Sikorsky S76A (Modified), G-BJFL

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Aircraft Type and Registration:	Sikorsky S76A (Modified), G-BJFL
No & Type of Engines:	2 Turbomeca Arriel 1S turboshaft engines
Year of Manufacture:	1980
Date & Time (UTC):	19 September 1999 at 1545 hrs
Location:	Norwich Airport
Type of Flight:	N/A
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - None - Passengers - N/A
Nature of Damage:	Severe fire damage to area between main rotor gearbox and engine air intakes. Destruction of rotor brake unit and much of the brake operating hydraulic system
Commander's Licence:	Airline Transport Pilot's Licence (H), with instrument rating
Commander's Age:	38 years
Commander's Flying Experience:	4,500 hours, (of which 1,000 were on type) Last 90 days - Not known Last 28 days - Not known
Information Source:	AAIB Field Investigation

Background

The helicopter had had a fuel control unit filter replaced on the No 1 engine and was required to undergo a ground run on that engine for leakage checks, followed by a further run for an engine vibration check, once the oil was fully warmed up. The aircraft was then scheduled to re-enter revenue service.

The incident

For the purpose of the engine runs the pilot occupied the captain's seat on the right side of the aircraft. Both the supervising engineer and air traffic control gave the pilot clearance to start the engine and as this occurred the engineer moved to join a colleague standing by the baggage bay door on the left-hand side of the aircraft. It was his intention to give this technician a demonstration of the vibration measuring equipment during the first run, since the technician was unfamiliar with its use.

The pilot, having carried out normal start-up checks (with the exception of items associated with flight over water and operation of No 2 engine) started No 1 engine and noted the first indication of T5. At the same time both he and the supervising engineer observed that the rotor blades had begun to move at a rate consistent with that to be expected with the rotor brake off.

It is normal practice during ground runs for the engine to be run up and stabilised at ground idle before the rotor brake is released. The brake on this version of the aircraft is controlled by way of a switch on the right side of the console close to the commander's seat. The pilot carried out a visual check of the switch and confirmed that it was in the upright 'off' position. He attempted to secure the blades by operating the rotor brake switch but this was seen to have no effect.

Being anxious to avoid risk to the personnel under the disk, the pilot gave priority to continuing the advancement of the speed select lever, in order to achieve a safe and stable rotor speed. This was done in what seemed to him to be a routine and normal manner. Hydraulic and gearbox transmission indications were seen to be correct.

At approximately 48% N1, a check of the No 1 DC generator was carried out. At a stable N1 of 70% with hand on the collective lever prior to checking the hydraulics, a fairly rapid engine acceleration occurred which required the pilot to actively decelerate the unit back to 70%.

A run of approximately 5 minutes duration was then carried out at 100% rotor RPM, after which the engine was shut down in the normal way. As the rotors slowed through 60% with the engine at idle, the pilot prepared to select the rotor brake switch to 'on'. He then observed, however, that it was already 'on'. At about the time the rotors came to a halt, the ground personnel indicated to the pilot that the aircraft was on fire. The pilot looked at the instrument panel and observed nothing amiss. It was clear from the reactions of the external personnel, however, that all was not well, so he notified the tower that the aircraft was burning and the airport fire service then attended. Meanwhile the engineer attacked the fire with the cabin extinguisher. The pilot then ran to a large CO_2 extinguisher some distance away. He pulled this to the aircraft where the operating knob was unscrewed and the unit brought into use.

Another member of the company personnel realised that this was a rotor brake fire and he therefore opened the engine intake doors to allow extinguishant to be sprayed into the root of the fire. Once the airport fire service were in position they were able to put the fire out rapidly.

Damage

On examination it was found that severe fire damage had occurred to the Kevlar composite components aft of the main rotor gearbox, including the engine intake doors and the main upper fairing as well as the internal panels surrounding the tail rotor shaft and the rotor brake. Severe heat damage had occurred to the brake unit and significant wiring damage was evident. Extinguishant and burnt debris was found to have entered the compressor areas of the engines. The extent of the fire damage to hydraulic, electrical and mechanical elements of the rotor brake system precluded any effective functioning of the brake unit.

The components of the unit were removed and so far as possible dismantled. No evidence of any defect was found other than the obvious effects of heat and fire. The only source of heat capable of initiating the fire was considered to be that generated by friction between the brake pucks and the disk.

Significant aircraft features

This version of the S76 type is equipped with a hydraulic rotor brake which incorporates an electrically driven pump. The pump is controlled by the three-position switch on the control console. The 'on' position operates the pump, until a pressure threshold is reached, thus applying the brake. The spring loaded 'release' position operates a solenoid which opens a dump valve allowing fluid to return from the brake, thus exhausting the pressure. Placing the switch in the 'off' position ensures that the pump does not operate.

A pressure sensor is fitted within the brake operating system. A system pressure above 15 psi illuminates the ROTOR BRAKE caption on the Central Warning Panel (CWP). It also causes fluid pressure to exhaust to the reservoir if the brake switch is in the OFF position. The brake pressure caption is one of a number present if the brake is in use during single engined operation (ie numerous captions are present associated with the non-operating engine). It is then not particularly compelling.

The normal rotor RPM for brake application is stated by the manufacturer to be 50% to 60% with one or both engines at IDLE or both engines shutdown. Although the rotor RPM at which the brake was applied is not known, it is assumed that the engine torque was significantly above that normally occurring at idle, since the brake failed to bring the rotor to a halt.

Pilot background

The pilot involved in this incident was previously employed by an operator who used a later version of the S76. That aircraft is understood to have been equipped with a manually applied rotor brake which uses a handle within the cockpit to create the required hydraulic pressure**.** Although qualified as a Captain on the S76 type (which is certificated for single pilot operation) he was not defined by his company at the time of the incident as a North Sea Commander but was employed as a co-pilot. (The customer for this operation required all flights to be carried out using two pilots). He had undergone an Operational Proficiency Check and a line check in the right hand seat on 7 May and 31 December 1998 respectively but the bulk of his S76 flying was carried out as co-pilot from the left-hand seat. Whilst carrying out the engine run on 19 September 1999 he occupied the right-hand seat, ie that normally used by the Captain.

Pilot action

It appears that on this occasion the pilot inadvertently started the engine with the rotor brake off. He then omitted to re-select the brake switch to the 'off' position once he had attempted, and failed, to bring the rotor to a halt by putting the switch in the 'on' position.

The failure of the brake, when selected, to bring the rotors to a halt was probably the result of applying the unit too late in the start-up sequence ie at a time when the output torque from the one engine exceeded the torque capability of the brake. The amount of heat damage indicates that a reasonable degree of pressure was being exerted between the pucks and the disc for a sustained period.

The fact that the pilot was not occupying his normal seat, coupled with his likely concern for the safety of personnel working alongside the aircraft, may have distracted him from correct brake operation initially. The presence of the maintenance personnel probably also caused him to concentrate on raising the rotor RPM and controlling the rotor disc once he found the rotors were turning, further distracting his attention from the status of the brake after he had attempted and failed to stop the rotor.

The presence of brake system pressure, signified by the relevant CWP caption, was not noticed, probably since a large number of captions were present on the warning panel relating to the non-operating engine. Fortunately, it had not been planned to take the aircraft into the air, so the serious hazard of experiencing a brake fire in the aircraft whilst airborne was not encountered.