INCIDENT

Aircraft Type and Registration:	Saab 340B, ES-NSD	
No & Type of Engines:	2 General Electric CT7-9B turboprop engines	
Year of Manufacture:	1989	
Date & Time (UTC):	30 August 2019 at 0645 hrs	
Location:	Carlisle Airport, Cumbria	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 3	Passengers - 13
Injuries:	Crew - (None)	Passengers - (None)
Nature of Damage:	None reported	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	50 years	
Commander's Flying Experience:	7,300 hours (of which 6,100 were on type) Last 90 days - 130 hours Last 28 days - 46 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further AAIB enquiries	

Synopsis

During the climb the commander was unable to adjust the propeller rpm on the left engine. The engine was shut down and the aircraft landed without further incident. Inspection of the left engine revealed that the condition lever control cable was damaged, probably as a result of chafing against the accessory gearbox. A service bulletin published in 1988 provided instructions to fit chafing protection in this area. The aircraft maintenance records did not indicate that the service bulletin had been performed on ES-NSD, but photographs of the damaged cable showed that the chafing protection had been fitted. However, it was not in the correct location and would not have provided the intended protection. It was not established how this occurred.

Following the incident the operator introduced a periodic inspection of the engine control cables in its maintenance programme and the aircraft manufacturer took action to update the aircraft maintenance manual.

History of the flight

The aircraft was operating a scheduled passenger flight from Carlisle Airport to London Southend Airport. When the aircraft was at approximately 2,500 ft during the climb, the commander attempted to adjust the climb power having noted that the left engine propeller rpm was low. Attempts to adjust the rpm were not successful. The flight crew advised ATC of their intention to return to Carlisle as they had difficulty climbing. ATC declared a local standby.

The flight crew followed the checklist to shut down the left engine and the commander declared an emergency to ATC. ATC upgraded the incident and alerted external emergency services. The remainder of the flight was uneventful, and the aircraft landed at Carlisle twelve minutes after takeoff. The airport Rescue Firefighting Services (RFFS) were in attendance and advised ATC that no further assistance was required so the external emergency services were stood down.

Subsequent inspection of the left engine revealed that the section of the condition control cable which runs between the hydromechanical unit (HMU) and pitch control unit (PCU), was damaged.

Engine control system description

The aircraft was equipped with two General Electric (GE) CT7-9B turboprop engines, fitted with Dowty propellers. Engine control is provided by separate power and (propeller) condition levers, mounted on the control quadrant on the centre pedestal of the cockpit. Each power and condition lever are connected to the PCU and HMU fuel control gearbox on the respective engine, by a mechanical push-pull cable and a series of bellcranks and pulleys. The cables provide an adjustable, mechanical connection between the HMU and PCU units (Figure 1).

The condition lever, through the push-pull cable and PCU, adjusts the pitch of the propeller blades and sets the propeller speed. It also provides inputs to the HMU, which delivers high pressure metered fuel to the engine.

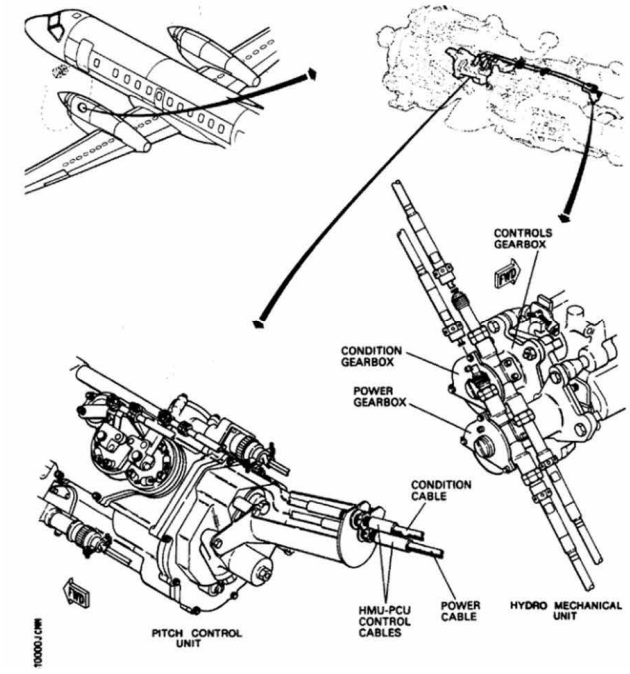

Figure 1

Figure from Saab 340 aircraft maintenance manual showing engine control cable routing between HMU and PCU

The construction of the power and condition control cables consists of three stainless steel races separated by two rows of free-floating stainless steel ball bearings. The balls are held in position by stainless steel or Teflon ball guides. This stack of races, balls and ball guides are enclosed in a flexible stainless steel casing and protective vinyl cover.

Aircraft examination

There were no photographs of the damaged condition control cable prior to it being removed from the engine but Figure 2 shows the cable after it was removed from the engine. The operator noted that a short section of plastic tubing secured by cable-ties, had been fitted adjacent to the area of visible damage.

The operator initially indicated that the cable appeared to have failed due to chafing against the accessory gearbox and attributed this to the large radius bend at the opposite end of the cable, near the HMU (Figure 3). It subsequently suggested that the cable had broken in the bend near the HMU.

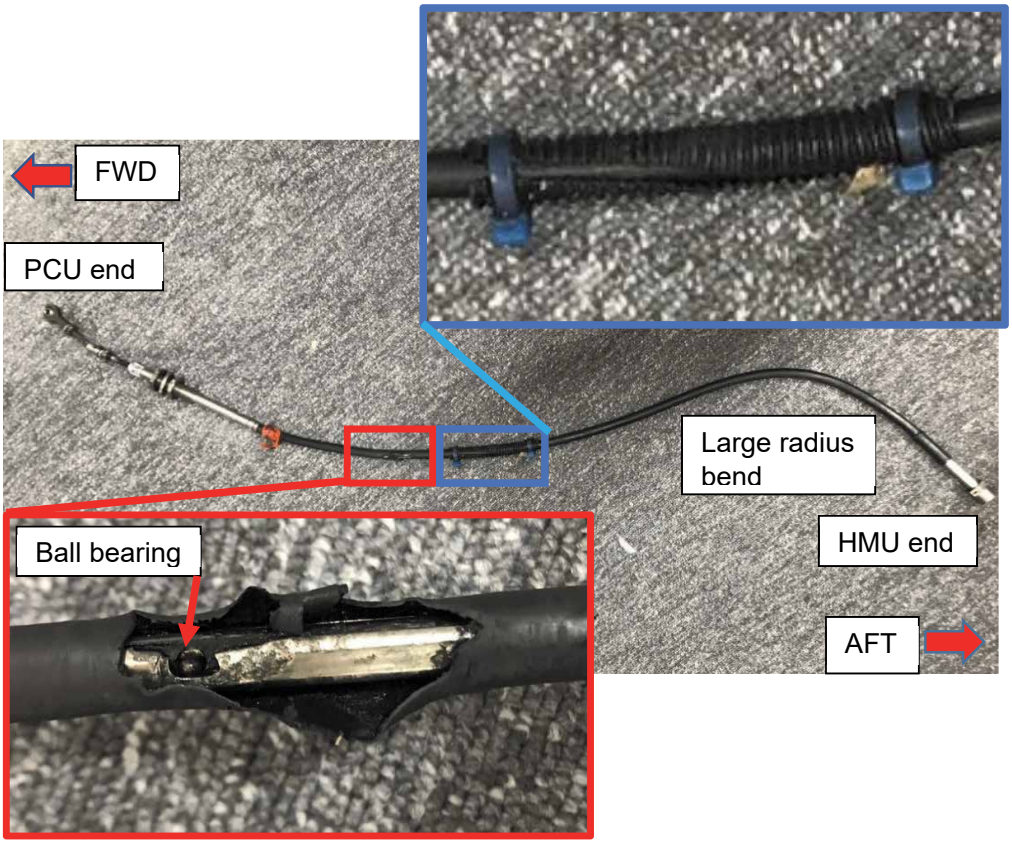

Figure 2

ES-NSD left engine condition control cable, insets show damage and chafing protection

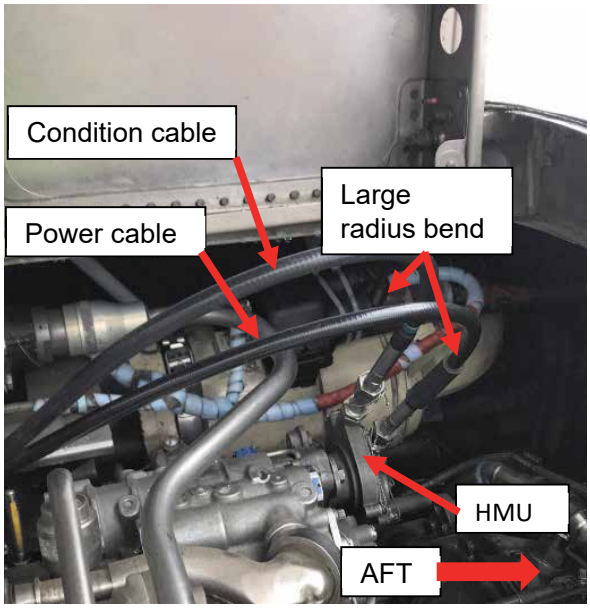

Figure 3

Bend in engine control cables near HMU
(taken after replacement of condition control cable)

Information from the manufacturer

Background information

The aircraft manufacturer advised that during 35 years of operation of the Saab 340, there had been several reported failures of engine power or condition control cables, especially in the early years of operation. Typical failures included a broken inner (centre) race or loose rivets on the inner race attachment joints. Some failures were related to incorrect installation of the cables, but others were related to the original routing of the cables. As a result, several modifications were introduced via service bulletin (SB) to prevent further failures.

The manufacturer is aware of ten engine control cables failures since 2001, excluding ES-NSD; in six of those occurrences the cables had not been modified and in four occurrences, the modification status was unknown.

SB 340-76-027

SB 340-76-027 Revision 01 *'Engine controls – powerplant – chafing protection of engine control cables'* was issued on 12 November 1988. It described attaching silicon tape and a 4-inch long section of plastic convolex tubing at a specified location on the HMU-PCU section of the condition control cable, to prevent chafing of the cable on the accessory gearbox. Compliance with the SB was described as 'recommended'. Figure 4, taken from SB 340-76-027 shows the location in which the convolex tube should be installed.

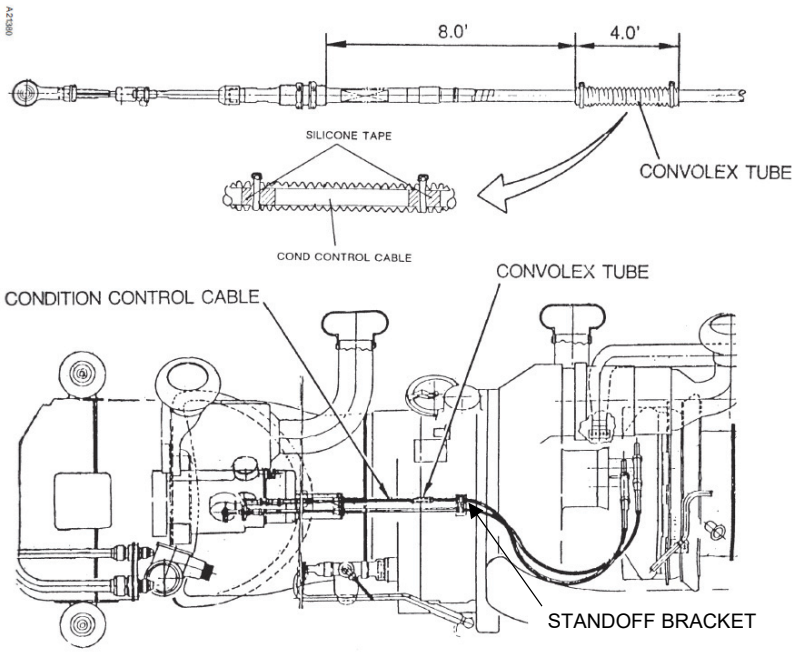

Figure 4

Location of anti-chafing protection on condition control cable from SB 340-76-027

SB 340-76-044

SB 340-76-044 Revision 01 *'Engine controls – engine control cables – relocation of condition and power lever cable standoff bracket'* was issued on 19 April 2016. It stated that chafing between the condition lever cable and the engine accessory gearbox had been found on some aircraft due to inadequate clearance between the cable and the accessory gearbox. The SB provided instructions to relocate the existing cable standoff bracket from the aft side of the engine case flange to the forward side of the flange, to provide addition clearance between the cable and the accessory gearbox. The location of the standoff bracket is identified in Figure 4. Compliance with the SB was described as 'recommended'.

Assessment of cable damage

The cable from ES-NSD was not examined, but the aircraft manufacturer reviewed the photographs of the damaged condition control cable provided by the operator. It assessed that the large holes in the outer flexible stainless steel casing and vinyl covering were consistent with chafing damage. The ball guide and outer race on the affected side appeared to be damaged, such that the ball bearings were exposed. As far as could be determined from the photographs, the centre race appeared undamaged. The manufacturer noted that chafing protection, although fitted, was not in the correct position and would not have protected the cable from chafing against the accessory gearbox. The correct location is approximately coincident with the area of damage shown in Figure 2. Figure 5 also shows the correct location of chafing protection on a condition cable installed on the engine of another aircraft.

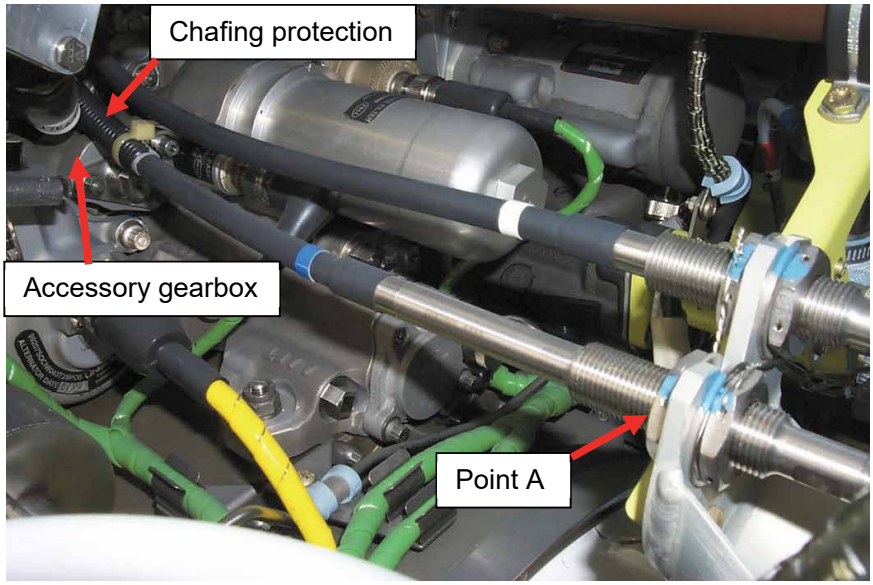

Figure 5

Correct location of chafing protection on condition control cable (view looking aft)

Point A in Figure 5 corresponds approximately to the datum shown in SB 340-76-027 (Figure 4); the chafing protection should be installed 8 inches from this point.

Cable installation

The manufacturer stated that an important consideration when installing the HMU-PCU engine control cables is how the cables are bent. Due to the internal construction of the control cables they should only be bent in one direction when installed. Otherwise, the resulting unfavourable bend shape will cause increased friction and wear which will reduce the life of the cable. The specific cable installation requirements are described in the Powerplant Build-up Manual (PBM). When comparing the PBM with the Aircraft Maintenance Manual (AMM) the manufacturer noted that the procedure which provides detailed guidance on how the cables should be bent, was not included in the AMM. As control cables sometimes need to be replaced in-service, the manufacturer will update the AMM to include the detailed cable installation guidance.

Aircraft information

The aircraft had been in the operator's fleet since June 2019 and underwent its last maintenance, which was a line check, on 29 August 2019.

A review of the maintenance records indicated that the left engine had been changed in January 2016 and the propeller gearbox in March 2018. There were no other documented inspections or maintenance actions during which the condition control cable would have been disturbed and no record that it had ever been replaced. There was no record that SB 340-76-027 had been embodied on ES-NSD, or on the other Saab 340s in the operator's fleet. It subsequently requested instructions from the aircraft manufacturer to complete the SB.

It could not be established, from inspection or from the aircraft's maintenance records, if SB-340-76-044 had been embodied on ES-NSD.

The operator conducted a fleet inspection of the condition lever cables for signs of chafing; no anomalies were noted. It also created a periodic inspection of the cables in its maintenance programme.

Analysis

Chafing of the condition control cable where it passes over the accessory gearbox is a known condition and the aircraft manufacturer published non-mandatory SB 340-76-027 in 1988 to mitigate this problem with the addition of chafing protection. It also published optional SB 340-76-044 in 2016 to increase clearance between the condition lever and the accessory gearbox.

Despite the presence of convolex tubing on ES-NSD's left engine condition control cable, the aircraft's maintenance records did not contain any reference that SB 340-76-027 had previously been embodied. Possible explanations could include that the cable, or entire left engine assembly, had previously been installed on another aircraft having SB 340-76-027 embodied; or, that at some point in the past, maintenance personnel had added chafing protection without formal embodiment of the SB.

SB 340-76-027 described the precise location in which the chafing protection should be added to condition control cable to prevent chafing against the accessory gearbox. The chafing protection on the condition control cable from ES-NSD was installed at an incorrect location, and was adjacent to, rather than coincident with, the area where chafing damage was most likely to occur. It was not established why the chafing protection was installed in this location but there are several possible explanations: the position of the chafing protection may have been measured from an incorrect datum, for example the end of the rigid metal cable sleeve shown in Figure 5; if the cable-ties were not sufficiently tight, the chafing protection may have slipped from its original position; or, it may have been installed without reference to SB 340-76-027. Following this incident, the operator requested instructions from the manufacturer to perform SB 340-76-027 on all of its Saab 340s and introduced inspections of the cable in its maintenance programme.

In addition to the visible damage, the operator suggested that the cable had broken in the large bend near the HMU gearbox. The cable was not physically examined but it was considered possible that the cable had also suffered an internal failure at this point, which was not externally visible in the photographs provided. But the manufacturer considered that the substantial chafing damage evident in the photographs would have been sufficient to cause problems with cable operation and could have accounted for the lack of response from the condition lever during the incident.

It was not established if SB-340-76-044 had been embodied on ES-NSD but it is likely that if the standoff bracket had been in its original (pre-SB) position, it would have been visible on the left edge of Figure 3. Therefore, it was considered likely that SB-340-76-044 had been embodied.

The aircraft manufacturer noted a discrepancy in the instructions for cable installation between the PBM and AMM and will update the AMM to ensure the same information is included in both manuals.

Conclusion

During the climb after takeoff, the left engine condition lever did not respond to the commander's inputs and he was unable to adjust the propeller rpm on the left engine.

The condition control cable had suffered damage due to chafing against the accessory gearbox, which most likely affected the correct operation of the cable. Although chafing protection was fitted to the cable, it was not in the correct location and would not have provided the intended protection.