Ministry of Defence

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2017-01415

[redacted]

9 February 2017

Dear [redacted]

Release of Information

Thank you for your correspondence dated 25 January 2017 requesting the following information:

> *'Please find below further information you require to reconsider my request for information with regard to my helicopter ditchings:*
>
> *The first ditching took place on 22nd May 1975*
> *Helicopter: Wessex I*
> *Aircraft Registration: XS880*
> *Ditching took place: South Atlantic*
> *Embarked onboard: HMS Ark Royal*
> *Pilot: Lt*
> *Aircrewman: Myself*
> *Squadron Commander: Lt Cdr*
> *Diver involved in the rescue: PO*
> *Mission: Plane guard, aircraft ditched after engine failure SAR flight.*
>
> *The second ditching took place on 17th September 1975*
> *Helicopter: Wessex I*
> *Aircraft Registration: XPIIZ*
> *Ditching took place: South West approaches*
> *Embarked onboard: HMS Ark Royal*
> *Pilot: Lt*
> *Aircrewman: Myself*
> *Squadron Commander: Lt Cdr*
> *Diver involved in the rescue: PO*
> *Mission: Cabin gun firing. Aircraft ditched after engine fire. SAR flight.*

Your enquiry has been considered to be a request for information in accordance with the Freedom of Information Act 2000.

I can confirm that the Ministry of Defence holds information within the scope of this request. I have included in this letter a copy of the Aircraft Accident Investigation Unit Report (AAIU) into the accident to Wessex HAS Mk I XS880 on 22 May 1975. Please note that the personal information of other individuals involved in the accident or accident investigation have been withheld under section 40(2) of the FOI Act (personal data).

Section 40(2) applies to personal data relating to third parties. The release of personal information relating to other individuals would contravene the principles of the Data Protection Act 1998, namely Principle 1 – personal data shall be processed fairly and lawfully and not unless certain specified conditions are met, and Principle 2 – personal data shall be obtained and processed only for specified and lawful purposes and not further processed in a manner incompatible with the purposes. In this instance, data has been provided for investigative purposes only and not with the expectation that it would be made public.

With regard to the second ditching unfortunately no AAIU report exists however we have located the following information from HMS Ark Royal's Report of Proceeding for 13 June to 27 October 1975:-

> On 17 September whilst operating in the Plymouth exercise areas SAR Wessex 047 ditched during GPMG firings. The aircrew were rescued uninjured, but unfortunately the aircraft sank during recovery operations. A separate report is attached at Annex C".
>
> Annex C reads as follows: -
>
> 1. At 1459 on the 17th September Wessex 047 ditched 2.5 miles from the ship, whilst it was conducting practice firings with a GPMG. The pilot received a fire warning light and a sight of smoke from the area of the engine. After reducing power, the light remained burning, so the aircraft was put down into the sea. Only one wheel flotation bag operated and the aircraft turned turtle. All the aircrew escaped uninjured.
> 2. The stand-by SAR helicopter was airborne within 8 minutes and brought the aircrew back to the ship. At the moment the helicopter ditched, the ship was steaming at 28 knots in the midst of an 80% full power trial. Consequently, it was over an hour before the ship could be laid alongside the wrecked aircraft – although the whaler, with divers, extra flotation bags and a recovery strop were put in the water at once.
> 3. In the interim period, HMS BACCHANTE, from exercising nearby, provided a seaboat to stand-by until relieved by the ship' seaboat which attached the extra flotation bags and lifting strops to the Wessex. When recovery operations finally started, some of the flotation bags detached from the wreck and the aircraft sank in 42 fathoms of water.

If you are not satisfied with this response or you wish to complain about any aspect of the handling of your request, then you should contact me in the first instance. If informal resolution is not possible and you are still dissatisfied then you may apply for an independent internal review by contacting the Information Rights Compliance Team, Ground Floor, Zone D, MOD Main Building, Whitehall, SW1A 2HB (e-mail CIO-FOI-IR@mod.uk). Please note that any request for an internal review must be made within 40 working days of the date on which the attempt to reach informal resolution has come to an end.

If you remain dissatisfied following an internal review, you may take your complaint to the Information Commissioner under the provisions of Section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not investigate your case until the MOD internal review process has been completed. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website, http://www.ico.org.uk.
Yours sincerely

Navy Command Secretariat – FOI Section

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AIRCRAFT ACCIDENT INVESTIGATION UNIT

OFFICE COPY

REPORT R4/75

SUBJECT ACCIDENT TO WESSEX HAS MK 1 XS 880 ON 22 MAY 1975

Copy No 20
of 22 copies

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Accident Investigation Unit
HMS DAEDALUS
Lee on Solent
PO13 9NY.

AIU R4/75

17 March 1976

REPORT ON INVESTIGATION INTO ACCIDENT TO WESSEX HAS MK1 XS 880 OF HMS ARK ROYAL SAR FLIGHT ON 22 MAY 1975

AIRCRAFT CREW: PILOT — LIEUTENANT XXXXXXXXXXXXXXXXXXXX
SAR DIVER — PO ACMN XXXXXXXXX
SAR WINCHMAN - LACMN P HOPE

1. The aircraft took off from ARK ROYAL at 0813 local time to carry out planeguard duties during a 'fixed wing' launch. As the aircraft was being transitioned to a slow forward speed alongside the bow catapult, "... the engine rumbled and flames issued from the jet pipes ...".

2. The pilot closed the HP cock, transmitted a MAYDAY call and had time to raise the lever fully to cushion the impact of the aircraft on the water.

3. The crew vacated the ditched aircraft and were rescued by the standby SAR helicopter.

INVESTIGATION

4. The initial AIU investigation was carried out aboard ARK ROYAL at Gibraltar on 5 June. Detailed airframe and engine investigations were carried out at Lee on Solent and RNAY Fleetlands after the ship's return to UK. Annex A to this report contains details of the technical investigations and of subsequent flight tests which were conducted.

CONCLUSIONS

5. a. The accident occurred when the engine malfunctioned due to compressor surge.

b. The cause of the compressor surge was considered to be poor engine performance in response to a demand for a rapid acceleration from a CRPM below that recommended by the manufacturers for surge free operation.

RECOMMENDATIONS

6. a. A study into the relevance of 14,500 revs/min as the installed Flight Idling CRPM be undertaken by Rolls Royce (1971) Limited.

b. That installed engine response check detailed in AP 102C-0305-1 Sect 3 Chapter 2 Item 8 be examined by Rolls Royce (1971) Limited with respect to the possibility of including a time limit.

c. That consideration should be given to carrying out the installed engine response test on a routine basis in conjunction with Annual Maintenance Test Flights and testing in accordance with STI/GAZELLE/51 (IGV/CRPM relationship testing).

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d. That a flying restriction be imposed upon the aircraft such that during normal operations the minimum in flight CRPM to be used is 14,500 except when the aircraft is within auto rotative distance of a suitable landing area.

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XXXXXX

Lieut Cdr RN
Officer in Charge AIU

ENCLOSURES:- ANNEX A - Investigating Officer's Report and Photograph

DISTRIBUTION:-
Adviser on Aircraft Accidents
Flag Officer Naval Air Command
Flag Officer Carriers and Amphibious Ships
Commanding Officer HMS ARK ROYAL
Captain HMS OSPREY
Commanding Officer HMS SEAHAWK
Commanding Officer HMS ARK ROYAL SAR FLIGHT
Commanding Officer 771 Squadron
Commanding Officer 772 Squadron
Officer in Charge RN Flight Safety Centre
MOD (DFS) RAF
MOD PE TA (M) DG ENG
MOD PE D/HP
Structures Dept (Accident Section) RAE Farnborough
Accidents Investigation Branch, Dept of Trade
Rolls Royce (1971) Limited

ANNEX A TO AIU REPORT NO R4/75

TECHNICAL INVESTIGATION INTO ACCIDENT TO WESSEX XS 880 OF HMS ARK ROYAL SAR FLIGHT ON 22 MAY 1975 BY LT XXXXXXXXXX, AA1(AE) XXXXXXXXXX & AA1 (AE) XXXXXXX

CIRCUMSTANCES

1. Wessex XS 880 had taken off from HMS ARK ROYAL at 0813P on 22 May 1975 in order to carry out Planeguard duties during a launch of Gannet, Buccaneer and Phantom aircraft. The crew was LT XXXXXXXXXX RN, Pilot, POACMN XXXX XXXXX, SAR Diver and LACMN P HOPE, SAR Winchman. The same aircraft and crew having already carried out Planeguard duties at 0645P that day.

2. After take off from No 3 helicopter spot a check hover was carried out off the port bow of the ship. All temperatures and pressures were normal. The aircraft was then flown in a wide left-handed circuit, the pilot's intention being to take station parallel with the bow catapult where the first fixed wing aircraft was being prepared for launch. As the aircraft was flared to reduce to ship's speed the throttle was opened slightly using the twist grip. The compressor speed (CRPM) increased by 200 to 300 revs/min and then began to decrease. Shortly after this a rumbling noise was heard and flames were observed coming from the jet pipes.

3. The pilot closed the HP cock and transmitted a MAYDAY call, full collective was then applied to cushion the impact with the sea, the aircraft hit the water heavily. Both PO ACMN XXXXX AND LACMN HOPE suffered slight back injury, the pilot was unhurt. The flotation gear operated on contact with the sea and the aircraft floated in an upright position. The crew abandoned the aircraft and 5 minutes later it inverted, but remained afloat. The crew was recovered by the standby SAR Wessex after approximately ten minutes.

4. The aircraft was salvaged and lifted on board ARK ROYAL at 1200P, it having been immersed for 3¾ hours. On recovery it was noted that all aircraft fuselage structure aft of station 296 was missing, and that the four main rotor blades had broken off approximately 2 metres (6 feet) outboard of the main attachment points (PHOTO 1). As the aircraft fuel tanks were ruptured fuel samples were not taken, however, samples of fuel from the refuelling point last used by the aircraft and from the ship's tanks were taken and sent to NAML for analysis. The samples were later reported to be satisfactory (NAML's J2113/22.1 of 2 July 1975).

5. The meteorological observation made at the time of the accident was:-

Present weather	Nil
Barometric Pressure	1015.5 mbs
Wind	150° 14 knots
Visibility	16 kms
Humidity	80%
Sea State	2 (light swell)

6. The assistance of the Accident Investigation Unit was requested, and the investigating team arrived on board ARK ROYAL at Gibraltar on 5 June.

PRELIMINARY INVESTIGATION

7. The aircraft wreckage was stowed in the forward extension of the upper hangar. The main rotor blades, nose door, cabin windows and all electrical gear had been removed. The flotation gear, gas generators, rescue winch, cargo hook and weapons carrier, with the remains of the drop tank which had been fitted, were stowed inside the aircraft cabin.

8. There was an area of damage to the upper nose structure, immediately below the starboard windscreen. The upper and lower aerial posts and aerials had been torn off, a large section of the starboard transmission platform was missing. The aircraft structure below the cabin door was badly buckled and distorted. The aft fuselage was torn at Station 246, the tear extending to waterline 0 on the port side and continuing round the aircraft refuelling point on the starboard side. The upper surface of the tail cone was torn open between stations 246 and 296 and the tail rotor drive shaft had broken off at the No 4 shaft flexible coupling at Station 316.

9. The port yaw control cable had parted at Station 296 and the tail cone cat walk was virtually separated from the upper fuselage structure by longitudinal tearing along waterline 0 on port and starboard sides. The port side of the aircraft forward of Station 246 was relatively undamaged, and both undercarriages were intact.

10. The underside of the aircraft was badly buckled and deformed, the ECU lower access panels and the No 1 fuel tank fairing had been bent inwards by impact with the sea. The main rotor gearbox was corroded, with holes appearing in the casing and the main rotor head was badly damaged. The engine intake front face and throat were corroded and the rotating assembly of the gas generator was seized. The deformed ECU lower access panel noted earlier had distorted the throttle push pull rod, giving a throttle angle of 45^{o}, the rod was straightened by the investigation team. The Inlet Guide Vanes (IGV) angle was found to be 40^{o}. All engine connections were made and appeared normal. Engine controls were operating through their full range and in the correct sense.

11. All sound proofing had been removed from the cabin interior, the cabin structure appeared undamaged but the underwater escape guide rails were broken at Station 243 on the aircraft's centreline and a section was missing forward of Station 151. The starboard yaw control cable had parted close to the pulley on the aircraft centreline. The port and starboard pilot's seats were undamaged, the harnesses appeared to be undamaged and functioning. The starboard cyclic stick was broken at its lower attachment.

INTERVIEWS

12. LT XXXXXXXXXX - PILOT The pilot reported that the aircraft was manned at 0800P for an 0815P fixed wing launch. Start up and rotor engagement were completed without incident and the aircraft took off at 0813P. A check hover was carried out off the port bow of the ship, all temperatures and pressures were normal. The pilot then flew the aircraft in a wide left hand circuit which brought the aircraft parallel with the ship's side alongside the bow catapult and slightly higher than flight deck level. (Approximately 75 ft AMSL) As he transitioned the aircraft from approach speed to ship's speed he noted the CRPM as being in the range 14,700 to 15,000 revs/min, he opened the throttle slowly to ensure a smooth increase in CRPM as he levelled and increased collective

pitch. Response to throttle opening seemed normal and the CRPM rose by 200 - 300 revs/min, the CRPM began to decrease with a corresponding decrease in engine noise. A low rumbling was heard and flames were seen coming from the jet pipes. He closed the HP cock and transmitted a MAYDAY call three times before raising the collective lever fully in order to cushion the impact with the sea. The impact was heavy, the flotation bags inflated and the crew abandoned the aircraft.

13. Other Crew Neither PO XXXXXX nor LACMN HOPE had anything of relevance to add. They were not strapped in seats at the time of the accident and both suffered slight sprain to the dorsal spine (T9, 10, 11).

14. Maintenance Personnel The SAR Flight maintenance personnel had observed nothing relevant to the accident. A turn round inspection had been carried out before the last take off, and engine bay leak checks had been carried out after the engine start up and rotor engagement. A routine oil sample taken prior to the last flight was subsequently reported to be satisfactory (NAML's PR 281657Z MAY refers).

ENGINE DETAILED INVESTIGATION

15. The engine was removed from the airframe by the investigating team. During the removal a fuel drain pipe connection was found detached from the lower starboard jet pipe. The appearance of the fracture face suggested that the crack was not of recent origin and was considered not relevant to the accident. There was no evidence of fire or overheating in the rear engine bay. A serious defect signal was raised (ARK ROYAL's DRA/DOR 081521Z JUN refers). The free power turbine and jet pipes appeared undamaged and clean, and the turbine was free to rotate. The Inlet Guide Vanes (IGVs) were free and able to move through their full range of movement. Inspection of the IGVs and first two stages of the compressor using a mirror revealed no obvious damage. The gas generator was seized and severe internal corrosion of the engine intake assembly was noted on removal of the engine driven generator.

ENGINE STRIP

16. On arrival in the United Kingdom the engine was taken to the investigation section at RNAY Fleetlands. The fuel system components were removed and prepared for rig testing at the Manufacturers, the units being inhibited by the fuel section at Fleetlands on 19 June. The engine was then stripped into its main assemblies, the results of the strip examination being as follows:-

a. Air Intake Casing As noted in paragraph 15 the intake casing was severely corroded. When the accessory drives cover was removed the accessory drives were found jammed and corrosion products were present. The IGVs were undamaged and were free to move. No damage to the compressor front bearing labyrinth seals was observed.

b. Compressor Assembly The compressor rotor and stator appeared undamaged, there was some evidence of salt encrustation on the rotor blades. The width of compressor interstage sealing gaps was satisfactory. It was noted that the 11th stage sealing disc was to Pre MOD 889 standard.

c. Support Plate The support plate was badly corroded internally and externally. The Outlet Guide Vanes appeared to be undamaged.

d. Combustion System Assembly The combustion system was in good condition and no collapse of the flame tubes observed. The burners appeared carbon free, but there was evidence of carbon deposits on the inside face of the inner flare and swirler assembly. The amount of carbon present was not considered excessive in view of the engine hours run since Rectification (232:20).

e. Compressor Turbine Rotor and Intermediate Casing The stage 1 and 2 compressor turbine blades were undamaged, no burning or erosion was observed. All casings and nozzles were in good condition and appeared to have been unaffected by their immersion in salt water.

f. Free Power Turbine Rotor Casing The Free Power Turbine and casing appeared undamaged and generally in good condition.

g. Exhaust Casing and Reduction Gearbox With the exception of the broken fuel pipe boss described in paragraph 15 the exhaust casing and reduction gearbox assembly was undamaged.

17. Testing of Fuel System Components The IGV Control Unit, Fuel Metering Unit, Fuel Pump, and Acceleration Control Unit were delivered to the manufacturers, J. Lucas Limited, for rig testing and strip examination. Due to annual holidays and other unavoidable delays the tests were not commenced before 13 August. The results of the tests were as follows:-

a. IGV Control Unit - Serial No CGVS 845 - hrs run 446.35 (102C-0305-1 Sect 1 Chap 2A Fig 9).

The unit was installed on the test rig and run in the presence of the investigating officer. When fuel pressure was applied to the unit the servo piston moved to the minimum rev/min stop (IGVs closed) and remained there despite any increase in fuel pump speed. The signal pressures from the fuel pump and the constant flow input to the control valve were checked and found correct. The diaphragm housing was removed and the diaphragm examined, no tearing or other damage was evident. The control valve was then exercised manually against the action of the control valve spring and the diaphragm housing replaced. The unit then began operating when fuel pump speed was increased. After some initial difficulty, due to incorrect assembly by an inexperienced test engineer, the operation of the unit during the acceleration phase was found to be within schedule. Datum drift in the negative sense (smaller IGV angle for the same pump speed) was observed after 1 hours running, the amount of drift was not considered excessive. When the operation of the unit was checked during a deceleration phase it was noted that as pump speed was decreased there was a large transient overswing towards the minimum rev/min stop before the unit established the correct angle for the lower pump speed. It was considered that this instability was primarily due to a one way 'stiction' within the unit, causing a fractional delay in the follow up action which normally re-centralises the control valve. A second test run showed that the instability was reduced by continued operation of the unit. The unit was then stripped and the following noted:-

(1) Corrosion Corrosion products and deposits of salt-contaminated grease were found on the rocking beam pivot, the control spring end plates and the pin securing the servo piston to rocking beam. (The control valve spring and rocking beam chambers are vented through the fuel drains system to the jet pipes and it is considered that ingress of salt water probably occurred when the engine was immersed.)

(2) Wear Several wear sites were identified within the unit, these included 'pick-up' on the lands of the control valve and witness marks on the servo piston rod, at a point where the rod passes through the seals in the casing. Witness marks were also evident on the control valve push rod from the diaphragm. It was noted that the witness marks on the servo piston rod and control valve push rod were diametrically opposed indicating that these items were subject to tilting during operation of the unit. Five other units on overhaul at J Lucas Limited were then examined and similar wear was noted, although the unit on test was marginally worse on visual examination in the area of the servo valve lands. The items under investigation were checked dimensionally and found to be within tolerance.

b. Fuel Metering Unit - Serial No GMFU 1077 - Hrs run 446:35. On rig test the fuel metering unit showed a satisfactory throttle angle/fuel flow relationship. No defects relevant to the accident were noted. Some stiction in the rotor speed governor null indicator pick off was present, it was found to be due to the presence of corrosion products in the pick off housing. It was considered that this was as a result of immersion in sea water.

c. Fuel Pump - Serial No 3052R - Hrs run 232:20. Fuel pump operation on the test rig was satisfactory.

d. Acceleration Control Unit - Serial No 1006BR - Hrs run 232:20. When tested the ACU was found to be operating outside limits. In the active range of the unit between 190 and 500 lbs/hr the unit was 1 second slow at 5.5 seconds. No cause for the slow operation of the unit was found, and examination of engine records revealed no evidence of the unit having been adjusted in service. The unit responded normally to adjustment during rig testing. The operation of the unit as found would give a marginally slow acceleration from Ground Idle to 14,500 CRPM.

18. ECU History The engine was reconditioned at Fleetlands on 12.7.68 and had run a total of 446:35 hours. A summary of the engine's history is as follows:-

EVENT	DATE	HOURS RUN
1st recondition at Fleetlands (Job No 35315)	12.7.68	NIL
Installed XM 841	17.7.68	NIL
Removed XM 841 for S.O.A.P. investigation	20.11.68	19:25
Cat 4 repair at Fleetlands (Job No 35409)	10.7.69	119:25
Installed XP 158	6.8.69	119:25
Removed XP 158	31.7.70	214:15
MOD programme at Fleetlands (Job No 35517)	15.11.71	214:15
Installed XS 880	11.1.72	214:15
Removed XS 880 - vibration at ground idle	11.1.72	214:15

Investigation at Fleetlands (IR2509)
Bearing wear and minor FOD.

Rectification 1 at Fleetlands (Job No 35577)	6.11.72	214:15
Installed XS 880	22.5.73	214:15
Accident to XS 880	22.5.75	446:35

19. Servicing All servicing relevant to the engine had been carried out and was in date. The compressor had been washed the day before the accident. A high speed surge boundary assessment check had been carried out 50 hours prior to the accident and the engine was assessed as surge free at $+3^{\circ}$ IGV angle with a safe OAT of 40°C.

20. Flight Tests at HMS DAEDALUS To establish that the engine conditions observed by the pilot prior to the accident were consistent with normal engine operation it was decided to carry out a series of practical tests on a serviceable Wessex 1 aircraft, and an aircraft from 772 Squadron at Portland was loaned to AIU for this purpose. The tests consisted of a number of manoeuvres at low level in simulation of the aircraft's flight prior to the accident. For comparison purposes it was decided to carry out a 'flare' from 60kts to 30 kts IAS with and without using the twist grip. The results of the tests were as follows:-

TEST	MANOEUVRE	CRPM	RRPM	NGIL IND POSN	REMARKS
1.	Straight and level flight 60ft at 60 kts IAS.	18000	221	½ Div left	Best estimate of aircraft height and speed prior to flare.
2.	'Flare' from 60kts to 30 kts IAS 60 ft. No twist grip application.	14200	236	3 Divs right	'Harsh' flare
3.	Flare from 60 kts to 30 kts IAS 60 ft with twist grip application.	14000	236	3 - 4 Divs	'Harsh' flare
4.	Flare from 90 kts to 30 kts IAS at 60 ft with twist grip application.	13600	236	4 Divs right	Estimate of aircraft Maximum speed prior to flare.

It was noted that on levelling on completion of each flare the aircraft lost between 25/30 feet of height.

21. It can be seen from the results at paragraph 20 that the action of the Rotor Speed Governor (RSG) during a flare is to bleed off fuel; this is due to a transient overspeed condition of the rotor disc. The greater the difference in approach and end speeds the more fuel was bled off by the RSG. As the RSG bleeds off fuel downstream of the throttle valve it would, within the authority of the governor bleed, decrease the CRPM below that dictated by the throttle system. Application of the twist grip prior to the flare could result in a marginally greater bleed off of fuel by the RSG and consequently a lower value of CRPM. (See paragraph 20, test 3). As a result of these observations it was decided to examine some aspects of the engine handling considerations contained in the Aircrew Manual, namely:-

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a. Maximum Rate of Collective Pitch Application The maximum rate of collective pitch application during autorotation or 'quick stops' is quoted as 4° per second (AP 101C-0101-15 Part 3 Chap 2 Para 15j). This limitation was confirmed during flight testing of the Wessex 1 aircraft after fitment of the Rotor Speed Governor. It was established that, because of throttle lag and the poor acceleration response of the engine between 12,250 and 14,500 revs/min, collective pitch application in excess of this figure resulted in Transient Rotor RPM droop below the acceptable value. This limitation still obtains and the note in the aircrew manual is still relevant.

b. Flight Idling CRPM This limitation, quoted as 14,500 revs/min, is described as the minimum CRPM from which the engine will accelerate to 95% power in 5 seconds at any ambient temperature (AP 101C-0101-15 Part 2 Engine Limitations). This aspect of the engine's performance is checked during test bed running after Rectification or Reconditioning (AP 102C-0305-6BCD Test Schedule Routine 7 Operations 3 & 4). No record of confirmation of this limitation by flight testing could be found.

DISCUSSION

22. From the symptoms reported by the pilot and the observations of other witnesses the primary cause of the accident appeared to be engine failure due to compressor surge. Previous experience has shown that the main contributory factors to Gazelle compressor surge are:-

a. Mechanical failure.

b. Fuel control system malfunction.

c. Poor compressor performance at low CRPM.

d. Other factors.

23. Each of these is discussed separately below:-

a. Mechanical Failure Strip examination revealed no evidence of mechanical failure.

b. Fuel Control System Malfunction Due to the length of time between the accident and rig testing, the possibility that the instability found in the IGV Control Unit was due to internal corrosion could not be discounted.

c. Poor Compressor Performance at Low CRPM The pilot reported that the CRPM on entering the flare prior to surge was in the range 14,700 to 15,000 revs/min. This was considerably lower than the 18,000 revs/min noted during test 1 at paragraph 20; it is considered that this was due to RSG operation as forward speed and altitude was progressively reduced in the circuit. The null indicator position on entering the flare was not known. The effect of increasing the CRPM using the twist grip would be to marginally increase the bleed off of fuel as shown in test 3 paragraph 20. The reduction of CRPM noted by the pilot after the initial 200 - 300 revs/min increase was probably due to RSG operation. The minimum value of CRPM prior to surge was not known. Application of collective pitch on levelling the aircraft would result in:-

(1) Reduction of Rotor RPM due to Static and Transient Droop, thus reducing the bleed through the RSG.

(2) Increase in throttle opening due to collective/throttle interconnection.

It is considered that under these conditions the engine would be subject to a demand for rapid acceleration from a low CRPM value. The probability of engine surge in this high ambient temperature (24.8°C) is thought to be high. Surge free response to slam acceleration is normally checked during post installation tests (AP 101C-0305-1 Sect 3 Chap 2 Item 8). With the RSG inoperative and the bleed closed the engine is subjected to a slam acceleration from 205 Rotor RPM, the engine having first been decelerated from 220 Rotor RPM. The engine is considered satisfactory providing the acceleration is surge free, the test does not include a time limit. Practical tests by 771 and 772 Squadrons have shown that the minimum CRPM experienced during this test is in the range 13,000 - 13,500 revs/min. It is considered that while the engine response test described above is an effective method of proving surge free response from CRPM values below 14,500 revs/min it depends upon the ambient temperature, the speed of twist grip application and ACU setting. A marginally slow application of twist grip with the ACU set to the 'slower' end of the range (11,250 to 14,500 revs/min in $2\frac{1}{2}$ to $4\frac{1}{2}$ seconds) on a cold day could result in surge free response from a relatively unstable engine. The test is not normally carried out on a routine basis, although it is known that some units include the test during STI/GAZELLE/51 (IGV/CRPM relationship testing). Normal in flight operation of the engine below 14,500 CRPM is considered inadvisable (AP 101C-0101-15 Aircrew Manual Part 3 Chap 2 Para 15), due to the possibility of engine surge, it should be noted that the tests at paragraph 20 established that CRPM values below 14,500 revs/min can be experienced during 'flares' or quick stops due to the operation of the RSG. No surge was experienced during the tests at paragraph 20 but the ambient temperature was 15.3°C, and the sink observed at the end of each flare would indicate a marginally slow application of collective pitch by the pilot.

d. Other Factors Some cases of Gazelle engine surge resulting from such factors as intake airflow disruption and the ingestion of small amounts of water have been recorded. No evidence of the presence of such factors could be found.

CONCLUSIONS

24. The primary cause of the accident was due to compressor surge. The cause of the compressor surge was not established, but was considered to be due to poor engine performance in response to a demand for a rapid acceleration from a low CRPM value.

RECOMMENDATIONS

25. It is recommended that:-

a. A study into the relevance of 14,500 revs/min as the installed Flight Idling CRPM be undertaken by Rolls Royce (1971) Limited.

b. That installed engine response check detailed in AP 102C-0305-1 Sect 3 Chapter 2 Item 8 be examined by Rolls Royce (1971) Limited with respect to the possibility of including a time limit.

c. That consideration should be given to carrying out the installed engine response test on a routine basis in conjunction with Annual Maintenance Test Flights and testing in accordance with STI/GAZELLE/51 (IGV/CRPM relationship testing).

d. That a flying restriction be imposed upon the aircraft such that during normal operations the minimum in flight CRPM to be used is 14,500 except when the aircraft is within auto rotative distance of a suitable landing area.

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(xxxxxxxxxxxxx)
Investigating Officer

Enclosure to AIU Report No R4/75

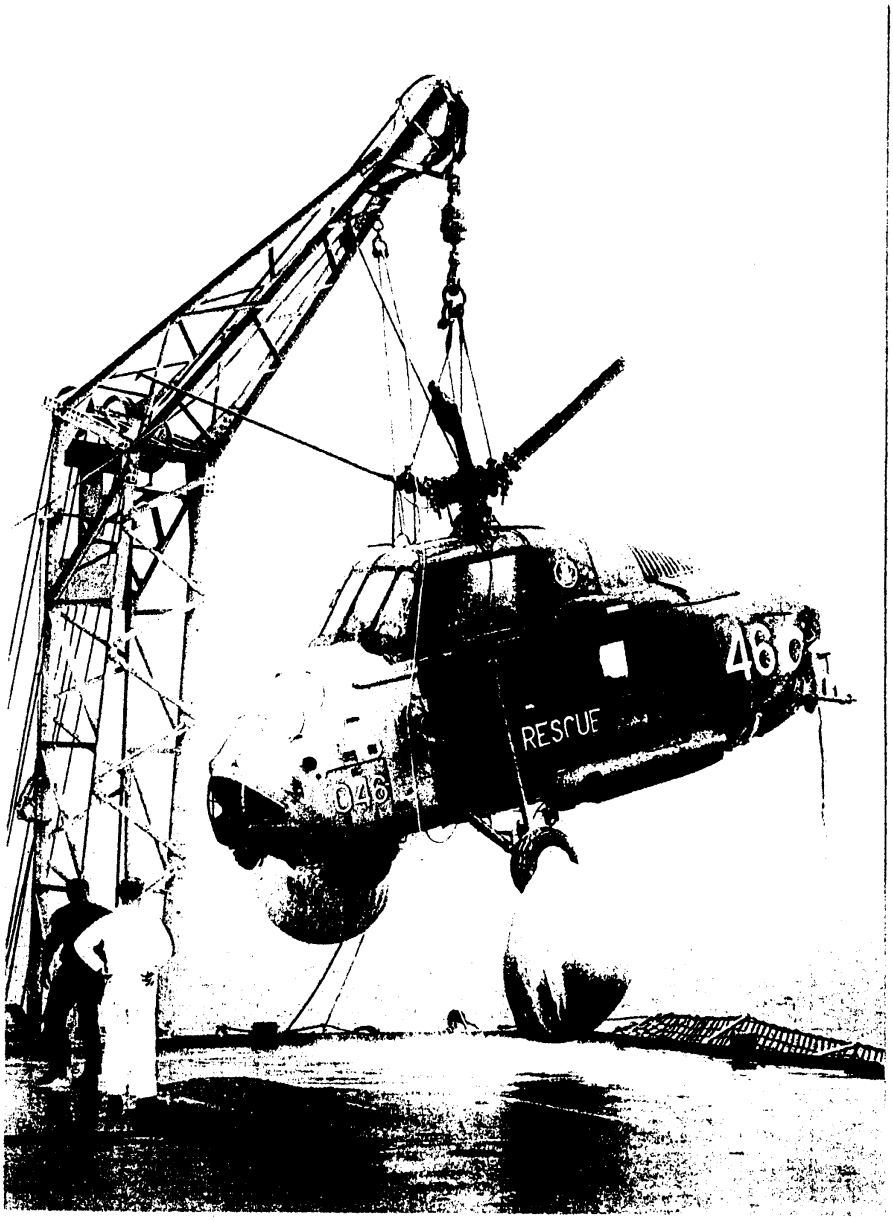

PHOTO 1 Condition of aircraft on recovery