or about the time of impact. Such a misconception would entail unobserved or mistakenly interpreted landmarks and also a failure to realise that the aircraft had not turned left through about 90° onto the base leg. Although it was a dark night with some haze and no clear horizon the aircraft had already made five successful circuits and therefore such an 'explanation' may, quite properly, be considered too facile, particularly in view of the instructor's local knowledge and experience.

After full consideration, and in the absence of any sound explanation based on mechanical failure, incapacitation or preoccupation, it is only possible to state that the accident was undoubtedly the result of a combination of errors in position and in height, but that there is insufficient evidence from which to derive substantiable explanation for those errors. In consequence it has not been possible to establish the primary cause(s) of this accident.

3. Conclusions

(a) *Findings*

- (i) The aircraft had been properly maintained and its documentation was in order.
- (ii) There was no evidence of any pre-crash defect or malfunction of the aircraft or its engines and propellers.
- (iii) The commander was properly licensed and was both qualified and well experienced for the instructional flight he was making.
- (iv) The student pilot had very limited night flying experience and this was his first exposure to a simulated engine failure and consequential asymmetric flight in darkness.
- (v) When making his 'downwind' RTF report the commander had indicated his intention to make a practice one-engined approach.
- (vi) Examination of the wreckage confirmed that the aircraft trim configuration and the propeller evidence was consistent with asymmetric flight under conditions simulated feathering of the left propeller.
- (vii) There is insufficient evidence to conclude that either a bird strike or pilot incapacitation was a factor in this accident.

(b) *Cause*

The accident resulted from the reduction in circuit height by about 500 feet and the extension of the downwind leg into an area of high ground. No satisfactory reason for these departures from the standard circuit pattern has been established.

R D Westlake
Inspector of Accidents

Accidents Investigation Branch
Department of Trade

March 1977