

No: 1/89

Ref: EW/C1077

Category: 2a

Aircraft Type and Registration: Sikorsky S-61N, G-BEID

No & Type of Engines: 2 General Electric Company CT58-140-1 Gas Turbo-Shaft Engines

Year of Manufacture: 1964

Date and Time (UTC): 13 July 1988 at 1428 hrs

Location: North Sea 29.5 nm north-east Sumburgh

Type of Flight: Public Transport (Passenger)

Persons on Board: Crew - 2 Passengers - 19

Injuries: Crew - None Passengers - None

Nature of Damage: Aircraft destroyed by fire

Commander's Licence: Airline Transport Pilot's Licence (Helicopter)

Commander's Age: 33 years

Commander's Total Flying Experience: 4658 hours helicopters (of which 2855 were on type)

Information Source: AAIB Investigation

1. HISTORY OF THE FLIGHT

The aircraft was returning to Sumburgh with a full passenger load from the semi-submersible vessel, the "Safe Felicia". At 1423 hrs contact was established with Sumburgh ATC, at a range of 40 nm on Track "J", while cruising at a height of 1500 feet.

At 1428 hrs the co-pilot, who was the handling pilot, heard an unusual noise. While discussing it with the commander the No.2 engine fire warning light illuminated although other engine indications reportedly remained normal. The "Engine Fire in Flight" drill was completed, the engine was shut-down and the fire extinguisher was fired. During the execution of the drill, a gradual descent was initiated and the commander made a "Mayday" call stating that he intended to descend to 500 feet and continue VFR. The No.2 engine fire warning light remained illuminated. While waiting for the specified 30 second period before firing the Reserve fire extinguisher the No.1 engine fire warning light also illuminated.

At 1430 hrs the commander transmitted to ATC, "G-ID now showing fire on both engines continuing VFR towards the coast". The passengers were briefed to prepare for an emergency ditching and at a height of 100 feet the commander took control. The co-pilot looked out and behind, saw a great deal of smoke and reported that the aircraft was on fire.

At 1431 hrs a "ditching" call was made and soon afterwards a successful ditching was carried out. The co-pilot deployed the flotation gear, the sea anchor and operated the rear emergency exit door jettison switch.

2. EVACUATION

While the rotor-blades were running-down, the co-pilot went back into the cabin, which was filling with smoke, and prepared the forward life raft for launching from the starboard cargo door. The commander attempted to apply the rotor brake, but found that the normal resistance to brake lever operation was not present.

When the rotor blades had stopped rotating the commander ordered the passengers to board the life raft. Dense, noxious smoke in the aircraft prevented the crew from seeing to the rear of the cabin and ascertaining that those passengers who had not boarded the forward life raft had left by the rear emergency exit. Despite repeated attempts to penetrate the smoke the crew were unable to get to the rear of the aircraft and were forced to board the forward life raft. Meanwhile the passengers at the rear of the cabin had managed, with some difficulty, to launch and board the rear life raft. The two life rafts were paddled, also with difficulty, away from the burning aircraft, linked together and passengers re-distributed to equalise the loads.

An S-61N in the vicinity was diverted to the scene by ATC on receipt of the Mayday call and arrived overhead at 1436 hrs. It remained in the area until released by an SAR helicopter which was scrambled from Sumburgh at 1441 hrs and arrived at the scene at 1459 hrs. It completed winching up all the passengers by 1529 hrs and landed back at Sumburgh at 1549 hrs.

3. AIRCRAFT SINKING

After landing on the sea, ID drifted under the influence of tidal currents and wind with the fire growing and gradually broke into pieces and sank, with wreckage widely distributed on the seabed.

Witness evidence, including that from the crew of the escort S-61N, indicated that shortly after touchdown the fire was centred in the forward part of the main transmission bay. The fire spread within a few minutes into the cabin and, after a period, the main rotor head and main transmission were seen to subside into the cabin. Evidence from witnesses (which was later confirmed from wreckage examination subsequent to recovery) indicated that the fire destroyed almost all the fuselage structure above the floor line. Exceptions were the tail boom and the rear two metres of the cabin; steel and titanium parts of the engine bay structure; and the cabin rear emergency exit door, which was seen floating independently.

Approximately one hour after the ditching the remnants of the aircraft capsized, and floated with only the tail boom above the sea surface. After an unknown period of flotation in this configuration, with the tail boom sustaining damage from a surface-borne fire, the fuselage remains parted at a position close to the attachment points of the main landing gear sponsons, and the forward portion of fuselage sank to the seabed.

The aft portion of the fuselage continued drifting supported by the right sponson and associated flotation bag. The Lerwick Lifeboat sighted the bag and commenced towing the sponson, it not being apparent initially that a large portion of the aircraft was hanging beneath it, but after a short distance the aft fuselage remains broke away and sank. After being towed for about a mile, the sponson also sank, approximately 3 hours after the ditching. The sea depth over the area of the wreckage site was found to be between 90-110 metres.

4. WRECKAGE RECOVERY

AAIB commenced a recovery operation using the Stena Marianos, a 99 metre long Diving Support Vessel (DSV) with a Dynamic Positioning (DP) capability and provided with a saturation diving system configured to be capable of maintaining one diver on the seabed continuously. The ship was fitted with

a small Remotely Operated Vehicle (ROV) able to provide colour television pictures of the seabed within the range of its tether; with two Dukane acoustic beacon detector systems; and with a basic Sidescan Sonar system. Navigational information for the search was provided by a Trisponder microwave ranging system, set up for the operation on the shores of the Shetland Islands and potentially capable of indicating position in the area of the site to within ± 4 metres.

The Marianos arrived on site, based on a Decca position supplied by the Lerwick Lifeboat crew, at 1800 hrs on 16 July 1988. At this position signals from the Dukane acoustic beacon fitted to the Cockpit Voice Recorder (CVR) installed in ID's tail boom were detected by hand-held Dukane detector equipment deployed from an inflatable dingy. The beacon enabled rapid location of the aft fuselage section, which, together with the CVR, was landed on deck at 0030 hrs on 17 July.

Visual searching by diver and ROV of the seabed in an area based on tide and wind drift predictions located the forward fuselage section, 500 metres from the aft fuselage section, and this was recovered, together with a considerable number of items of scattered wreckage found. However, the operation had to be terminated at 2200 hrs on 19 July, because of other Marianos commitments, without the engines, the main rotor or the majority of the main transmission components having been found.

Shell Expro Ltd, ID's charterers at the time of the accident, provided facilities for a further phase of the recovery operation. This commenced on site at 0200 hrs on 2 August 1988 using the Norskald, a 102 metre long DSV with a DP capability and provided with a saturation diving system. The vessel was fitted with a small tethered ROV able to provide monochrome Silicon Intensified Target (SIT) television pictures of the seabed; and with a seabed-based, 100 metre range Scanning Sonar system. A Trisponder system was again used for on-site navigation. The recovery operation was slowed by navigational difficulties, but the engines, the majority of the main transmission components and the main rotor were located at 0400 hrs on 5 August 1988 and raised the same morning.

5. COCKPIT VOICE RECORDER ANALYSIS

Spectral analysis of the CVR recording by the AAIB Flight Recorder Section showed a change in the recorded signature over a period which terminated in an unusual noise. This noise was identified as that heard and remarked upon by the co-pilot shortly before the engine fire warning became apparent. The signature change constituted an increase in the amplitude of the signal at a number of different frequencies. Some of these were identified as being associated with a rotational frequency corresponding to that of an engine power turbine (PT) rotor and main transmission spur gear, together with the shafting connecting the two.

6. WRECKAGE EXAMINATION

The wreckage recovered in the two phases comprised virtually all parts of the aircraft that survived the fire, with the exception of the right sponson for which no recovery attempts were made. The engines were generally intact, still mounted in the remains of the engine bay structure. No parts of the magnesium alloy main transmission casing or rotor brake caliper casing were found, but all components of the main transmission geartrain were recovered. This included the rotor brake disc, and some internal parts of the brake caliper were also recovered. The main rotor was substantially complete, albeit with one blade severely fire damaged.

The recovered wreckage was examined at sea and then transported to the AAIB at Farnborough for more detailed examination. Initial examination and disassembly revealed that severe damage had been sustained by the No. 2 engine, and by the structure and shafting connecting this engine to the main gearbox.

Each engine comprises a free PT (Fig 1) driven at a normal nominal operating speed of 18966 rpm by the gas flow from a gas generator. The PT rotor shaft is supported by the No 4 Roller Bearing and the No 5 Ball Bearing, and protrudes via a carbon oil seal through the aft end of the module casing, where it fits into the three-lobed socket of a polygon coupling. An input drive shaft (IDS) connected to the

polygon coupling via a flexible Thomas coupling drives a main transmission input spur gear via a splined coupling. Both the Thomas and the splined couplings are designed to tolerate a degree of axial misalignment. The polygon coupling and the IDS run inside the engine mounting rear support tube which, by virtue of rigid attachment to the rear of the PT module casing and gimbal-mounting to the main gearbox casing, provides a rear mount structure for the engine carcass. Normal radial clearance between the Thomas coupling assembly and the mounting rear support tube is approximately 0.13 inches.

The PT module damage consisted of extensive break-up of the cage of the No 5 Bearing and gross eccentric re-profiling of its inner race, which showed evidence of severe overtemperature, together with severe rubs of various parts of the PT rotor assembly against static parts of the PT module. Parts of the Thomas coupling assembly and the forward flange of the IDS had heavily rubbed the interior of the rear mounting tube, and the tube had parted circumferentially at this point.

A marked eccentricity of the damage to the PT rotor assembly and IDS components showed that the rotor assembly had operated for a period with a rotating angular displacement of its axis, centred on the No 4 Bearing, such that the shafting at the position of the No 5 Bearing and the Thomas coupling was undergoing a significant degree of orbiting at its rotational speed. Further investigation is being directed towards determining the cause(s) of the No 5 Bearing failure.

Information has been found on an incident to a UK registered S-61N in 1976 (Mandatory Occurrence Report 061-ABDN) where damage very similar in many respects to that sustained by ID's No 2 powerplant and gearbox drive system was found following an in-flight engine fire warning. In 1985 a similar aircraft in the USA suffered similar damage to the No 5 bearing and the engine mounting rear support tube.

An Inspector's Investigation is being carried out into this accident.

S-61N POWER TURBINE AND MAIN GEARBOX DRIVE SCHEMATIC

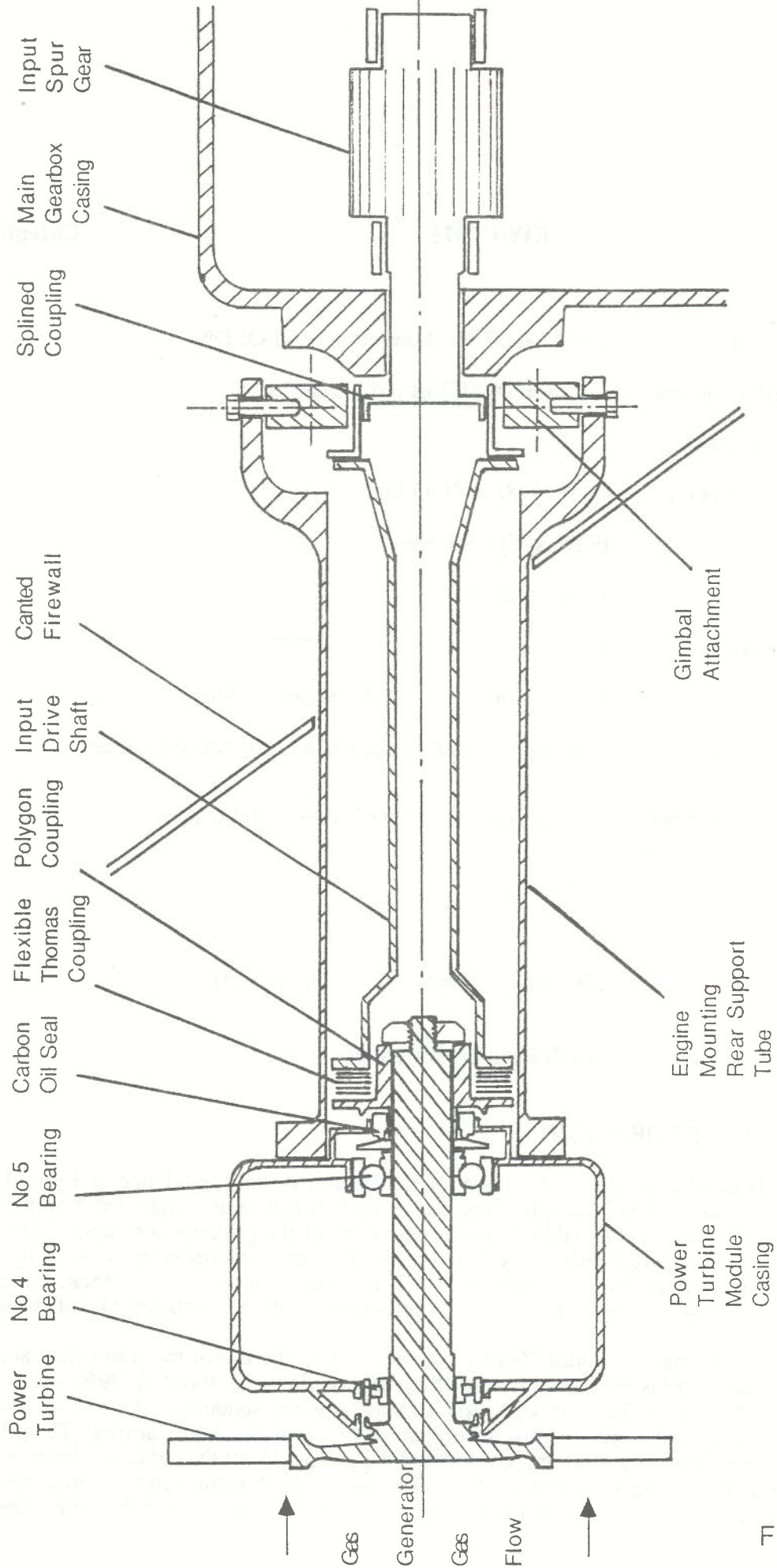


Figure 1