INCIDENT

Aircraft Type and Registration:	BAe ATP, G-MANP
No & Type of Engines:	2 Pratt & Whitney PW-126 turboprop engines
Year of Manufacture:	1990
Date & Time (UTC):	1 March 1995 at 1130 hrs
Location:	On approach to Runway 24 at Manchester Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 4 Passengers - 38
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	3,750 hours (of which 3,500 were on type) Last 90 days - 134 hours Last 28 days - 31 hours
Information Source:	AAIB Field Investigation

History of the flight

The aircraft had departed Belfast City Airport at 1045 hrs for a Public Transport flight to Manchester with two pilots, two cabin crew and 38 passengers on board. Both pilots, who were well rested, were flying the third sector of their duty day which had commenced at 0615 hrs that morning. On departure from Belfast the aircraft fuel load was 2,150 kg. This was sufficient for the flight given that the estimated trip fuel requirement was 495 kg.

The departure was flown from a wet runway with icing conditions forecast. The crew therefore selected continuous ignition, engine and propeller de-icing 'ON' for the takeoff and initial climb. For the later part of the climb and for most of the cruise phase, at FL170, the aircraft was in clear conditions. The crew elected, however, to keep the engine and propeller de-icing selected ON throughout. They reselected continuous ignition 'ON' as the aircraft encountered cloud tops at FL170 several minutes before they initiated their descent for Manchester. The crew reported that all systems functioned normally.

The weather conditions at Manchester were obtained by the crew from the Manchester ATIS frequency. This gave the actual arrival conditions as: surface wind 230°/09 kt , Runway 24 RVR 900 metres in rain and snow, with scattered nimbostratus at 600 feet, broken cloud at 1,800 feet, overcast conditions at 9,000 feet with a temp of +3°C, dewpoint of +2°C and a QNH of 998 mbs. Because of the conditions, the crew briefed for an autopilot coupled CAT II approach.

An aftercast obtained from the Meteorological Office at Bracknell by AAIB after the incident confirmed the conditions and gave the synoptic situation at 1200 hrs as an unstable westerly airstream established over the area with a marked trough passing Manchester at around 1100 hrs. The cloud structure of the trough was fairly extensive and moist with a temperature of -20°C at FL120, with moderate icing below this level. A witness, on the ground at Manchester at the time of the aircraft's approach, stated that it was snowing with "snowflakes the size of pancakes".

The aircraft commenced its descent and entered cloud at FL140, encountering light turbulence and accumulating a light trace of ice on the wing leading edges. The aircraft held at FL70 for two to three minutes before continuing its descent under radar control for the final approach.

At approximately 5.5 nm on finals, at a speed of 140 kt with the autopilot engaged, flaps selected to 20°, gear down, propellers at 85%, and torque set to 30 to 35%, the aircraft suddenly yawed to the left followed by a yaw to the right. The crew then noticed that the left engine had run down and later reported that there had been no warning captions associated with this event.

The commander called for the 'engine in-flight shutdown drill memory items' to be carried out by the first officer. Once the engine was secure the first officer transmitted a 'MAYDAY' to ATC stating that the commander's intention was to continue the approach to land. The commander then liaised with the senior cabin crew member informing her of the problem and his intentions. The Subsequent Emergency Checklist actions were then completed, followed by the landing checks.

The landing was uneventful and the aircraft taxied to the stand normally. The commander reported that before the engine shutdown drill was completed there had been no warnings or indications of any engine distress.

Flight Data Recorder

The aircraft was fitted with a Plessey 1584 Flight Data Recorder. Included in the recovered data were No 1 and No 2 engine parameters, including torque (Q), high pressure rotor speed (NH), low pressure rotor speed (NL), and propeller speed (NP) (Figure 3).

The torque record showed No 1 engine torque reducing from 34% to 0.9% in one second (one sample period) and it did not recover prior to engine shutdown. A short 3 second 'spike' present some 20 seconds after the rundown was consistent with propeller feathering. No torque discrepancies were apparent on the No 2 engine torque record.

The start of torque reduction on the No 1 engine was concurrent with a reduction in NH from 84.3% to 38,7% over a 7 second period. NH started to recover from its low of 38.7%, however recovery did not run to completion. Sixteen seconds following the initiation of rundown the NH levelled off at approximately 74%, and 8 seconds following this NH started to decay to windmilling speeds. This characteristic was consistent with the pilot having carried out the engine shutdown drill at 16 seconds following rundown (ie power lever reduction, condition lever to feather and fuel off). The propeller feathering spike on the torque trace was consistent with the fuel shut-off having occurred at this point. The FDR trace was consistent with No 1 engine power reduction as a result of flameout, followed by re-ignition and the start of a recovery.

Engine de-icing and anti-icing systems

De-icing system

The engine de-icing is provided by a number of electrically powered heater mats located in the intake area (Figure 1). The heater mats use three phase variable frequency 200/115 volt AC current and are operated either continuously, or cyclically, depending on their position. The function of the heater mats is to prevent and/or disperse any formation of ice before its development can constitute a hazard to the engine.

Anti-icing system

The engine compressor air intake anti-icing system is provided by engine oil and associated misted oil being circulated around the engine's compressor air inlet shroud and bearing support struts (Figure 1). Ice protection should be satisfactory provided the engine oil is kept above 45°C, as indicated on the engine oil temperature gauge in the cockpit.

Engine oil system

A single 'wet sump' oil system (Figure 2) provides lubrication and cooling for the 'turbomachine', propeller reduction gearbox and the AC generator. The system also provides oil for the propeller pitch control system and heating for the fuel and air inlet anti-icing system.

The oil system has an airframe mounted oil cooler which is located, with its own ram air cooling intake, in the forward lower nacelle beneath the engine (Figure 1). Contained within the oil cooler is a combined bypass and thermal control valve which operates on the principle of expansion of a wax capsule, with increased oil temperature opening the valve. This allows the engine oil to quickly achieve its working temperature in cold climates and prevents over cooling of the oil. The air passing through the oil cooler matrix is regulated by a flap valve located in the air exhaust duct. The flap valve is normally controlled automatically by the flap valve controller, which in turn senses the oil temperature from a temperature probe located in the oil cooler's outlet. The flap valve controller maintains the oil temperature within the operating limits up to ambient temperatures of ISA +30°C during cruise. The normal oil temperature control range is 90 to 100° C.

The Technical Description of the engine oil system in the Operator's Operating Manual, which is compiled from the Manufacturer's Operating Manual, states:

> *"<u>Minimum Oil Temperature</u>*
>
> *In operation the oil cooler is designed to maintain oil temperatures above 45 degrees C throughout the operating envelope of the aircraft. Use of a minimum oil temperature limit is therefore applicable only to engine starting. Where the ambient temperature is less than - 54 degrees C engine starting is not permitted. As a consequence of this no minimum oil temperature limit is marked on the oil temperature indicator. If the engine is started at an ambient temperature below 0 degrees C, the power roll -over lever must not be advanced above its ground idle position until the oil temperature exceeds 0 degrees C."*

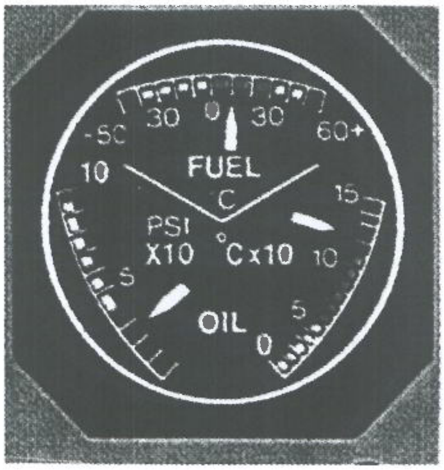
Note (b) of the Engine and Propeller Limitations in the Aircraft Flight Manual (AFM) states:

> *"Oil temperature must be maintained above 45 degrees C to ensure protection against intake icing."*

On this aircraft, as with all similar aircraft types operated under CAA requirements, there was a cockpit placard located above the heads of the flight crew which included the wording:

> *" Oil temperature must be maintained above 45 deg. C to ensure protection against intake icing."*

The engine oil temperature is indicated to the flight crew on a 'triple indication' gauge mounted within the engine instrumentation group on the central instrument panel, the temperature being taken from a sensor located in the oil supply line to the main bearings of the turbomachine (Figure 2). The scale of the oil temperature gauge is 27 mm in length and shows a range of 0 to 150° in 10 degree divisions. The scale is colour coded amber from 0 to 45 degrees and green from 45 to 115 degrees.



TRIPLE INDICATOR (actual size)

Photograph supplied by Jetstream Aircraft Ltd.

It may be noted from Figure 2, the engine oil system schematic, that the engine oil temperature sensor is located in an area of the oil system that is not directly associated with the oil that provides the engine compressor air intake anti-icing. It may also be noted that between the oil system temperature sensor and the compressor air intake anti-icing there is an Oil Heated Fuel Heater and a Fuel Cooled Oil Cooler. Both of these units have a direct effect on the temperature of the engine oil that supplies the compressor air intake anti-icing. Mounted within both of these units are temperature dependent bypass thermal control valves.

The three thermal control valves fitted in the engine oil system are maintained as 'on condition' items. There are no procedures in the Aircraft Maintenance Manual (AMM) for checking the condition of these valves subsequent to installation.

Engine ignition system

Each engine has an ignition exciter and two spark igniters. Mounted on the centre sloping instrument panel in the cockpit are switches for selecting continuous ignition and arming the automatic ignition system (post modification 30141A, which was applicable to this aircraft). The automatic ignition system utilises the NH monitoring function in the Engine Electronic Control (EEC). When armed, the system provides automatic igniter operation to the engine when the EEC detects a reduction in NH below 23,000 RPM (69%) (ie engine rundown). The system resets to armed when NH increases above 23,100 RPM. When continuous ignition is selected the spark igniters are continuously active. When an engine flameout occurs reignition will only be achieved when the fuel/air mixture within the combustion chamber is at a specific ratio; this is a function of a lean burn engine. This ratio is the same regardless of whether the ignition is selected to continuous or automatic. In practice, the NH will drop as low as 40% prior to reignition and the process can take as long as 25 seconds before a rise in engine torque is seen.

Examination of the aircraft

A detailed examination of the No 1 (left) engine de-icing and anti-icing systems was carried out. The complete electric de-icing system was removed from the aircraft and taken to the associated manufacturers for examination and testing. The items were individually tested and then assembled to the aircraft configuration and tested as a complete system. No faults were found. Parts of the intake de-icing system were immersed overnight in water and subsequently tested, but no fault was found.

During the disassembly of the engine intake area it was found that the insulation on the two electrical cables that connected the engine oil cooler temperature sensor to the flap valve controller had been severely 'chafed' in the area where the cables were routed through a 'P' clip. This chafing had been sufficiently deep to expose the electrical conductors. It was noted that these two cables were not protected by 'spiral wrap', which was evident on other electrical cables within this zone. Tests carried out by the aircraft manufacturer showed that, under a particular condition, it was possible for a partial 'short' of these cables to cause the flap valve controller to fully open the flap valve, which would 'over-cool' the engine oil.

The engine oil cooler was removed and sent to the manufacturer for examination and test. It was found during testing that the bypass thermal control valve had failed in the bypass closed position which would have had the effect of directing all the engine oil through the cooler matrix, regardless of the oil temperature. The bypass thermal control valve was sent to the manufacturer for examination where it was found that the PTFCE plug within the valve had absorbed enough engine oil to cause the valve to extend permanently to the fully closed position. The reason for this appeared to be that the plug material absorbs engine oil at a slow rate whenever it is in contact with the oil. Since there is no control over the amount of internal leakage, some valves will be more susceptible than others. It was determined that this valve had been manufactured approximately 8 years prior to the incident. Due to the greater awareness of the significance of engine oil temperatures following this incident, another operator of the aircraft type found a similar failed engine oil cooler bypass thermal control valve which had been manufactured approximately 5 years previously.

History of the engine operating parameters

The aircraft had been the subject of an engine data gathering exercise in conjunction with the manufacturer and the CAA to validate an automatic data gathering system. This exercise had involved the flight crew noting certain engine parameters during the cruise phase of each flight. Examination of these recordings showed that the No 1 engine's oil temperature had been significantly lower than that of the No 2 engine for at least the previous forty flights. The difference ranged between 0 and 17° C with the No 1 engine oil temperature being recorded at 45°C on a number of occasions. It was reported by the operator's engineering staff that this aircraft had a recent history of noticeable differences between the No 1 and No 2 fuel temperature indications in that the No 1 temperature was higher than the No 2, although both were within their operating ranges.

Service Bulletin (SB) ATP-79-19 (Modification 35207A)

There are two standards of engine oil cooler system installed on the aircraft type, pre and post SB ATP-79-19. The incident aircraft had a pre-SB ATP-79-19 installation.

Pre-SB ATP-79-19	Post SB ATP-79-19
Oil cooler has approximately 30% oil flow through the matrix with the bypass fully closed.	Oil cooler has only leakage flow through the matrix with the bypass fully closed.
	Oil cooler bypass channel located adjacent to the matrix to keep the matrix oil fluid when the bypass is open.
Dual flap valve actuator system with a continuously variable flap valve control.	Two position single flap valve system with fully closed redefined as 30 degrees open.

Flight tests

The aircraft manufacturer conducted a number of flight tests with pre and post SB ATP-79-19 aircraft. The details of these tests are described below and the significant findings are summarised in Figure 4:

Following the occurrence, the operator of the incident aircraft agreed to record engine oil temperature data not only during cruise but also within the start and finish of the descent phase on two other pre-SB ATP-79-19 aircraft. The worse case recorded was a descent from 15,000 feet to 7,000 feet at Static Air Temperatures (SAT) of -31°C to -5°C during which the lowest indicated oil temperature was 52°C.

In order to determine the effect of a failed bypass thermal control valve and oil cooler flap valve on the engine oil temperature of a pre-SB ATP-79-19 installation, the aircraft manufacturer conducted a number of flight tests. One of the aircraft's two engines was nominated as the test engine on which the fault conditions were reproduced. The test engine was fitted with a special oil cooler bypass thermal control valve which was fixed in the 'full cooling' position. In the cruise and with the flap valve operating normally, the failed oil cooler bypass thermal control valve had no significant effect on the engine oil temperature, indicating that the flap valve had enough authority to compensate for the failed bypass thermal control valve. In the descent, the test engine oil temperature was 50°C, ie 10°C colder than that of the fully serviceable engine.

With the flap valve selected open on the test engine, ie simulated double failure, the oil temperature was running 40°C cooler than the other engine during cruise, at a value of 45°C. In descent, this fell to an indicated 32°C.

It was also intended to test the system with the flap valve failed in the closed position in addition to the bypass thermal control valve 'failed'. However, due to the temperature limitations of the special bypass thermal control valve, this was not possible.

In order to review the sensitivity of the post-SB ATP-79-19 system to such failures, the manufacturer decided to perform flight testing and to request cruise trend data from two operators of post-SB aircraft.

Over a three week period, engine oil temperature data was recorded during the flying of production and test aircraft. This data showed that a normally operating engine oil cooler system in 'cold temperature' conditions (SAT -35°C in cruise to SAT -7°C at the bottom of a low power descent) still held the indicated oil temperature above 60°C. This data was supported by the evidence provided by the operators.

The opportunity was also taken during the manufacturer's testing to determine the effect of a 'failed open' engine oil cooler flap valve. The lowest temperature achieved was 61°C following a low power descent from a SAT -35°C in the cruise to a SAT of -7°C at the end of the descent. This indicated that a single engine oil cooler flap valve failure would be unlikely to result in an unacceptable compressor air inlet ice protection temperature, even accounting for the effect of precipitation.

A post-SB ATP-79-19 aircraft was flown by the aircraft manufacturer with a deliberately 'failed closed' oil cooler bypass thermal control valve fitted to the No 2 engine. A repeat of the cruise and descent points previously tested with the pre-SB system were performed. During the cruise at

18,000 feet with the oil cooler flap valve operating normally on the No 2 engine, the indicated engine oil temperature was 90°C compared with 95°C on the No 1 engine that had the oil cooler bypass thermal control valve operating correctly (SAT -19°C). However, at the end of a prolonged descent at low power, the No 2 engine indicated 70°C compared to 83°C on the No 1 engine.

With the flap valve selected open on the No 2 engine (simulated double failure) the cruise test produced an indicated engine oil temperature of 48°C compared with 95°C on the No 1 engine (SAT -19C). In the descent at low power the temperature split reduced, with an indicated 40°C on the No 2 engine and 65°C on the No 1 engine.

These results again demonstrated that in the cruise, the oil cooler flap valve has sufficient authority to counteract the effect of a failed oil cooler bypass thermal control valve. As with the pre-SB system, the split in the indicated engine oil temperatures increases with reduced power and change in ambient temperature associated with the descent phase of flight. The simulated double failure again produced an extreme split with indicated engine oil temperatures below the 45°C limit, even without the effect of precipitation.

The aircraft manufacturer conducted a review of flight test reports from the ice test programme during 1993/94. These reports showed that the engine oil temperature could reduce by as much as 25°C during severe icing encounters, the temperature recovering on leaving icing conditions. Other comments identified oil temperature reductions of the order of 10°C during rain encounters.

Engine oil system tests

The engine manufacturer has conducted tests on the engine oil system to establish the effect on the temperature of the oil at the compressor air intake anti-icing system when the two other Thermal Control Valves, in the Oil Heated Fuel Heater and the Fuel Cooled Oil Cooler, fail in positions that would allow maximum cooling of the oil within the two units. The result of these tests showed that the temperature of the oil at the compressor air intake anti-icing system would reduce by approximately 1°C.

Other aircraft installed with Pratt & Whitney PW-100 series turboprop engines

The Pratt & Whitney PW-126 turboprop engine is one of many variants of the PW-100 series engines. It is understood that the compressor air intake anti icing system on all the PW-100 series engines is of similar design and operation to that of the PW-126 engine. The PW-100 series engines are installed in a number of turboprop aircraft types.

Follow-up action

Subsequent to the incident, the aircraft manufacturer issued two 'Notices To Aircrews' (NTAs); these were published as Operational Notice No OP34 (issue 1) and Technical Notice No OP35 (issue 1), in addition to a Service Bulletin.

OPERATIONAL NOTICE: No OP34 ISSUE 1 (issued 3 Apr 1995)

TITLE: LOW ENGINE OIL TEMPERATURE

APPLICABILITY: All Aircraft

INTRODUCTION

This Notice to Aircrew is to draw attention to Note (b) of the Engine and Propeller Limitations in the Aircraft Flight Manual (AFM) which states 'Oil temperature must be maintained above 45°C to ensure protection against intake icing'. It has become apparent that operators may not be fully aware of:

1. *The significance of this limitation*
2. *The guidance on how to deal with such a condition.*

TECHNICAL

Ice protection for the engine intake shroud and bearing support struts is achieved by the internal circulation of engine oil at a temperature above 45°C. The engine manufacturer has demonstrated that, providing the engine oil is maintained above this temperature, ice protection will be satisfactory.

OPERATIONAL INSTRUCTIONS

When in icing conditions, and particularly at low power, the engine oil temperature gauge should be regularly monitored. If the indication falls below 45°C (into the amber band), the engine power should be increased to increase the oil temperature (Ref AFM - Normal Procedures - Operations in Icing Conditions).

Any in-flight occurrences of low engine oil temperature should be reported to ground engineering for further investigation.

PUBLICATIONS AFFECTED

None

TECHNICAL NOTICE: No OP35 ISSUE 1 (issued 6 May 1995)

TITLE: ENGINE INDICATIONS DURING FLAMEOUT AND RELIGHT

APPLICABILITY: All Aircraft

INTRODUCTION

This Notice to Aircrew provides information about engine behaviour during a flameout and relight whether the relight is initiated by the continuous ignition system, or by an optional automatic ignition system (Mod 30141A).
The information enables diagnosis of such an occurrence, to prevent the shutdown of an engine in the process of relighting.

TECHNICAL

If partial flame extinction occurs there may be an instant relight.
If a full flameout occurs tests have shown that relight characteristics are similar, whether AUTO or CONTINUOUS ignition is used.

NOTE: Use of continuous ignition is recommended under certain conditions as it provides indication of a working system.
Automatic ignition was introduced to reduce the use of continuous ignition, and therefore prolong igniter life (Refer to the aircraft flight manual).

CAUTION:
If the NH drops to 25%, FROZEN will be annunciated on the ENG CTL PBSI. In this event, carry out the Engine In-flight Shut-down procedure before carrying out the Engine In-flight Starting procedure.

Auto Feather Armed

Engine flameout is characterised by a rapid rundown of torque to zero %. NH and NL reduce more slowly, and after 5 to 7 seconds will be below 50%, NH will continue to reduce until, at about 30%, the relight will take effect and spool up the engine (NL will follow a similar profile).

Approximately 30 seconds after the start of the rundown, NH/NL will fully recover. Because of the auto-feather and uptrim signals, NP will remain between zero and 10%; If the power lever is above FLIGHT IDLE, an overtorque will occur as the engine accelerates and attempts to drive the feathered propeller. In this condition some thrust will be produced. The engine can be recovered by selecting the power lever to FLIGHT IDLE, and then selecting the condition lever to FTHR then to MIN. Engine operation following this exceedence is determined by operational necessity, the engine should be operated normally, but must be inspected after landing.

Auto Feather Not Armed

Engine flameout is characterised by a rapid rundown of torque to zero %. NP will remain at the RPM set by the condition levers. However, at low airspeed the propeller windmilling RPM may reduce and stabilise at a lower value. NH and NL reduce more slowly and after 5 to 7 seconds will be below 50%. NH will continue to reduce until at about 30% the relight will take effect and spool up the engine (NL will follow a similar profile).

Approximately 30 seconds after the start of the rundown NH/NL will fully recover. This will be accompanied in the last few seconds by a rapid recovery in engine torque.

OPERATIONAL INSTRUCTIONS

None

PUBLICATIONS AFFECTED

None

SERVICE BULLETIN: ATP-79-26 (issued 31 March 1995)

TITLE: OIL-INSPECTION OF THE ENGINE OIL COOLER WIRING IN ENGINE NACELLES.

EFFECTIVITY

All British Aerospace ATP Aircraft Constructor's No 2002 to 2063 Pre-Mod 35027A (Service Bulletin ATP-79-19).

REASON

Evidence of oil temperature sensor cable chafing damage has recently been observed. Under certain circumstances this could result in over cooling. This can degrade the engine de-icing protection significantly in icing conditions.

DESCRIPTION

This Service Bulletin affects engine oil cooling actuator control.

The tasks are as follows:

Inspection of wiring and clipping in zones 431-00-00 and 441-00-00 for damage (Module 3).

-Replacement of damaged wires and/or 'P' clips.

-Test of the engine oil cooling actuator control system.

APPROVAL

This service bulletin has been classified as OPTIONAL.

Jetstream Aircraft Limited HIGHLY RECOMMEND the embodiment of this service bulletin at the earliest opportunity.

The technical content of the bulletin is approved under the authority of CAA Approval No DAI/9386/92.

This service bulletin complies with British Civil Airworthiness Requirements, Section A, Chapter A2-5.

Since the incident, the engine manufacturer has also issued a Service Information Letter:

SERVICE INFORMATION LETTER No PW100-011 issued 17 April 1995

TITLE: AWARENESS OF THE SIGNIFICANCE OF OIL TEMPERATURE.

APPLICABILITY - All PW100 Engine Models (except PW125B/PW127B)

There have been a small number of incidents of engine power interruption and recovery involving aircraft equipped with the PW100 engine. In most of these incidents, it has been concluded that ice ingestion was the major contributing factor. In a recent incident, involving a PW126 operator in the United Kingdom, the Air Cooled Oil Cooler was found to have defects which could have resulted in the oil being cooled below 45 deg.C.

P&WC wishes to ensure that the significance of the minimum oil temperature of 45 degrees C is understood.

Oil being scavenged from the RGB is routed through an internal passage in the Front Inlet Case at the air intake flange. Heat from oil in this passage is used to prevent significant amounts of ice from accumulating on the air intake flange, intake struts and/or No 1 & 2 bearing housing.

Certification testing of the PW100 engine showed that, in order to prevent the accumulation of significant amounts of ice in the intake, the minimum allowable oil temperature must be 45 degrees C.

When operating in icing conditions and particularly when at low power in icing conditions, Flight Crew should regularly monitor the engine oil temperature gauge. Should the oil temperature indication fall below 45 deg. C, the relevant Aircraft Flight Manual should be consulted.

After landing, if the Low Oil Temperature occurrence is considered abnormal in accordance with the Aircraft Flight Manual, Maintenance should be informed and corrective action taken.

Operation with oil temperature below 45 degrees C in icing conditions could result in significant ice buildup in the engine air intake.

Therefore, it is most important that the aircraft oil cooler system is operating correctly, and that overcooling of the oil is recognised and corrective action taken as soon as possible.

Further Action Proposed

With regard to the oil cooler bypass thermal control valve, the following actions are being proposed by the aircraft manufacturer:

a) The imposition of a 6 year life, from manufacture, on the oil cooler bypass thermal control valve.

b) Changing the plug material from PTFCE to viton, to reduce oil absorption.

c) Introduction of a viton seal at the top of the valve to prevent oil ingress into the plug.

d) Introduction of instructions in the Aircraft Maintenance Manual to permit operators to remove and replace the oil cooler bypass thermal control valve.

The aircraft manufacturer is also proposing to amend the Aircraft Flight Manual to introduce additional checks into the Flightcrew Checklists calling for the monitoring of the engine oil temperatures in the cruise and descent phases of flight, and an Abnormal Procedure for an engine oil temperature indication of less than 45 degrees C.

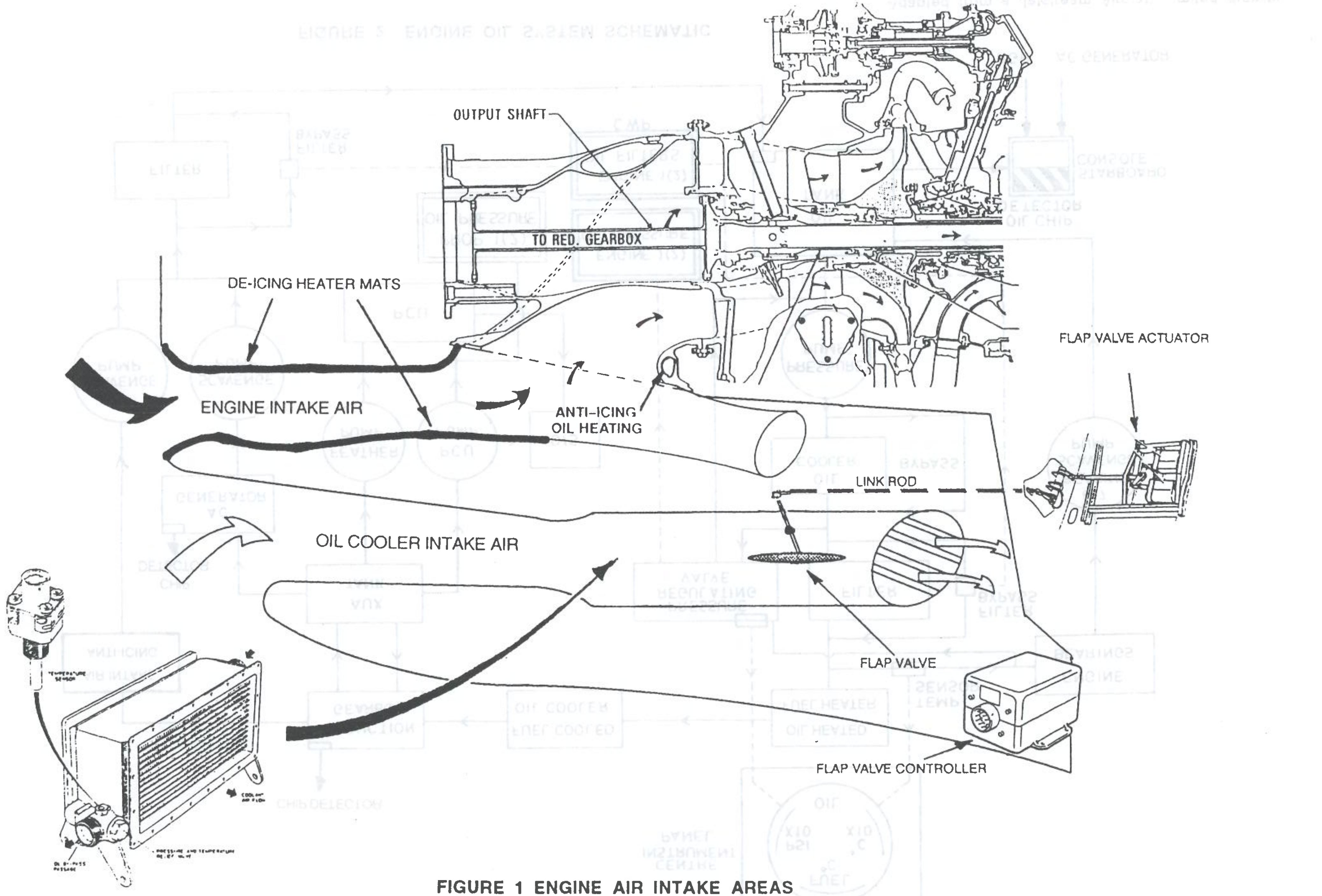
The aircraft manufacturer is proposing to amend the Aircraft Master Minimum Equipment List to ensure that aircraft cannot be dispatched into known, or forecast, icing conditions with an unserviceable engine oil temperature indicator.

In addition the aircraft manufacturer is proposing to amend the Minimum Oil Temperature section of the Technical Description of the BAe ATP engine oil system in the Manufacturer's Operating Manual to reflect the information contained in Operational Notice No OP34.

Safety Recommendation

The following Safety Recommendation is made:

95-13: The Civil Aviation Authority should review all aircraft types on the UK register that have Pratt & Whitney PW-100 series turboprop engines installed to ensure that the Aircraft Flight Manuals and Maintenance Manuals contain appropriate warnings and procedures to maintain oil temperature above 45°C to ensure protection against engine compressor air intake icing.



ENGINE OIL COOLER

FIGURE 1 ENGINE AIR INTAKE AREAS

Adapted from a Jetstream Aircraft Limited drawing

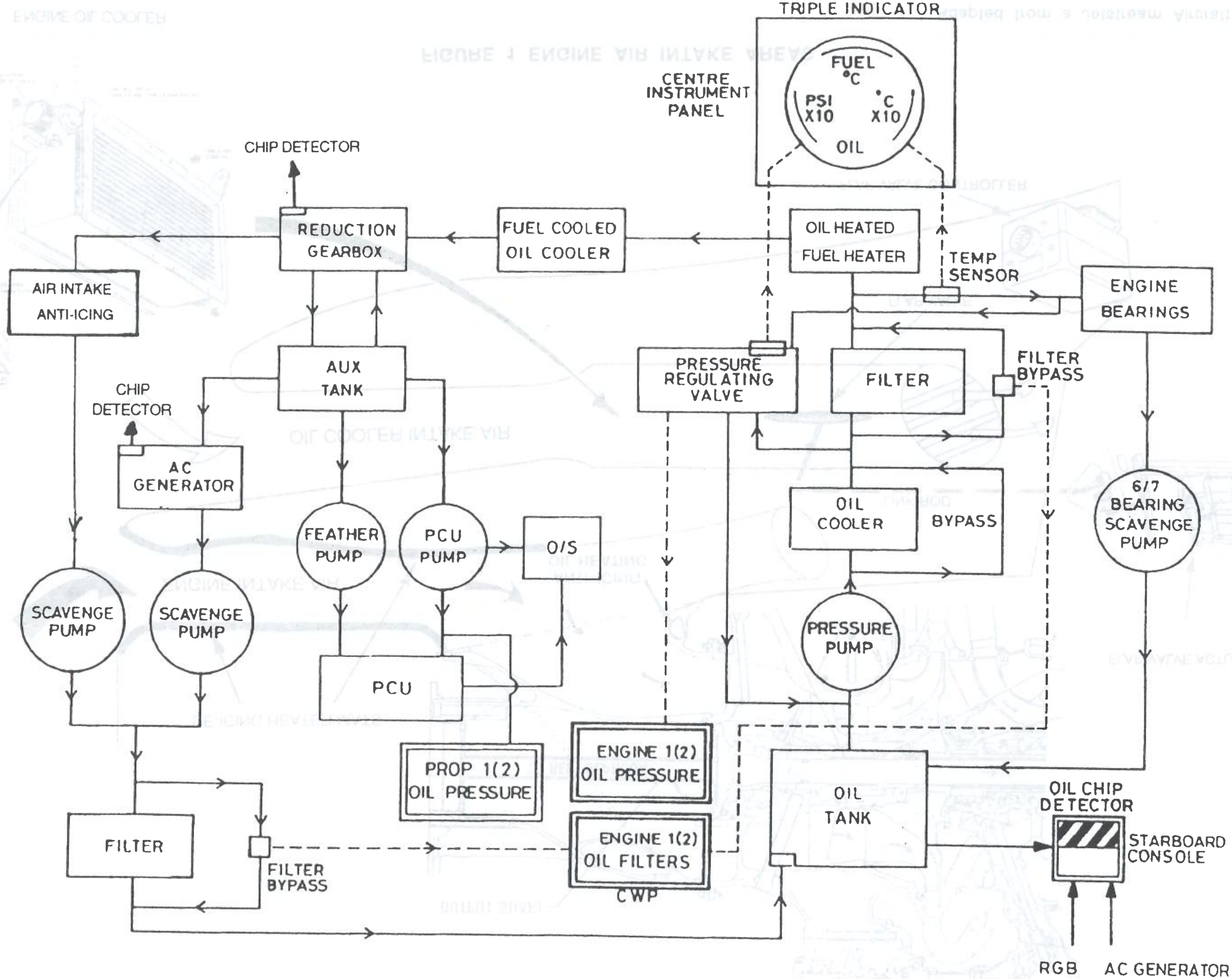
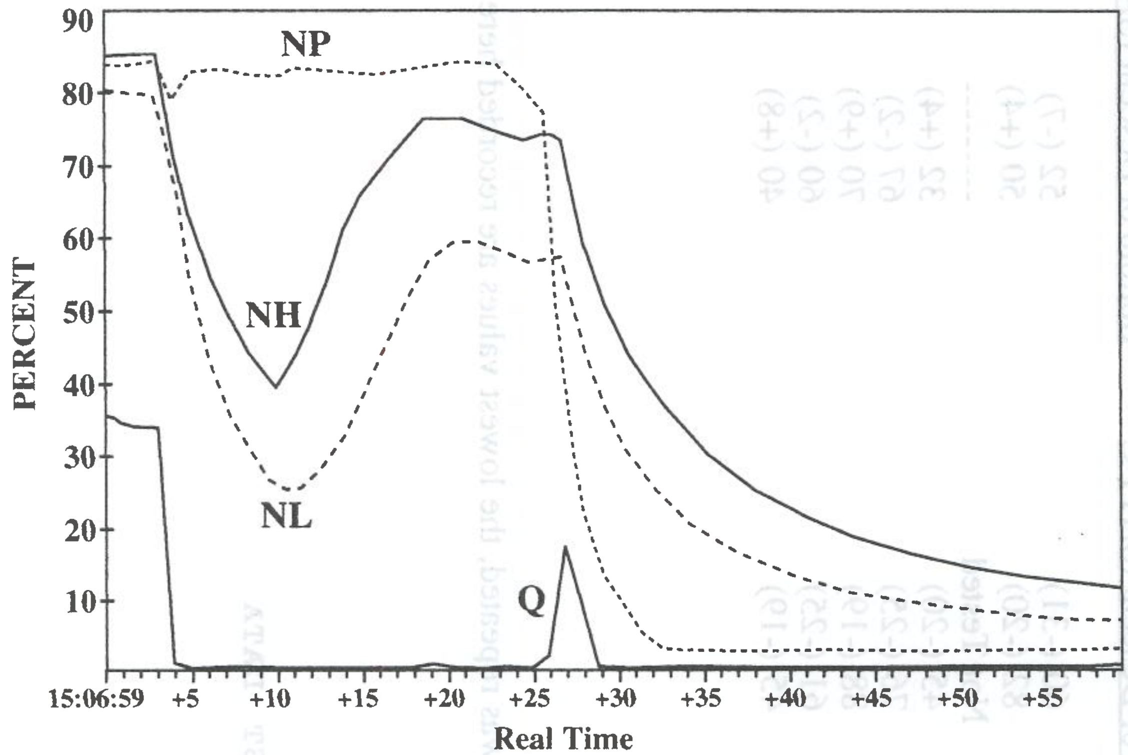


FIGURE 2 ENGINE OIL SYSTEM SCHEMATIC

Adapted from a Jetstream Aircraft Limited drawing

FDR TRACE No 1 ENGINE



FDR TRACE No 2 ENGINE

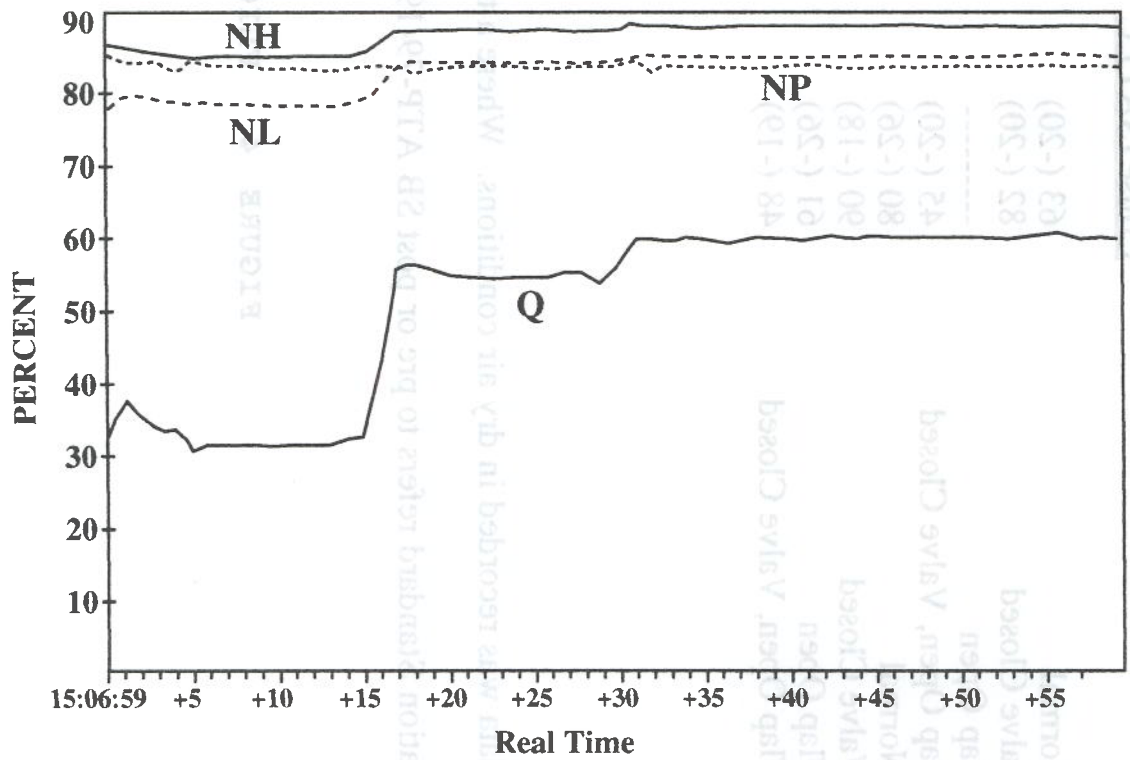


FIGURE 3 FDR TRACES FOR BOTH ENGINES

Modification Standard/Configuration	Flight Mode Cruise (SAT)°C	Top of Descent (SAT)°C	Bottom of Descent (SAT)°C
Pre-Mod Normal	63 (-20)	60 (-31)	52 (-7)
Pre-Mod/Valve Closed	82 (-20)	82 (-20)	50 (+4)
Pre-Mod/Flap Open	---------	Not Tested	---------
Pre-Mod/Flap Open, Valve Closed	45 (-20)	45 (-20)	32 (+4)
Post-Mod/Normal	80 (-26)	76 (-25)	67 (-2)
Post-Mod/Valve Closed	90 (-18)	88 (-19)	70 (+9)
Post-Mod/Flap Open	61 (-26)	61 (-25)	60 (-2)
Post-Mod/Flap Open, Valve Closed	48 (-19)	45 (-19)	40 (+8)

NOTE:

1. Above data was recorded in dry air conditions. Where a test point was repeated, the lowest values are recorded here.

2. Modification Standard refers to pre or post SB ATP-79-19

FIGURE 4 FLIGHT TEST DATA