CHAPTER

72

ENGINE

CHAPTER 72
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ENGINE GENERAL - DESCRIPTION

1. General

See Figure 1 through Figure 3.

These instructions are based on the assumption that the reader is already familiar with the fundamentals and theory of a turbojet engine. In the following description of the JT8D engine, frequent reference may be made to fundamental and theoretical principles as an aid to discussing the configurational relationships of the parts and assemblies of this engine. If the reader is not yet familiar with turbojet fundamentals and theory, it is recommended that reference be made to the following P&W publication, copies of which have been supplied to all commercial operators of P&W engines:

"General Operating Instructions for Dual Axial Compressor Non-Afterburning Turbojet Engines"

This engine operates similarly to all turbojet versions of a gas turbine engine in that it derives its propulsive force through the application of Sir Isaac Newton's third law which states that for every action there is an equal and opposite reaction. The engine cases form the backbone of the engine when bolted together, and support all of the inner parts of the engine through struts and bearings. The fan discharge air is ducted outside the inner cases because the air has already been accelerated by the fan and has therefore served its purpose of provided additional thrust, the same kind of additional thrust that would be gained from air passing through the propeller of a turboprop or reciprocating engine.

The JT8D engine is an axial-flow front turbofan engine having a fourteen stage split compressor, a nine can (can-annular) combustion chamber, and a split four stage reaction impulse turbine. See Figure 3. The engine is equipped with a full length annular fan discharge duct. The low pressure system is made up of the front compressor rotor and the 2nd, 3rd, and 4th stage turbine rotors and is mechanically independent of the high pressure system which consists of the rear compressor rotor and the 1st stage turbine rotor.

The engine is mounted from two points. The front mount is located at the fan discharge intermediate case. The engine rear mount is located at the turbine exhaust section outer duct.

ENGINE SPECIFICATIONS

ENGINE SPECIFICATIONS	
General	
Type	Axial-Flow, gas turbine turbofan
Number of Combustion Chambers	9
Type of Combustion Chamber	Can-annular
Type of Compressor	Two-spool, 14 stage, front fan, having a 7 stage low pressure compressor and a 7 stage high pressure compressor
Type of Turbine	4 stage, split, having 1st stage high pressure and 2nd, 3rd, and 4th stage low pressure turbine
Engine Dry Weight (approx.)	4410 lbs (2002.14 kilograms)
Engine Length at Room Temperature (approx.)	154.2 In. (3.91 meters)
Engine Inlet Diameter at Room Temperature (approx.)	54 In. (1.37 meters)
Ignition System	
Ignition Exciter	Bendix-Scintilla or General Laboratory Associates (GLA)
Igniter Plugs	Champion
Lubricating System	

ENGINE SPECIFICATIONS (Continued)

ENGINE SPECIFICATIONS	
Oil Specification	PWA 521
Oil Tank Usable quantity	4.0 gallons (3.33 Imperial gallons or 15.14 liters)
Fuel System	
Fuel Specification	SB 2016
Fuel Control	Hamilton Standard
Fuel Pump	Thompson Ramo Woolridge

DIRECTIONAL REFERENCES

Unless otherwise specified in the procedural text, right and left, clockwise and counterclockwise, upper and lower, and similar directional references apply to the engine as viewed from the rear (exhaust end) with the engine in a horizontal position and with the main accessory section at the bottom of the engine. The rotation of the rotor assemblies is clockwise.

COMBUSTION CHAMBER NUMBERING

The combustion chambers are numbered one to nine in a clockwise direction, with the top center combustion chamber designed as number one. The number four and seven chambers have spark igniter bosses. See Figure 4.

MAIN BEARING NUMBERING AND COMPANION SEAL IDENTIFICATION

In practice the main engine bearings are commonly referred to, as to location, by number. In the interests of brevity and clarity these bearings and their companion seals will be referred to by number in this publication. The following bearing designation table is provided to familiarize personnel with the full nomenclature, location, and designated number of bearings. See Figure 5. The companion seal types are described in Main Shaft Oil and Airseal.

Table 1 BEARING DESIGNATION TABLE

NAME	LOCATION	NUMBER	TYPE
Front Compressor Front	Inlet case; Front compressor front hub	1	Roller
Front Compressor Rear	Compressor (intermediate) case front; Front compressor rotor rear hub	2	Ball
Rear Compressor Front	Compressor (intermediate) case rear; Main accessory drive gear	3	Ball
Rear Compressor Rear	Diffuser case; Rear compressor rotor rear hub	4	Duplex Ball
Turbine Inter-shaft	In line with mid-point of combustion chamber case; Outer race within rear compressor drive turbine shaft; Inner race and rollers on front compressor drive turbine shaft	4 1/2	Roller
Turbine Front	In line with combustion chamber case rear flange; Inner race on rear compressor drive turbine shaft	5	Roller
Turbine Rear	Turbine exhaust case; Front compressor drive turbine rear hub	6	Roller

ENGINE SECTIONS

The engine has six general sections, the air inlet section, the compressor section, the combustion section, the turbine and exhaust section, the accessory drives, and the fan discharge section. Detailed information on each is given within the appropriate code-numbered sections of the manual. See Figure 6.

ENGINE FLANGE DESIGNATIONS

To facilitate identification of the engine flanges, they are designated by letter. Interruptions in the lettering sequence may result where development changes have removed or added flanges. See Figure 7.

ENGINE SECTIONAL NUMBERING

AIR INLET/FRONT ACCESSORY SECTION	72-21/23
COMPRESSOR SECTION	72-33/34/36/37/38
COMBUSTION SECTION	72-41
TURBINE AND EXHAUST SECTION	72-51/52/53/54/55
ACCESSORY DRIVES	72-61
FAN DISCHARGE SECTION	72-71

FAN DISCHARGE SECTION

Bolted behind the rear fan case is the fan exit case. Enclosed within it are the fan exit vanes.

At this location the gas flow divides, with the fan discharge air passing through these vanes and the central air stream passing through the basic inner engine.

Enclosing the engine, from the fan exit case rearward, is a series of fan discharge outer ducts and cases. These outer ducts and the outer surface of the inner ducts and basic engine cases, form the annular duct air passage for fan discharge air flow to the rear of the engine. The fan discharge section is described in greater detail in DIFFUSER OUTER FAN DUCT SECTION, SUBJECT 72-38-00, EXHAUST SECTION, SUBJECT 72-54-00, and FAN DISCHARGE SECTION - DESCRIPTION, PAGEBLOCK 72-71-00/001.

ACCESSORY AND COMPONENT DRIVES

There are two units on the engine to accommodate accessory and components drives. The first is the front accessory drive housing which is mounted on the front of the inlet case. It incorporates, on its front face, an external pad for mounting an N1 (front compressor) tachometer generator. See AIR INLET FRONT ACCESSORY SECTION - DESCRIPTION, PAGEBLOCK 72-21-00/001, for detailed information.

The second unit is the accessory and components drive gearbox, mounted beneath the engine at the fan discharge intermediate case. It has one drive pad for the fuel pump and fuel control. In addition, one 10-inch and two 5-inch drive pads are incorporated for airframe-furnished accessories such as an alternator, starter, and hydraulic pump. A standard pad is provided for an N2 tachometer generator. Oil pressure and oil scavenge pumps (in one pump assembly), an oil pressure relief valve, and an oil filter and bypass valve are incorporated. See MAIN ACCESSORY GEARBOX SECTION - DESCRIPTION, PAGEBLOCK 72-61-00/001, for a detailed description.

MAIN SHAFT BEARINGS

General

The front compressor system (low pressure) with its related turbine rotor, is supported by four anti-friction bearings - one (No. 1) in front of and one (No. 2) behind the front compressor rotor and one (No. 4 1/2) in front of and one (No. 6) behind the front compressor drive turbine rotor. The No. 2 bearing is a single ball thrust bearing and locates the front compressor system axially.

The rear compressor system (high pressure) and related turbine rotor, is mounted on three anti-friction bearings - one (No. 3) in front of and one (No. 4) behind the rear compressor rotor and one (No. 5) in front of the rear compressor drive turbine motor. The No. 4 bearing assembly consists of a matched pair of ball thrust bearings and locates the rear compressor system axially.

The No. 4 bearing is a duplex bearing consisting of two ball bearings installed in pairs in order to obtain a better safety margin. The bearings are manufactured in matched pairs and assembled in the engine so as to obtain the best possible distribution of the load for this type of arrangement. The bearing oil baffle, which is positioned between the bearing outer races, serves to ensure the proper distribution of oil to each of the two bearings, and also, in case of failure of one bearing, prevents a flow of chips into the second bearing. The inner races of each bearing are split to permit a maximum ball complement as well as a one piece cage.

The main accessory drive gearshaft rotates inside the upper roller and lower ball bearings inside the intermediate section of the compressor case. See Figure 5 for the location of all the main shaft bearings and Figure 8 through Figure 13 for details of each bearing arrangement.

Structure

All the roller bearings employ a one piece cage, a recessed race ring and a plain raceway ring. Either the inner or the outer ring of a bearing may be the recessed race ring, the determining factor being assembly and disassembly requirements. The rollers in the bearings are crowned in a conventional fashion.

MAIN SHAFT OIL AND AIRSEALS

General

The main shaft seals for the Numbers 1, 2, 3, 4, and 5 bearing locations are face-type carbon seals. Split ring type seals are used at the No. 4 1/2 and No. 6 bearing locations.

Labyrinth seals are used in conjunction with main shaft seals of face-type carbon design, to regulate rotor air pressurization of bearing compartments. In addition to the labyrinth seals, expanding metal seal rings are used at the No. 2, 3, 4, and 5 bearing locations to provide oil sealing features beyond main carbon face seal.

The following table lists the main shaft seals by companion bearing number and type.

Oil And Airseal Table

Number	Type	Location
1	Face Type Carbon	Rear Of No. 1 Bearing
2	Face Type Carbon	Forward Of No. 2 Bearing
3	Face Type Carbon	Rear Of No. 3 Bearing
4	Face Type Carbon	Forward Of No. 4 Bearing
4 1/2	Split Ring Seal	Rear Of No. 4 1/2 Bearing
5	Face Type Carbon	Rear Of No. 5 Bearing
6	Split Ring Seal	Forward Of No. 6 Bearing

Main Bearing Seal Drain System

See Figure 14

The bearing compartments at locations No. 1 through No. 4 are equipped with seal drain features outboard of the carbon seals. At each of these locations oil which may leak past the carbon seal is conducted through tubing to the outside of the engine. Drained oil from Nos. 1, 2, and 3 bearings is carried to a connector on the gearbox overboard breather outlet. Drained oil from the No. 4 bearing area is carried downward to a check valve on the bottom of the engine at the diffuser outer fan duct.

No. 1 Bearing Seals

See Figure 8.

To the rear of the No. 1 bearing is a face-type carbon seal which rides against a rotating seal seat positioned behind the No. 1 bearing inner race. A knife-edge airseal on the front compressor front hub, rearward of the face-type carbon seal assembly, regulates rotor air flow into the seal area.

No. 1 Bearing Compartment Venting

The No. 1 bearing compartment is vented forward of the bearing by the oil breather and scavenge systems. Oil and vapors are conducted rearward by external tubing to the gearbox. At the rear of the bearing compartment, any oil which may leak past the carbon seal is conducted to the outside of the fan inlet case by seal drain tubing. External tubing conducts this seal drain oil rearward to the left side of the gearbox.

No. 2 And 3 Bearing Seals

See Figure 9.

The No. 2 bearing area incorporates a face-type carbon seal forward of the bearing, riding against a rotating seal seat in front of the bearing inner race. In addition to the face-type carbon element, a stationary expanding metal seal ring controls oil flow beyond the face-type seal, and a rotating knife-edge seal at the outer edge of the bearing compartment controls rotor air flow into the compartment.

With a design similar to that of the No. 2 bearing area, the No. 3 bearing area incorporates a face-type carbon seal, backed up by an expanding seal ring and knife-edge airseal.

No. 2 And No. 3 Bearing Compartment Venting And Pressurization

The No. 2 and No. 3 bearings occupy the front and rear sides respectively, of the compressor intermediate case. Oil delivery and removal of breather air and scavenged oil is accomplished by tubing inside the compressor intermediate case. An oil pressure tube leads upward from a gearbox discharge port to a nozzle in the bearing compartment, and a breather and scavenge oil tube leads downward from the bottom of the bearing compartment. In addition, a No. 2 bearing seal drain tube extends downward from the No. 2 bearing seal area outside the case and re-enters the case at the front wall to conduct excess oil and oil vapor away from the seal area. Similar seal drain tubing conducts oil away from the No. 3 bearing seal area, and this No. 3 bearing seal drain tubing is connected, together with the No. 2 bearing seal drain tube, to a connector on the gearbox.

No. 4 Bearing Seal

See Figure 10.

The No. 4 bearing seal is a face-type carbon seal with two sealing elements facing in opposite directions. These carbon elements each ride against rotating seal plate surfaces, and tandem metal sealing rings control oil flow around the carbon seals. Two rotating knife-edge seals on the rear compressor rear hub control rotor airflow into the bearing compartment. Heat shielding around the seal area protects the bearing compartment from excessive heat, and a seal drain tube at the 6 o'clock position on the front of the seal assembly conducts excessive accumulations of oil and oil vapor away from the seal.

No. 4 Bearing Air Check Valve

The No. 4 Bearing air check valve is located at the bottom of the engine at the diffuser outer fan duct, at the outer end of the No. 4 bearing outer drain tube. This valve is of the spring-loaded ball type and is open at low pressure and closed at high pressure in the drain tube. During engine operation this valve is open at Idle, allowing internal air pressure and oil vapor to flow downward from the No. 4 bearing seal and out of the engine. At power levels above Idle (approximately 66 percent N2 and able) increased internal pressure closes the valve.

No. 4 1/2 Bearing Seal

See Figure 11.

This seal consists of split bonded-graphite ring seals mounted between spacers on the front compressor drive turbine rotor shaft and rotating within the bore of the rear compressor drive turbine rotor shaft. The split ring seals are forced outward against the bore of the rear compressor drive turbine shaft by centrifugal force and by gas pressure acting on the inner diameter. The gas pressure acting on the face of seal ring forces the other face against the adjacent spacer.

No. 5 Bearing Seal

See Figure 12.

The No. 5 bearing seal is a face-type carbon seal with two sealing elements facing in opposite directions. These carbon elements each ride against rotating seal plate surfaces, and tandem metal sealing rings control oil flow around the carbon seals. A rotating knife-edge seal on the rear compressor drive turbine shaft controls rotor airflow into the bearing compartment. The No. 5 bearing seal area is heat shielded to protect it from excessive engine heat.

No. 6 Bearing Seal

See Figure 13.

This seal consists of split, bonded-graphite ring seals mounted between spacers on the front compressor drive turbine rotor rear hub and rotting within the bore of a stationary seal housing welded inside the No. 6 bearing support. The split ring seals are forced outward toward the bore of the stationary housing by centrifugal force and axially, toward the forward and rearward seal spacers, by a central spring washer between the seals.

LUBRICATING SYSTEM

General

The engine lubrication system is of a self-contained, high pressure design consisting of a pressure system which supplies lubrication to the main engine bearings and to the accessory drives, and a scavenge system by which oil is withdrawn from the bearing compartments, and from the accessories, and then returned to the oil tank. A breather system connecting the individual bearing compartments and the oil tank completes the lubrication system. See Figure 15.

Pressure Oil System

Oil is gravity fed from the oil tank into the main oil pump within the gearbox. The pressure section of the main oil pump forces oil through the main oil strainer located immediately downstream of the pump discharge. The main oil strainer filter element is either a re-usable filter element or a disposable filter element. A bypass valve is incorporated in the center of the filter element. If the filter element becomes clogged, the bypass valve will move off its seat and the oil will bypass through the center of the filter.

Proper distribution of the total oil flow to the various locations is maintained by metering orifices and clearances. The main oil pump is regulated by a valve to maintain a specified pressure and flow. Pressure, relative to internal engine breather pressure (tank pressure), and flow are essentially constant with changes in altitude and engine speed.

Oil leaves the gearbox and flows to the fuel-coolant oil cooler (optional). If the cooler is blocked, an oil cooler bypass valve opens to permit the continuous flow of oil. Oil leaves the cooler (or passes through the valve) and flows into the oil pressure tubing to the main bearing compartments. The pressure sense line maintains a constant oil pressure at the bearing jets, regardless of the pressure drop of the oil at the fuel oil cooler.

No. 1 Bearing Lubrication

See Figure 8.

Oil for the No.1 bearing enters the bearing compartment through tubing in the 6 o'clock vane of the inlet case. Transfer tubes conduct oil forward into the front accessory support and internal passages in the support route oil to nozzles which spray oil not only into the bearing directly, but also in the center of the front accessory spur gear so that the oil is flung outward through holes in the gear wall and hub into the No. 1 bearing seal area.

In addition to lubrication, oil is used for vibration damping in the No. 1 bearing support structure. Oil is carried from the front accessory support to the No. 1 bearing support and ported into a space around the outside of the No. 1 bearing outer race. The pressurized oil layer around the bearing absorbs front compressor rotor vibration during engine operation.

No. 2 And No. 3 Bearing Lubrication

See Figure 9.

Oil enters the No. 2 and No. 3 bearing compartment through compressor intermediate case internal tubing and is sprayed onto the bearings through a three-legged oil nozzle assembly. A front leg (or nozzle) directs oil toward the No. 2 bearing, a second toward the No. 3 bearing, and a third toward the gearbox drive shaft upper bearing. Oil flows through holes in the front compressor rear hub to the ID of the No. 2 bearing. Flow through the gearbox drive bevel gear holes carries oil to the ID of the No. 3 bearing.

No. 4 and 5 Bearing Lubrication

See Figure 10, Figure 12 and Figure 16.

Pressure oil for the No. 4 and No. 5 bearings enters the No. 4 bearing compartment through tubing in the diffuser case and diffuser outer duct. Oil is conducted into a No. 4 bearing oil nozzle, which sprays oil into passages under the bearing inner races.

Oil is piped rearward from a port in the No. 4 bearing nozzle to the No. 5 bearing area through a turbine shafts heatshield. In the No. 5 bearing compartment a nozzle sprays oil under the bearing inner race, where grooves in the inner race allow the oil to travel rearward, cooling and lubricating the No. 5 bearing and seal. The grooves in the No. 5 bearing inner race are shown in Figure 16.

A transfer tube from the No. 5 bearing oil nozzle carries oil into the No. 5 bearing housing, where the oil fills a space between the No. 5 bearing outer race and the housing bore. This oil layer around the bearing absorbs rear compressor drive turbine rotor vibration during engine operation.

No. 4 1/2 And No. 6 Bearing Lubrication

See Figure 11 and Figure 13.

Pressure oil enters the No. 6 bearing compartment through tubing in the 1 o'clock strut of the turbine exhaust duct. Oil flows through a passage in the No. 6 bearing scavenge pump to the No. 4 1/2 bearing nozzle assembly, where the oil flow divides. Part of the oil is released through holes in the outside of the nozzle into a space inside the turbine hub and is allowed to spin outward into the No. 6 bearing and seal area. The remaining nozzle flow is directed into the No. 4 1/2 and 6 bearing tube assembly, which rotates inside the front compressor drive turbine assembly and carries oil forward to the No. 4 1/2 bearing and seal area between the front compressor drive turbine shaft and the rear compressor drive turbine shaft.

Oil is also taken from the pressure oil passage in the No. 6 bearing scavenge pump to provide vibration damping of the No. 6 bearing. An oil delivery tube from the pump to the No. 6 bearing outer race and absorbs front compressor drive turbine rotor vibration during engine operation.

Scavenge Oil System

General

The scavenge oil system of the engine consists of four gear-type pumps (five pump stages) which scavenge the main bearing compartments and deliver the scavenged oil to the engine oil tank.

No. 1 Bearing Compartment

See Figure 8.

A single-stage scavenge pump for the No. 1 bearing compartment is located in the cavity of the front accessory drive support. The pump is driven by the front accessory drives gearshaft located in the front hub of the compressor rotor. The pump picks up the oil and sends it outward through a passage in the housing, then down a tube located in the bottom vane of the inlet case.

No. 2 and No. 3 Bearing Compartment

See Figure 9.

A second scavenge pump is the scavenge stage of the main oil pump assembly in the main accessory gearbox. Scavenge oil from the gearbox drive bevel gearshaft bearings and the No. 2 and No. 3 bearings which has drained downward from the bearing compartment is pumped into the oil tank by this scavenge stage of the main oil pump.

No. 4, No. 4 1/2, and No. 5 Bearing Scavenging

See Figure 10, Figure 11, Figure 12.

The third scavenge pump is the No. 4 and 5 bearing scavenge pump, located in the No. 4 bearing housing sump. This two-stage pump scavenges oil from the No. 4 bearing housing sump and from the No. 5 bearing compartment by means of an extension tube from the No. 4 to the No. 5 bearing area. In addition, scavenge oil from the No. 4 1/2 bearing enters the No. 4 bearing compartment through holes in the rear compressor drive turbine shaft and collects in the No. 4 bearing housing sump. Scavenge oil from the No. 6 bearing, pumped forward through the No. 4 1/2 and 6 bearing tube assembly by the No. 6 bearing scavenge pump, enters the No. 4 bearing compartment through similar holes in the shaft. The scavenge oil from these various sources is pumped through diffuser case tubing to the outside of the engine and from there is carried to the main accessory gearbox.

No. 6 Bearing Compartment

SeeFigure 13.

The fourth scavenge pump is located in the No. 6 bearing scavenge pump housing where it is driven by a gearshaft bolted to the rear of the turbine rotor (4th stage) rear hub. It scavenges oil from the No. 6 bearing compartment and pumps it upward into the inner passage of the No. 6 bearing oil nozzle assembly. The oil flows forward in the nozzle inner passage and is discharged through the center tube of the nozzle into the No. 4 1/2 and 6 bearing tube assembly. This tube assembly carries the scavenge oil forward and discharges it through holes in the front compressor drive turbine shaft and the No. 4 1/2 bearing inner race retaining nut. From here the oil is spun outward through holes in the rear compressor drive turbine shaft into the No. 4 bearing compartment.

Return oil passed forward by the two rearmost pumps, as well as that from the front oil suction pump, is directed into the gearbox cavity. From here the oil is pumped, by the scavenge stage of the gearbox pump, to the oil tank. Within the tank, the oil passes through a deaerator where the major part of the entrapped air is removed.

Breather System

To ensure proper oil flow and to maintain satisfactory scavenge pump performance during operation, the pressure in the bearing cavities is controlled by the breather system. The atmosphere of the No. 2 and 3 bearing cavity vents into the accessory gearbox. Breather tubes in the compressor inlet case and diffuser case discharge through external tubing into the accessory drive gearbox. Breather air fro the No. 6 bearing compartment comes forward through the No. 4 1/2 and 6 bearing tube assembly, with the scavenge oil from that compartment, to the No. 4 bearing compartment.

In the gearbox, vapor-laden atmosphere passes through rotary breather impellers, mounted on the starter drive gearshaft, where the oil is removed. The relatively oil-free air reaching the center of the gearshaft is conducted overboard.

AIR SYSTEMS

Anti-Icing Air System

This system is provided to prevent undesirable icing of the engine air inlet surfaces. This is accomplished by piping hot air (8th stage bleed) forward to the inlet section. See AIR, CHAPTER 75 for a detailed description of this system.

Compressor Bleed System

The compressor bleed air system is primarily designed to permit operational flexibility by allowing 8th and 13th stage air to bleed overboard. See AIR, CHAPTER 75.

Cooling Air System

Cooling air for the interior of the combustion chamber and turbine area is 13th stage compressor air which passes between the multi-edge airseal on the rear of the 13th stage disk and the mating seal rings at the inner shroud of the exit vanes. This air enters the diffuser case inner cavity, formed by the rear compressor rear hub and the diffuser front surface, and goes rearward between the combustion chamber inner case and the turbine shafts heatshield. From this area it passes through holes in the No. 5 bearing housing.

A tubing system from the diffuser case inner cavity to the upper left boss on the diffuser outer fan duct provides a means to measure the turbine cooling air pressure

A portion of the air passes between the 1st stage turbine disk (front side) and airseal and through holes in the 1st stage disk and blades. The rest of the air passes through holes located just aft of the disk front flange cooling the disk rear face.

Burner pressure air is used to cool the 1st stage turbine vanes. Air which passes rearward at the outside of the combustion section is allowed to flow through holes in the outer wall of the combustion chamber duct assembly and into the space outboard of the 1st stage turbine vanes. Holes in the vane outer platforms allow this air to flow into the vanes and the air exits into the gaspath through holes in the vane trailing edges, cooling the vane surfaces.

A portion of 6th stage compressor air escapes via the interstage airseals, while the remainder of the cooling air enters the front compressor drive turbine shaft and circulates around the turbine disks before passing outward through the rear hub. Cooling air passes around the No. 6 bearing support housing and the sump heatshield as well as joining the engine exhaust gas flow ahead of the exhaust struts.

Key To Figure 8 (Sheet 1)

Index Number	Nomenclature
1	No. 1 Bearing Housing Assembly
2	No. 1 Bearing Seal Assembly
3	No. 1 Bearing Airseal
4	No. 1 Bearing Sealing Ring
5	No. 1 Bearing Rear Support
6	Inlet Case
7	No. 1 Bearing
8	Front Accessory Support Assembly
9	No. 1 Bearing Oil Scavenge Pump
10	Front Accessory Spur Gear
11	No. 1 Bearing Nozzle Assembly

Key To Figure 8 (Sheet 2)

Index Number	Nomenclature
1	Front Accessory Support Assembly
2	Inlet Case Elbow
3	No. 1 Bearing Housing Assembly
4	Transfer Tube
5	No. 1 Bearing
6	Transfer Tube
7	No. 1 Bearing Nozzle Assembly

Key To Figure 9 (Sheet 2)

Index Number	Nomenclature
1	Gearbox Drive Bevel Gearshaft (See Sheet 1)
2	Towershaft Nozzle Of Index 6 Nozzle Assembly
3	Turbine Shaft Coupling
4	Gearbox Drive Bevel Gear
5	No. 3 Bearing
6	No. 2 and 3 Bearing Oil Nozzle Assembly

Key To Figure 10

Index No.	Nomenclature
1	No. 4 Bearing Sealing Ring Assembly
2	No. 4 Bearings
3	Seal Rings
4	Oil Seals (Carbon Face Type)
5	No. 4 Bearing Spacer
6	No. 4 Bearing Seal
7	No. 4 Bearing Inner Drain Tube
8	No. 4 Bearing Seal Seat
9	No. 4 Bearing Heatshield

Key To Figure 11

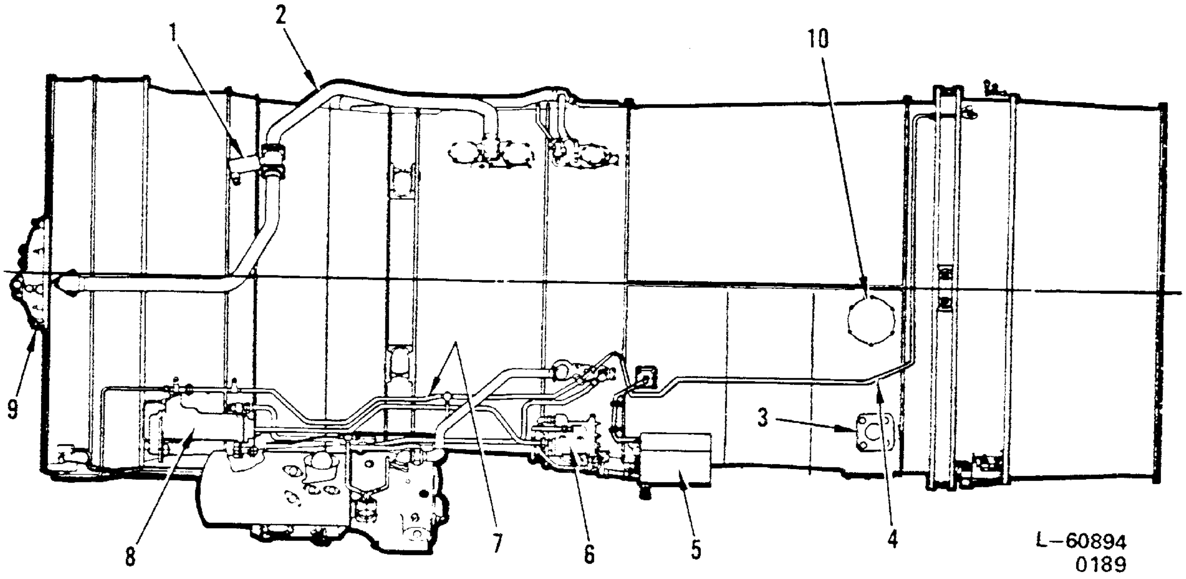
Index No.	Nomenclature
1	Turbine Shaft Coupling Lock
2	No. 4 1/2 Bearing Spacer
3	No. 4 1/2 Bearing Spacer / Seal Liner
4	No. 4 1/2 Bearing Inner Race Retaining Nut
5	No. 4 1/2 And 6 Bearing Tube Assembly

Key To Figure 11 (Continued)

Index No.	Nomenclature
6	No. 4 1/2 Bearing
7	No. 4 1/2 Bearing Rear Seal Spacer
8	No. 4 1/2 Bearing Face Seal
9	No. 4 1/2 Bearing Intermediate Seal Spacer
10	Spring Washer
11	No. 4 1/2 Bearing Front Spacer

Key To Figure 13

Index No.	Nomenclature
1	No. 6 Bearing Outer Race Seal Rings
2	No. 6 Bearing Outer Race
3	No. 6 Bearing Retaining Plate
4	No. 6 Bearing Oil Scavenge Pump
5	No. 6 Bearing Seal Spacer
6	No. 6 Bearing Seal
7	Spring Washer
8	No. 6 Bearing Seal Loading Ring
9	No. 6 Bearing Seal Spacer
10	No. 4 1/2 And 6 Bearing Tube Assembly
11	No. 4 1/2 And 6 Bearing Oil Nozzle



1. Anti-Icing Air Shutoff Valve
2. Anti-Icing Air Tube
3. Borescope Access Cover
4. No. 6 Bearing Oil Pressure Tube
5. Ignition Exciter
6. Fuel Pressurizing And Dump Valve
7. Main Bearing Oil Pressure Manifold
8. Fuel/Oil Cooler
9. Pt2 Connection
10. Fan Air Bleed Boss (Not Applicable)

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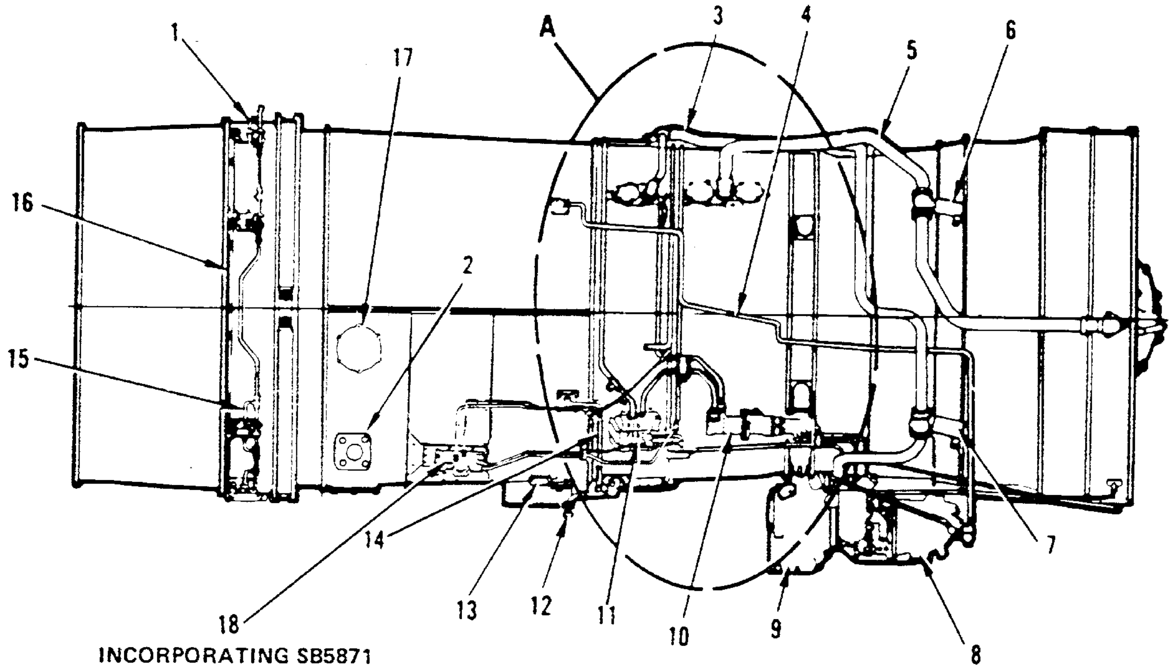
Engine Left Side View
Figure 1/72-00-00-990-803

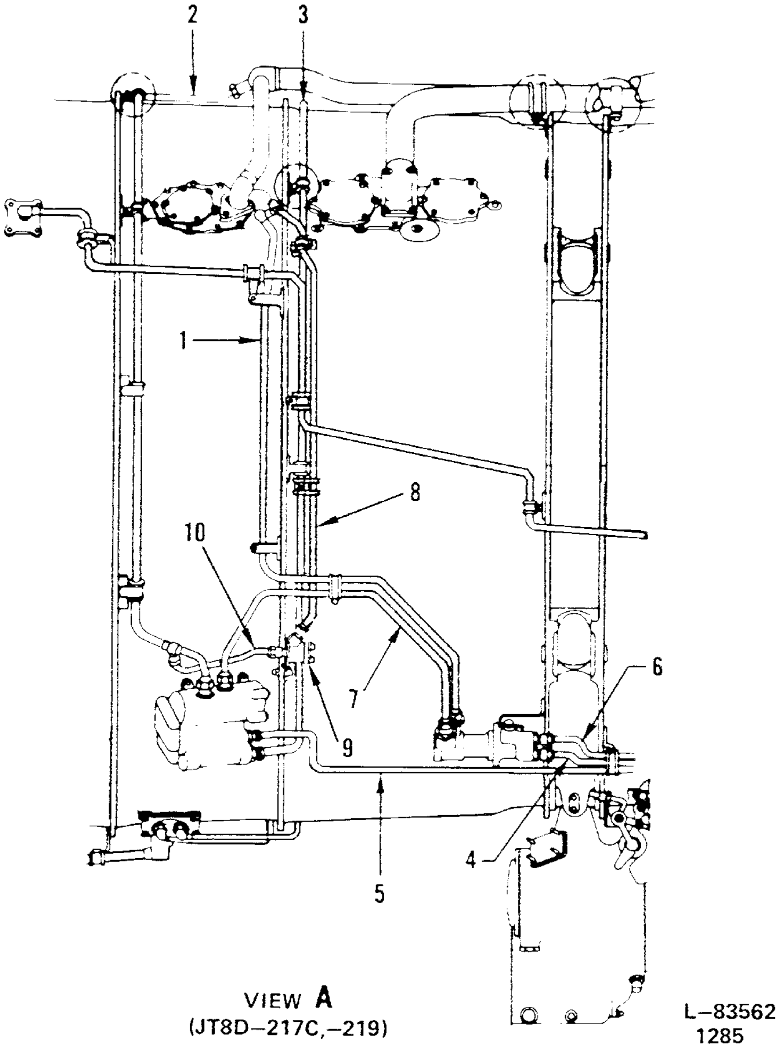


L-60895
1089

1. Pt7 Connection
2. Borescope Access Cover
3. Fuel Deicing Air Manifold
4. Fuel Control Burner Pressure Sensing Tube
5. Anti-Icing Air Tube
6. Anti-Icing Air Shutoff Valve
7. Fuel Deicing Air Shutoff Valve
8. Fuel Control
9. Main Accessory Gearbox
10. Bleed Valve Control
11. Pressure Ratio Bleed Control
12. No. 4 Bearing Seal Drain Tube
13. Air Bleed Pad (Fan Bypass)
14. Igniter Plug High Tension Lead
15. Pt7 Manifold
16. Thermocouple (Tt7) Harness
17. Fan Air Bleed Boss (Not Applicable)
18. Pressure Ratio Bleed Control (6th Stage)

BBB2-72-77

Engine Right Side View
Figure 2/72-00-00-990-804 (Sheet 1 of 2)



1. Bleed Valve Upper Supply Manifold
2. Bleed Control Ps4 Supply Tube
3. Bleed Control Ps3 Tube
4. Bleed Valve Control Fuel Signal Tube
5. Bleed Control Pt2 Tube
6. Bleed Valve Control Fuel Pressure Tube
7. Bleed Control Lower Ps4 Supply Tube
8. Bleed Control Ps4 Tube (Upper)
9. Start Bleed Control Valve (Pre SB 5863)
10. Bleed Control Ps4 Tube (Lower)

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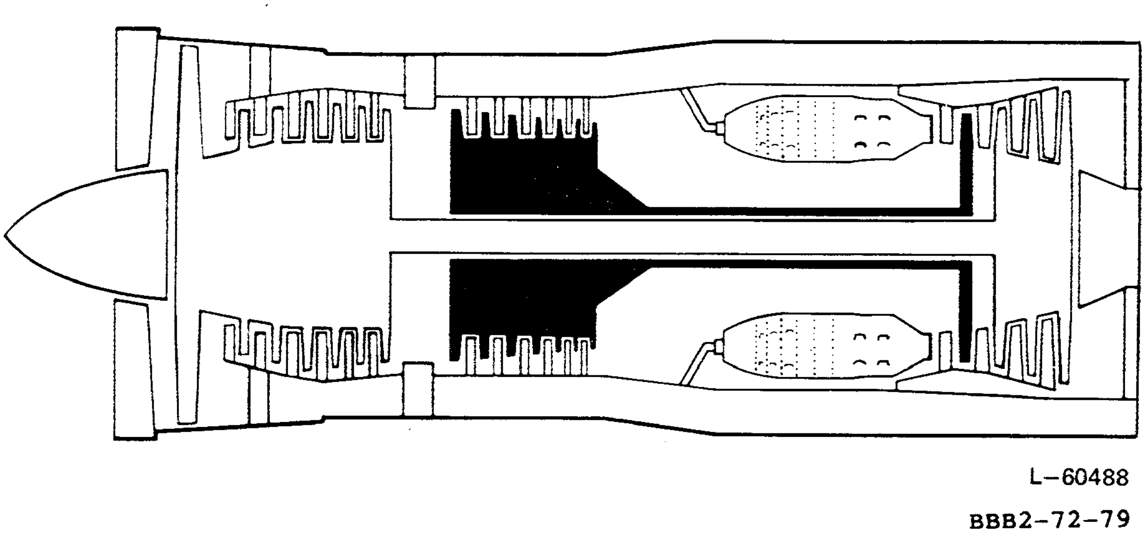
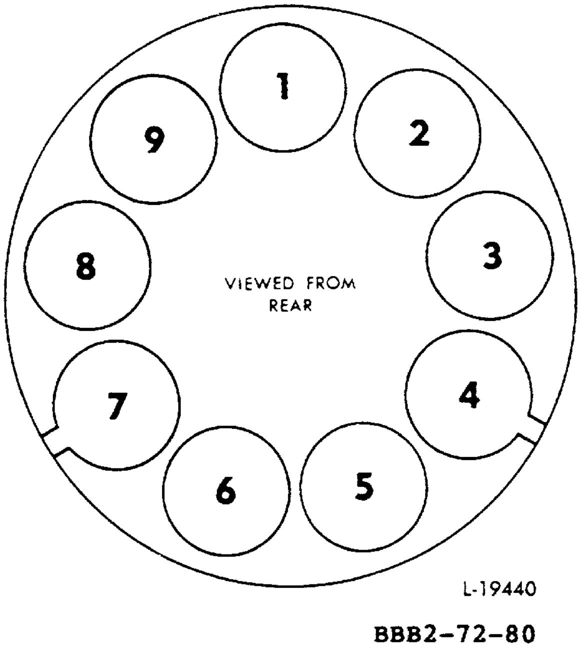
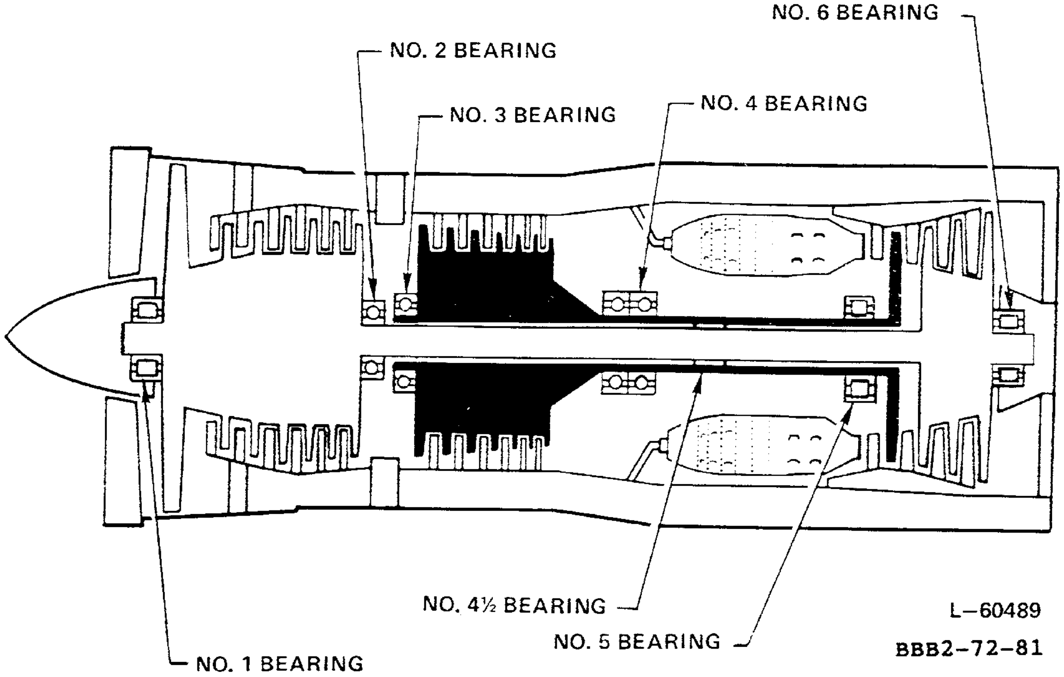
Engine Right Side View
Figure 2/72-00-00-990-804 (Sheet 2 of 2)



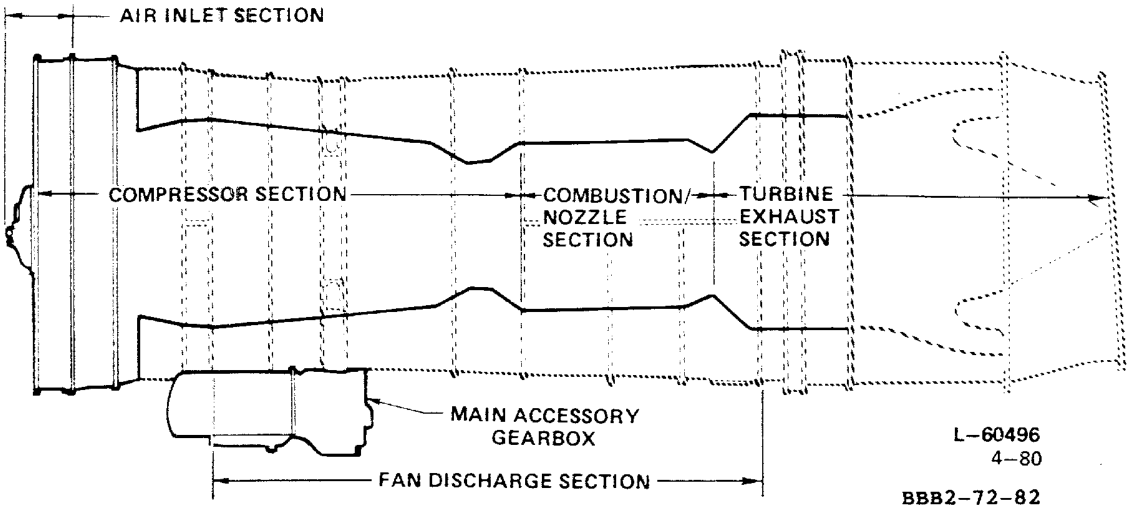
Split Compressor And Turbine
Figure 3/72-00-00-990-805



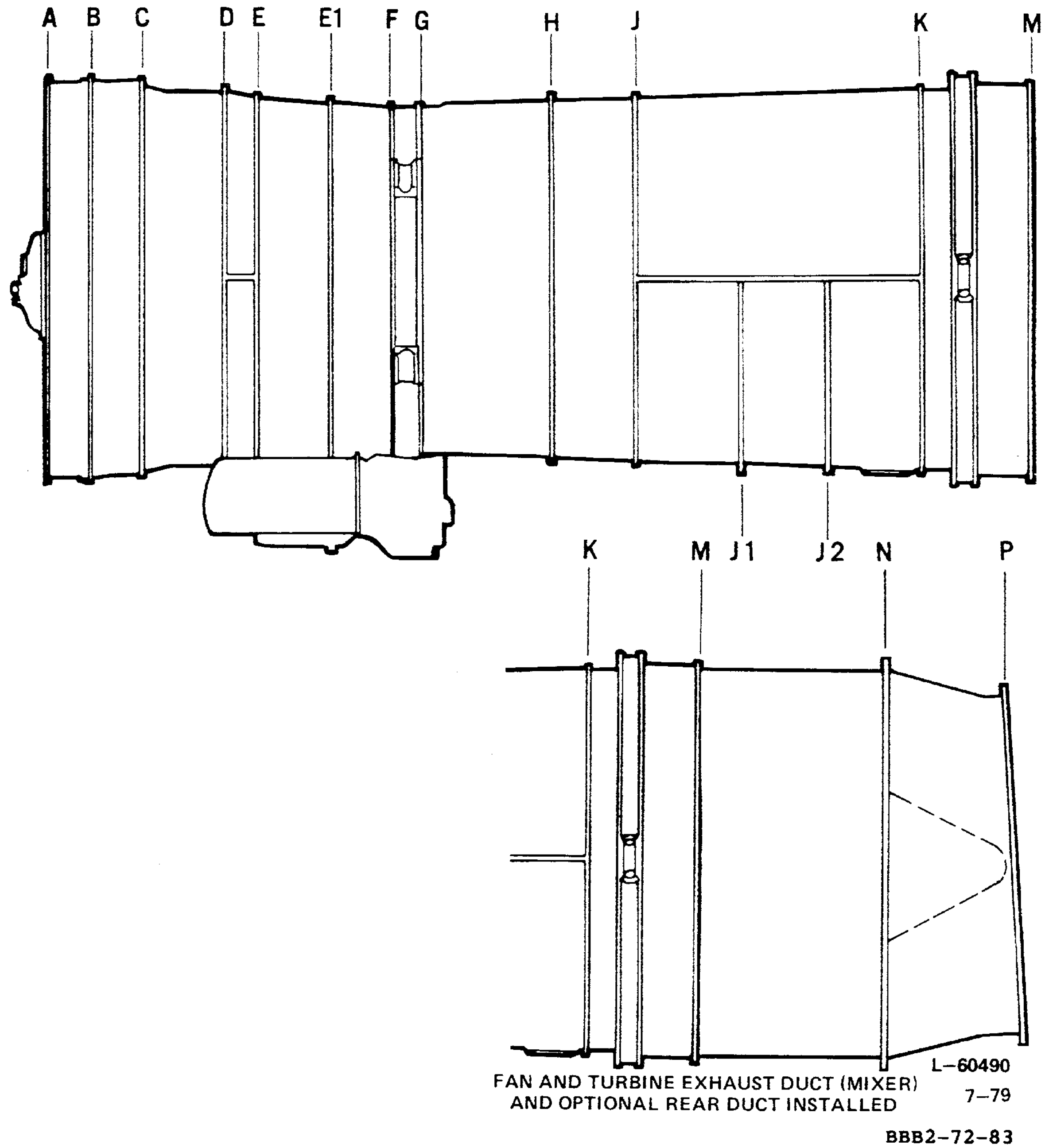
Combustion Chamber Numbering
Figure 4/72-00-00-990-806



Bearing Location Diagram
Figure 5/72-00-00-990-807

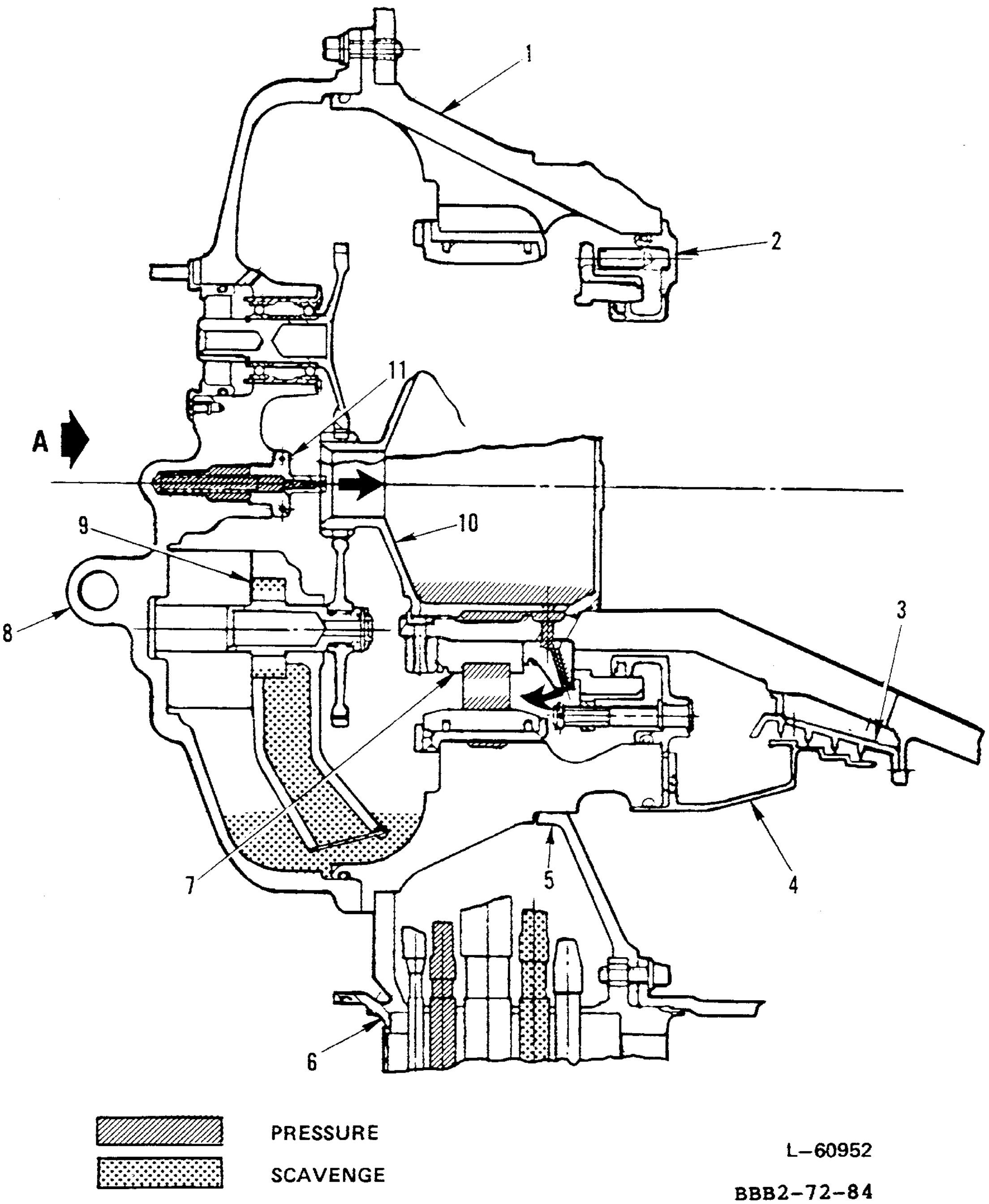


Identification of Engine Sections
Figure 6/72-00-00-990-808

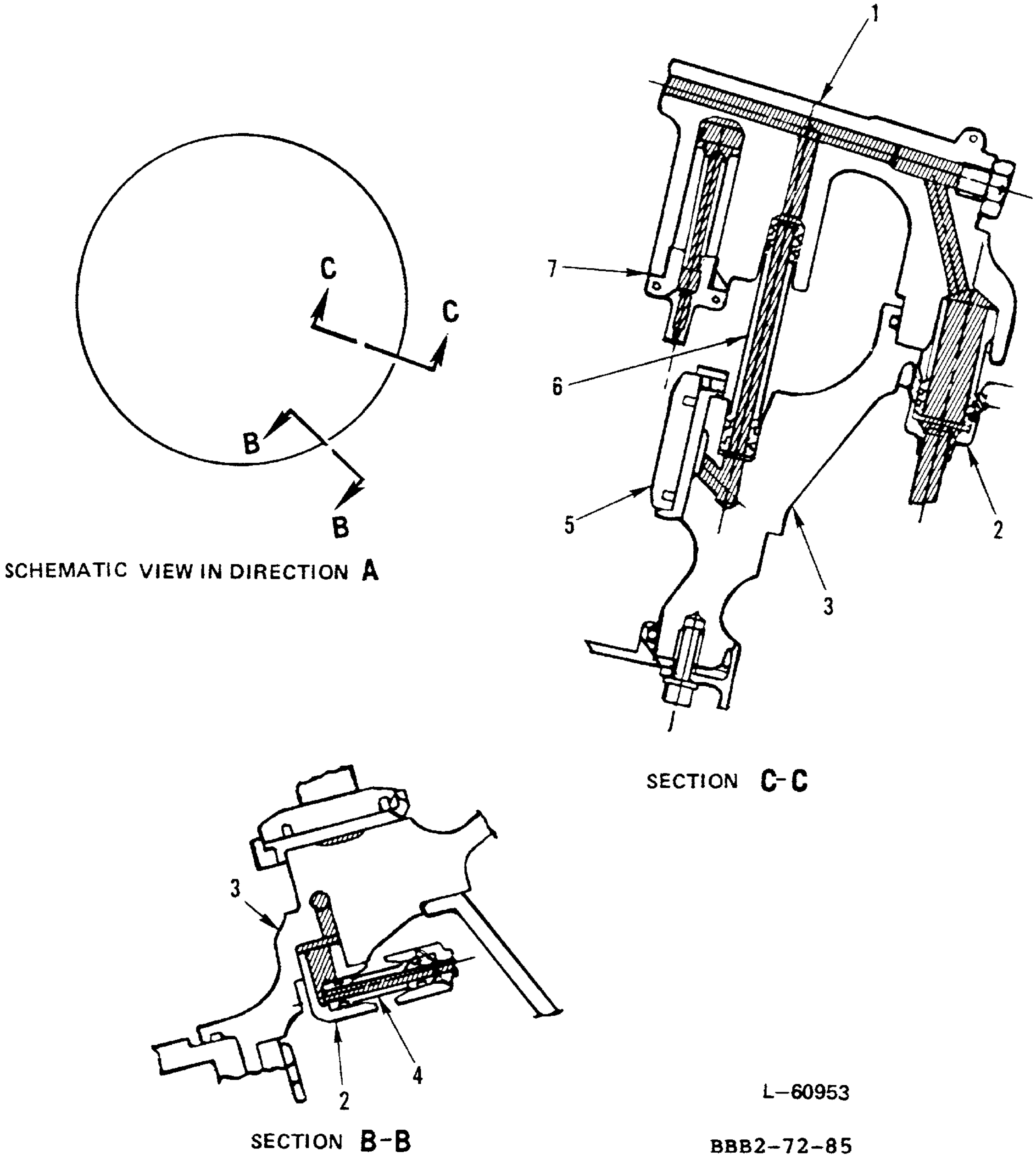


FAN AND TURBINE EXHAUST DUCT (MIXER) AND OPTIONAL REAR DUCT INSTALLED

Engine Flange Designations
Figure 7/72-00-00-990-809



No. 1 Bearing And Seal Lubrication
Figure 8/72-00-00-990-810 (Sheet 1 of 2)

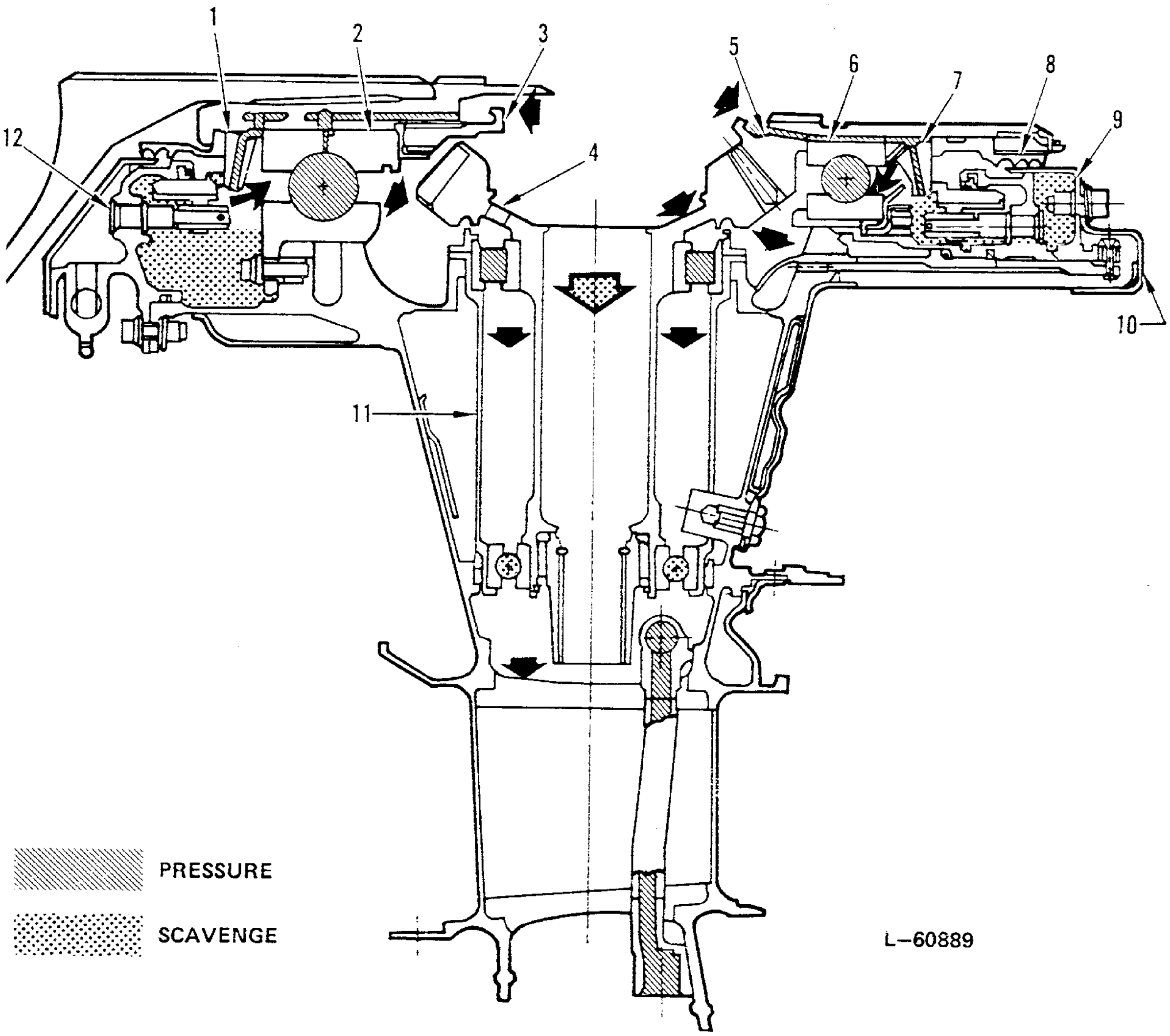


SCHEMATIC VIEW IN DIRECTION A

SECTION C-C

SECTION B-B

No. 1 Bearing And Seal Lubrication
Figure 8/72-00-00-990-810 (Sheet 2 of 2)



1. No. 2 Bearing Seal Seat
2. No. 2 Bearing
3. No. 2 Bearing Inner Race Retaining Nut
4. Gearbox Drive Bevel Gearshaft
5. Gearbox Drive Bevel Gear
6. No. 3 Bearing
7. No. 3 Bearing Seal Seat
8. No. 3 Bearing Spacer
9. No. 3 Bearing Seal Assembly
10. No. 3 Bearing Heatshield
11. Gearbox Drive Bearing Housing
12. No. 2 Bearing Seal Assembly

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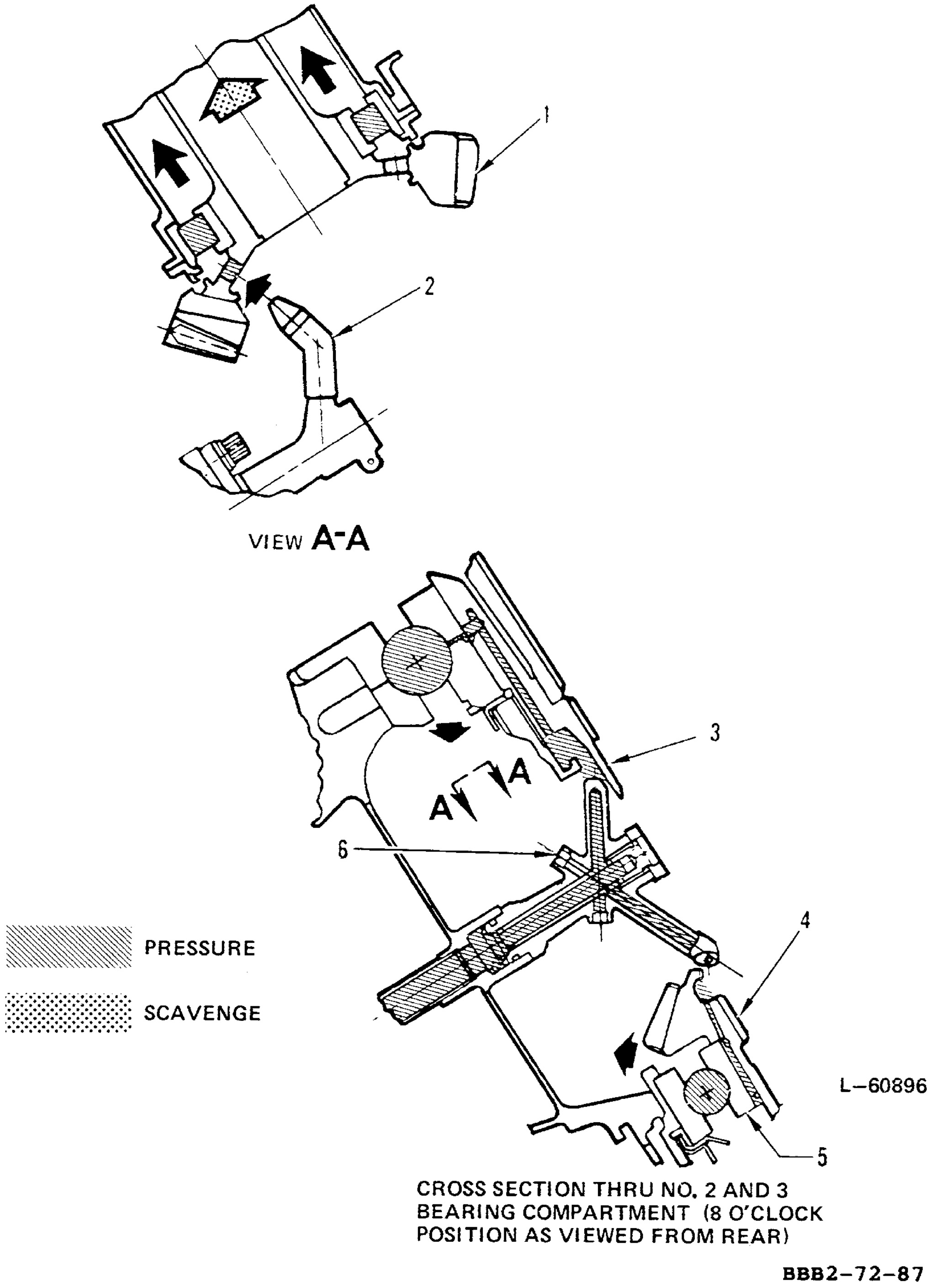
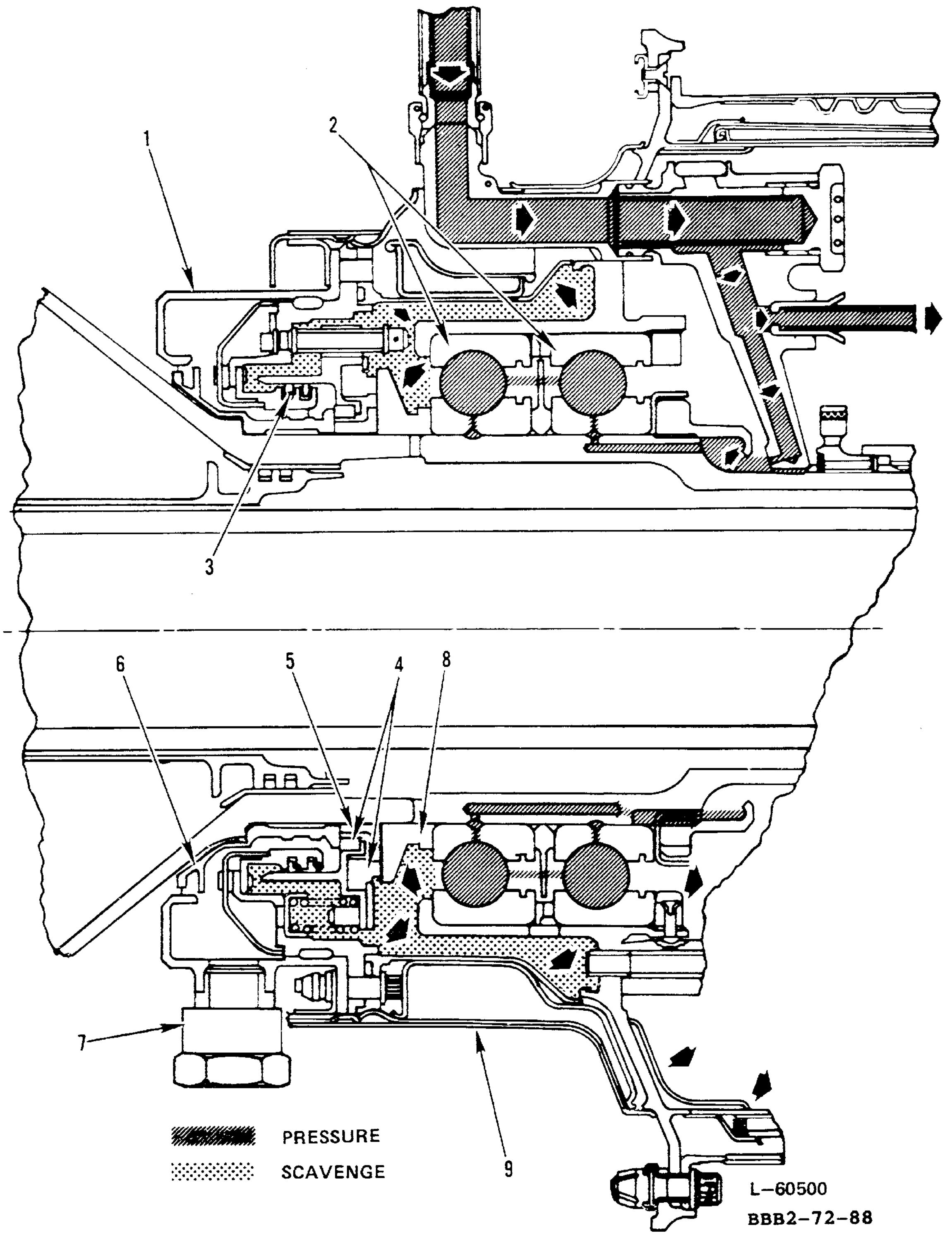
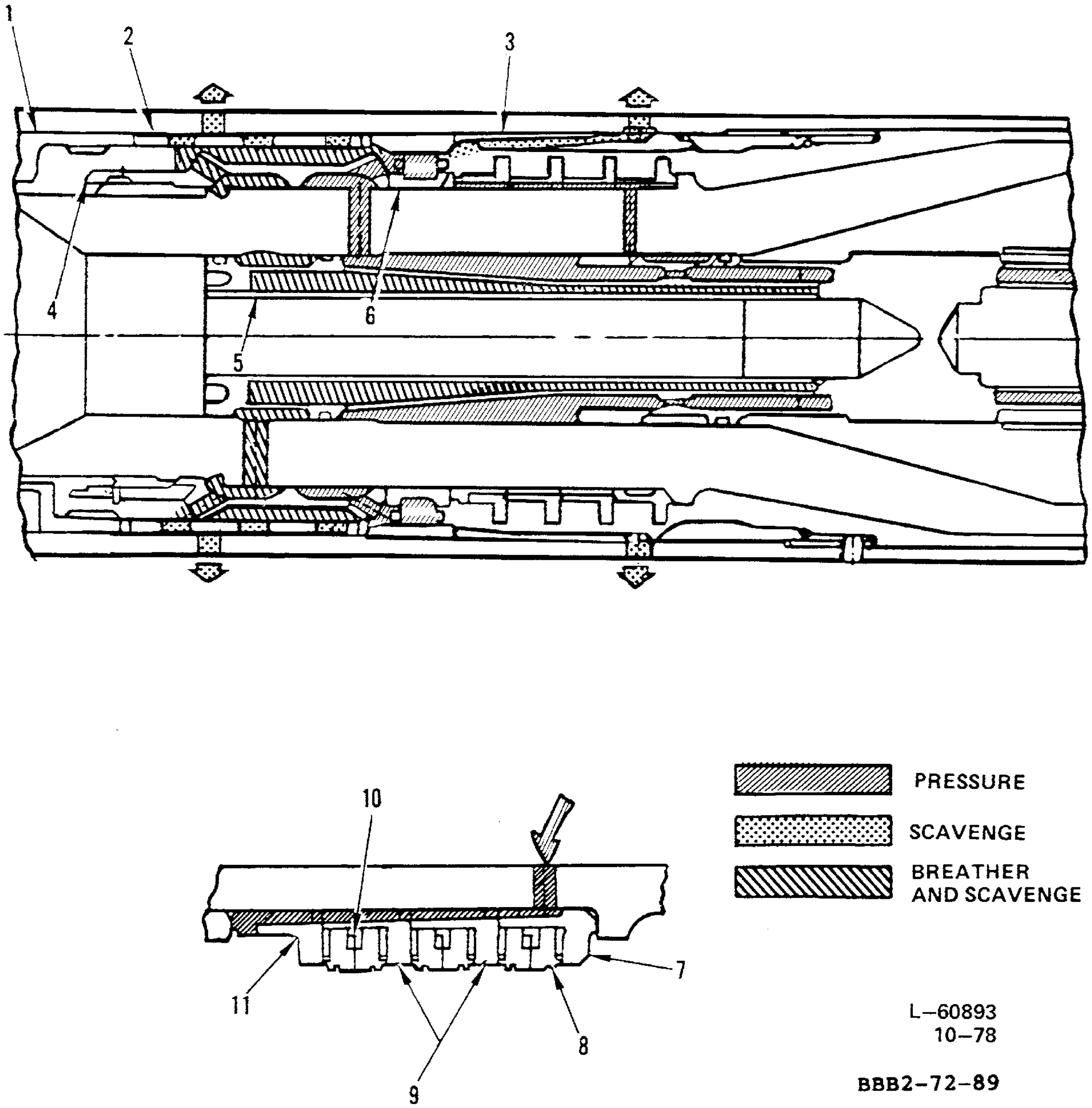
No. 2 And 3 Bearing And Seal Lubrication
Figure 9/72-00-00-990-811 (Sheet 1 of 2)



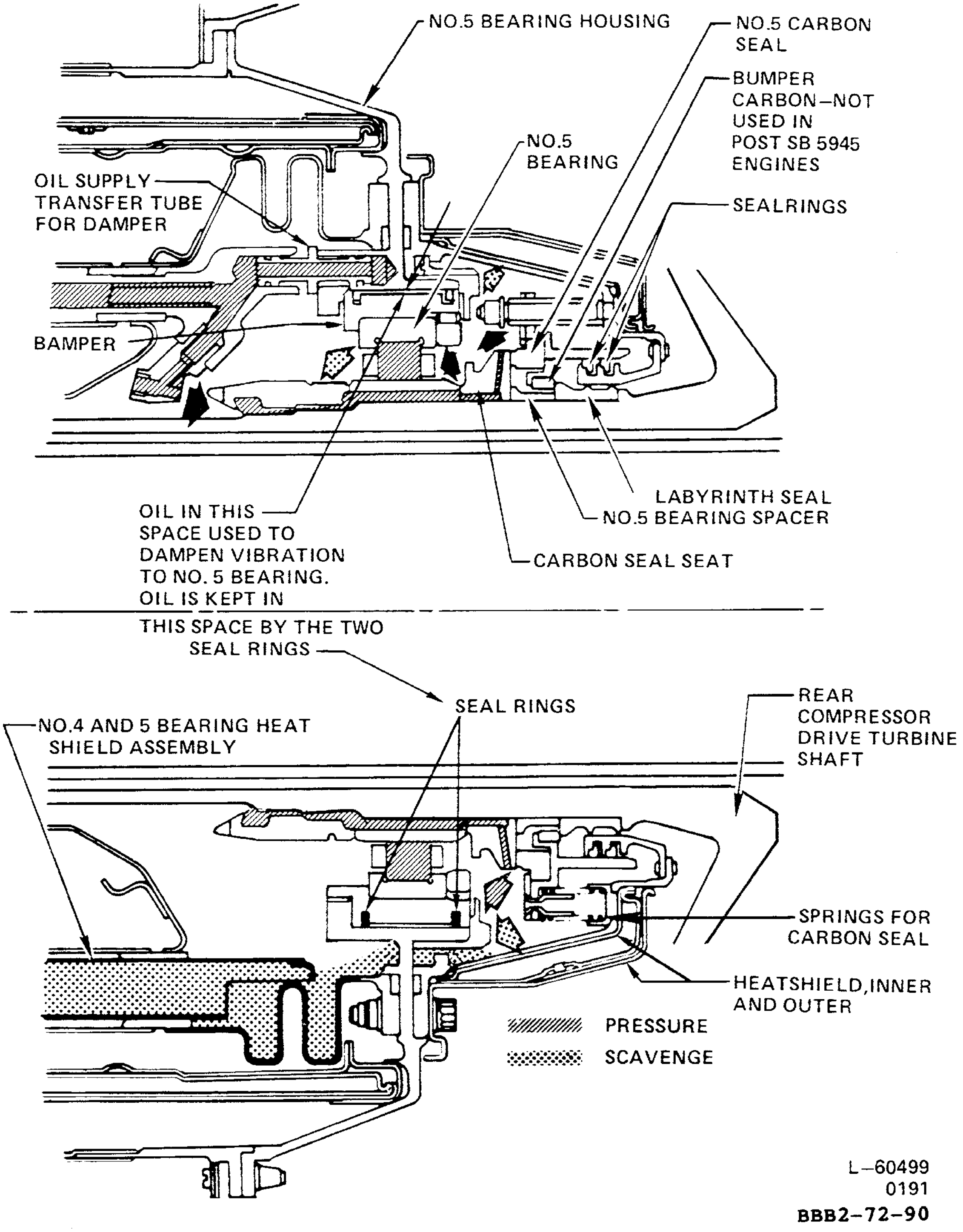
No. 2 And 3 Bearing And Seal Lubrication
Figure 9/72-00-00-990-811 (Sheet 2 of 2)



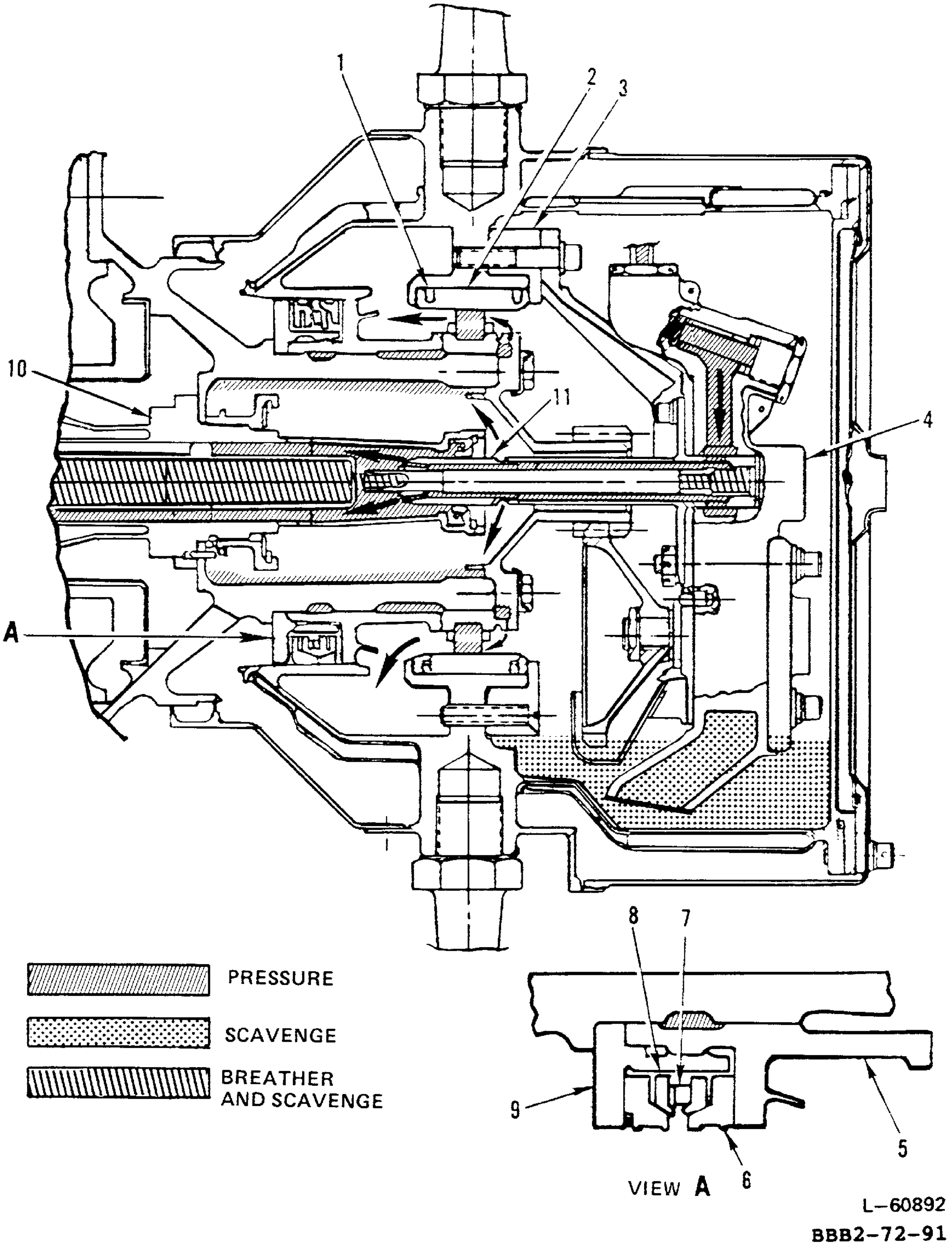
No. 4 Bearing Compartment Lubrication
Figure 10/72-00-00-990-812



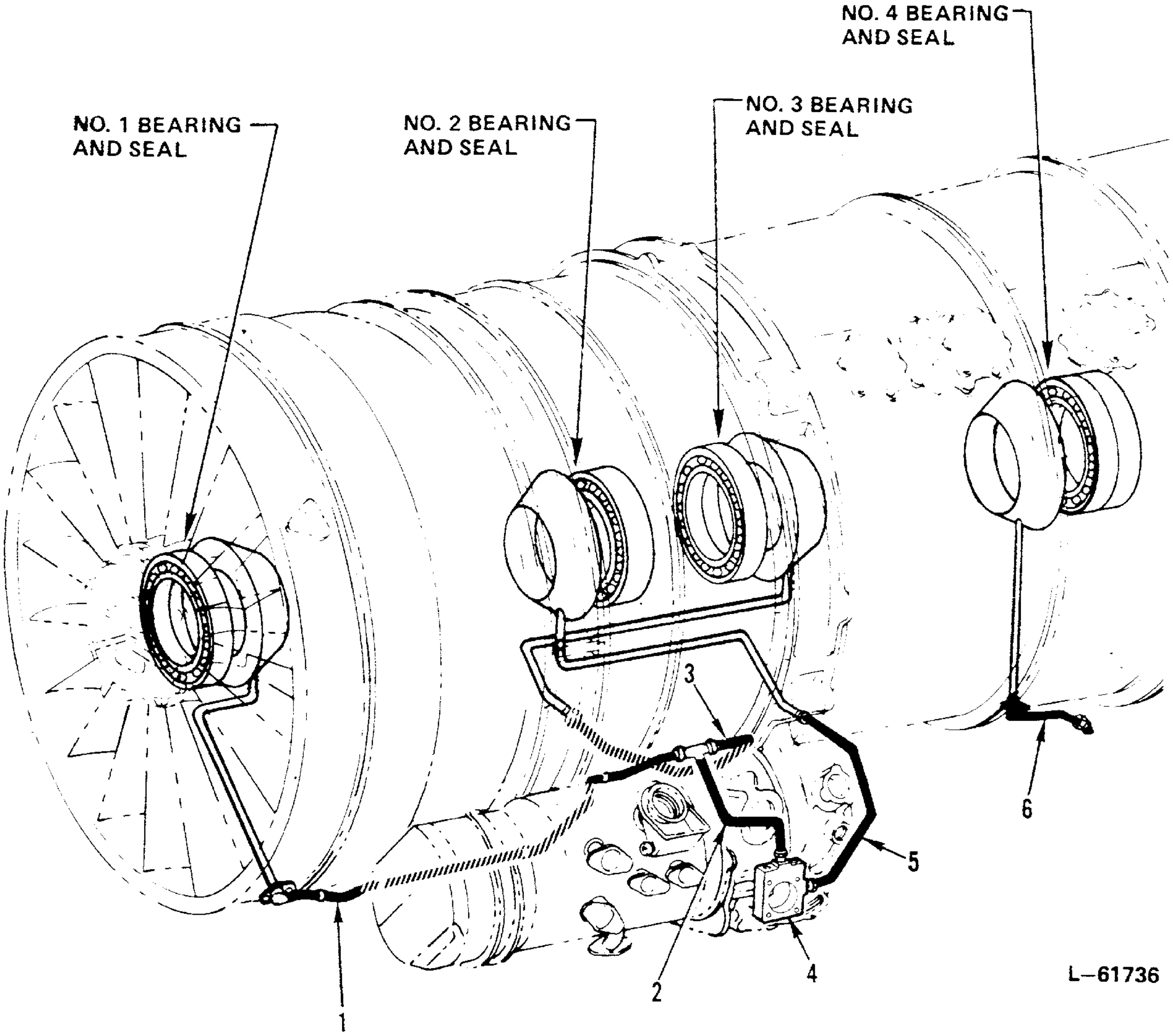
No. 4 1/2 Bearing And Seal
Figure 11/72-00-00-990-813



No. 5 Bearing And Seals
Figure 12/72-00-00-990-814



No. 6 Bearing And Seals
Figure 13/72-00-00-990-815



1. No. 1 Bearing Drain Tube
2. Main Bearing Drain Manifold
3. No. 3 Bearing Drain Tube
4. No. 2 Bearing Tube Connector
5. No. 2 Bearing Drain Tube
6. No. 4 Bearing Air Check Valve

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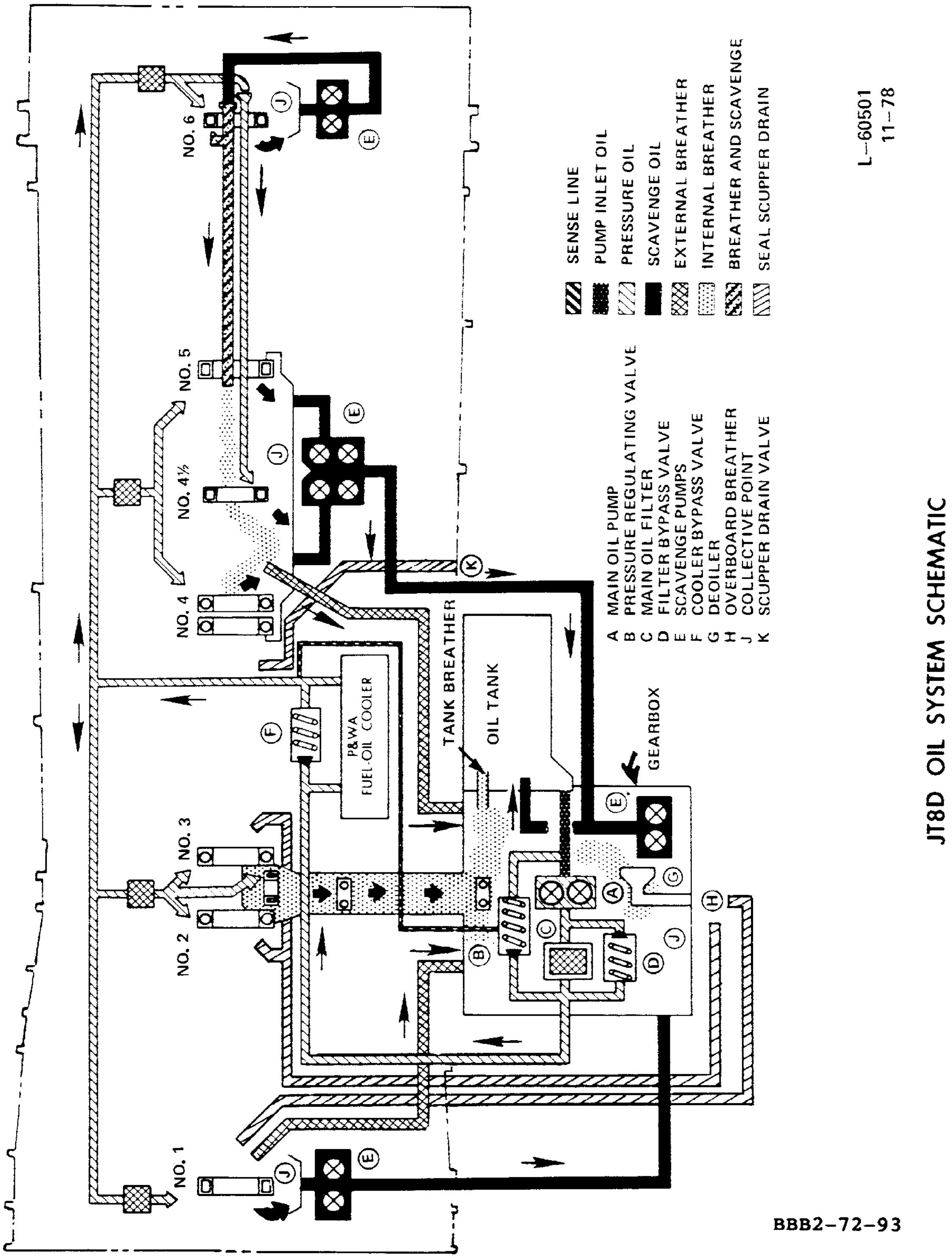
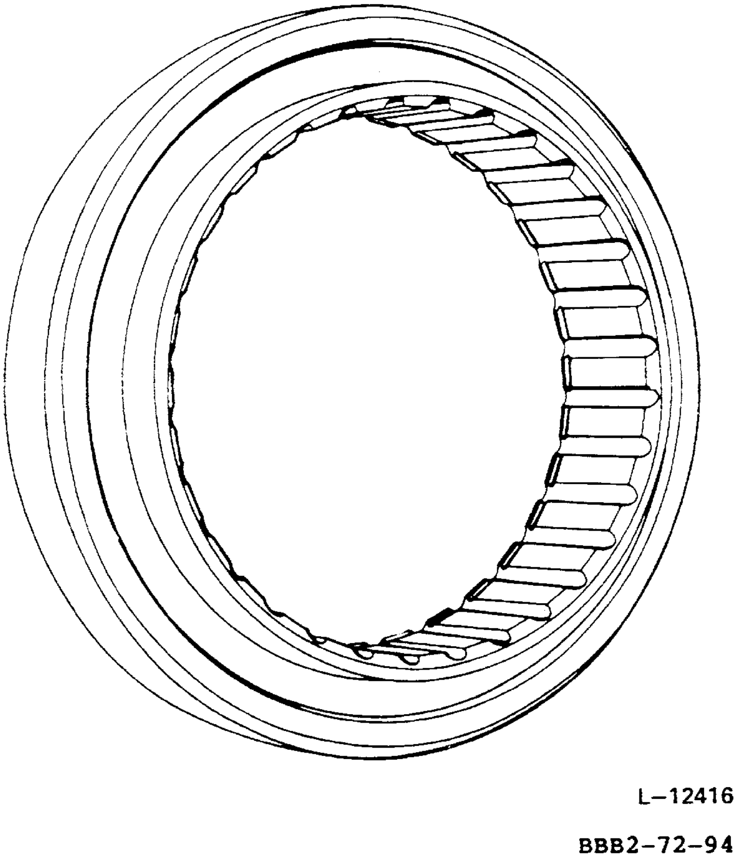
Main Bearing Seal Drain Schematic
Figure 14/72-00-00-990-816



Oil System Schematic
Figure 15/72-00-00-990-817



Roller Bearing Under-Race Oil Grooves
Figure 16/72-00-00-990-818

ENGINE GENERAL - TROUBLE SHOOTING

1. ENGINE GENERAL

A. TROUBLE SHOOTING -01 THROUGH -08 (72-00-00-01 - 72-00-00-08 HAVE BEEN REPAGINATED TO READ 72-00-01 THROUGH 72-00-08 AND MOVED TO FOLLOW ENGINE GENERAL - CLEANING-01, PAGEBLOCK 72-00-00/701.

GENERAL - MAINTENANCE PRACTICES

1. General

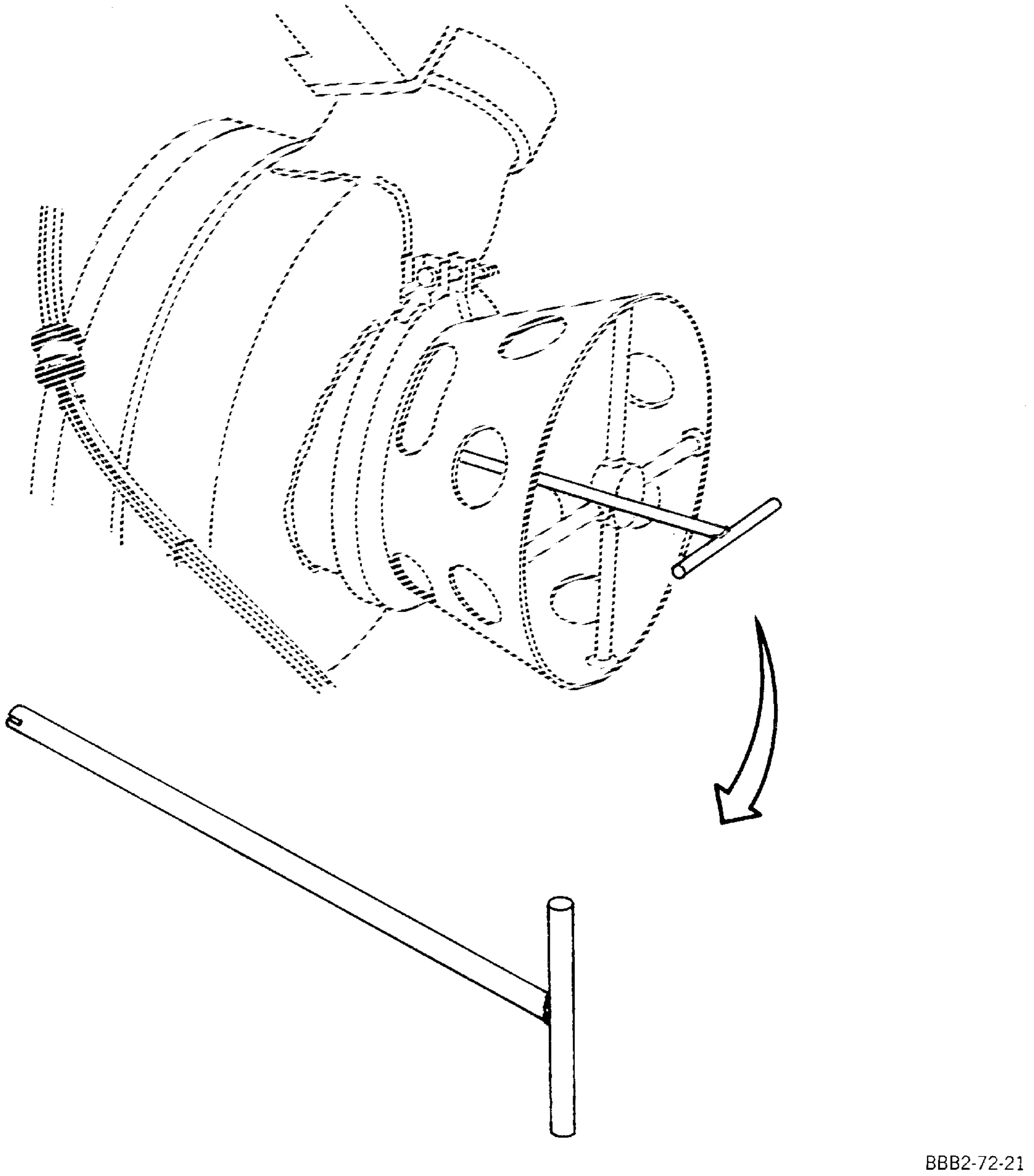
A. An engine rotation tool can be used to rotate the engine for borescoping purposes by engaging the starter shaft. (Figure 201)

2. Equipment and Materials

NOTE: Equivalent substitute may be used instead of the following listed item:

Table 201

Name and Number	Manufacturer
Tool-engine rotation 4954192	Douglas Aircraft Co.



Engine Rotation Tool
Figure 201/72-00-00-990-802

ENGINE GENERAL - SERVICING

1. Fuel

A. General

(1) The fuel for the JT8D engine shall conform to specifications contained in SB 2016.

(2) Fuel contamination may occur in shipment, during transfer from one container to another, or in the aircraft fuel system from scale, lint from packings and seals, and deterioration of fuel lines and hoses. Serious malfunction of the engine will occur, even to the extent of engine stoppage, as a result of contaminants in the fuel reaching the engine fuel system. It is important, that the filter screens in the aircraft fuel system upstream of the engine fuel pump be inspected periodically for removal of all foreign particles.

2. Fuel Tanks

A. See Airframe Service Instructions

3. Lubricating Oil

A. General

(1) The oil for the JT8D engine shall conform to PWA 521B specifications.

(2) The engine internal oil system is shown schematically in Engine - Description.

B. Fuel Contamination Of Oil System

(1) Failure within the fuel-oil cooler can cause contamination of the oil system with fuel. Depending upon the degree of contamination, certain procedures are required.

(2) Upon discovering fuel contamination of the oil system and correcting its cause, the following basic procedures must be performed:

(a) Drain oil and fill the oil tank to 2/3 capacity with new oil. (ENGINE OIL SYSTEM - SERVICING, PAGEBLOCK 12-12-04/301)

(b) Operate engine at idle (see Adjustment/Test) for two-five minutes and shut down.

(c) Drain oil and fill oil system to full capacity with new oil.

(d) Following the next flight, inspect main oil filter or strainer (Refer to the JT8D Oil Monitoring Guide Sections D).

(e) Repeat main oil filter or strainer inspections at 25, 50 and 75 hours thereafter. If there is no evidence of loosened carbon deposits at the 75-hour inspection, resume normal filter or strainer check interval.

(3) The following dilution levels and engine operating limits apply: (Figure 301 or Figure 302)

NOTE: Percentage of fuel in oil is best determined by laboratory analysis to determine the viscosity. See the curve shown for viscosity vs. temperature to determine the percentage of dilution (of fuel in the oil).

As an alternate , if laboratory analysis is not available, specific gravity method with a density meter or hydrometer are considered suitable to approximate the percentage of dilution.

Specific gravity methods are only accurate above the 25 percent level. The viscosity method is the preferred method to be used.

Table 301

Percentage of Dilution	Permissible Engine Operating Time (While Contaminated)
Up to 10 percent	Unlimited

Table 301 (Continued)

Percentage of Dilution	Permissible Engine Operating Time (While Contaminated)
10 - 25 percent	Up to 10 hours
25 -50 percent	Up to 2 hours
Above 50 percent	Momentary (provided maximum thrust was not used)

(a) If an engine exceeds operating time limits specified for the degree of contamination found, it must be removed and routed to a maintenance facility for disassembly and inspection of all main bearings.

(b) If an engine's operating time while contaminated was within limits given, only oil system flushing and main oil filter or strainer checks described in Paragraph 3.B.(2) are required.

C. Hydraulic Fluid Contamination Of Oil System

CAUTION: CONTAMINATION OF OIL WITH HYDRAULIC FLUID IS SERIOUS. AT ENGINE OPERATING TEMPERATURE HYDRAULIC FLUID REACTS WITH SYNTHETIC OILS TO FORM THICK, BLACK GUMMY SUBSTANCE WHICH COULD BLOCK OR DRASTICALLY RESTRICT OIL FLOW THROUGH JETS, NOZZLES, OR FINE MESH SCREENS. DEPENDING UPON AMOUNT AND DURATION OF CONTAMINATION AND OPERATING TEMPERATURE, HYDRAULIC FLUID MAY REACT CHEMICALLY WITH PREFORMED PACKINGS. REMOVE PROTECTIVE COATINGS FROM GEARBOX HOUSING INTERNAL SURFACES, AND CAUSE LEAKS AND CORROSION OF OIL SYSTEM PARTS.

(1) If contamination of oil by hydraulic fluid (or jet fuel) is suspected or confirmed, perform the following:

NOTE: Hydraulic fluid may be introduced into oil system by leaks (i.e. as a result of hydraulic pump failure) or by inadvertently adding hydraulic fluid to oil tank during servicing.

(a) Drain oil tank, flush and refill with new oil.

(b) Drain gearbox of any residual oil.

(c) Replace oil filter or strainer.

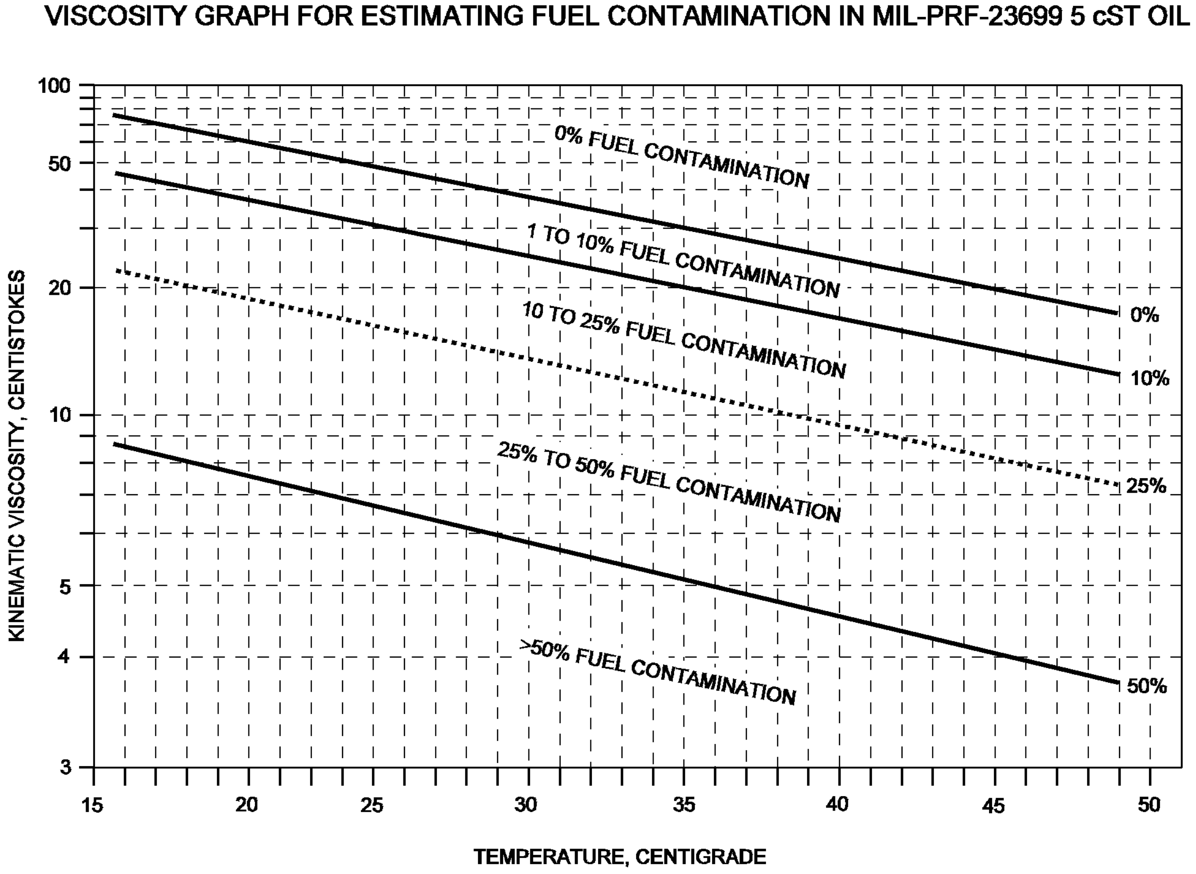
(d) Operate engine at Idle to warm oil, accelerate to Part Power and return to Idle five times, run at Part Power for 20 minutes, and shut down.

1) If oil shows contamination during this analysis, repeat Paragraph 3.C.(1)(a) through Paragraph 3.C.(1)(d).

NOTE: Engine may be continued in service while oil sample is being analyzed.

2) Sample exhibiting viscosity appreciably different from that of sample of same brand of oil which is known to be uncontaminated is indicating contamination with either jet fuel or hydraulic fluid.

3) Contamination of oil with hydraulic fluid can best be detected by measuring phosphorus content, either by wet chemical test (ASTM-D-1091-64) or by spectrographic oil analysis. Phosphorus content higher than that of same brand of oil which is known to be uncontaminated indicates contamination by hydraulic fluid.



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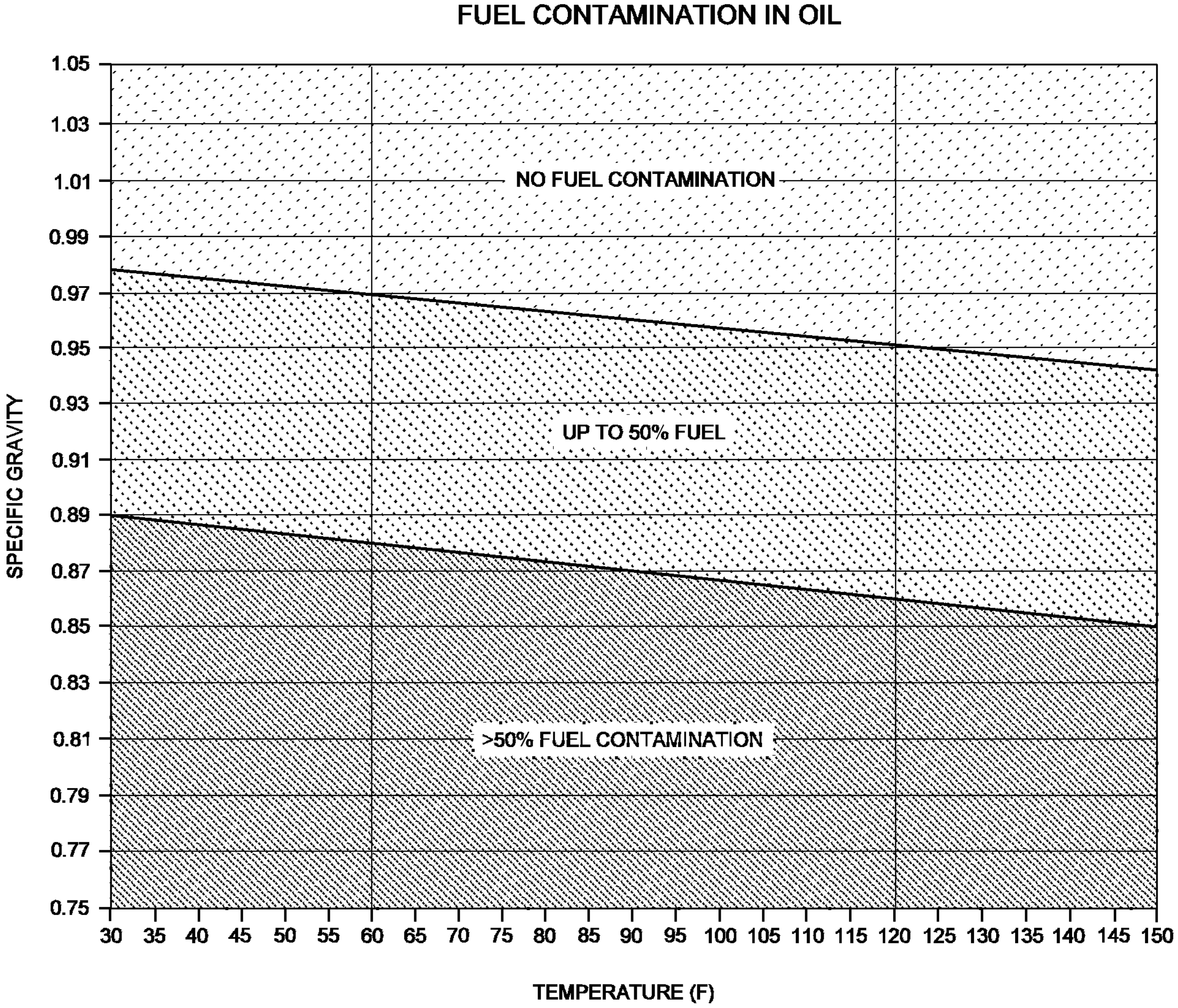
Fuel Contamination in Oil Graph - Laboratory Method
Figure 301/72-00-00-990-C45



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Fuel Contamination in Oil - Specific Gravity Method
Figure 302/72-00-00-990-C46

4. Extreme Weather Maintenance

A. Cold Weather Procedures

(1) General

(a) A discourse on the effects of cold weather upon turbofan engine operation is not the purpose of this publication; however, it is felt that a summary of a few of the more prevalent effects will aid in troubleshooting some of the problems arising from cold weather operations.

(b) Aviation fuels will normally contain little or no water, but the percentage of water is governed to a great extent by storage and handling conditions of the fuel. Fuel exposed to dampness or ordinary atmospheric conditions naturally contain a larger percentage of water than those kept in tightly sealed containers. This water content, under poor conditions, may average as high as several gallons in every thousand gallons of fuel.

(c) As temperatures are reduced, the solubility of water in the fuel is also markedly reduced, which results in the water separating from the fuel, seeking the lowest point in the tank, system, and/or accessory concerned and freezing there if the temperature goes low enough. Under these conditions it also will freeze in the fuel, forming tiny needle-shaped crystals which may be found impinged on the strainers, restricting fuel flow and in severe cases clogging the strainers entirely. Should this condition occur it will be evidenced by a drop in, or loss of fuel pressure to the engine. The only remedy is hot air applied to the engine and fuel components. Refer to airframe manufacturer's recommendations for externally applied heat.

(d) Under these conditions, it is most important that all sumps, strainers, traps (burner pressure sensing line moisture trap) and filters be thoroughly inspected on all preflight checks. As long as fuel will flow freely from the drain cocks in the tank sumps and strainers it can be surmised that the system is free of ice.

(e) In the event that water has collected and frozen in the sumps and/or strainers (indicated by a lack of flow from the drain cock) heat should be applied per the airframe manufacturers recommendations.

CAUTION: DO NOT ASSUME THAT ALL THE ICE HAS MELTED IF IT IS POSSIBLE TO DRAIN FUEL FROM THE DRAIN COCK AFTER SEVERAL MINUTES OF HEATED AIR APPLIED TO THE EXTERIOR OF THE AFFECTED COMPONENT. THE ICE ADJACENT TO THE INTERIOR OF THE AFFECTED UNIT MAY MELT AND ALLOW SOME WATER AND FUEL TO FLOW FROM THE DRAIN, BUT A LUMP OF ICE MAY STILL REMAIN IN THE FUEL CREATING A SERIOUS HAZARD TO ANY FLIGHT OPERATION. THE FLOW OF FUEL TO THE OUTLET, ON ENGINE STARTING MAY CAUSE THIS BLOCK OF ICE TO SLIP OVER THE OUTLET AND RESTRICT OR PLUG THE OPENINGS CREATING A DANGEROUS SITUATION. IF FUEL DOES FLOW FROM THE DRAIN COCK, CONTINUE TO APPLY HEATED AIR FOR A SHORT TIME, CHECKING THE DRAIN COCK FLOW FREQUENTLY. THIS FUEL SHOULD BE CAUGHT IN A CONTAINER AND INSPECTED FOR GLOBULES OF WATER UNTIL IT IS EVIDENT THAT IT IS REMOVED FROM THE AREA.

(f) It is well to note that a similar situation may exist in the lubrication system, with the water coming from condensation of air in the tank or engine case area. When a hot engine is shut down under low temperature conditions and allowed to stand for a period of time or possibly overnight in the open, the possibility of ice in the fuel and lubrication system is much more prevalent. Extra precautions should be observed to prevent this condition and the system should be checked for the presence of ice on the preflight.

CAUTION: WHEN STARTING AN ENGINE WHICH HAS EXPOSED TO LOW TEMPERATURES OVERNIGHT, CAREFULLY OBSERVE THE FUEL AND OIL PRESSURES. THE LACK OF ANY INDICATION BELOW THE NORMAL OPERATING LIMITS, IS CAUSE FOR IMMEDIATE ENGINE SHUTDOWN. INSPECT FOR ICE IN THE SYSTEM(S) OR MOVE THE PLANE INDOORS AND/OR APPLY HEATED AIR BEFORE ATTEMPTING ANOTHER START.

(2) Additional Preflight Inspection

(a) Examine the engine exhaust section for the collection of ice. Rotational freedom of the rear turbine should be verified.

(3) Starting Engine

(a) Start the engine using the normal starting procedure.

CAUTION: IF THERE IS NO INDICATION OF OIL PRESSURE AFTER 30 SECONDS OF ENGINE OPERATION, OR IF THE PRESSURE DROPS TO ZERO AFTER A FEW MINUTES OF GROUND RUNNING, STOP THE ENGINE AND INVESTIGATE.

(b) Although not absolutely necessary, it is desirable when a start is made during extreme cold weather with an engine which has cold soaked to a temperature of -30°F (-35°C) or below to warm up the engine for two minutes before advancing the power lever above IDLE rpm.

NOTE: If should be noted that engine thrust developed at low ambient temperatures is higher than that developed at standard day conditions at comparable power lever settings.

(4) Engine Shutdown

(a) Shut down engine in the normal manner.

B. Hot Weather Procedures

(1) Starting Engine

(a) Normal starting procedures are used in hot weather. Temperatures will probably be on the high side of operating ranges.

(2) Warm-up and Ground Test

(a) Ground testing should be complete but accomplished as rapidly as possible.

5. Identification Of Engine And Engine-To-Aircraft Connections For Instrumentation, Fuel, And Oil

A. The JT8D engines are permanently marked to identify the engine-to-aircraft connections for instrumentation, fuel, and oil. Where the marking location has suitable area, the "Identification Marking" is used, otherwise the "Location Code" marking is used. (Figure 303), (Figure 304), and (Table 302)

Table 302 IDENTIFICATION MARKS FOR ENGINE AND ENGINE-TO-AIRCRAFT CONNECTIONS FOR INSTRUMENTATION, FUEL, AND OIL

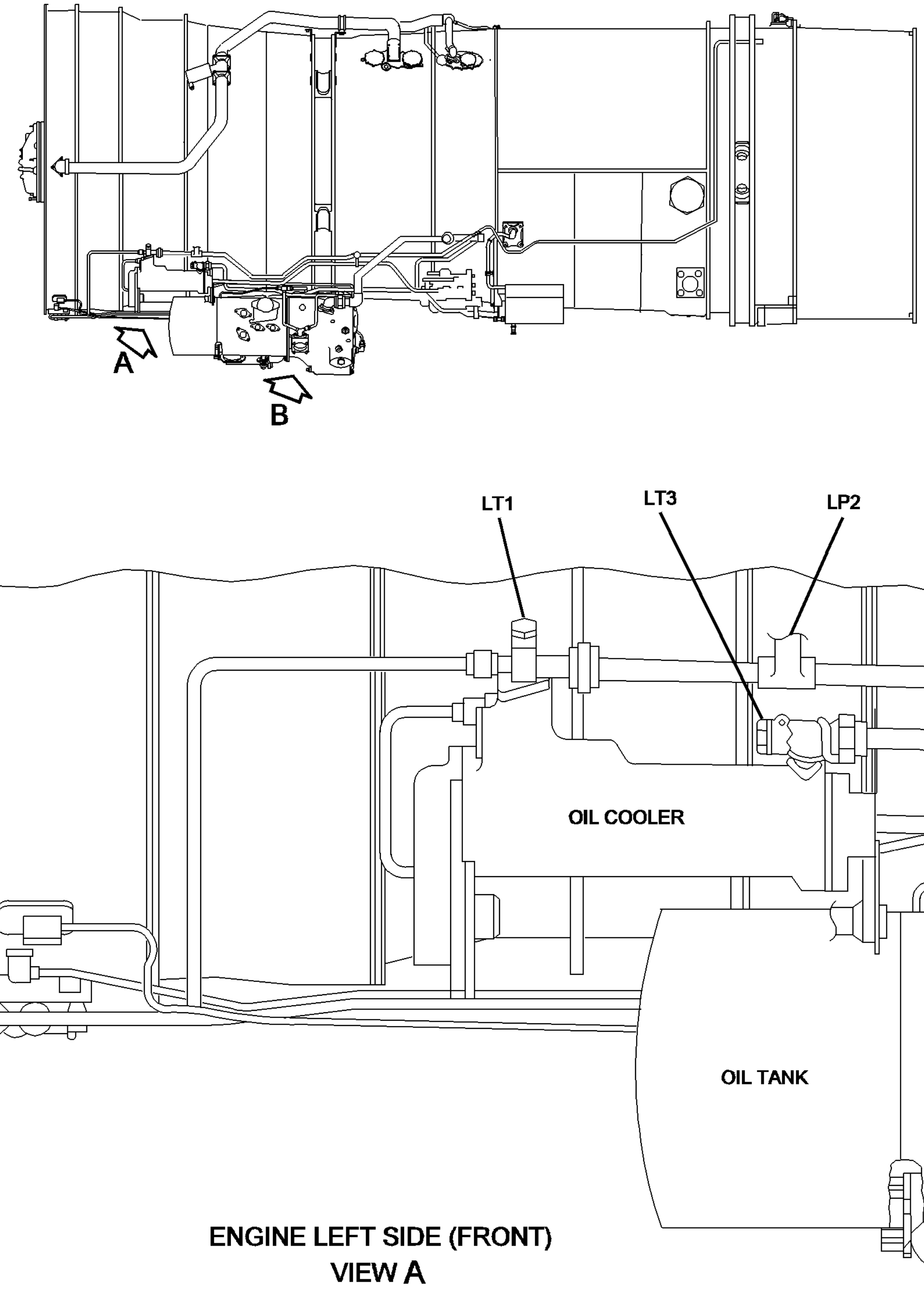
LOCATION CODE	BASIC NOMENCLATURE	IDENTIFICATION MARKING
	FUEL DRAIN	
FD1 FD3 FD4	Combustion Chamber Fuel Drain Fuel Filter DRAIN Fuel Filter DRAIN	FUEL DRAIN 1 FUEL DRAIN 3 FUEL DRAIN 4
	FUEL FLOW	

Table 302 IDENTIFICATION MARKS FOR ENGINE AND ENGINE-TO-AIRCRAFT CONNECTIONS FOR INSTRUMENTATION, FUEL, AND OIL (Continued)

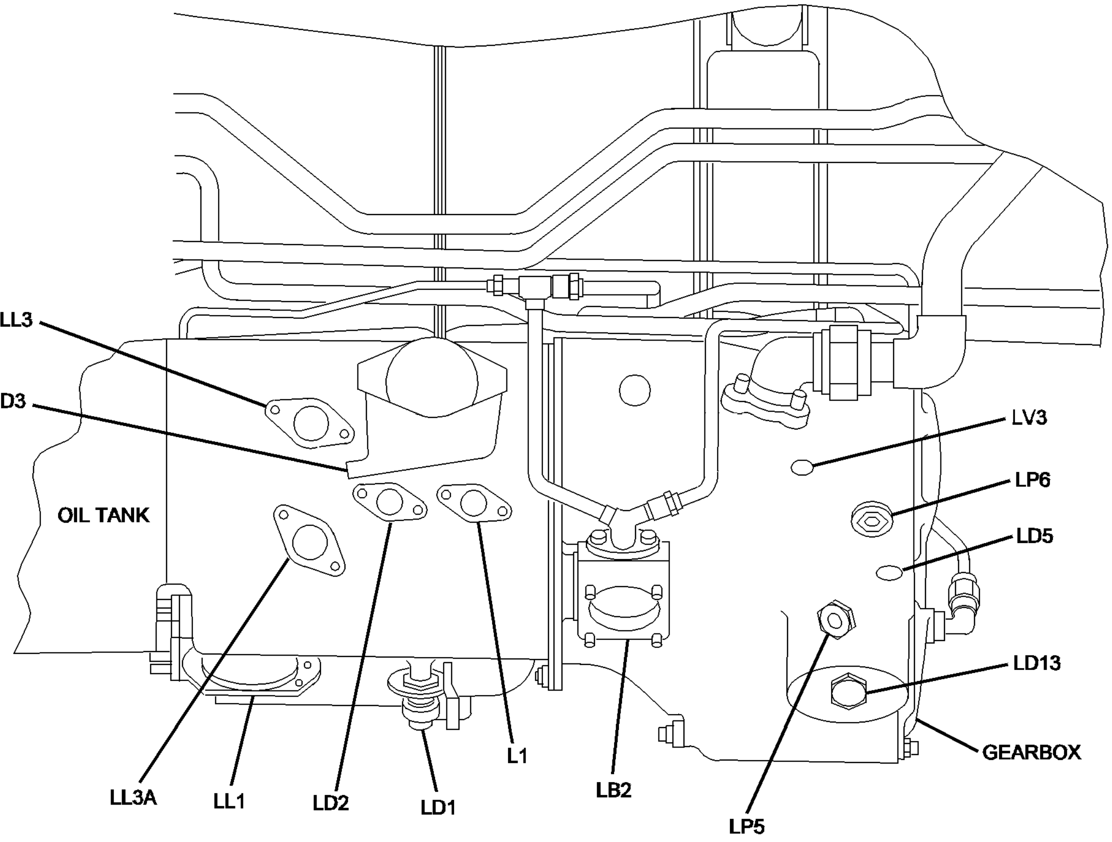
LOCATION CODE	BASIC NOMENCLATURE	IDENTIFICATION MARKING
F1 F2 F3 F5	Fuel Pump Main Supply Inlet Fuel Flowmeter Supply Inlet Fuel Flowmeter Supply Outlet Fuel Filter Supply Inlet	FUEL IN 1 FUEL IN 2 FUEL OUT 3 FUEL IN 5
	FUEL PRESSURE	
FP1 FP3 FP4 FP5 FP6 FP16	Fuel Pump Inlet Pressure Fuel Pump Outlet Pressure Pressurizing Valve Primary Fuel Pressure Pressurizing Valve Secondary Fuel Pressure Fuel Filter Pressure Drop Fuel Pump Inlet Pressure Return	FUEL PRESS 1 FUEL PRESS 3 FUEL PRESS 4 FUEL PRESS 5 FUEL PRESS 6 FUEL PRESS 16
	FUEL TEMPERATURE	
FT1 FT3	Heater Outlet Fuel Temperature Fuel Pump Inlet Temperature	FUEL TEMP 1 FUEL TEMP 3
	FUEL VENT	
FV2	Fuel Pump Vent Outlet	FUEL VENT 2
	OIL BREATHER	
LB2	Main Overboard Breather Pad/Gearbox Overboard Breather Discharge Port/No. 2 Bearing Tube Connector	OIL BREATHER 2
	OIL DRAIN	
LD1 LD2 LD3 LD4 LD5,6, 7,8 LD13 LD14	Oil Tank Drain Oil Tank Overflow Drain Outlet Oil Cap Overflow Drain Gearbox Main Oil Drain Accessory Drive Overboard Drain Main Oil Filter/Strainer Drain No. 4 Bearing Compartment Overboard Oil Drain (Seal Scupper Drain)	OIL DRAIN 1 OIL DRAIN 2 OIL DRAIN 3 OIL DRAIN 4 OIL DRAIN 5,6, 7,8 OIL DRAIN 13 OIL DRAIN 14
	OIL FLOW	
L1	Oil Tank Remote Filler Inlet	OIL IN 1
	OIL LEVEL	
LL1 LL3	Oil Tank Indicator Oil Tank Sight Gage Boss	OIL LEVEL 1 OIL LEVEL 3
	OIL PRESSURE	
LP2 LP5 LP6	Low Main Oil Pressure Warning Oil Filter Inlet Pressure Oil Filter Outlet Pressure	OIL PRESS 2 OIL PRESS 5 OIL PRESS 6
	OIL TEMPERATURE	

Table 302 IDENTIFICATION MARKS FOR ENGINE AND ENGINE-TO-AIRCRAFT CONNECTIONS FOR INSTRUMENTATION, FUEL, AND OIL (Continued)

LOCATION CODE	BASIC NOMENCLATURE	IDENTIFICATION MARKING
LT1 LT3	Oil Temperature Oil Temperature Cooler Inlet	OIL TEMP 1 OIL TEMP 3
	OIL VENT	
LV3	Oil Pressure Transmitter Oil Vent/Gearbox Breather Pressure	OIL VENT 3
	TEMPERATURE SENSING	
IT7 ITT7	Turbine Exit Temperature (Average) Turbine Exit Temperature (Individual)	TURB DISCH AVG TEMP TURB DISCH TEMP
	PRESSURE SENSING	
PT2 PT7	Compressor Inlet Pressure Turbine Exit Pressure	COMPR IN PRESS 2 TURB DISCH AVG PRESS



Engine Test/Instrumentation Connections (Left Side)
Figure 303/72-00-00-990-C37 (Sheet 1 of 2)



ENGINE LEFT SIDE (CENTER)
VIEW B

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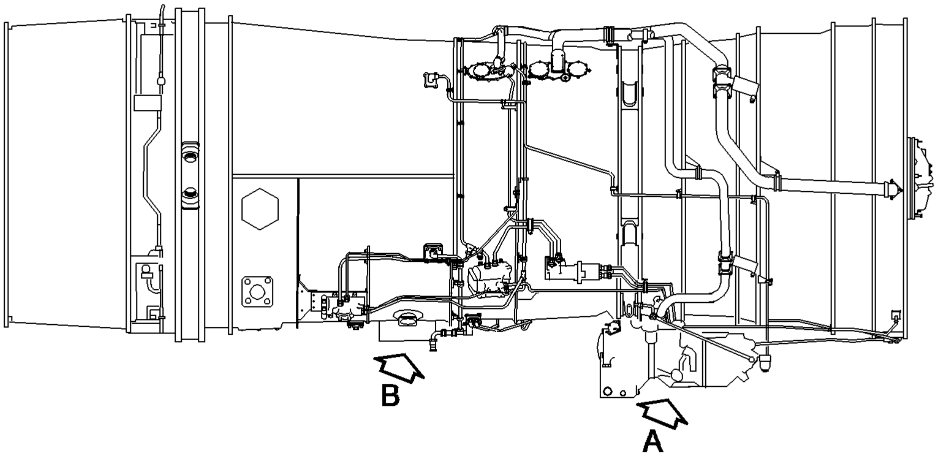
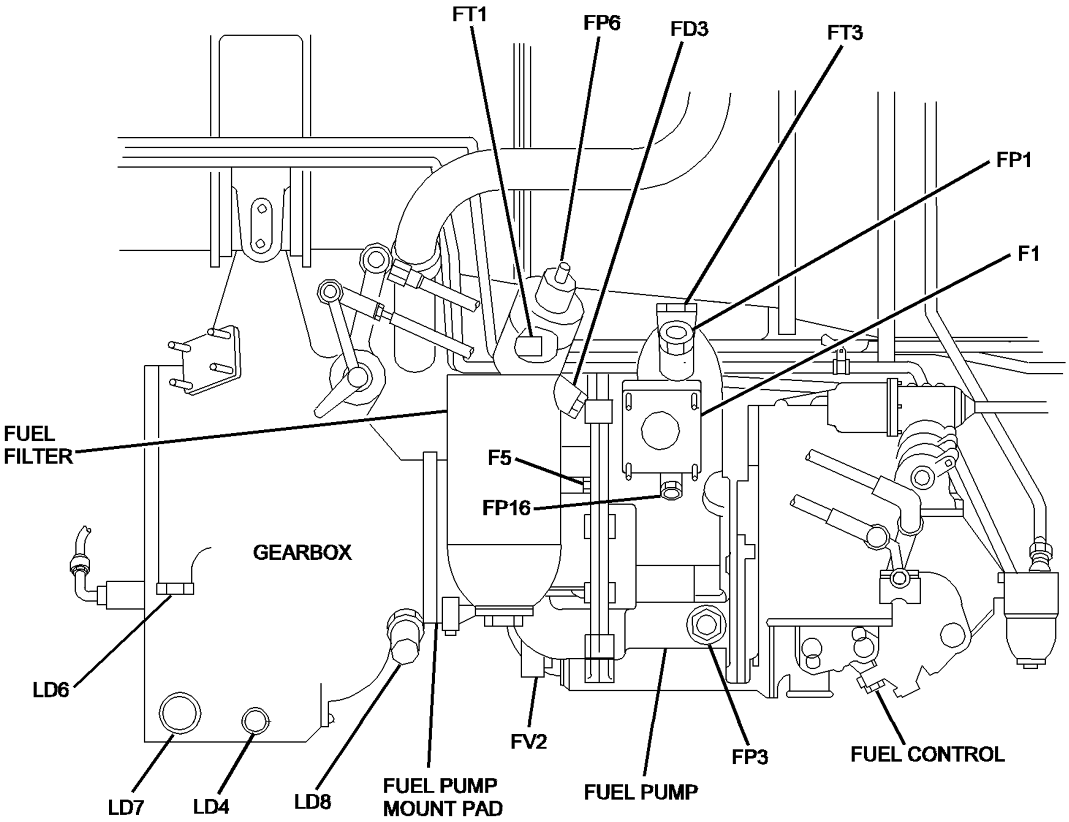
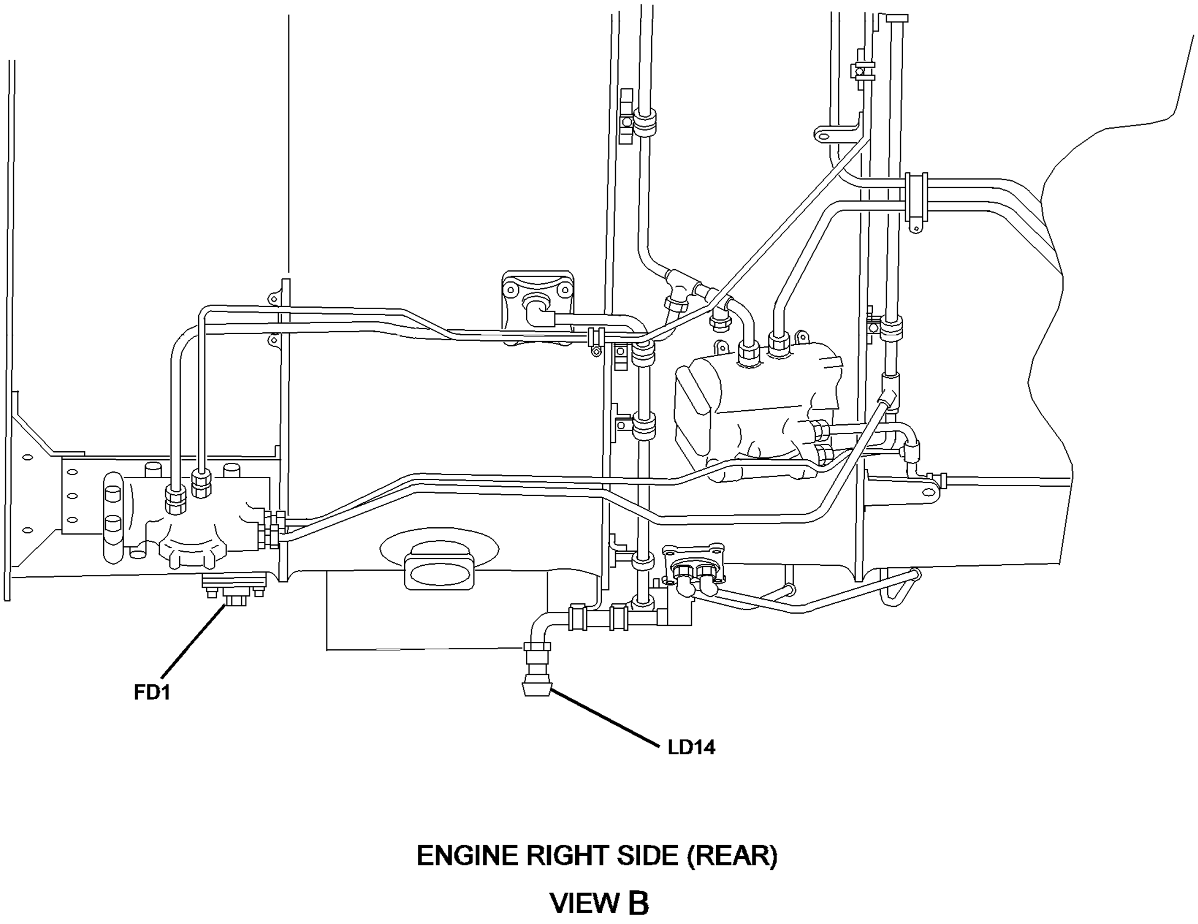
Engine Test/Instrumentation Connections (Left Side)
Figure 303/72-00-00-990-C37 (Sheet 2 of 2)





ENGINE RIGHT SIDE (CENTER)
VIEW A

Engine Test/Instrumentation Connections (Right Side)
Figure 304/72-00-00-990-C38 (Sheet 1 of 2)



Engine Test/Instrumentation Connections (Right Side)
Figure 304/72-00-00-990-C38 (Sheet 2 of 2)

6. Engine Preservation

A. Equipment And Materials Required

(1) Support Equipment

PWA 12386

(2) Consumables

Lubicant (PWA 36500)

Dehydrating Agent

Engine Oil (PWA 521)

Filtered Slushing Oil (PMC 9852)

Aqueous Cleaner (SPMC 148-1, -2, -3 or -4)

B. Procedure

CAUTION: UNDER NO CIRCUMSTANCES SHALL PRESERVATIVE OIL BE SPRAYED INTO THE COMPRESSOR OR TURBINE END OF THE ENGINE. DIRT PARTICLES DEPOSITED ON THE BLADES AND VANES DURING OPERATION WILL ALTER THE AIRFOIL SHAPE AND ADVERSELY AFFECT COMPRESSOR EFFICIENCY.

(1) Engine Preservation Schedule

(a) If an engine is stored without the preservation procedures in this section, added inspection and maintenance procedures will be necessary before this engine can go back into service. (Paragraph 8.)

(b) 0 to 7 days.

Engines may be left in an inactive status with no preservation protective requirements provided.

1) Engine is sheltered.

2) Humidity is not excessively high.

3) Engine is not subjected to extreme temperature changes which would produce condensation.

(c) 7 to 28 days.

Engines which are to be inactive up to 28 days may have no preservation providing all engine openings are sealed off and the relative humidity in the engine is maintained at less than 40 percent. This can be accomplished by placing approximately 26 pounds (11.79 kg) of dehydrating agent in the engine inlet and the tailpipe. Place the dehydrating agent on racks to keep it off engine parts. Suitable windows shall be provided in inlet and exhaust closures to allow observation of humidity indicators.

(d) 28 to 90 days.

Engines which are to be stored longer than 28 days but not to exceed 90 days need only fuel system preserved. Engine oil system need not be drained or preserved. Desiccant agents, humidity indicators, engine coverings such as intake, exhaust, breather discharge, etc., must be utilized.

(e) 90 plus days.

Engine preservation must be complete. Preserve engine oil system and engine fuel system as described in following paragraphs.

(f) Engine shut down in flight.

CAUTION: ENGINE SHUT DOWN IN FLIGHT SHALL BE DRIED OUT PER FOLLOWING PROCEDURE.

1) Blow hot dry air through engine to remove moisture before continued preservation or storage. Hot air velocity shall not be high enough to cause rotor rotation.

NOTE: If engine will be operated immediately, drying process is not required.

(g) Engine awaiting repair or overhaul

CAUTION: ENGINE AWAITING REPAIR OR OVERHAUL MUST HAVE ADEQUATE PRESERVATION MEASURES ACCOMPLISHED UPON REMOVAL OF ENGINE FROM AIRCRAFT.

(2) Engine Oil System Preservation

(a) The following procedures shall be followed for preservation of engines which are to be inactive for periods exceeding 90 days.

1) Rotate engine with starter or auxiliary power unit at starter pad until oil pressure and high compressor (N2) speed is indicated. Disengage starter.

2) Open drain on bottom of oil tank and remove drain plug from bottom of main accessory gearbox. Drain all oil into suitable containers.

NOTE: To facilitate draining, remove plug and connector from standpipe outlet (LD7) to drain CSD cavity.

3) With drains open, motor engine over to 1600 minimum rpm with starter, allowing scavenge pumps to clear engine (indicated by cessation of steady stream of oil from drains). To prevent excessive operation with limited lubrication, limit rotation to shortest possible time to fulfill above requirement. Starter operating time limits should not be exceeded.

4) Allow engine oil to drain to slow drip for approximately one-half hour.

5) Replace oil strainer or filter element and close previously opened drains.

NOTE: For engines which have just completed post-overhaul test using fresh oil, Paragraph 6.B.(2)(a)7) through Paragraph 6.B.(2)(a)12) are not required.

6) Fill oil tank with clean oil.

7) Motor engine over with starter until oil pressure indication is observed.

8) Start and operate engine for five minutes at 75 percent maximum continuous and shutdown engine. Specific engine operating instructions should be observed during preservation run.

9) Drain oil tank and accessory case by opening the oil tank drain and removing the drain plug and connector from the bottom of main accessory gearbox. Drain oil into suitable containers.

10) Close oil tank drain. Coat main gearbox drain plugs with new engine oil and reinstall connector with packing and drain plugs. Lockwire plugs.

11) Remove cover plates from the pads of accessory drives upon which accessories are not installed and spray exposed surfaces with new engine oil. Reinstall cover plates.

12) Plugs, caps, covers or screens should be installed over all openings to prohibit entrance of foreign material and accumulation of moisture.

13) If engine is to remain in aircraft, install 52 pounds (23.58 kg) of dehydrating agent, distributing 26 pounds (11.79 kg) in compartment. The balance should be distributed equally in aircraft inlet and exhaust section.

14) Oil filler caps should be tagged as to date of preservation. Using airtight moisture barrier or other suitable covers, cover inlet and exhaust end of engine compartment, installing humidity indicator at each end. Inspection windows at each end should be provided through which indicators will be visible.

15) Inspection of preserved unit should be made every two weeks if aircraft is stored outside or every 30 days if aircraft is stored inside. If relative humidity as indicated on humidity cards is 40 percent or less, no further action is required. If humidity indicator on silicagel bags indicates 40 percent or higher, entire engine system, including fuel and oil, should be depreserved and represerved.

(3) Fuel System Preservation

(a) Disconnect fuel-in supply at inlet pad of fuel pump and connect supply of filtered slushing oil at an inlet pressure of 5 psi (34.5 kPa) to 25 psi (172.4 kPa) and a minimum temperature of approximately 60°F (15.6°C). Extreme care should be taken to prevent foreign material from being drawn into the engine fuel system. Equipment should be provided with suitable filters and/or strainers of no coarser mesh than used in the engine. A ten micron filter is recommended for this purpose.

NOTE: Filtered slushing oil should be a light mineral based oil equivalent to MIL-L-6081 Grade 1010 which is mixable with fuel and test fluids and compatible with fuel system materials. Oil meeting this criteria is available through most major oil suppliers.

(b) Remove fuel pressurizing and dump valve strainer and cover at rear of pressurizing and dump valve.

(c) Install PWA 12386 Adapter on pressurizing and dump valve in place of cover.

(d) Attach standard hose from adapter to suitable container having minimum capacity of six gallons (22.71 liters).

(e) With ignition switch off and fuel shutoff valves OPEN, move fuel control lever to full OPEN position. Motor engine with starter at minimum N2 speed of 1600 rpm until at least two gallons of oil are discharged from pressurizing and dump valve filter cavity. During motoring period fuel shutoff valve should be moved from open to closed to open to purge bypass system.

(f) Replace pressurizing and dump valve filter cover, with new packing lubricated with a thin layer of PWA 36500 Assembly Fluid, and connect the fuel supply line.

(g) Fuel control lever should be tagged as to preservative used and date of preservation.

(4) Engine Preservation (Transport Stand Method)

(a) Change the oil in the oil system as follows:

1) If necessary remove the protective covers from all the engine openings.

2) Drain the oil from the engine oil system and replace the oil filter element.

3) Fill the engine oil tank with clean oil.

(b) Air motor the engine as follows:

NOTE: This alternate method to motor the engine can be used when a test cell is not available. Refer to the special procedure that follows for dry motoring the engine in a transport stand.

1) Remove the engine hydraulic pump(s).

WARNING: MAKE SURE THE ENGINE IS CORRECTLY INSTALLED IN THE STAND AND THE WHEELS OF THE STAND ARE LOCKED.

WARNING: DO NOT OPERATE THE STARTER MORE THAN THE RECOMMENDED DUTY CYCLE OF ONE ATTEMPT/START FOLLOWED BY FIVE MINUTES OFF. SECOND ATTEMPT/START FOLLOWED BY FIVE MINUTES OFF. THIRD ATTEMPT/START FOLLOWED BY ONE HOUR OFF. THIS WILL HELP PREVENT HEAT DAMAGE TO THE STARTER.

2) Connect the external supply pressure source to the starter air valve.

WARNING: BE SURE YOU ARE FAMILIAR WITH STARTER CART OPERATION BEFORE YOU USE THE CART. OTHERWISE, THERE MAY BE STARTER DAMAGE AND/OR BODILY INJURY.

3) If any of the accessories were removed from the main gearbox, be sure the pad covers and gaskets are installed. Put a cap on the pad cavity drains to prevent the loss of engine oil.

4) Be sure no lines in the fuel or oil systems were disconnected or removed. If necessary, connect and/or install lines by the instructions in the applicable manual section.

5) Use a wrench with an extension or an aide to manually hold open the starter air valve. This will prevent the need to stand adjacent to the starter during operation.

CAUTION: IF YOU USE A PNEUMATIC CART, HOT AIR WILL BE DISCHARGE DURING OPERATION.

6) Dry motor the engine with the starter for three minutes. If necessary, increase the starter inlet air pressure to turn the fan (LPC). The maximum starter inlet pressure is 50 PSI.

   NOTE: When you dry motor the engine, the fan (LPC) must turn. This is necessary to lubricate the entire oil system.

WARNING: DO NOT OPERATE THE PNEUMATIC START CART FOR A LONGER TIME THEN ALLOWED. BODILY INJURY CAN RESULT IN THE EVENT OF A STARTER FAILURE.

7) Stop motoring the engine and permit the engine to come to a full stop.

8) Preserve the fuel system before you drain the oil system.

(c) Preserve the fuel system as follows:

   1) Connect the preservation hose to the engine fuel system.

      NOTE: Refer. to Fuel System Preservation for the details (Paragraph 6.B.(3)).

   2) Preserve the fuel system with PMC 9852 lubricating oil.

   3) Remove the fuel preservation hardware as follows:

      a) Disconnect the hose and drain the fuel system.

      b) Remove the applicable adapter from the fuel system.

      c) Remove the protection covers from the openings as necessary to prevent engine damage.

      d) Connect and install any fuel system hardware that may have been disconnected or removed.

         NOTE: Refer to the applicable manual for specific details.

(d) Drain the engine oil from the engine oil system (Paragraph 6.B.(2)).

(e) Change the starter oil. Refer to the applicable manual or Component Maintenance Manual as necessary for specific details.

(f) Examine, clean and preserve the gearbox as follows:

CAUTION: DO NOT LET HYDRAULIC FLUID STAY ON THE MAIN GEARBOX DURING THE PRESERVATION PROCESS. THE HYDRAULIC FLUID CAN CAUSE CORROSION AND DAMAGE TO THE GEARBOX HOUSING.

1) Examine the gearbox for hydraulic fluid on gearbox housing.

2) Examine the hydraulic pump overboard drain tube(s) for any hydraulic fluid leaks. If any hydraulic fluid leaks are seen, remove the pump for access to the drive pad.

3) If any hydraulic fluid leaks are seen on the gearbox housing(s), remove it by one of the methods that follow:

a) Clean the engine externals with Aqueous Cleaner (SPMC 148-1, -2, -3 or -4).

b) Clean the engine externals by solvent wipe method, SPOP 208.

c) If you see corrosion of the magnesium gearbox housing, repair the corrosion by SPOP-41.

d) If any accessories are removed from the main gearbox drive pads, spray engine oil (PWA 521) on the gearbox drive pads.

e) Install the accessory gearbox covers on the gearbox.

(g) Preserve the engine for relative humidity as follows:

NOTE: The relative humidity must be 40 percent or less inside the engine at the time of preservation for the best corrosion preservation.

NOTE: It is necessary to drain the oil from the engine system after preservation of the fuel system and before preservation of the engine for relative humidity.

1) Install SPMC 214 dehydrating agent R (desiccant) by these steps:

CAUTION: DO NOT PUT SPMC 214 DEHYDRATING AGENT (DESICCANT) NEAR FAN OR TURBINE BLADES. ROTATION OF THE BLADES CAN CAUSE DAMAGE TO THE BAGS.

a) Put the specified amount of SPMC 214 dehydrating agent (desiccant) in the engine bag or shipping container. Refer to the appropriate section for the correct amount and placement location.

b) Put relative humidity indicators inside the inlet and exhaust areas.

2) Seal the engine for storage as follows:

a) Seal all the engine openings. Install a tarpaulin or PVC plastic sheet over the intake cowl, fan exhaust area and the engine exhaust area.

b) The protective covers must have windows so that the relative humidity indicators inside the engine can be seen.

3) Make a record of the engine preservation method and the date of each engine. Include the procedures used for the oil (oil drained) and the fuel systems (flushing oil).

4) Examine the engine while preserved as follows:

a) Every 15 days or less, examine the humidity indicators.

b) If the relative humidity is less than 40 percent, the engine may continue in storage for 15 more days.

c) If the relative humidity is more than 40 percent but less then 60 percent, replace the dehydrating agent and the engine may continue in storage for 15 days more.

d) If the relative humidity is more than 60 percent, replace the dehydrating agent. If no lines in the fuel system were disconnected during the preservation period, only preserve the oil system again. Refer to the steps to change the oil and air motor the engine (Paragraph 6.B.(4)(a) and Paragraph 6.B.(4)(b)).

e) If the relative humidity is more than 60 percent, replace the dehydrating agent. If the lines in the fuel system were disconnected during the preservation period, preserve both the fuel and oil system again (Paragraph 6.B.(4)(a) and Paragraph 6.B.(4)(c)).

7. Engine Depreservation

A. Equipment And Materials Required

(1) Support Equipment

PWA 12386

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

B. Procedure

NOTE: Use the procedures in this paragraph if the engine was preserved by the procedures applicable to the time the engine was not used. Refer to the paragraph that follows if the engine did not get the applicable preservation procedures for the time the engine was in storage.

(1) Engine Depreservation Schedule

(a) 0 to 28 days.

No depreservation required.

(b) 28 to 90 days.

Depreserve fuel system.

(c) 90 plus days.

Complete depreservation is required.

(2) Engine Depreservation Procedure

NOTE: Check all oil passages for obstructions before installing accessories which are dependent on engine oil.

(a) Remove all moisture barriers, humidity indicators, and dehydrating agent.

(b) Fill oil tank with engine oil.

(c) Connect fuel supply line to fuel inlet pad.

(d) Place suitable container having minimum capacity of six gallons (22.71 liters) under fuel pressurizing and dump valve.

(e) Remove strainer and cover assembly from fuel pressurizing and dump valve.

(f) Install PWA 12386 Adapter on fuel pressurizing and dump valve in place of cover and connect suitable length of hose to adapter outlet fitting to drain fuel into six-gallon container.

CAUTION: ROTATION OF THE ENGINE SHOULD BE LIMITED TO SHORTEST POSSIBLE TIME IN ORDER NOT TO EXCEED STARTER OPERATING LIMIT.

(g) With ignition OFF, fuel shutoff valve OPEN, and fuel control lever in full open position, motor engine over with starter on external power source to a high rotor (N2) speed of 1600 rpm minimum.

(h) When at least two gallons (7.57 liters) of fluid have been discharged from overboard dump line, move fuel control lever to closed position and disengage starter.

(i) Replace fuel pressurizing and dump valve strainer, with a new packing lubricated with a thin layer of PWA 36500 Assembly Fluid.

CAUTION: IF ENGINE WILL BE STARTED IMMEDIATELY AFTER DEPRESERVATION, CLEAR ENGINE OF FUEL VAPORS BY MOTORING FOR 10 TO 20 SECONDS WITH FUEL SHUTOFF. REFER TO ADJUSTMENT/TEST, CLEAR ENGINE PROCEDURE. BEFORE ATTEMPTING ENGINE START, ALLOW EITHER 30-SECOND FUEL DRAINING PERIOD OR PRESCRIBED STARTER COOLING PERIOD, WHICHEVER IS LONGER.

(j) Remove preservation tags and make proper entry in engine records.

8. Engine Depreservation (When Applicable Procedures for Preservation Were Not Done)

NOTE: Use the procedures in this paragraph when the engine did not get the preservation specified in this manual for the time period during which the engine was in storage. Some steps are done more than one time because they are specified in the procedures for more than one engine system, but it is permitted to do such steps one time only where applicable.

A. Oil System Depreservation

NOTE: These procedures are necessary if the 7 - 28 day (gaspath) preservation procedure was not done and the engine storage or inactivity period was more than 7 days, or if the 90-plus day (oil system) procedure was not done and the engine storage or inactivity period was more that 90 days.

(1) Do checks of the main oil filter (MOF) or strainer and magnetic chip detectors (MCD) (if used). Refer to the JT8D Oil Monitoring Guide, Sections D and E.

(a) Look for unwanted material.

1) If MOF and MCD checks show no contamination, install the MOF and MCD units and go on to the subsequent step.

2) It is recommended that the magnetic chip detectors be cleaned if necessary. Also, replace the main oil filter or strainer at this time. This will prevent incorrect indications during checks after engine operation.

3) If MOF and MCD checks are not satisfactory, disassemble the engine.

(2) Do a check of the engine oil for total acid number (TAN), water content (WC), and kinematic viscosity (KV). For the TAN and KV refer to SB 238 and the JT8D Oil Monitoring Guide, Sections B and C. Refer to ASTM D6304-00 for WC, 800 PPM maximum.

(a) If the TAN, KV, and WC are satisfactory, go to the subsequent step.

(b) If the TAN, KV, and WC are not satisfactory, change the oil before the engine operation referred to in subsequent procedures. Continue with the subsequent procedures.

(3) Remove the front accessory drive group. (AIR INLET FRONT ACCESSORY SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-21-00/401) Examine the inside of the front accessory drive group and the inside of the No. 1 bearing compartment for indications of corrosion.

(a) If there is no corrosion, install the front accessory drive group and the inside of the No. 1 bearing compartment for indications of corrosion.

(b) If there is corrosion, disassemble the engine for visual inspection of all the main shaft bearings, and bearing stack/compartment detail parts for corrosion (refer to the Standard Practices Section and the applicable Engine Manual section). Also examine the interior of the oil tank and gearbox for corrosion. Do all corrective actions when necessary.

(4) Remove the No. 6 bearing oil pump assembly to examine the No. 6 bearing compartment. (NO. 6 BEARING OIL SCAVENGE PUMP ASSEMBLY - REMOVAL/INSTALLATION, PAGEBLOCK 72-54-25/401) Examine the compartment for indications of corrosion.

(a) If there is no corrosion, install the No. 6 bearing oil pump. (NO. 6 BEARING OIL SCAVENGE PUMP ASSEMBLY - REMOVAL/INSTALLATION, PAGEBLOCK 72-54-25/401)

(b) If there is corrosion, disassemble the engine for visual inspection of all main shaft bearings, bearing compartments, and bearing stack/compartment detail parts for corrosion (refer to the Standard practices Section and the applicable Engine Manual section). Also examine the interior of the oil tank and gearbox for corrosion. Do all corrective actions when necessary.

(5) Do an engine run to part power and do an oil leak check.

(a) If there are no leaks, the engine can go back to service with one final check after 50 hours (see the subsequent steps).

(b) If oil leaks are found, identify and correct the leaks. Do an engine run to part power and do an oil leak check again.

(6) After 50 hours of operation, do a SOAP analysis of an oil sample. Do a special analysis for high iron (fe) content. Refer to the JT8D Oil Monitoring Guide, Section G.

NOTE: High iron content can be an indication of main bearing distress.

(a) If the oil analysis is not satisfactory, disassemble the engine.

(b) If the oil analysis is satisfactory, no other step is necessary.

B. Fuel System Depreservation

NOTE: These procedures are necessary if the 28 - 90 day (fuel system) preservation procedure was not done and the engine storage or inactivity period was more than 28 days.

(1) Before an engine run, get a fuel sample from the fuel control or fuel pump. Approximately one quart or one liter is necessary. Make sure that no water is seen (refer to ASTM D4176 (procedure 1), Visual Inspection method). Also make sure that the fuel is clear and bright by a visual inspection.

(a) If the fuel sample is satisfactory, go to the subsequent step.

(b) If the fuel sample is not clear and bright or if water is found (or if a fuel sample was not available for a test), replace (or disassemble and examine) the fuel pump, fuel heater, fuel control, oil cooler, and pressurizing and dump valve.

(2) Do an engine run at part power and a fuel leak check.

(a) If there are no leaks, go to subsequent step.

(b) If fuel leaks are found, identify and correct all leaks. Do an engine run at part power and a fuel leak check again.

(3) If fuel system components were not replaced, examine the fuel filters and screens for unwanted material.

(a) If contamination is found, clean the filters and screens. Do the engine run and filter and screen checks again. If material is found after the second engine run, replace all fuel system components.

(b) If the filters and screens are clean, no more actions are necessary, and the engine can go into service.

C. Engine External Inspection

NOTE: These procedures are necessary if there was not a tight cover on the engine.

(1) Examine all probes, pressure ratio bleed control vents, air signal lines, and Ps3 strainer for possible blockage (for example insects or bird nests).

(2) Do an engine run at part power and a fuel and oil leak check. Do an anti-surge bleed operation check.

(3) Do an anti-surge bleed operation check. (ENGINE GENERAL - TROUBLESHOOTING-04 (POWER AND ENGINE RESPONSE), PAGEBLOCK 72-00-04/101)

D. Rear Compressor Inspection

(1) Make sure that all rear compressor disks (stages 7 through 12) are in compliance with the corrosion inspections in ASB 6435 (this ASB makes corrosioin inspection of disks necessary).

NOTE: As specified in the ASB, engine storage does not add Years Since New/Re-Coat (YRSNRC) to rear compressor disks, but only if the engine is correctly preserved and stored immediately after new or overhauled disks are installed. Engine preservation by the specified 7 - 28 day (gaspath) procedure is satisfactory for this.

9. Identification of Metal Particles

A. General

(1) When unidentified particles of metal are found, they must be either steel, tin, aluminum, magnesium, silver, bronze, or cadmium. In some cases the type of metal may be determined by the color and hardness of the pieces. However, when the particles cannot be positively identified by visual inspection and knowledge of the exact character of the metal is desired as an aid to troubleshooting, a few simple tests will determine the kind of metal present.

WARNING: USE EXTREME CARE IN HANDLING THE ACIDS.

(2) The following equipment and chemicals are required to make these tests: A source of open flame, a permanent magnet, two ounces of aqueous solution containing ten percent ammonium nitrate, an electric soldering iron, two ounces each of 50 percent by volume hydrochloric acid, and concentrated nitric acid, sodium hydroxide pellets, a watch glass, a white porcelain spot plate, ammonium bifluoride crystals, 5 to 10 percent hydrofluoric acid or concentrated sulfuric acid, 3 to 10 percent hydrogen peroxide, and concentrated phosphoric acid.

B. Test Procedure

(1) The following test procedure is recommended for determining the character of unknown metal particles. For best results, follow the steps as outlined:

(a) Steel - The particles can be isolated by means of the permanent magnet. Steel or iron is attracted by the magnet.

WARNING: IN FOLLOWING PROCEDURE NEVER ATTEMPT TO BURN MORE THAN A FEW PARTICLES OF METAL SUSPECTED TO BE MAGNESIUM. MAGNESIUM POWDER OR DUST IS EXPLOSIVE.

(b) Magnesium - A simple test for these particles is burning. Magnesium will burn with a bright white flash.

(c) Cadmium - Place the remaining particles in the aqueous (water) solution of ammonium nitrate. If all or any of the particles dissolve in this solution, they are cadmium. After this test, rinse and dry any remaining particles.

(d) Tin - The tin particles can be distinguished by their low melting point. With a clean soldering iron, heated to 500°F (260°C) and tinned with 50-50 solder (50 percent tin - 50 percent lead), a tin particle dropped on the iron will melt and fuse with the solder.

WARNING: HYDROCHLORIC ACID IS DANGEROUS AND REQUIRES SPECIAL HANDLING.

(e) Aluminum - When a particle of aluminum is placed in hydrochloric acid 50 percent by volume, it will fizz with rapid emission of gas bubbles and gradually disintegrate and form a black residue (aluminum chloride). Silver and bronze do not noticeably react with hydrochloric acid.

(f) Aluminum Paint - Use this procedure to determine whether or not the material is aluminum silicone paint, aluminum chips, or silver particles.

1) Make a sodium hydroxide solution by adding one pellet of sodium hydroxide to three cubic centimeters of water.

2) Place several drops of this solution in a watch glass and drop in the suspected particles.

3) If the particles are aluminum silicone paint, there will be a mild reaction in the form of gas bubbles and some visible gas as the particles change to sodium aluminate.

4) If the particles are aluminum chips, the reaction will be much more active with many more gas bubbles forming and more visible gas.

5) If the particles are silver, there will be no reaction.

(g) Silver - When a silver particle is placed in nitric acid, it reacts rather slowly, producing a whitish fog in the acid.

(h) Bronze - When a bronze (or copper) particle is placed in nitric acid, a bright green cloud is produced.

C. Test Procedure for Titanium

(1) Place a piece or pieces of the metal to be identified on a white porcelain spot plate. A piece of titanium or titanium bearing metal should be placed on another spot plate to observe and verify the results obtained.

(2) Add several crystals of ammonium bifluoride and 5-10 drops of water to the metal particles. (2-3 drops of a 5-10 percent hydrofluoric acid solution can be used instead.)

(3) Let stand 20 to 30 minutes, or until the solution becomes slightly discolored.

(4) Add 2-3 drops of 1:1 sulfuric acid (1 part water to 1 part concentrated acid).

(5) Let stand 20-30 minutes, or until solution becomes more discolored.

(6) Add 3-4 drops of 3-10 percent hydrogen peroxide. Solution must not be too old.

(7) If titanium is present a yellowish color will develop. This yellow color will become progressively darker with time, if allowed to set.

(8) Add 2-3 drops of concentrated phosphoric acid, and stir to discharge any yellow color due to the possible presence of iron.

WARNING: ABOVE CHEMICALS ARE HAZARDOUS AND REQUIRE SPECIAL HANDLING. SOLID AMMONIUM BIFLUORIDE IS CRYSTALLINE AND CAN BE CONVENIENTLY STORED IN A DRY PLACE AND USED AS NEEDED.

(9) Any light yellow to orange coloration indicates the presence of titanium.

D. Gear and Bearing Material Identification. (Table 303 through Table 306)

(1) If it is not known where a chip in the oil system comes from, use spectrographic analysis to find the material.

(2) Tables Table 303 through Table 306 show what percent of a gear or bearing part is a given material (it is possible to find small particles or chips of these engine parts in oil).

Table 303

	Gear Material		**Bearing Material**			
	AMS 6260		**PWA 723**		**PWA 725**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**
Carbon	0.07	0.13	0.95	1.10	0.77	0.85
Manganese	0.40	0.70	0.25	0.45	--	0.35
Silicon	0.20	0.35	0.20	0.35	--	0.25
Phosphorus	--	0.025	--	0.025	--	0.015
Sulfur	--	0.025	--	0.025	--	0.015
Chromium	1.00	1.40	1.30	1.60	3.75	4.25
Nickel	3.00	3.50	--	0.15	--	0.15
Molybdenum	0.08	0.15	--	0.10	4.00	4.50
Copper	--	0.35	--	0.15	--	0.15
Vanadium	--	--	--	--	0.90	1.10
Cobalt	--	--	--	--	--	0.25
Tungsten	--	--	--	--	--	0.25
Iron	Remainder		Remainder		Remainder	

Table 304

	Bearing Material		**Bearing Material**			
	PWA 724		**AMS 6440**		**AMS 6441**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**
Carbon	0.10	0.15	0.98	1.10	0.98	1.10
Manganese	0.40	0.60	0.25	0.45	0.25	0.45
Silicon	0.20	0.35	0.15	0.35	0.15	0.35
Phosphorus	--	0.025	--	0.025	--	0.025
Sulfur	--	0.025	--	0.025	--	0.025

Table 304 (Continued)

	Bearing Material		Bearing Material			
	PWA 724		AMS 6440		AMS 6441	
	Min	Max	Min	Max	Min	Max
Chromium	1.35	1.75	1.30	1.60	1.30	1.60
Nickel	2.60	3.00	--	0.25	--	0.25
Molybdenum	4.80	5.20	--	0.10	--	0.10
Copper	--	0.35	--	0.35	--	0.35

Table 305

	Gear Material			Gear Material		
	PWA 6265		AMS 6274		AMS 6414	
	Min	Max	Min	Max	Min	Max
Carbon	0.07	0.13	0.17	0.23	0.38	0.43
Manganese	0.40	0.70	0.60	0.95	0.60	0.90
Silicon	0.15	0.35	0.15	0.35	0.15	0.35
Phosphorus	--	0.015	--	0.025	--	0.015
Sulfur	--	0.015	--	0.025	--	0.015
Chromium	1.00	1.40	1.35	0.65	0.70	0.90
Nickel	3.00	3.50	0.35	0.75	1.65	2.00
Molybdenum	0.08	0.15	0.15	0.25	0.20	0.30
Copper	--	0.35	--	0.35	--	0.35

Table 306

	Bearing Material		Bearing Material			
	AMS 4616		AMS 6294		AMS 6490	
	Min	Max	Min	Max	Min	Max
Copper	90.00	--	--	0.35	--	0.10
Manganese	--	1.00	0.45	0.65	--	0.35
Silicon	2.40	4.00	0.15	0.35	--	0.25
Phosphorus	--	0.10	--	0.025	--	0.015
Carbon	--	--	0.17	0.22	0.77	0.85
Sulfur	--	--	--	0.025	--	0.015
Nickel	--	--	1.65	2.00	--	0.15
Molybdenum	--	--	0.20	0.30	4.00	4.50
Chromium	--	--	--	0.20	3.75	4.25
Vanadium	--	--	--	--	0.90	1.10
Cobalt	--	--	--	--	--	0.25

Table 306 (Continued)

	Bearing Material		Bearing Material			
	AMS 4616		AMS 6294		AMS 6490	
	Min	Max	Min	Max	Min	Max
Tungsten	--	--	--	--	--	0.25
Zinc	1.50	4.00	--	--	--	--
Iron	1.00	2.00	--	--	--	--
Total Named Elements	99.50	--	--	--	--	--
NOTE: Refer to the JT8D Oil Monitoring Guide, Part No. 821432 for more information on the identification of oil wetted parts.						

ENGINE GENERAL - REMOVAL/INSTALLATION-01

1. Remove Engine From Airframe

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

B. Procedure

(1) General Engine Removal Procedures

CAUTION: AFTER REMOVAL OF ENGINE FROM AIRCRAFT DO NOT USE NYLON SELF-LOCKING NUTS ON ENGINE MOUNT SHIPPING BOLTS SINCE LOSS OF TORQUE CAUSING ENGINE/BOLT MOVEMENT MAY RESULT.

(a) When removing engine from aircraft, in order to reduce possibility of getting oil in compressor, do not tilt engine more than 20 degrees below or above fore and aft horizontal centerline or do not rotate more than 30 degrees above or below a horizontal outer line at right angles to fore and aft axis. This applies when oil is present in gearbox but is not of concern during normal assembly to service of oil tank or during disassembly for overhaul.

(2) General Tool Procedures

CAUTION: DO NOT CONTACT TITANIUM ENGINE PARTS WITH CADMIUM-PLATED PARTS, TOOLS, OR FIXTURES. SUCH CONTACT CAN CAUSE EMBRITTLEMENT OF TITANIUM.

(3) Specific Engine Removal Procedures

(a) Refer to GENERAL, SUBJECT 71-00-00, Page 401.

2. Install Engine In Airframe

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

Engine Oil (PWA 521)

B. Procedure

(1) General Engine Installation Procedures

(a) When installing engine in aircraft, in order to reduce possibility of getting oil in compressor, do not tilt engine more than 20 degrees below or above fore and aft horizontal centerline or do not rotate more than 30 degrees above or below a horizontal outer line at right angles to fore and aft axis. This applies when oil is present in gearbox but is not of concern during normal assembly to service of oil tank or during dis-assembly for overhaul.

(2) General Tool Procedures

CAUTION: DO NOT CONTACT TITANIUM ENGINE PARTS WITH CADMIUM-PLATED PARTS, TOOLS, OR FIXTURES. SUCH CONTACT CAN CAUSE EMBRITTLEMENT OF TITANIUM.

(3) Specific Engine Installation Procedures

(a) Refer to GENERAL, SUBJECT 71-00-00, Page 401.

ENGINE GENERAL - ADJUSTMENT/TEST

1. Engine Ground Safety Precautions

A. General

(1) The operating characteristics of jet engine powered aircraft have changed the ground safety picture. To prevent injury to persons and damage to property, handling and working procedures must be modified to meet new exposures. On piston engine aircraft the propeller was carefully avoided. In the case of the jet engine powered aircraft, one must avoid not only the engine intake ducts, but also the exhaust nozzle where hot, high velocity exhaust gases are discharged. Listed below are some of the general safety items which shall be supplemented according to the needs of the job, to prevent accidents.

B. The Air Intake (Figure 501)

WARNING: ALL PERSONNEL MUST AVOID HAZARD AREAS AROUND THE POWER PLANT AND REMAIN OUTSIDE OF ENGINE SAFETY BARRIER, IF USED, DURING GROUND RUNNING OPERATIONS. THE ENGINE IS CAPABLE OF DEVELOPING ENOUGH SUCTION AT THE INLET TO PULL A PERSON UP TO OR PARTIALLY INTO THE INLET WITH POSSIBLE FATAL RESULTS. THEREFORE, WHEN APPROACHING ANY TYPE OF JET ENGINE, PRECAUTIONS MUST BE TAKEN TO KEEP CLEAR OF THE INLET AIR STREAM. THE SUCTION NEAR THE INLET CAN ALSO PULL IN HATS, GLASSES, LOOSE CLOTHING AND WIPE-RAGS FROM POCKETS. ANY LOOSE ARTICLES MUST BE MADE SECURE OR REMOVED BEFORE WORKING AROUND THE ENGINE.

C. Exhaust Characteristics (Figure 501)

(1) Velocity. At high engine speeds the exhaust may pick up and blow loose dirt, sizeable stones, sand and debris a distance of several hundred feet. Therefore, due caution must be used in parking the aircraft for run-up to avoid injury to persons or damage to property or other aircraft. A blast fence is suggested if the engines are going to be run-up for trim and power adjustment in an area where there is not sufficient space available for dissipation of the exhaust blast.

(2) Temperature. High temperature will be found up to several hundred feet from exhaust nozzle depending on wind conditions. Closer to engine, exhaust temperature is high enough to deteriorate bituminous pavement, therefore, concrete aprons are suggested for run-up areas. Occasionally when a jet engine is started, excess fuel that has accumulated in the tailpipe ignites and long flames are blown out of exhaust nozzle. Possibility of this hazard must be watched and all flammable materials kept in the clear.

(3) Toxicity. Tests have indicated that carbon monoxide content is low but other gases are present which have disagreeable odor and are irritating in effect. Exposure will usually cause watering or burning sensation of the eyes. Less noticeable but important is respiratory irritation which may be caused. For both these reasons exposure must be avoided, particularly in confined spaces or pockets where concentration may build up.

D. Engine Cool Down

WARNING: USE APPROPRIATE HAND PROTECTION WHEN WORKING AROUND ENGINE AREAS WHICH ARE LIKELY TO BE HOT.

(1) After engine operation no work or inspection shall be done on tailpipe for at least one-half hour, preferably longer. All other parts may usually be worked upon without danger.

(2) Certain parts of the engine which contain or are exposed to high compressor air, like fuel deicing air tubing and anti-icing air tubing, may be hot immediately after engine shutdown. The use of insulated gloves is recommended whenever work must be performed on the engine in the vicinity of such parts soon after engine shutdown.

E. Engine Noise

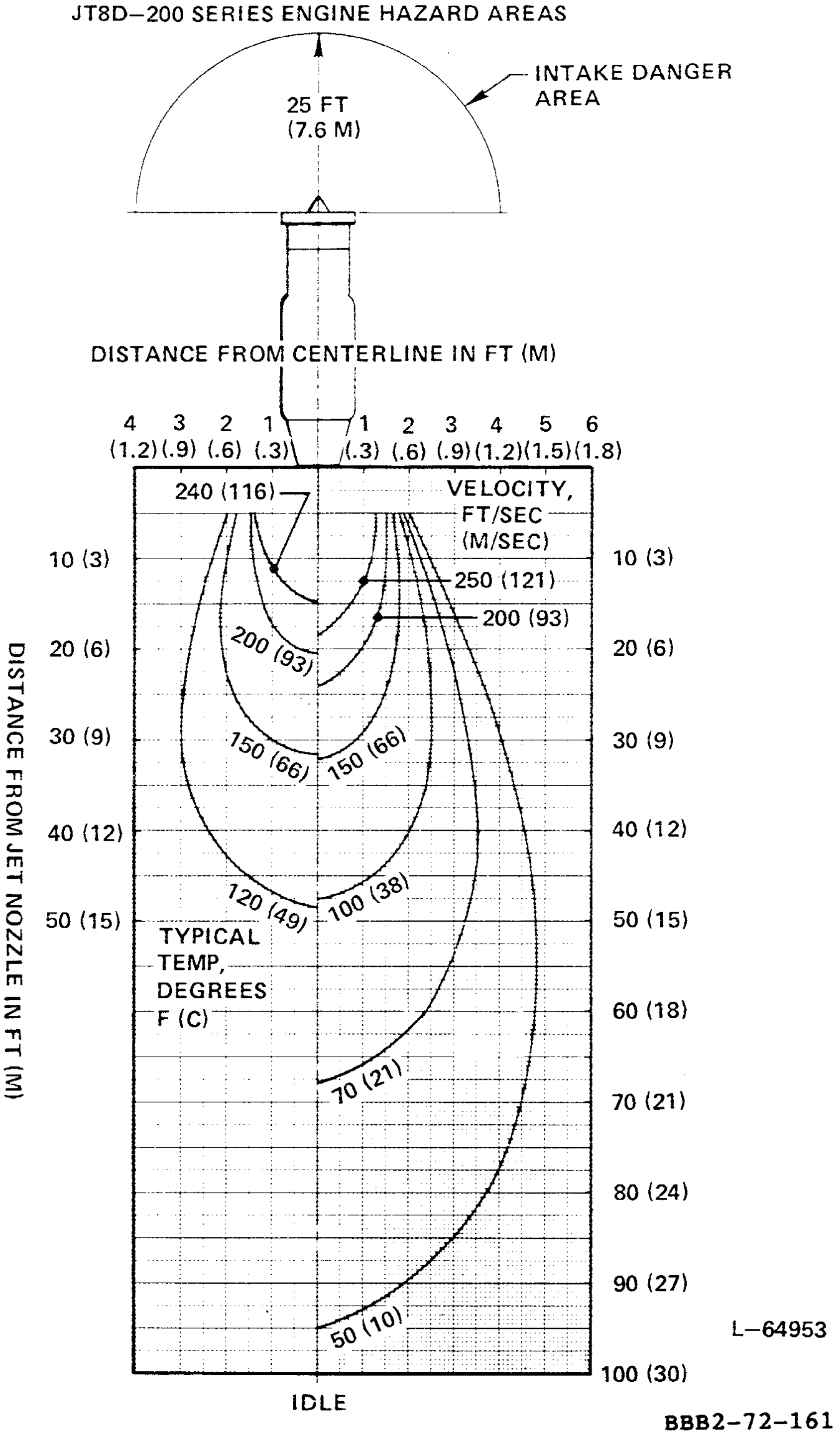
(1) Jet engines typically produce noise capable of causing temporary, as well as permanent, loss of hearing. Even short exposures to extreme noise may result in damage to ears and all personnel must use some means of protection. Noise can effect ear mechanism in such a way as to cause unsteadiness or inability to walk or stand without reeling. Therefore, use of cup type ear protection is recommended. If engines are to be serviced from aero-stands or platforms these shall be equipped with protective railings to prevent falls.

F. Engine Ignition

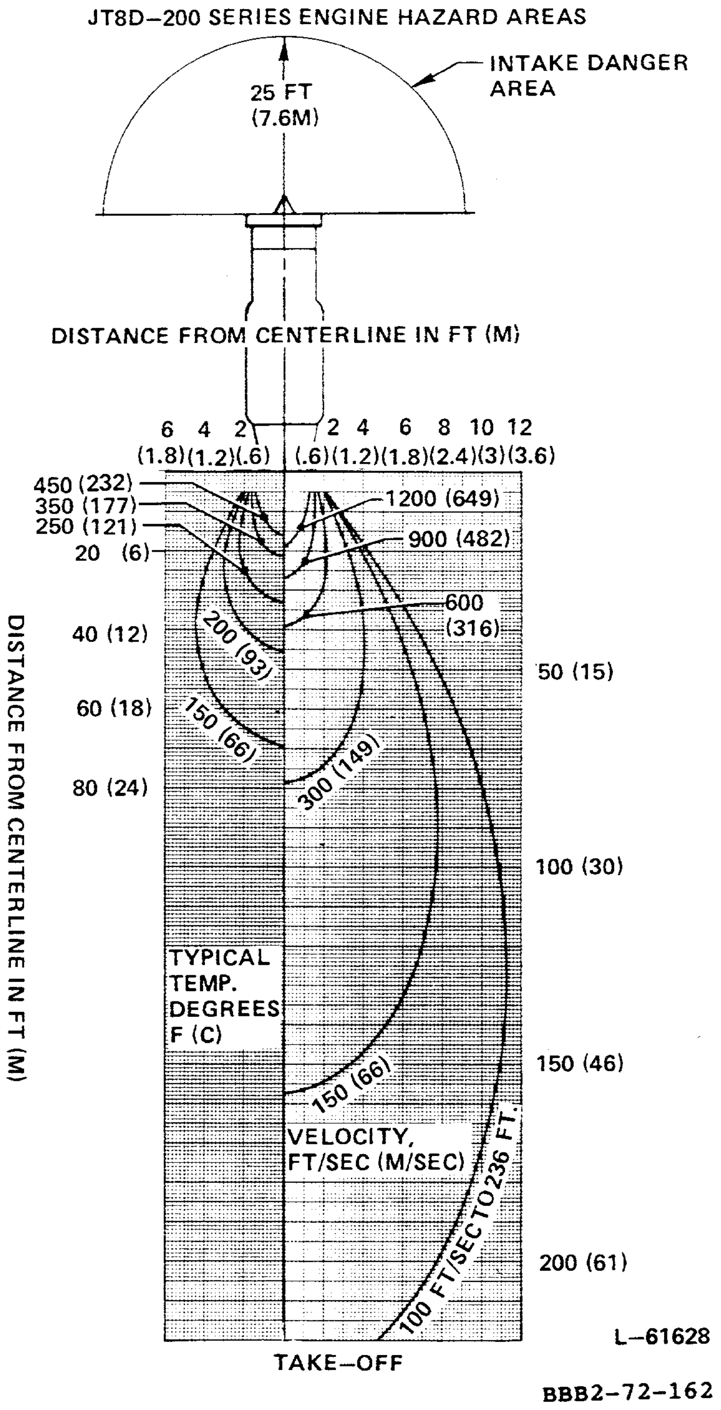
WARNING: THE JT8D ENGINE IGNITION SYSTEM IS CHARACTERISTICALLY HIGH IN ENERGY. THE NATURE OF THE SYSTEM IS SUCH AS TO RENDER IT A HAZARDOUS, POSSIBLY FATAL, SOURCE OF ELECTRICAL SHOCK UNLESS NECESSARY PRECAUTIONS ARE EXERCISED. DO NOT TOUCH IGNITER PLUGS WHEN IGNITION IS ON. DO NOT TEST IGNITION SYSTEM WHEN PERSONNEL MAY BE IN CONTACT WITH IGNITER PLUGS OR WHEN FLAMMABLE MATERIALS ARE NEARBY.

G. Fuel And Lubricating Oils

(1) All fuels and lubricating oils tend to dry the skin. Precautions shall be taken to avoid contact as much as possible.



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-819 (Sheet 1 of 2)



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-819 (Sheet 2 of 2)

2. Testing Information

A. General

(1) Pratt & Whitney strongly recommends that the measurement and setting of engine thrust be accomplished by use of turbine discharge pressure and compressor inlet pressure as the primary parameters, while using engine speed, tailpipe temperature, and fuel flow as secondary parameters to monitor engine condition, and as limits. Engine speed (low and high compressor Revolutions Per Minute (RPM)) is not a sufficiently accurate indicator of thrust, to provide adequate control of engine thrust and internal conditions under normal service operation. Therefore, the engine fuel control is adjusted in order to obtain desired turbine discharge pressure (P_{t7}) or engine pressure ratio (P_{t7}/P_{t2}) shown on applicable engine trim curves. Turbine discharge pressure or pressure ratio overshoot, or higher than normal reading, may be noted when power lever is first advanced to PART THRUST stop on a cold engine. For accurate indication of engine thrust during engine test or trimming, engine must be allowed to stabilize.

NOTE: It is suggested that a remote fuel control trimmer such as is available from Lear Siegler Inc. be employed when trimming engine.

(2) Whenever trimming engines installed in aircraft, aircraft manufacturer's trim curves, corrected for specific inlet duct loss, must be used.

(3) Symbols have been designated for the various stations within the engine, and the external working pressures and temperatures. These variables are listed in Table 501 below:

Table 501 Engine Station Symbols

TAMB	Compressor Ambient Temperature
PAMB	Compressor Inlet Ambient Pressure
N_1	Low Pressure Compressor RPM
N_2	High Pressure Compressor RPM
Ps3	Intercompressor Static Pressure
Ps4	Bleed Annulus Static Pressure
P_{t2}	Compressor Inlet Total Pressure
T_{t7}	Turbine Discharge Total Temperature
P_{t7}	Turbine Discharge Total Pressure
P_{t7}/PAMB	Engine Pressure Ratio
PBAR	True Barometric Pressure

(4) The extent of repair and replacement will vary with each engine; therefore, the degree of test necessary to demonstrate satisfactory repair will vary also. To minimize ground running and to conserve fuel, this section provides five ground test procedures which are related to the extent of repair or replacement. Before attempting to test an engine after repair, the applicable sections of the Table Table 507 must be consulted to determine the test required for any given engine repair.

(5) The Engine Check Chart provides the general operating condition limits and references to the necessary test curves for testing an installed engine. The ratings listed in the Engine Check Chart are described as follows and are obtained by positioning the power lever to a predetermined turbine discharge pressure (P_{t7}):

(a) Maximum Takeoff - This is the maximum thrust certified for takeoff. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. In the event of an engine out situation this rating is provided by the Reserve Takeoff Thrust mechanism when operating at the Normal Takeoff rating. This rating is time-limited to a total of five (5) minutes including the time spent at the Normal Takeoff Rating.

(b) Normal Takeoff - The Normal Takeoff Rating is the maximum thrust normally set for takeoff operation. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. The rating is time limited to five (5) minutes.

(c) Maximum Continuous - The Maximum Continuous Rating is the maximum thrust certified for continuous use. For the purpose of P&W service policy coverage and prolonging engine life, this rating should be used, at the pilot's discretion, only when required to ensure safe flight. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(d) Maximum Climb - Maximum Climb thrust is the maximum thrust approved for normal climb. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(e) Maximum Cruise - This is the maximum thrust approved for cruising. The Maximum Cruise is obtained in the same manner as Maximum Climb or Maximum Continuous thrust.

(f) Idle - This is not an engine rating but, rather, a power lever position suitable for minimum thrust operation on the ground or in flight. It is obtained by positioning the power lever in the IDLE detent or the IDLE stop position.

(g) Reverse - Reverse thrust will be obtained at power lever positions below IDLE.

B. Operating Limits and Performance Data

(1) JT8D-209: See Table 502.

Table 502 Engine Check Chart For JT8D-209

Oil: PWA 521			**FUEL: Service Bulletin (SB) 2016**	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Maximum Takeoff	5 (3)	1058°F (570°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Continuous	Continuous	986°F (530°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Climb	Continuous	959°F (515°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Cruise	Continuous	941°F (505°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

Table 502 Engine Check Chart For JT8D-209 (Continued)

Oil: PWA 521			FUEL: Service Bulletin (SB) 2016	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting Ground Flight		 932°F (500°C) (6) 1058°F (570°C) (6)	(9)	
Acceleration T.O. (4)		1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the Exhaust Gas Temperature (EGT) must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 Pounds per Square Inch Gauge (PSIG) (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.F. for procedures related to oil temperature.

C. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-209

   (a) Normal Takeoff power level engine speed limits.

      1) Maximum permissible operating speeds are 7,850 RPM (95.5 percent) for N_1 and 12,150 RPM (99.2 percent) for N_2.

      2) Engines run at speeds between 7,850 - 8,150 RPM (95.5 - 99.2 percent) N_1 or 12,150 - 12,370 RPM (99.2 - 101.0 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) function and determine cause and correct problem prior to reactivating ART (RTT) function.

      3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

   (b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,370 RPM (101.0 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.C.(1)(a)1) or Paragraph 2.C.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If visual inspection reveals physical damage, or if N_1 speed exceeds 8,450 RPM (102.8 percent), or if N_2 speed exceeds 12,550 RPM (102.5 percent) proceed as follows:

1) Remove high and low compressors and perform complete overhaul inspection.

2) Inspect all turbine disks for growth and hardness.

3) Inspect all turbine blades for stretch.

4) Inspect all disks and blades by fluorescent penetrant.

D. Overtemperature

WJE 412, 414

(Figure 502)

WJE 405-411, 880, 881, 883, 884

(Figure 506)

WJE 405-412, 414, 880, 881, 883, 884

(Figure 503)

(Figure 504)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition.

WJE 412, 414

(Figure 502)

WJE 405-411, 880, 881, 883, 884

(Figure 506)

(Figure 503)

(Figure 504)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C, it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

(see Figure 508 or Figure 509)

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time at peak temperature.

(5) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine Engine Pressure Ratio (EPR), fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft Digital Flight Data Recorder (DFDR), or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

E. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near or above maximum values listed above shall be investigated promptly.

F. Oil Inlet Overtemperature Limits and Procedures

(1) JT8D-209

(a) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

G. Operating Limits and Performance Data

(1) JT8D-217:JT8D-217A, JT8D-217C, JT8D-219: See Table 503.

(2) ENGINE CHECK CHART

Table 503 Engine Check Chart For JT8D-217, -217A, -217C, -219

Oil: PWA 521			**FUEL: SB 2016**	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Maximum Takeoff	5 (3)	1157°F (625°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1094°F (590°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting Ground Flight		 932°F (500°C) 1157°F (625°C) (6)	(9)	
Acceleration (Maximum Takeoff) (4)	2	1166°F (630°C)	40-55 (275.8 -	275°F (135°C)
Acceleration (Normal Takeoff)	2	1103°F (595°C)	379.2 kPa)	

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.K. for procedures related to oil temperature.

H. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-217

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 7,770 RPM (94.5 percent) for N_1 and 12,285 RPM (100.3 percent) for N_2.

2) Engines run at speeds between 7,770 - 8,150 RPM (94.5 -99.2 percent) N_1 or 12,285 - 12,550 RPM (100.3 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond permissible limits in Paragraph 2.H.(1)(a)1) or Paragraph 2.H.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,584 RPM (102.8 - 104.4 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is continued-in-service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(1)(e) below if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(1)(e) below if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(1)(e) below if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1.

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

   a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

   b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

   b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is returned to service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,584 RPM (104.4 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(2) JT8D-217A, -217C

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,080 RPM (98.3 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,080 - 8,350 RPM (98.3 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,459 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12.675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.H.(2)(a) or Paragraph 2.H.(2)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(2)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(2)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(2)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1.

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is continued-in-service.

10) Visually examine the 4th stage turbine blades to make sure that no blade shrouds are missing. Repair any 4th stage turbine with missing shrouds before the engine is continued-in-service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(3) JT8D-219

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,120 RPM (98.8 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,120 - 8,350 RPM (98.8 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.H.(3)(a) or Paragraph 2.H.(3)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

   NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(3)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(3)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(3)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1.

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

   a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

   b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

   b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

I. Overtemperature

WJE 412, 414

(Figure 505)

WJE 405-411, 880, 881, 883, 884

(Figure 506)

WJE 405-412, 414, 880, 881, 883, 884

(Figure 508) (Figure 509)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition.

WJE 412, 414

(Figure 505)

WJE 405-411, 880, 881, 883, 884

(Figure 506)

WJE 405-412, 414, 880, 881, 883, 884

(Figure 508) (Figure 509)

NOTE: Action required as a result of overtemperature occurrence is based on the following.

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time period applies to time within applicable temperature band and not to time at peak temperature.

(4) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting-03 (Indication System) and Troubleshooting-04 (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below Idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

J. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near, or above maximum values listed above shall be investigated promptly.

Table 504

KEY TO Figure 508	
CHART ZONE	**ACTION**
A	Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B. An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.
NOTE: A 25 flight hour fly back interval is permitted before doing Zone B corrective action. Another excursion into Zone A during the fly back interval requires the completion of Zone B corrective action before the next flight. Subsequent excursions into Zone A get Zone B corrective action.	
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Disassemble the engine hot section and do full overhaul inspection.
NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.	
	or Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1)

Table 504 (Continued)

<table>
<tr><th colspan="2">KEY TO Figure 508</th></tr>
<tr><th>CHART ZONE</th><th>ACTION</th></tr>
<tr><td></td><td>An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D.
Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the procedures specified for Zone D.</td></tr>
<tr><td>D</td><td>Disassemble the engine hot section and do full overhaul inspection.</td></tr>
<tr><td colspan="2">NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.</td></tr>
<tr><td>F</td><td>Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated.
If an engine goes into Zone F four times since the last time the engine hot section got full disassembly and inspection, and an external cause for the overtemperature is not found, a borescope inspection (refer to Inspection/Check-01) can often find the problem (an internal condition can be the cause of the overtemperature).</td></tr>
<tr><td>G</td><td>No action necessary</td></tr>
<tr><td colspan="2">NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades.
NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades.
NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.</td></tr>
</table>

Table 505

<table>
<tr><th colspan="2">KEY TO Figure 509</th></tr>
<tr><th>CHART ZONE</th><th>ACTION</th></tr>
<tr><td>A</td><td>De-energize the ART system and find the cause of the overtemperature. Correct the cause before the ART system is energized.
Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B.</td></tr>
</table>

Table 505 (Continued)

KEY TO Figure 509	
CHART ZONE	**ACTION**
	An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Disassemble the engine hot section and do full overhaul inspection.
NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.	
	or Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D. Total time in this zone must not be more than 30 seconds per event. An engine above these limits must get the procedures specified for Zone D.
D	Disassemble the engine hot section and do full overhaul inspection .
NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.	
G	No action necessary
NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades.	

Table 505 (Continued)

KEY TO Figure 509	
CHART ZONE	ACTION
NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades. NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.	

K. Oil Inlet Overtemperature Limits and Procedures.

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

(2) After complying with the above and providing no engine damage is indicated, engine may be continued in service.

(3) If oil-in temperature exceeds 329°F (165°C) for any interval, remove engine to overhaul and inspect all main and accessory drive bearings for hardness and condition. All main shaft seals shall be inspected for condition.

L. Engine Windmilling or Oil Pressure Interruption/Low Oil Pressure

NOTE: You must record operating conditions before and after any oil pressure interruption, low oil pressure indication, engine shutdown and windmilling to find classification of windmilling.

NOTE: The classification of windmilling is based on time and oil pressure. Although the engine must show continuous oil pressure after shutdown, the oil pressure after in-flight shutdown (IFSD) (after the engine becomes stable) is what is used for the classification of the windmilling. Because oil pressure is a function of ram air, this pressure will usually decrease to less than 10 psi (68.9 kPa) during the descent and approach phases. Also the oil pressure can show zero when the ram air can no longer cause sufficient oil pump rotation (during landing, rollout, and taxi). These conditions are acceptable and do not change the classification of windmilling.

(1) Engine Windmilling

(a) Inspect all engines that have windmilled as a result of shutdown in flight.

NOTE: Operator must also do all corrective actions necessary to find cause of in flight engine shutdown.

(b) If an engine windmilled for 30 minutes or less, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can continue in service after satisfactory inspection of main oil filter and chip detectors (if installed), servicing of engine and ground run-up.

NOTE: Ground run-up is a normal start, followed by five minutes at idle then a normal shutdown.

Chip detectors are optional equipment. If installed, they are part of windmilling inspection procedure.

(c) If an engine windmills for more than 30 minutes but less than 60 minutes, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can be continued in service after satisfactory examination of main oil filter and chip detectors (if installed), servicing of engine and ground run-up. In addition, use a Spectrometric Oil Analysis Program (SOAP) requesting concentrations of Iron (Fe), Vanadium (V) and Molybdenum (Mo) as indicators of main shaft bearing distress. Refer to JT8D Oil Monitoring Guide (P&W Part Number 821432), Section "G" for more information on SOAP. Do main oil filter, chip detectors (if installed) and SOAP inspection after first flight, at 15 hours, at 50 hours and at 100 hours. Do any corrective action required.

NOTE: JT8D Oil Monitoring Guide - Part No. 821432

This guide describes the inspections and tests that can be done to the engine oil to find if there is something that should be done before it leads to an untimely removal of the engine. This guide will show various inspections and tests, in its own section that will identify and describe each, as well as provide information as to the results that will be found and how to understand them to best maintain the engine. For this purpose, the guide also includes tables and illustrations that give guidelines or samples of “limits” used in the field for various analysis techniques.

(d) If an engine windmilled for more than 60 minutes with more than 10 psi (68.9 kPa) of continuous oil pressure after engine shutdown or engines that windmilled for any length of time with 10 psi (68.9 kPa) or less oil pressure after shutdown, operator must disassemble it for an Oil System Components Inspection.

NOTE: Oil System Components Inspection includes a visual and dimensional inspection of all Bearings (Main and Accessory), seals and gears in both Engine and Main Accessory Gearbox. Do a careful inspection of No. 2, 3, 4 and 5 bearings. Bearing cages must not show excessive wear. No ball or roller skidding, loss of hardness or shape because of overheating is permitted. Acceptable parts may be continued in service.

(2) Oil Pressure Interruption/Low Oil Pressure

CAUTION: ANY POWER OPERATION AT OR ABOVE IDLE WITH OIL PRESSURE OF 34 PSI (234.4 KPA) OR LESS REQUIRES ENGINE TO BE DISASSEMBLED FOR AN OIL SYSTEM COMPONENTS INSPECTION.

(a) Be careful to operate engine with sufficient oil pressure.

M. Breather Pressure

(1) General

(a) Breather pressure is differential between gearbox internal pressure and pressure at gearbox breather discharge port.

(b) Prior to checking breather pressure, it is important to remove all hardware for gearbox breather port, including short breather outlet duct. Experience has shown that this duct affects reading obtained, and correction factors have been unreliable.

(2) Limits

(a) During acceptance test, breather pressure as determined by the differential between engine accessory gearbox pressure and the pressure measured in the disposal system immediately adjacent to the accessory gearbox discharge port shall not exceed 1.8 psi (12.4 kPa). Allow engine to remain at Normal Takeoff two minutes minimum. Record the breather pressure (see NOTE below). Bring the engine power back to idle. Shut the engine down.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

NOTE: Engines with breather pressure tests conducted using continuous permanent recording equipment may be continued in service if the steady state limit of 1.8 psi (12.4 kPa) is exceeded for not more than 30 seconds and the pressure level does not exceed 3.0 psi (20.7 kPa). An engine accepted to this additional limit must be put on watch and a repeat test conducted every 50 cycles thereafter.

N. Fuel and Oil Leakage Limits

(1) Fuel or oil leakage from overboard drains, accessory drive seal drains, or No. 6 bearing sump is acceptable provided leakage is within the following limits:

Table 506

Location	Fluid	Allowable Leakage
Gearbox Starter Drive Overboard Drain	Oil	10 cc/hr
Gearbox Hydraulic Pump Drive Overboard Drain	Oil	10 cc/hr
No. 1, 2 And 3 Bearing Fluid Seal Drain	Oil	0.5 cc/min (10 drops per min) from each drain.
No. 4 Bearing Air Check Valve	Oil	Oil leakage from check valve at Idle power is normal.
Fuel Pump Drive Overboard Drain	Oil	10 cc/hr
Fuel Pump Drain	Fuel	60 cc/hr with engine running or shut down
Fuel Control Drain	Fuel	None
P&D Valve	Fuel	None
Exhaust Case - No. 6 Bearing Sump	Oil	Oil wetness not resulting in oil puddling within 20 minutes after engine shutdown.
Combustion Chamber Drain	Fuel	1. No leakage with engine running. 2. 90 cc maximum one time upon engine shutdown. 3. 60 cc/hr maximum after engine shutdown.
Combustion Chamber Drain and/or Wet 1st Stage Turbine Vanes/Blades	Oil	1. For engines without SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed:

NOTE: Oil leakage from the combustion chamber drain and/or wet 1st stage turbine vanes/ blades is not permitted if the engine is post SB A6196 - Improved No 5. bearing oil return and compartment sealing.

Table 506 (Continued)

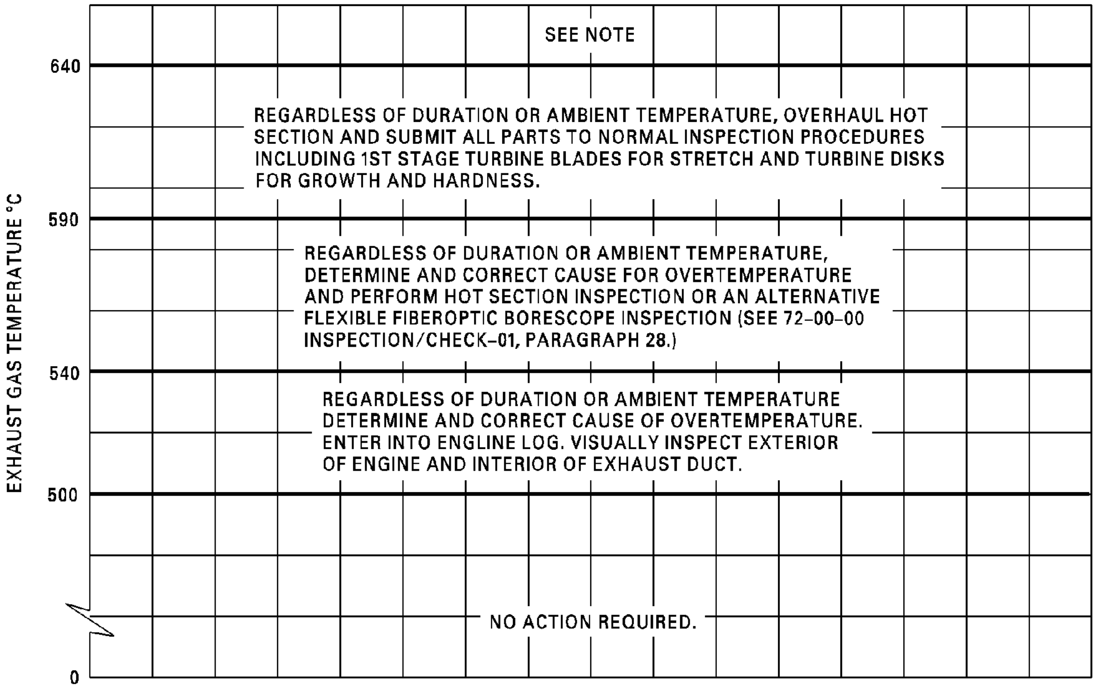
Location	Fluid	Allowable Leakage
		a. Be sure the condition seen is oil leakage and not fuel leakage. b. Operate the engine at idle for five minutes, then approximately cruise power or 1.8 EPR for five minutes, then at idle again for five minutes. Then shut down. c. After engine shutdown look for oil leakage from the combustion chamber drain (when it occurs, leakage usually starts ten minutes or less after shutdown). d. Engine removal for repair is necessary if oil leakage from the combustion chamber drain is more than 40 drops (or 2.0 cc), per minute. If oil leakage from the drain is less than 40 drops (or 2.0 cc), the engine can return to service with these limits: 1) Do a breather pressure test (must be in limits). 2) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection). 3) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 2. For engines with SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed: a. Be sure the condition observed is oil leakage and not fuel leakage. b. Do a visual inspection of the No. 4 - 5 scavenge oil temperature indicators as specified in SB A5944/SB 6101. c. If indicator color has changed, do corrective action as specified in SB A5944/SB 6101. d. If indicator color did not change, return engine to service with these limits: 1) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection). 2) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 3) Monitor the SB A5944/SB 6101 indicators at the intervals given in SB A5944/SB 6101.

(2) If leakage is found outside of the above limits the problem shall be repaired and the engine further tested using the following as a guide.

(a) For overboard drain leakage, run engine for five minutes at Max. Continuous and five minutes at Normal Takeoff.

(b) For accessory drive seal leakage and parting surface leakage, run engine for ten minutes at Max. Continuous and five minutes at Normal Takeoff.

JT8D-209, -217,-217A -217C, -219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



NOTE:

FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

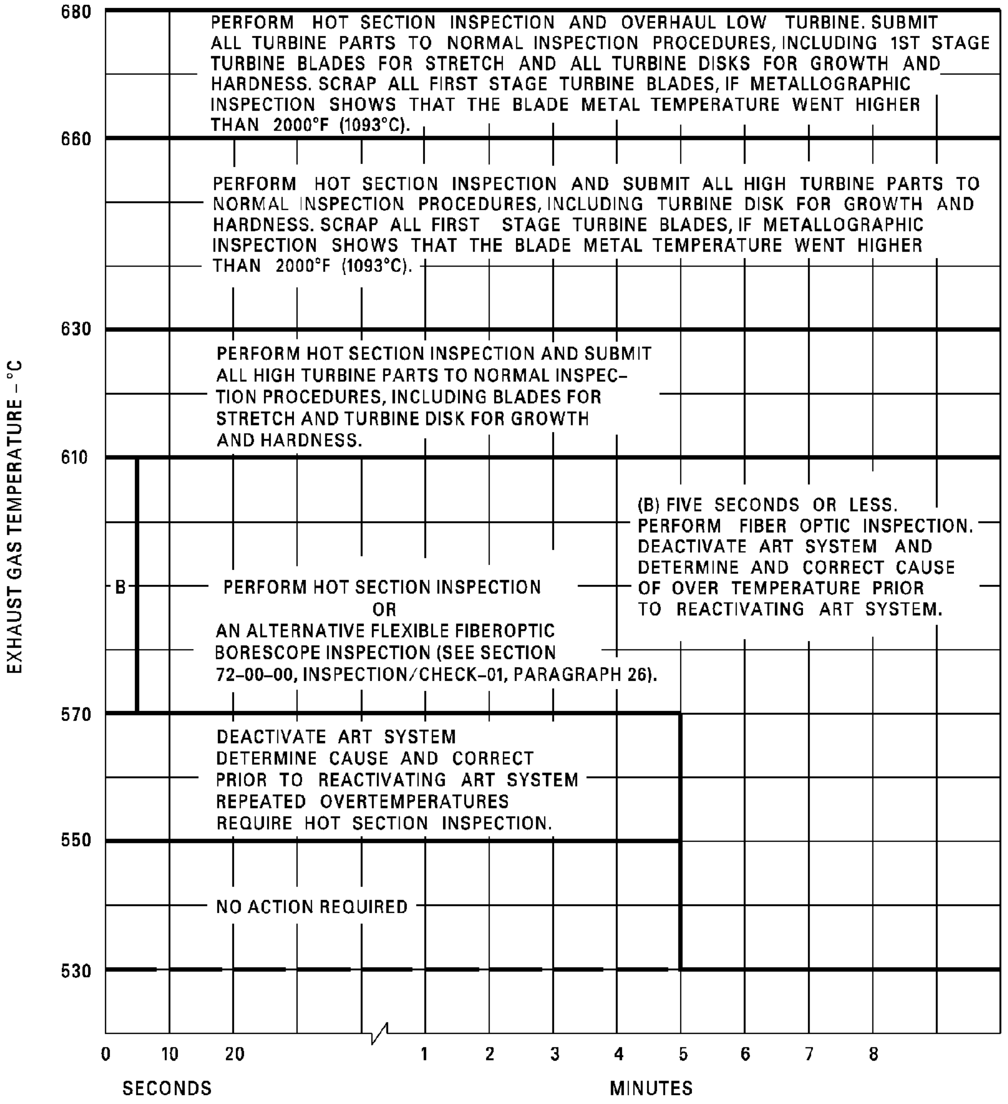
L-89085 (0299)

CAG(IGDS)

BBB2-72-40F

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 502/72-00-00-990-820

JT8D–209
NORMAL TAKEOFF
OVERTEMPERATURE LIMITS AND INSPECTION



PERFORM HOT SECTION INSPECTION AND OVERHAUL LOW TURBINE. SUBMIT ALL TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND ALL TURBINE DISKS FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING TURBINE DISK FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING BLADES FOR STRETCH AND TURBINE DISK FOR GROWTH AND HARDNESS.

(B) FIVE SECONDS OR LESS. PERFORM FIBER OPTIC INSPECTION. DEACTIVATE ART SYSTEM AND DETERMINE AND CORRECT CAUSE OF OVER TEMPERATURE PRIOR TO REACTIVATING ART SYSTEM.

PERFORM HOT SECTION INSPECTION
OR
AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE SECTION 72–00–00, INSPECTION/CHECK–01, PARAGRAPH 26).

DEACTIVATE ART SYSTEM
DETERMINE CAUSE AND CORRECT PRIOR TO REACTIVATING ART SYSTEM
REPEATED OVERTEMPERATURES REQUIRE HOT SECTION INSPECTION.

NO ACTION REQUIRED

NOTE:

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR–COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

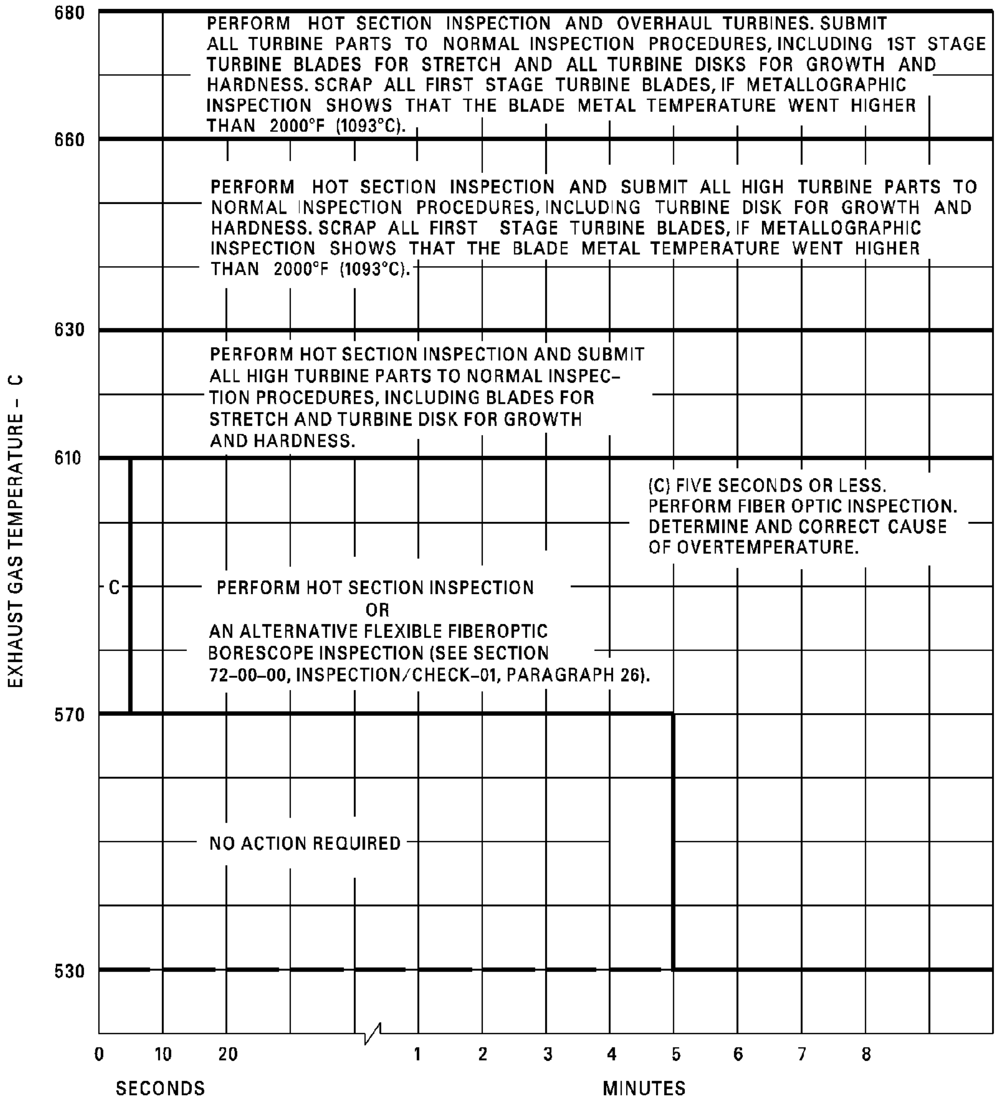
L–89086 (0299)

CAG(IGDS)

BBB2–72–163C

Normal Takeoff Overtemperature Limits and Inspection Procedures
Figure 503/72-00-00-990-821

JT8D-209
MAXIMUM TAKEOFF AND AIR STARTING
OVERTEMPERATURE LIMITS AND INSPECTION



PERFORM HOT SECTION INSPECTION AND OVERHAUL TURBINES. SUBMIT ALL TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND ALL TURBINE DISKS FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING TURBINE DISK FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING BLADES FOR STRETCH AND TURBINE DISK FOR GROWTH AND HARDNESS.

(C) FIVE SECONDS OR LESS. PERFORM FIBER OPTIC INSPECTION. DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE.

PERFORM HOT SECTION INSPECTION
OR
AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE SECTION 72-00-00, INSPECTION/CHECK-01, PARAGRAPH 26).

NO ACTION REQUIRED

NOTE:

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

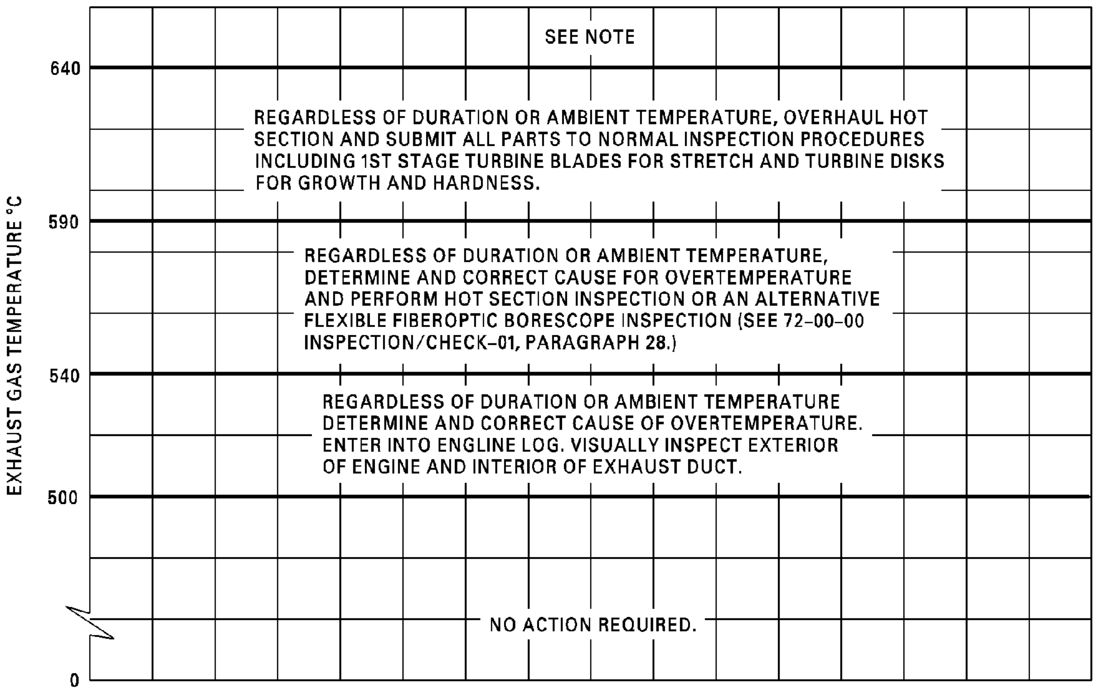
L-89087 (0299)

CAG(IGDS)

BBB2-72-164C

Maximum Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 504/72-00-00-990-822

JT8D-209, -217,-217A -217C, -219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, OVERHAUL HOT SECTION AND SUBMIT ALL PARTS TO NORMAL INSPECTION PROCEDURES INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND TURBINE DISKS FOR GROWTH AND HARDNESS.

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, DETERMINE AND CORRECT CAUSE FOR OVERTEMPERATURE AND PERFORM HOT SECTION INSPECTION OR AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE 72-00-00 INSPECTION/CHECK-01, PARAGRAPH 28.)

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE. ENTER INTO ENGLINE LOG. VISUALLY INSPECT EXTERIOR OF ENGINE AND INTERIOR OF EXHAUST DUCT.

NO ACTION REQUIRED.

NOTE:

FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

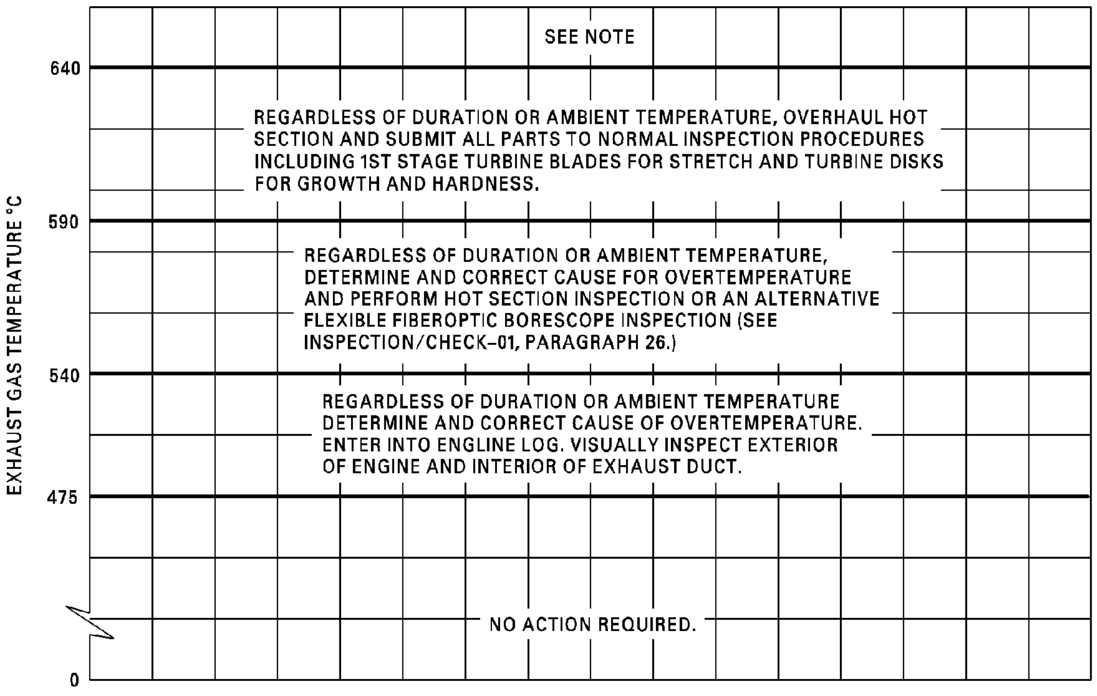
L-89085 (0299)

CAG(IGDS)

BBB2-72-40F

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 505/72-00-00-990-831

JT8D-209, -217,-217A -217C, -219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, OVERHAUL HOT SECTION AND SUBMIT ALL PARTS TO NORMAL INSPECTION PROCEDURES INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND TURBINE DISKS FOR GROWTH AND HARDNESS.

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, DETERMINE AND CORRECT CAUSE FOR OVERTEMPERATURE AND PERFORM HOT SECTION INSPECTION OR AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE INSPECTION/CHECK-01, PARAGRAPH 26.)

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE. ENTER INTO ENGINE LOG. VISUALLY INSPECT EXTERIOR OF ENGINE AND INTERIOR OF EXHAUST DUCT.

NO ACTION REQUIRED.

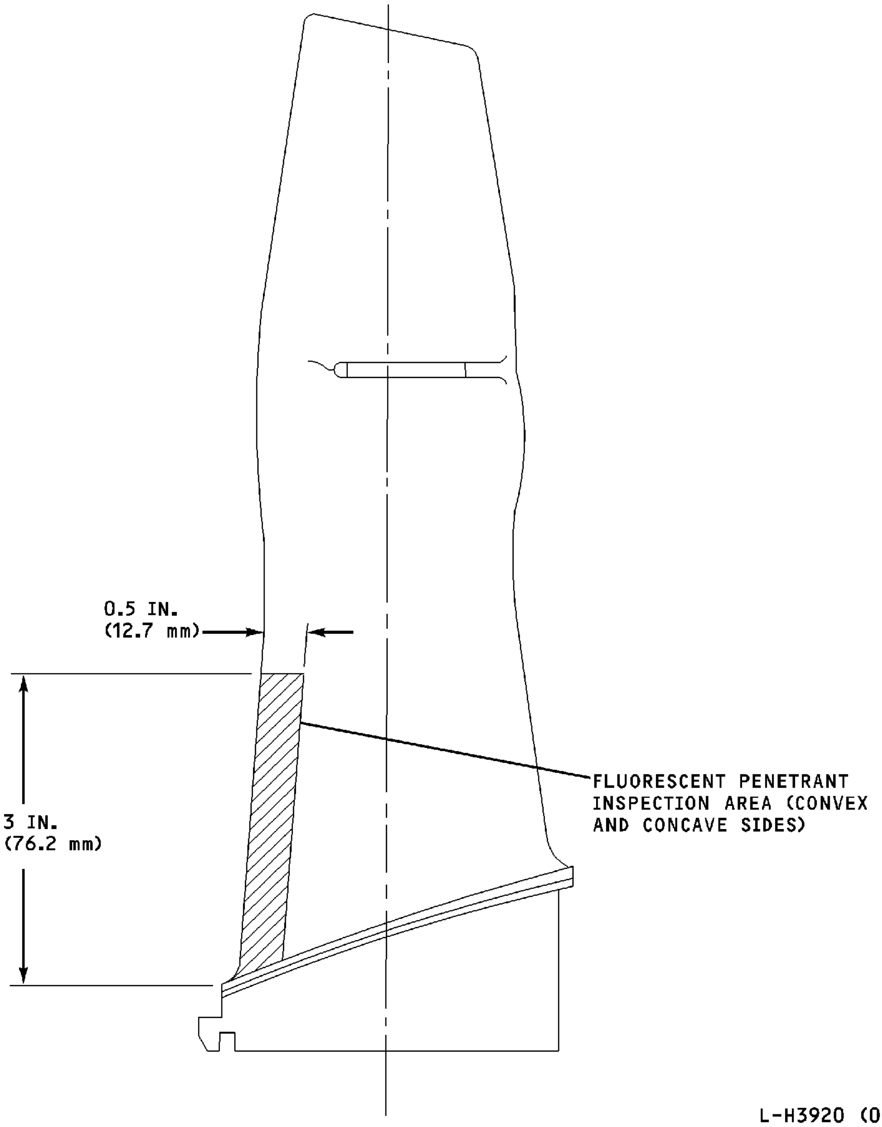
NOTE:

FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

CAG(IGDS)

BBB2-72-558A

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 506/72-00-00-990-832

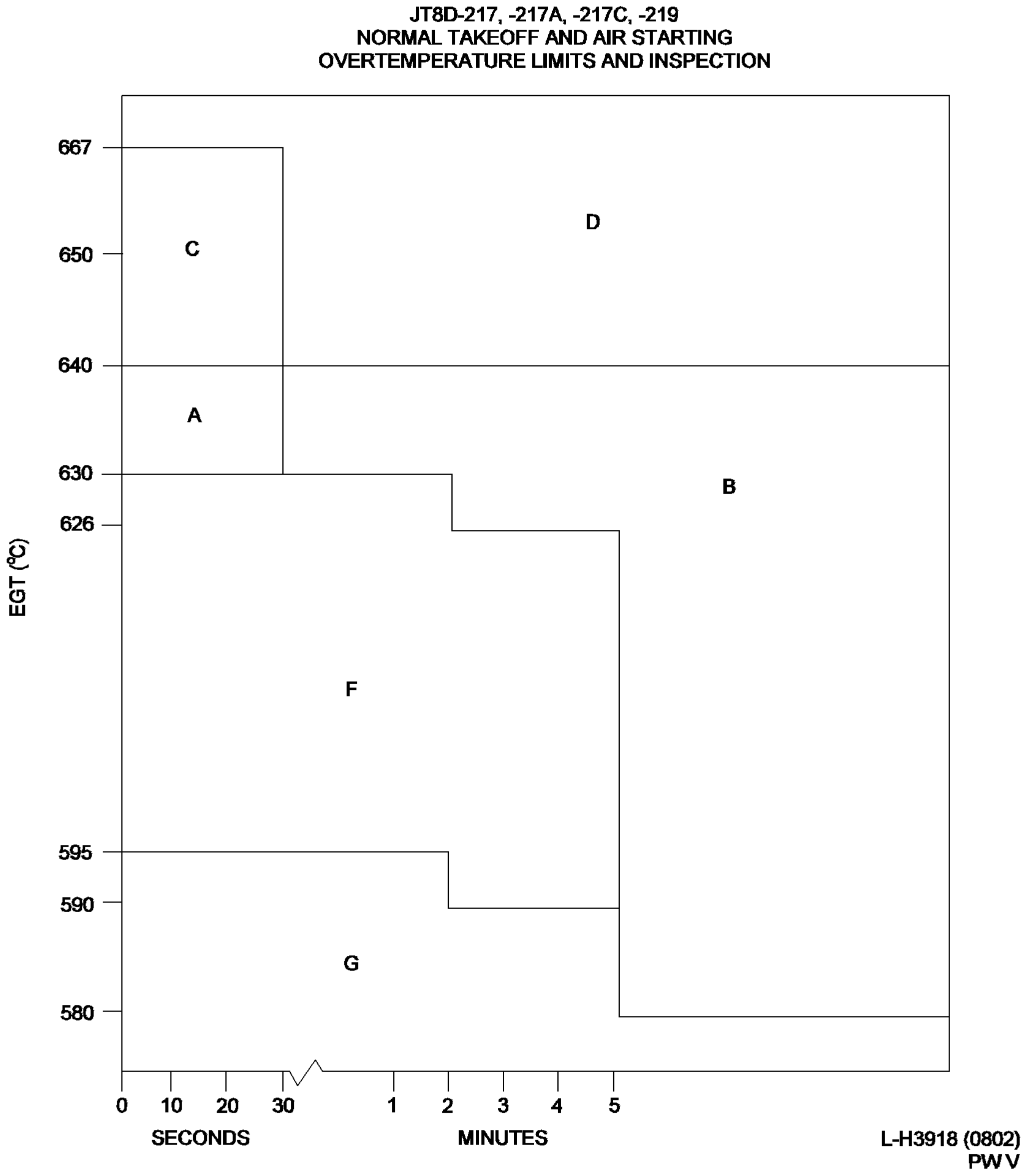


L-H3920 (0699)
PW V

CAG(IGDS)

BBB2-72-551

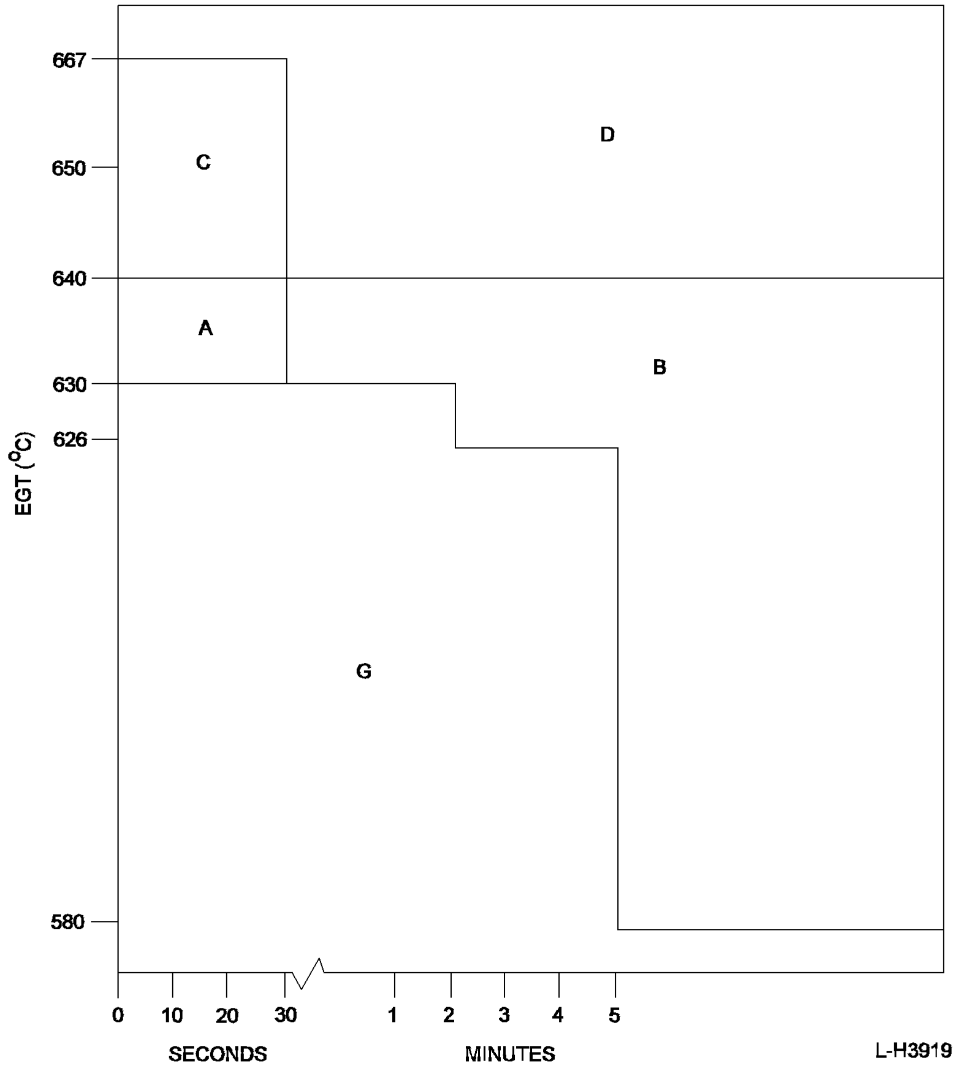
First Stage Fan Blade Inspection Zone
Figure 507/72-00-00-990-825



BBB2-72-549A
S0006554693V2

Normal Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 508/72-00-00-990-823

JT8D-217, -217A, -217C, -219
MAXIMUM TAKEOFF
OVERTEMPERATURE LIMITS AND INSPECTION



BBB2-72-550A
S0006554697V2

Maximum Takeoff Overtemperature Limits and Inspection Procedures
Figure 509/72-00-00-990-824

3. Inspection Prior To Test

A. Fuel System Inspection

(1) Fuel System

(a) Visually check all fuel system tubes and components for security and leakage.

(b) Remove, clean if necessary and install the fuel pump filters.

(c) Remove, clean if necessary and install the fuel control filters.

(d) Check the fuel system for the presence of water.

(e) Service the fuel system with an approved fuel conforming to SB 2016.

NOTE: The engine should be ground tested and trimmed using the same grade fuel as used for flight operations. Slight variations for any given lever position will result if alternate fuels are used.

B. Oil System Inspection

(1) Oil System

(a) Remove, disassemble, clean, and reinstall the main oil strainer. Replace filter if cartridge type.

(b) Visually check all of the oil system tubes and components for security and leakage.

(c) Fill the oil tank with an approved oil conforming to Specification 521 Synthetic Oil.

NOTE: Approved oils are listed in Turbojet Engine Service Bulletin No. 238.

CAUTION: UP TO TWO GALLONS OF OIL MAY BE IN THE SCAVENGE SECTIONS; THEREFORE, OIL MUST NOT BE ADDED TO THE TANK UNTIL THE SCAVENGE SECTIONS ARE CLEANED. IF THE ABOVE PROCEDURE IS NOT FOLLOWED, EXCESSIVE OIL MAY BE ADDED WHICH WILL RESULT IN A BUILDUP OF SUFFICIENT INTERNAL PRESSURE TO RUPTURE THE TANK DURING ENGINE OPERATION.

(d) If oil is required after starting the engine, the engine shall be operated for approximately one minute at IDLE speed. This is required to make certain that any oil which may be in the scavenge section of the engine is returned to the tank, thereby assuring an accurate oil level check.

C. Electrical System Inspection

(1) Electrical System

(a) Check the ignition system components for security.

WARNING: BECAUSE THE VOLTAGE TO THE SPARK IGNITERS IS DANGEROUSLY HIGH, THE IGNITION SWITCH MUST BE IN THE "OFF" POSITION BEFORE REMOVAL OF ANY OF THE IGNITION SYSTEM COMPONENTS. APPROXIMATELY THREE MINUTES OF TIME MUST ELAPSE BETWEEN THE OPERATION OF THE IGNITION SYSTEM AND THE REMOVAL OF COMPONENTS WHEN A SPARK IGNITER LEAD IS DETACHED FROM A SPARK IGNITER, TOUCH THE END OF THE LEAD TO THE SHELL OF THE IGNITER TO DISSIPATE THE RESIDUAL ENERGY.

(b) Remove both spark igniters; check and reinstall.

D. Instrumentation System Inspection

(1) Instrumentation System

(a) Check engine instrumentation for security and general condition.

(b) Inspect the pressure sensing probes for security.

(c) Visually check all indicating thermocouples for security.

(d) Check the thermocouple harness and all lead insulations and shields for chafing and security.

E. Engine Controls Inspection

(1) Engine Controls

(a) Check the power lever for full travel, ease of movement and security.

NOTE: To prevent dilution of the bearing lubrication medium, protect the prepacked bearings used in the power cross shaft assembly during any washing process. The same precautions must be taken when fuel lines near this assembly are disconnected and fuel is, or may be, in these lines.

(b) Inspect the compressor bleed valve, override control, pressure ratio bleed control, and the air tubes for security.

F. Run-Up Area and Engine Inlet Duct Inspection

(1) Run-Up Area and Engine Inlet Duct

(a) Prior to starting the engine, the inlet must be thoroughly inspected and cleaned of possible loose nuts, bolts, tools and other objects which could cause engine damage and possible subsequent failure.

(b) Examine the inlet and exhaust areas to ensure against the presence of foreign objects which could, under some circumstances, enter the engine.

4. Engine Test Procedure

A. Starting Procedure for Pneumatic and Combustion Starters. (GENERAL, SUBJECT 71-00-00)

B. Satisfactory Start. (GENERAL, SUBJECT 71-00-00)

C. Unsatisfactory Start. (GENERAL, SUBJECT 71-00-00)

D. Unsatisfactory Start Procedure. (GENERAL, SUBJECT 71-00-00)

E. Clear Engine Procedure. (GENERAL, SUBJECT 71-00-00)

F. Determination of Corrected N_2 Speed. (Figure 510 and Figure 511)

(1) Corrected N_2 speed is determined as shown in Figure 510.

(2) JT8D engine experience indicates a recommended high rotor data plate speed deterioration limit of plus 1.8 percent minus 0.8 percent corrected RPM be established.

G. Max. Observed Exhaust Gas Temperature & Spread Check.

(1) A check of the exhaust gas measurement system shall be made following a stabilization at Normal Takeoff power. Remove four screws and cover from thermocouple cable junction box located at 7 o'clock on rear rail of turbine exhaust outer duct. Remove nine nuts, chromel bus bar and two leads. Position PWA 45563 Adapter on the studs and secure with nuts previously removed. Torque nuts to 15 - 18 in-lb. (1.695 - 2.034 N·m), then connect instrumentation. Maximum allowable T_{t7} for any single probe reading is the maximum limit with averaging harness plus 110°F (61°C). Readings from each T_{t7} probe shall be recorded and maximum acceptable spread shall not exceed 230°F (127.8°C). Remove PWA 45563 Adapter, reinstall two leads, chromel bus bar and nine nuts. Torque nuts to 15 -18 in-lb. (1.695 - 2.034 N·m), then install and secure junction box cover.

(2) The JT8D Part Power Trim temperature spread check shall not exceed 230°F (127.8°C).

H. Shutdown Procedure. (GENERAL, SUBJECT 71-00-00).

I. Anti-Surge Bleed Operation Limits Refer to Paragraph 6.F..

N2 CORRECTION

(1) Corrected N2 (%) $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}}$

Where: $\sqrt{\theta} = \sqrt{\dfrac{\text{Compressor Inlet Temperature}\,^{\circ}\text{K}}{288}}$

(2) From the Inlet Temperature Correction Factor Chart determine N2 correction factor ($\sqrt{\theta}$) for compressor inlet temperature -

(3) Divide observed N2 speed by $\sqrt{\theta}$ -

Example: Inlet temperature = 30°C (86°F)

$\sqrt{\theta}$ (From the Inlet Temperature Correction Factor Chart) = 1.026

Observed N2 = 87.5%

Corrected N2 $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}} = \dfrac{87.5\%}{1.026} = 85.3\%$

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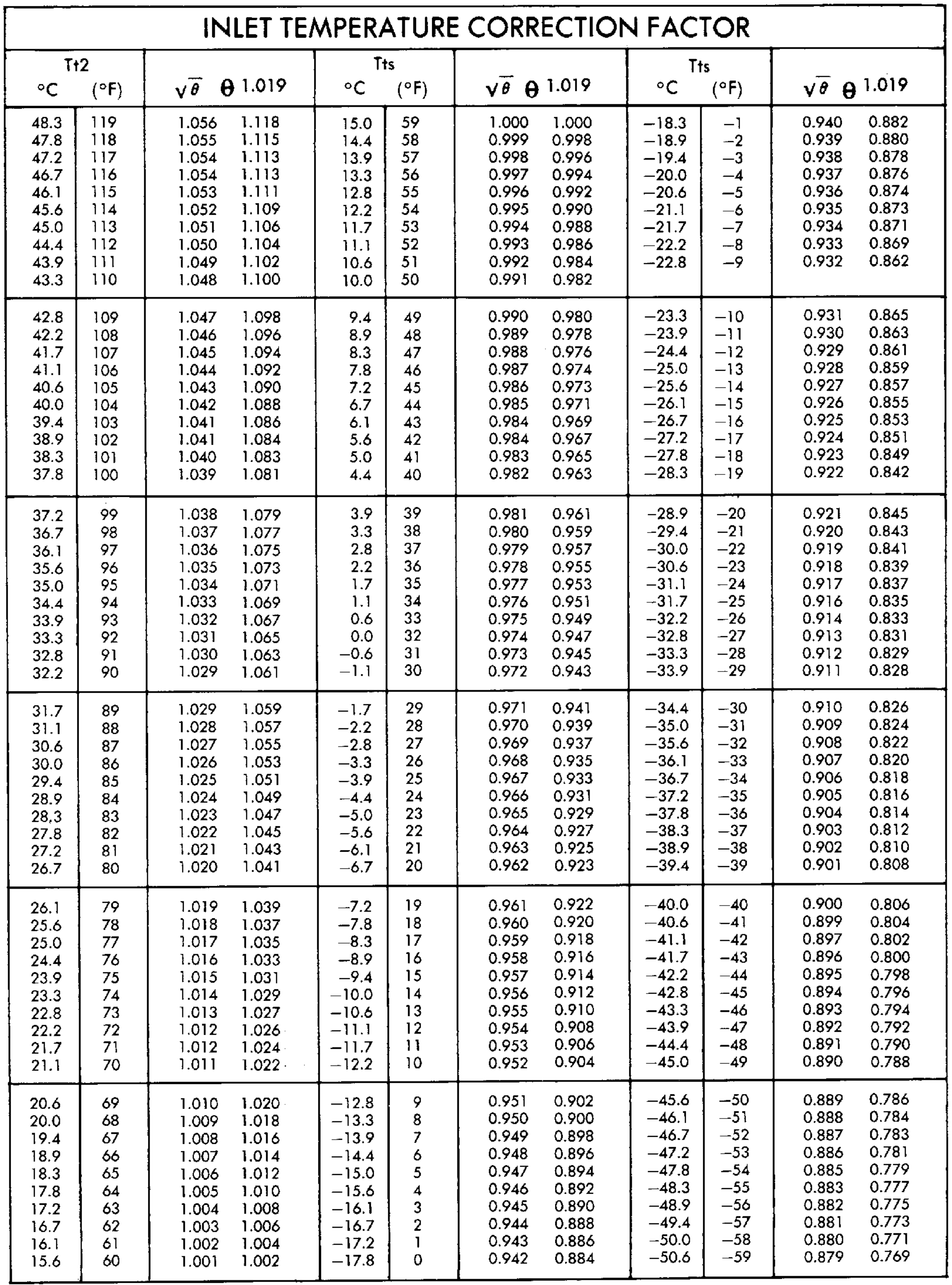
Rotor Speed Correction
Figure 510/72-00-00-990-833



INLET TEMPERATURE CORRECTION FACTOR

Tt2 °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	Tts °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	Tts °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$
48.3	119	1.056	1.118	15.0	59	1.000	1.000	−18.3	−1	0.940	0.882
47.8	118	1.055	1.115	14.4	58	0.999	0.998	−18.9	−2	0.939	0.880
47.2	117	1.054	1.113	13.9	57	0.998	0.996	−19.4	−3	0.938	0.878
46.7	116	1.054	1.113	13.3	56	0.997	0.994	−20.0	−4	0.937	0.876
46.1	115	1.053	1.111	12.8	55	0.996	0.992	−20.6	−5	0.936	0.874
45.6	114	1.052	1.109	12.2	54	0.995	0.990	−21.1	−6	0.935	0.873
45.0	113	1.051	1.106	11.7	53	0.994	0.988	−21.7	−7	0.934	0.871
44.4	112	1.050	1.104	11.1	52	0.993	0.986	−22.2	−8	0.933	0.869
43.9	111	1.049	1.102	10.6	51	0.992	0.984	−22.8	−9	0.932	0.862
43.3	110	1.048	1.100	10.0	50	0.991	0.982				
42.8	109	1.047	1.098	9.4	49	0.990	0.980	−23.3	−10	0.931	0.865
42.2	108	1.046	1.096	8.9	48	0.989	0.978	−23.9	−11	0.930	0.863
41.7	107	1.045	1.094	8.3	47	0.988	0.976	−24.4	−12	0.929	0.861
41.1	106	1.044	1.092	7.8	46	0.987	0.974	−25.0	−13	0.928	0.859
40.6	105	1.043	1.090	7.2	45	0.986	0.973	−25.6	−14	0.927	0.857
40.0	104	1.042	1.088	6.7	44	0.985	0.971	−26.1	−15	0.926	0.855
39.4	103	1.041	1.086	6.1	43	0.984	0.969	−26.7	−16	0.925	0.853
38.9	102	1.041	1.084	5.6	42	0.984	0.967	−27.2	−17	0.924	0.851
38.3	101	1.040	1.083	5.0	41	0.983	0.965	−27.8	−18	0.923	0.849
37.8	100	1.039	1.081	4.4	40	0.982	0.963	−28.3	−19	0.922	0.842
37.2	99	1.038	1.079	3.9	39	0.981	0.961	−28.9	−20	0.921	0.845
36.7	98	1.037	1.077	3.3	38	0.980	0.959	−29.4	−21	0.920	0.843
36.1	97	1.036	1.075	2.8	37	0.979	0.957	−30.0	−22	0.919	0.841
35.6	96	1.035	1.073	2.2	36	0.978	0.955	−30.6	−23	0.918	0.839
35.0	95	1.034	1.071	1.7	35	0.977	0.953	−31.1	−24	0.917	0.837
34.4	94	1.033	1.069	1.1	34	0.976	0.951	−31.7	−25	0.916	0.835
33.9	93	1.032	1.067	0.6	33	0.975	0.949	−32.2	−26	0.914	0.833
33.3	92	1.031	1.065	0.0	32	0.974	0.947	−32.8	−27	0.913	0.831
32.8	91	1.030	1.063	−0.6	31	0.973	0.945	−33.3	−28	0.912	0.829
32.2	90	1.029	1.061	−1.1	30	0.972	0.943	−33.9	−29	0.911	0.828
31.7	89	1.029	1.059	−1.7	29	0.971	0.941	−34.4	−30	0.910	0.826
31.1	88	1.028	1.057	−2.2	28	0.970	0.939	−35.0	−31	0.909	0.824
30.6	87	1.027	1.055	−2.8	27	0.969	0.937	−35.6	−32	0.908	0.822
30.0	86	1.026	1.053	−3.3	26	0.968	0.935	−36.1	−33	0.907	0.820
29.4	85	1.025	1.051	−3.9	25	0.967	0.933	−36.7	−34	0.906	0.818
28.9	84	1.024	1.049	−4.4	24	0.966	0.931	−37.2	−35	0.905	0.816
28,3	83	1.023	1.047	−5.0	23	0.965	0.929	−37.8	−36	0.904	0.814
27.8	82	1.022	1.045	−5.6	22	0.964	0.927	−38.3	−37	0.903	0.812
27.2	81	1.021	1.043	−6.1	21	0.963	0.925	−38.9	−38	0.902	0.810
26.7	80	1.020	1.041	−6.7	20	0.962	0.923	−39.4	−39	0.901	0.808
26.1	79	1.019	1.039	−7.2	19	0.961	0.922	−40.0	−40	0.900	0.806
25.6	78	1.018	1.037	−7.8	18	0.960	0.920	−40.6	−41	0.899	0.804
25.0	77	1.017	1.035	−8.3	17	0.959	0.918	−41.1	−42	0.897	0.802
24.4	76	1.016	1.033	−8.9	16	0.958	0.916	−41.7	−43	0.896	0.800
23.9	75	1.015	1.031	−9.4	15	0.957	0.914	−42.2	−44	0.895	0.798
23.3	74	1.014	1.029	−10.0	14	0.956	0.912	−42.8	−45	0.894	0.796
22.8	73	1.013	1.027	−10.6	13	0.955	0.910	−43.3	−46	0.893	0.794
22.2	72	1.012	1.026	−11.1	12	0.954	0.908	−43.9	−47	0.892	0.792
21.7	71	1.012	1.024	−11.7	11	0.953	0.906	−44.4	−48	0.891	0.790
21.1	70	1.011	1.022	−12.2	10	0.952	0.904	−45.0	−49	0.890	0.788
20.6	69	1.010	1.020	−12.8	9	0.951	0.902	−45.6	−50	0.889	0.786
20.0	68	1.009	1.018	−13.3	8	0.950	0.900	−46.1	−51	0.888	0.784
19.4	67	1.008	1.016	−13.9	7	0.949	0.898	−46.7	−52	0.887	0.783
18.9	66	1.007	1.014	−14.4	6	0.948	0.896	−47.2	−53	0.886	0.781
18.3	65	1.006	1.012	−15.0	5	0.947	0.894	−47.8	−54	0.885	0.779
17.8	64	1.005	1.010	−15.6	4	0.946	0.892	−48.3	−55	0.883	0.777
17.2	63	1.004	1.008	−16.1	3	0.945	0.890	−48.9	−56	0.882	0.775
16.7	62	1.003	1.006	−16.7	2	0.944	0.888	−49.4	−57	0.881	0.773
16.1	61	1.002	1.004	−17.2	1	0.943	0.886	−50.0	−58	0.880	0.771
15.6	60	1.001	1.002	−17.8	0	0.942	0.884	−50.6	−59	0.879	0.769

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Inlet Temperature Correction Factor Chart
Figure 511/72-00-00-990-834

5. Repair/Test Reference

(Table 507)

A. General

(1) Repair/test reference table lists various repairs, replacements and reinstallations and corresponding test to be performed following these actions. When more than one maintenance action has been done, combine different features of two or more tests, eliminate duplication, and perform resultant test during one period of operation. Where multiple tests each require single power setting, higher power setting shall be used.

(2) In order to achieve high degree of accuracy, it is recommended that all tests be conducted in P&W approved indoor test facility previous to installing engine in aircraft. However, in cases where such test facility was not available or if operator prefers to test engine on aircraft, test requirements are indicated in Table 507.

(3) It should be understood that quality of test data from an on-the-wing engine test may not be as accurate as data generated from indoor engine test facility. While quality of on-the-wing test data should be sufficient to determine if engine is acceptable, operator should be willing to sacrifice certain degree of troubleshooting or trend monitoring capability when relying on installed engine data.

Table 507 Repair/Test Reference

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Accessory Drive Seals	A
Anti-icing Air Shutoff Actuator And Valve	*[2]
Average Pressure Probe P_{t7} (8 Required)	B
Combustion Area Inspection	B
Combustion Chambers	B
Combustion Chamber Duct	F
Combustion Chamber Inner Case	F
Combustion Chamber And Turbine Fan Ducts	C
Compressor Inlet Duct	A
Compressor Inlet Group	A
Compressor Inlet and Front Compressor Section	B, I
Compressor Intermediate Group	F
Constant Speed Drive/Alternator Drive Oil Seal	A
Differential Fluid Pressure Switch	C
Diffuser Group	F
Diffuser Outer Fan Duct Group	C
Eighth Stage Bleed Valve	E
Engine Exhaust Case Section	G
Engine Oil Tank	A
Engine Oil Tank Drain Valve	None

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Fan Exhaust (Mixer) Rear Outer Duct	None
Fan Exhaust Outer Rear (Transition) Duct	None
Fan And Turbine Exhaust Duct (Mixer)	None
Fan Exit Stator Segments	None
First Stage Compressor (Fan) Blades	I(4)
First Stage Compressor Disk And Blade Assembly (Fan)	G(5), I(4)
First Stage Turbine Vanes (Through Hot Section With Turbines Installed)	B, H
First Stage Turbine Vanes (Turbines Removed)	F
Front Accessory Drive Group	A
Front Compressor Drive Turbine Group	F
Front Compressor Drive Turbine Group And Engine Exhaust Case Section Group	F
Front Compressor Drive Turbine Rotor And Stator Assembly	F
Front Compressor Rotor And Stator Assembly	G, I
Front Fan Case	A
Fuel Control (Replacement Fuel Control)	D, H
Fuel Control Condensation Trap	None
Fuel Control Main Filter	C
Fuel Deicing Air Shutoff Actuator And Valve	*[2]
Fuel Deicing Heater Assembly	C
Fuel Nozzle And Support Assemblies	B, H
Fuel Manifold Assembly	B, H
Fuel/Oil Cooler And Seals	C (6)
Fuel/Oil Cooler Bypass Valve And Seals	C (6)
Fuel Pressurizing And Dump Valve	C(3)
Fuel/Oil Cooler Inlet Tube And Seals	C (6)
Fuel/Oil Cooler Outlet Sensing Tube And Seals	C (6)
Fuel Pressurizing And Dump Valve Strainer	C
Fuel Pump (Same Fuel Control)	B(2), H
Fuel Pump Drive Oil Seal	A
Fuel Pump Filter	C
Fuel Pump And Fuel Control Package (Different Fuel Control)	D(2), H
Gearbox Coupling (Constant Speed Drive)	A
Gearbox Deairator Oil Seal	A
Hydraulic Pump Drive Oil Seal	A

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Igniter Plug (2 Required)	*[1]
Ignition Cable (2 Required)	*[1]
Ignition Exciter	*[1]
Main Accessory Gearbox Assembly (Same Fuel Control)	B
Main Accessory Gearbox Group (Same Fuel Control) (And Fuel Control Connecting Linkage)	B
Main Gearbox Drive Bevel Gearshaft And Bearings	B
Main Oil Filter (Strainer) And Seals	C (6)
Main Oil Pump And Seals	C (6)
N_1 Tachometer Drive Oil Seal	A
N_2 Tachometer Drive Gearshaft Oil Seal	A
No. 1 Bearing	G, I
No. 1 Bearing Air Sealing Ring And Seal Assembly	G, I
No. 1 Bearing Oil Scavenge Pump	A
No. 2 Bearing	F
No. 2 Bearing Seal Assembly	G, I
No. 3 Bearing And Seal	F
No. 4 Bearing	F
No. 4 Bearing Seal Assembly	F
No. 4 Bearing Sealing Ring	F
No. 4 And 5 Bearing Oil R Pressure/Scavenge Tube (External) And Seals	A
No. 4 And 5 Bearing Oil Breather Tube (External) And Seals	B
No. 4 And 5 Bearing Oil Scavenge Pump	F
No. 4 1/2 Bearing, Seals And Seal Spacers	F
No. 5 Bearing And Seal Assembly	F
No. 6 Bearing And Seals	G, I
No. 6 Bearing Oil Scavenge Pump	A
Oil Filter Pressure Relief Valve And Seals	C (6)
Oil Pressure Relief Valve Assembly	C(1), (6)
Power Lever Cross Shafts	B
Pressure Ratio Bleed Control	E
Rear Compressor And Diffuser Section	F
Rear Compressor Drive Turbine Rotor And Shaft Assembly	F
Rear Compressor Drive Turbine Group	F

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Rear Compressor Exit Stator Assembly	F
Rear Compressor Through The Rear Compressor Drive Turbine Section	F
Rear Compressor Rotor And Stator Assembly	F
Rear Fan Case	G
Starter Drive Gearshaft Coupling	A
Starter Drive Oil Seal	A
Thermocouple - T_{t7} (8 Required)	None
Thermocouple Box And Cable Assembly - T_{t7}	None
Total Pressure Probe - P_{t2}	E
Turbine Exhaust Cone And Duct	None
Turbine Nozzle Group	F
Turbine Shaft Inner Heat shield Assembly	F
Turbine Shaft Outer Heat shield Assembly	F
13th Stage Bleed Valve	E
13th Stage Compressor Sealing Ring	F

(1) When engine oil pressure adjustment is required, install 0 - 50 PSIG (0.0 - 344.7 kPa) direct-reading gage to LP2 tap on main oil pressure manifold, vented to LV3 tap on main accessory gearbox housing. Adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa at Idle. 100°F (38°C) oil temperature is recommended during oil pressure adjustment. See Paragraph 8..

(2) After replacing fuel pump and performing engine test run, torque fuel pump quick-disconnect nut per PAGEBLOCK 73-00-00/601.

(3) During and after this test, carefully inspect for fuel leakage at fuel manifold inlet tube to P&D valve tube end fittings. No Leakage is permitted.

(4) See the locations that follow for a 24 hour flyback time limit permitted before the vibration check is necessary:

- (a) Section ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1 - Inspect First Stage Compressor Blades.
- (b) Section PAGEBLOCK 72-33-21/401 - Replace First Stage Compressor Blades.
- (c) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.

(5) See the location that follows for a 24 hour flyback time limit permitted before the breather pressure check is necessary:

- (a) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.

(6) Test A (Ground Check at Idle) is an option to Test C for leak check of these replaced parts, but Test A will not give the increased oil pressure that is typical during engine accelerations. If an oil leak problem is possible, use Test C (with the thrust level modification specified for leak check) to see if there are oil leaks.

*[1] Aural Check Igniter Firing With Engine Not Running.

*[2] Observe Valve Position While Actuating Valve With Engine Not Running.

6. Test For Repaired Engines

A. When cleaning engines prior to test, following precautions must be taken.

CAUTION: IF FUEL LINES ARE TO BE DISCONNECTED, PRE-PACKED BEARINGS IN THE AREA MUST BE PROTECTED FROM ANY LOST FUEL.

(1) Protect all prepacked bearings, such as cross-shaft or control rod linkage bearings.

(2) Protect pressure ratio bleed control.

(3) Protect silicone rubber shock mounts on oil tank and oil tank strap. Wash down area as soon as possible after washing with cleaning solution.

B. Test A - Ground Check at Idle

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Allow engine to run at IDLE for minimum of three minutes for oil system repair/replacement as required for oil temperature to reach 100°F (38°C).

(4) Shut down. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

C. Test B - Ground Check at Normal Takeoff

(1) Inspect and clean engine test area.

(2) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Operate engine at IDLE until readings have stabilized and oil temperature reaches minimum of 100°F (38°C).

(4) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(5) Stabilize for three minutes at Normal Takeoff.

(6) Check that oil pressure, oil temperature and EGT are within limits of Table 503.

(7) Retard power lever to IDLE and operate engine for five minutes.

(8) Shut down engine (GENERAL, SUBJECT 71-00-00, Page 501) and perform normal engine inspection procedures. (GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 72-00-00/201)

NOTE: It is not necessary to inspect the oil filter if the oil system was not disturbed and no oil wetted components were replaced during the maintenance action.

D. Test C - Ground Check at 3000 lb/hr (1360 kg) Fuel Flow

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start engine (GENERAL, SUBJECT 71-00-00, Page 501) and allow to stabilize at idle for minimum of three minutes.

(3) Advance power lever as necessary until minimum of 3000 lb/hr of fuel flow is observed. Maintain for minimum of two minutes.

(4) After completion of check, return power lever to IDLE.

(5) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

E. Test D - Part Power Trim Check. (GENERAL, SUBJECT 71-00-00, Page 501)

F. Test E - Ground Check for Bleed System Operation. (Figure 512)

NOTE: This check is only applicable to the engine surge bleed system. With engines which have a 6th stage bleed system, refer to PAGEBLOCK 72-00-03/101 for a functional check. It is not possible to do a ground check of the 6th stage bleed system because the bleed closure and opening does not give a satisfactory engine parameter change.

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Run engine at IDLE until oil temperature reaches 100°F (38°C) minimum.

(4) Slowly accelerate engine and record N_1 speed at which anti-surge bleed valves close. Bleed closing is indicated by sudden increase in EPR.

(5) Slowly decelerate engine from stabilized point just above bleed valve closing and record N_1 speed at which anti-surge bleed valves open. Bleed valve opening is indicated by sudden decrease in EPR.

(6) Check bleed valve opening and closing per Figure 512.

(7) Retard power lever to Idle and shut down engine.

(8) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

(9) If anti-surge bleed valves do not open and close within limits of Figure 512, refer to PAGEBLOCK 72-00-03/101.

G. Test F - Acceptance and Performance

(1) Instrumentation Required

  (a) N_1 - cockpit

  (b) N_2 - cockpit

  (c) EGT - cockpit

  (d) EPR - cockpit

  (e) Fuel Flow - cockpit

  (f) Oil pressure - cockpit

  (g) Oil temperature - cockpit

  (h) PCP - external instrumentation - 0 - 200 psi (0.0 - 1379.0 kPa) range, measured at PCP fitting located on left side of engine diffuser case high pressure service bleed port near PS3 filter.

  (i) PS4 - external instrumentation - 0 - 300 psi (0.0 - 2068.4 kPa) range, measured at PS4 fitting located on right side of engine diffuser case high pressure service bleed port at upper end of bleed valve actuation pressure supply line.

  (j) P_{t7} - external instrumentation - 0 - 50 psi (0.0 - 344.7 kPa) range measured at P_{t7} line test fitting.

  (k) Breather pressure - external instrumentation - 09 - 30 psi (0.0 - 206.8 kPa) range. Refer to Paragraph 6.H. for installation.

  (l) Ambient temperature - Laboratory Quality Mercury Thermometer

  (m) Ambient pressure - Local facilities

  (n) Install vibration pickups at locations indicated in Figure 513. Connect to vibration monitoring instrumentation, including low frequency (40 cps) filter.

(2) To ensure accuracy of P_{t7} system, pressure check system as follows:

(a) Connect PWA 46415 (formerly 45513) Adapter to P_{t7} manifold outlet and attach source of dry, filtered compressed air, with PWA 21875 Regulator.

(b) Apply 35 - 45 PSIG (241.3 - 310.3 kPa) air pressure to P_{t7} system.

(c) Use soap and water solution, check each connection in manifold and at probes for leakage. No leakage is permitted.

(d) Disconnect and remove test equipment and reconnect manifold outlet.

(3) Verify proper exhaust nozzle area as specified by airframe manufacturer.

NOTE: Engine bleed and electrical loads must be minimized during test. Fuel heater, generator, air conditioning packs, anti-icing and low pressure airbleed must be off. However, generator cooling airbleed and hydraulic pumps shall be set as "low" or "no load".

(4) Inspect and clean engine test area.

(5) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Operate engine at idle for two minutes until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(7) Shut down engine and conduct Part Power Trim check per GENERAL, SUBJECT 71-00-00, Page 501.

(8) Service engine oil system and record oil level.

(9) Restart engine. (GENERAL, SUBJECT 71-00-00, Page 501). Inspect engine for evidence of fuel or oil leak.

(10) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(a) During acceleration, check that operation of anti-surge bleed valves is within limits of Figure 512, or applicable limits in airframe manufacturer's maintenance manual. If bleed valve operation is not within limits of Figure 512, refer to PAGEBLOCK 72-00-03/101.

(b) During acceleration, mark point on power lever pedestal where EPR is 0.03 EPR ratios above bleed closing point and preserve this mark for deceleration bleed control system check.

(c) Monitor engine vibration during acceleration to Normal Takeoff.

(d) Stabilize for three minutes at Normal Takeoff. Record a full set of the readings in Paragraph 6.G.(1) and make a mark to record the power lever position. Calculate 95 percent of Normal Takeoff N_2 and keep this result for the acceleration check.

(e) Check operation of fuel deicing system during this Normal Takeoff running. Open deicing air valve and observe change in fuel temperature using cockpit instrumentation. Fuel temperature must increase minimum of 104°F (58°C) in less than one minute after valve is opened. Do not adjust power lever for resultant loss of EPR. Do not allow fuel temperature to exceed 176°F (80°C). Close fuel deicing air valve.

(f) During Takeoff running, actuate engine anti-icing system. EPR should decrease by 0.08 - 0.11 ratio, when engine anti-icing air is turned on. Do not adjust power lever for resultant loss of EPR. Close engine anti-icing valves.

(11) Retard power lever to Descent/Ground Idle and deenergize idle select solenoid.

(12) Operate the engine at Approach Idle for five minutes. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, calculate Normal Takeoff EPR and do the procedure again from Paragraph 6.G.(13).

(13) Advance power lever slowly (in 30 seconds minimum) to Normal Takeoff EPR determined in Paragraph 6.G.(10) and stabilize for no more and no less than 60 seconds.

(14) Retard the power lever to Approach Idle, and in not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the mark made on the quadrant in Paragraph 6.G.(10)(d), in not more than one second.

(15) Record with a stop watch the time from when the power lever starts to move to when the engine gets to the 95 percent N_2 limit as calculated in Paragraph 6.G.(10)(d).

(16) Go back to Approach Idle and do Paragraph 6.G.(12) thru Paragraph 6.G.(14) two times again.

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(17) Calculate the average of all three acceleration times and compare this average to the limit curve calculated by the airframe manufacturer for this procedure.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in this maintenance procedure (in which a stop watch is used) are to make sure that the acceleration time is accurately calculated, with the same result each time. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Takeoff N_2) as calculated from test cell procedures.

(18) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

(19) Retard power lever to EPR = 1.75. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(20) Retard power lever to EPR = 1.65. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(21) Advance power lever to EPR = 1.8. Stabilize for 30 seconds then snap power lever in one second or less to point on pedestal marked in Paragraph 6.G.(10)(b) just above bleed closing point. Deceleration bleed system is operating normally if bleed valve supply pressure (PS4) drops to near ambient pressure and then increases to normal PS4 pressure.

(22) Retard power lever to Idle. During deceleration, monitor engine vibration. Also check that anti-surge bleed valves open within limits of Figure 512.

(23) Conduct functional check of reverse thrust system per airframe manufacturer's maintenance manual instructions.

(24) Perform functional check of Reserve Takeoff Thrust system as specified by airframe manufacturer's instructions.

(25) Shut down engine and perform normal engine inspection procedures as specified by airframe manufacturer, including oil filter inspection. (GENERAL, SUBJECT 71-00-00, Page 501)

(26) Service engine oil tank as necessary. Record amount of oil added.

(27) Compute oil consumption for acceptance test. Oil consumption shall not exceed 0.1 gal/hr.

(28) Corrected N_1 vs EPR should be checked per Figure 515. This curve is designed to verify accuracy of the EPR system. During Takeoff and part power, record N_1 speed, EPR and T_{t2} at both part power and Takeoff after engine has stabilized. Check corrected N_1 according to Figure 515.

(a) Engines which plot in band of Figure 515 are acceptable if all other operating limits are met.

(b) Engine plotting above band should be investigated for cause of high N_1. Troubleshooting must include leak check of P_{t7} indicating system. If no leaks are found, following items may also be investigated for cause of high N_1:

1) Inspect fan for FOD, blended blades.

2) Check N_1 indication system.

3) Waterwash engine per airframe manufacturer's instructions.

(c) If none of above items reduce high N_1 condition but all other operating limits are met, engine is acceptable. However, high N_1 condition may result in N_1 redline limiting situation on hot days.

(d) Engines which plot below band should be checked for N_1 indicating system problems and proper size exhaust nozzle. If N_1 indicating system is not cause of low N_1 speed, but all other engine operating limits are met, engine is acceptable.

(29) EGT shall be within recommended guidelines as specified in Figure 516. Available EGT margin at Normal Takeoff rating may be determined by calculating corrected EGT from data point observed EGT and TAMB as shown in notes on Figure 516 and computing difference relative to curve in Figure 516 at constant EPR.

(30) Oil pressure and oil temperature shall not exceed limits as specified in Table 509.

(31) Measure and record the turbine cooling air pressure ratio (TCAR) (Pcp/P_{s4}) and compare it to the limits in Figure 517.

Table 508

FIGURE 72-00-00-990-841	NOTE
Sheet 3	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 4	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 5	A. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is in the range shown (between the Minimum limit and the lower limit), do the sub-idle leak check specified in the test.
	B. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is less than the lower limit, it will be necessary to remove the engine for disassembly and corrective action.

(a) If a JT8D-217C/-219 engine (which is post-sb 6128 and pre-SB 6196) has a Pcp/Ps4 ratio less than the Minimum limit in (Figure 517) (Sheet 5), do a sub-idle leak test as follows:

1) Attach containers to the No. 4 bearing scupper drain and the No. 5 bearing area (combustion section) drain.

NOTE: For all engines a Pcp transducer (with an accuracy of ±0.1 psig) will be necessary to measure the low Pcp values at idle and lower accurately. You must not do an engine shutdown during this test procedure.

2) Do the usual acceptance test as specified in this section (but do not do an engine shutdown when the test is completed). Adjust the idle trim N2 to 46 percent (+0, -0.2 percent) and the maximum oil pressure to 50.0 psig (344.7 kPa) (-0, +0.5 psi (3.4 kPa)). Operate the engine at Idle for 20 minutes. Increase the Idle N2 to the (Figure 535) limits, then do an engine shutdown.

NOTE: Record the Pcp on all data points at idle or lower with the transducer specified above. If it is difficult to trim to low idle, or if the idle speed does not stay stable, tell Pratt & Whitney Engineering immediately.

3) After the test, look for streaks in the tailpipe and remove the drain bottles (record what is found in them). Attach new bottles, then (after an hour) remove these bottles and record what is in them.

4) Do a borescope inspection of the 1st stage turbine vane area (through the igniter plug ports) and look for wet surfaces or puddles of oil. Record the inspection results.

5) If no leaks are found, the engine is satisfactory. If oil leaks are found, remove the engine for disassembly to correct the leaks.

(32) Breather pressure shall not exceed limit given in Paragraph 2.M.(2).

(33) Vibration shall not exceed limits given in Table 509.

NOTE: If the engine vibration is above the limits, the operator can trim balance the engine on the aircraft to decrease vibration levels. However, trim balance only those engines on which the fan is replaced. See Paragraph 7..

Table 509 Acceptance Limits Vibration Amplitudes

Pickup Location	Single Amplitude	Double Amplitude
INLET SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
REAR SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
NOTE: The limits in this table are valid only when vibration pickups are mounted at locations specified and only when the low frequency filter (40 CPS) is selected in the vibration monitoring circuit.		

H. Test G - Breather Pressure Check (Figure 518 and Figure 519)

(1) Disconnect airframe breather duct from engine gearbox and leave gearbox port open.

(2) On engines with oil pressure transmitter vented to gearbox, disconnect airframe vent tube from gearbox LV3 fitting and remove fitting from gearbox port. On engines with oil pressure transmitter vented to ambient, remove fitting from gearbox LV3 port.

(3) Connect 0 - 10 PSIG (0.0 - 68.9 kPa) gage to LV3 port with the gage held above the LV3 port at all times (loops in the gage line can collect oil and cause false readings). Gage should be maximum-indication type with dial marker. Wire equipment securely to protect it from vibration. (Figure 518)

NOTE: If desired, PWA 33784 Cap may be used to obtain breather pressure measurement. Make sure the gage is held above the oil tank cap at all times to keep loops out of the gage line. See Figure 519. Breather pressure measured at this location will approximate breather pressure at gearbox LV3 port. If pressure reading obtained in the following procedure is close to or higher than limits given, procedure should be repeated with pressure gage connected to gearbox LV3 port.

WARNING: OBSERVE PROPER SAFETY PRECAUTIONS AROUND RUNNING ENGINE. WEAR EAR PROTECTORS AND STAY CLEAR OF ENGINE HAZARD AREAS. SEE "ENGINE GROUND SAFETY PRECAUTIONS" FOR ENGINE HAZARD DESCRIPTION.

(4) Start engine and operate at Idle for five minutes. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Slowly accelerate (60 seconds) to Normal Takeoff power (accelerate slowly to avoid possible overshoot on 0 - 10 psi (0.0 - 68.9 kPa) gage).

(6) After engine has stabilized at Normal Takeoff (two minutes minimum), retard engine power to Idle and record breather pressure.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

(7) Compare recorded breather pressure with maximum limit given in Paragraph 2.M.(2).

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

CAUTION: DO NOT RETURN ENGINE TO SERVICE IF IT HAS HIGH BREATHER PRESSURE. HIGH BREATHER PRESSURE IS AN INDICATION THAT HIGH TEMPERATURE, HIGH PRESSURE AIR MAY BE LEAKING INTO A BEARING COMPARTMENT, CREATING A POTENTIALLY DANGEROUS SITUATION.

(9) If observed breather pressure is not within limits, investigate and correct as necessary. Remove engine for inspection if necessary.

NOTE: If pressure reading from oil tank mounted gage fitting is close to limits, repeat engine test with gage mounted at gearbox. See Note after Paragraph 6.H.(3).

(10) Remove test equipment and reinstall engine fittings.

I. Test H - Acceleration Check

(1) Make sure the engine test area is clean.

(2) Start the engine (use the approved aircraft maintenance procedures).

(3) Set the flight deck switches in the correct positions to make sure that there is no engine air bleed or power extraction.

NOTE: Make sure that test instruments are kept sufficiently cool during the test procedure.

(4) Operate the engine at Idle until indications are stable and the oil temperature is at 100°F (38°C) minimum.

(5) Set the Approach Idle switch to On. Engine N_2 must increase to Approach Idle level.

(6) Operate the engine at Approach Idle for five minutes, until the N_2 is stable.

(7) Calculate the Normal Takeoff EPR limit from barometric pressure and temperature (refer to the airframe manufacturer's data).

(8) Advance the power lever slowly (in 30 seconds minimum) to the Normal Takeoff EPR limit calculated in Paragraph 6.I.(7). Keep the engine at this power level for no more and no less than 60 seconds.

(9) With the engine at Normal Takeoff EPR, make a mark to record the power lever position. Record EPR, N_1, EGT, and N_2. Calculate and record 95 percent of N_2 (as seen on the flight deck instrument).

(10) Retard the power lever to Approach Idle. In not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the Normal Takeoff mark made on the quadrant in Paragraph 6.I.(9) in not more than one second. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, then do the procedure again from Paragraph 6.I.(7).

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(11) Record with a stop watch the time from when the power lever started to move to when the engine gets to the 95 percent N_2 limit calculated in Paragraph 6.I.(9).

(12) Go back to Approach Idle and do Paragraph 6.I.(6) thru Paragraph 6.I.(11) two times again.

(13) After three accelerations are completed, retard the power lever to Idle and do the approved airframe powerplant shutdown procedure.

(14) Calculate the average of all three acceleration times. Compare this average to the limit curve given by the airframe manufacturer.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in the maintenance procedure in this manual (in which a stop watch is used and an average is calculated) are to keep variations to a minimum in this less accurate procedure. This average time value will give results that are as much the same each time as the more accurate test cell procedure. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Normal Takeoff N_2) as calculated from test cell procedures.

(15) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

J. Test I - Vibration Check

(1) Install vibration pickups at locations indicated in Figure 513. Connect pickups to vibration monitoring instrumentation, including low frequency filter (40 CPS).

(2) Inspect and clean test area.

(3) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(4) Operate engine at Idle until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(5) Make a slow (two to three minute) acceleration from Idle to Normal Takeoff EPR as specified by airframe manufacturer for ambient conditions. Monitor inlet and rear case vibration during acceleration. Record peak observed inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

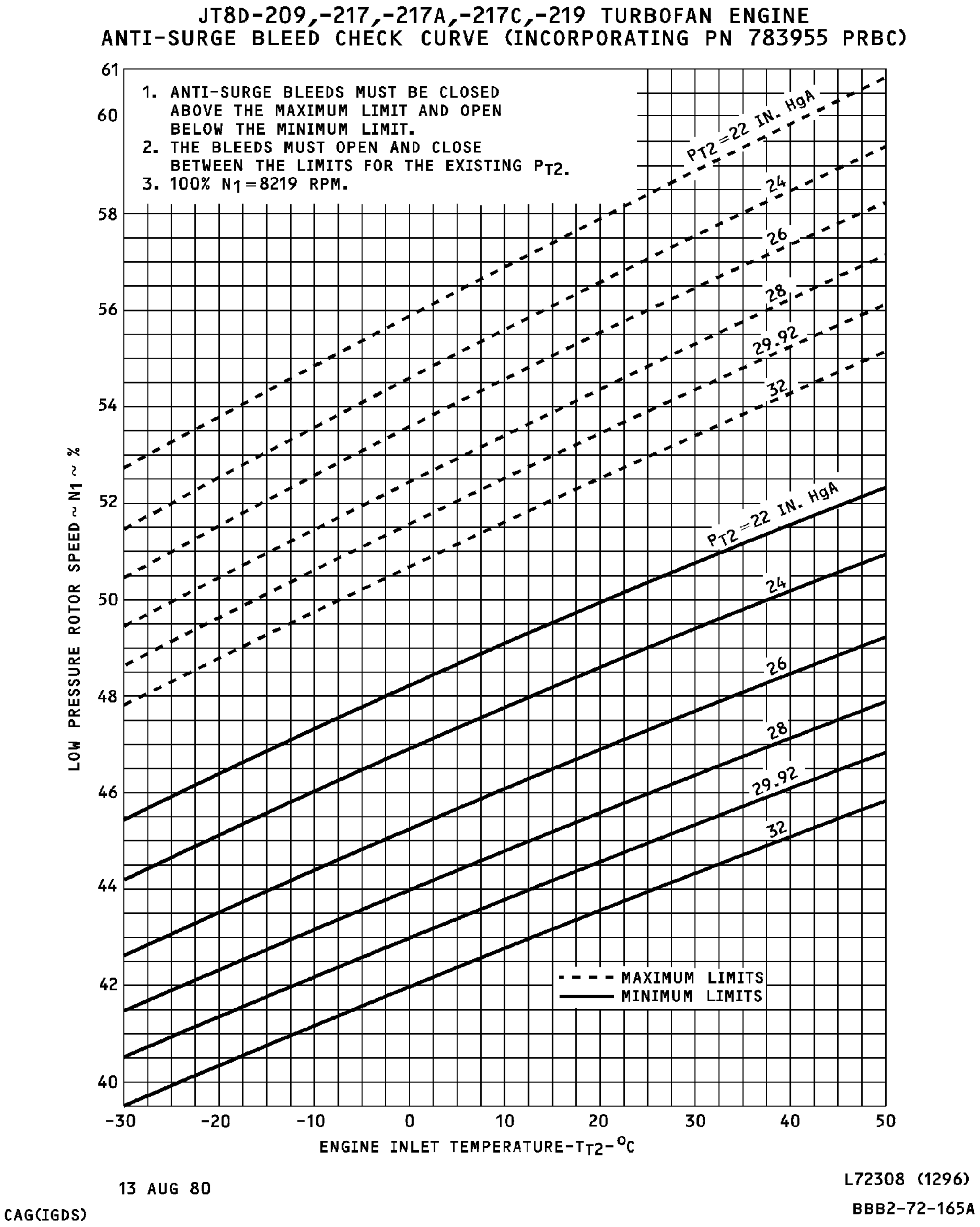
(6) Stabilize 30 seconds at Normal Takeoff EPR.

(7) Retard power lever slowly (two to three minutes) to Idle. Monitor inlet and rear case vibration during deceleration. Record Peak inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

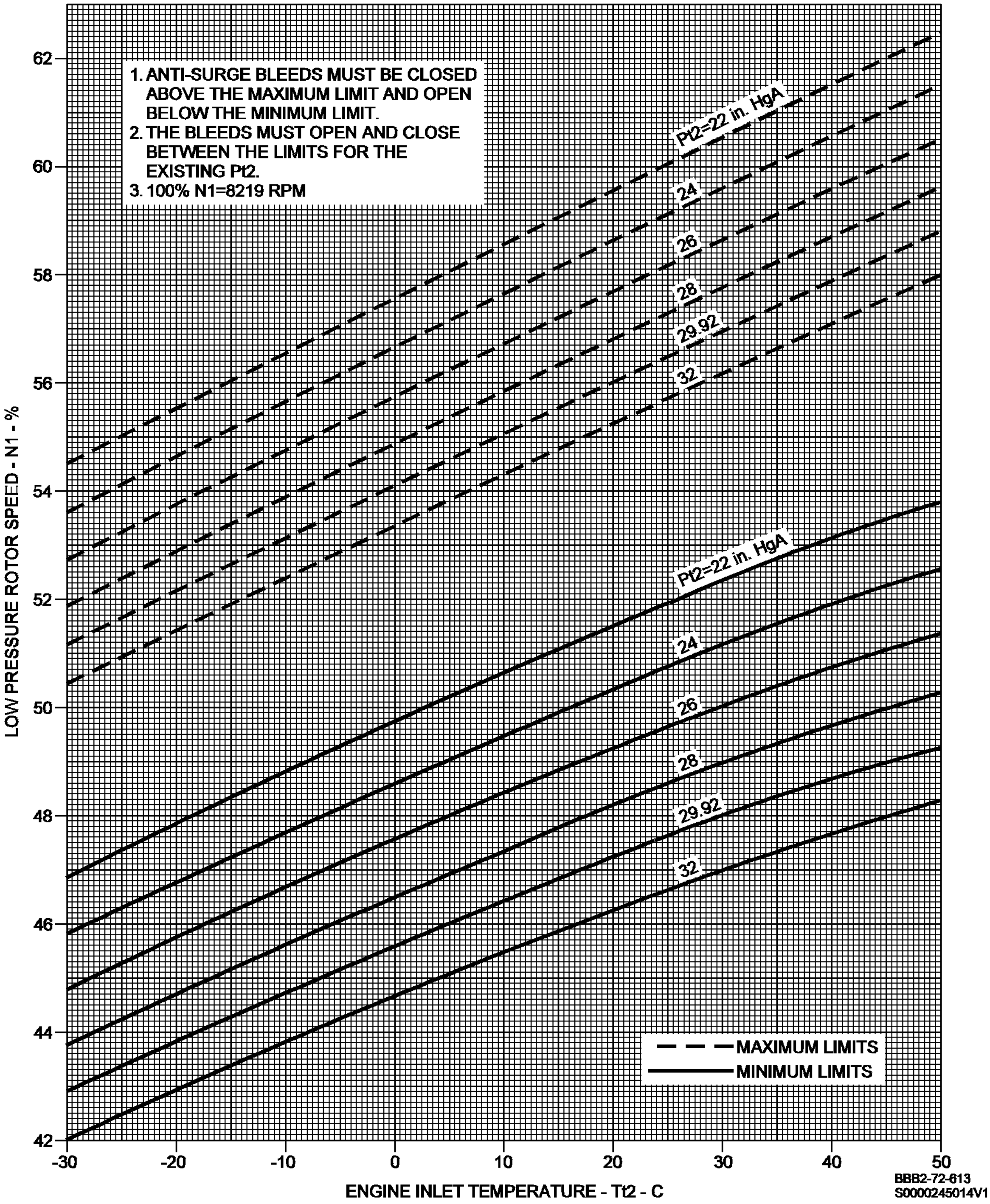
(9) Peak vibration shall not exceed limits in Table 509.

NOTE: The operator can trim balance repaired engines on the aircraft to decreased vibration levels. See Paragraph 9..



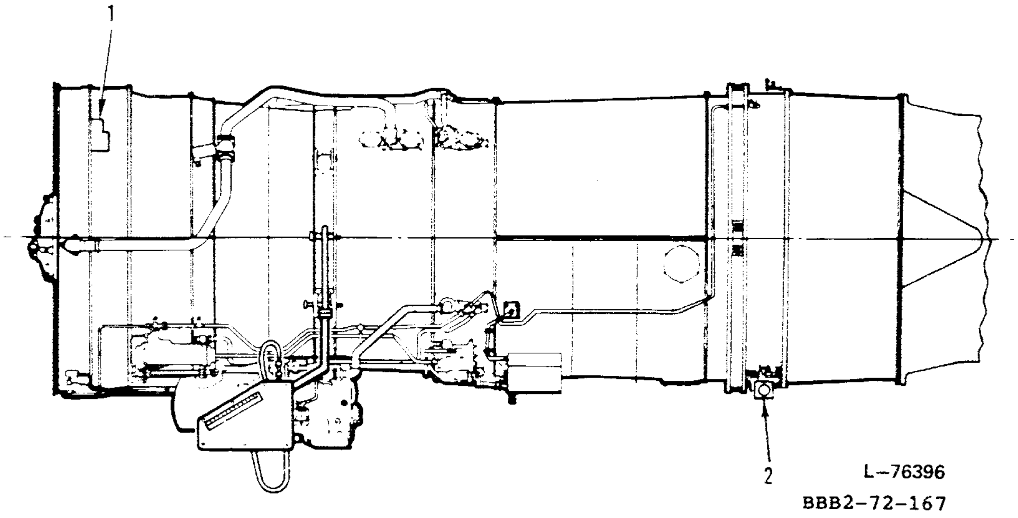
Anti-Surge Bleed Chart
Figure 512/72-00-00-990-835 (Sheet 1 of 2)

JT8D-209, -217A, -217C, -219 TURBOFAN ENGINE
ANTI-SURGE BLEED CHECK CURVE (INCORPORATING PN 790312 PRBC)



1. ANTI-SURGE BLEEDS MUST BE CLOSED ABOVE THE MAXIMUM LIMIT AND OPEN BELOW THE MINIMUM LIMIT.
2. THE BLEEDS MUST OPEN AND CLOSE BETWEEN THE LIMITS FOR THE EXISTING Pt2.
3. 100% N1=8219 RPM

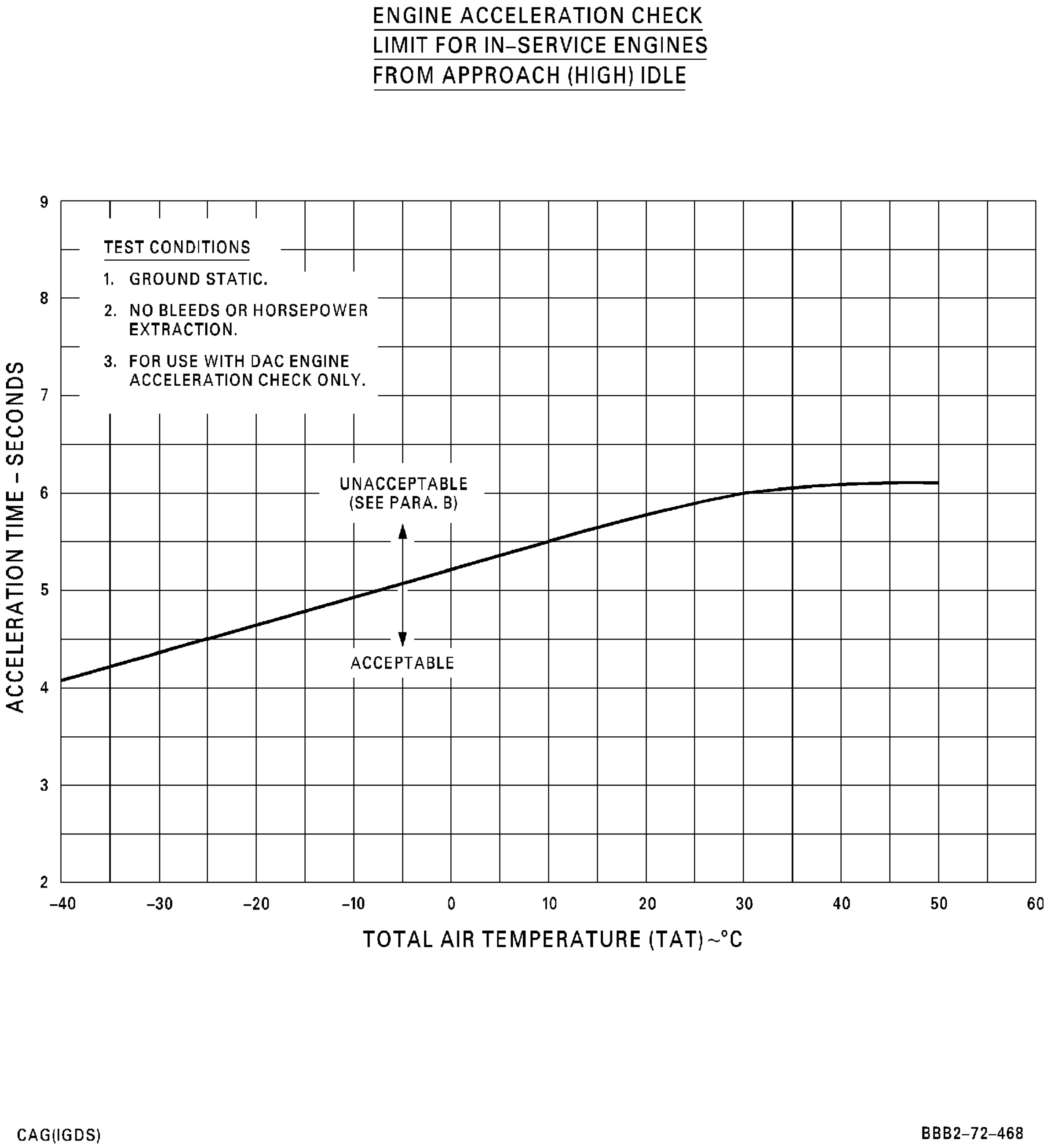
Anti-Surge Bleed Chart
Figure 512/72-00-00-990-835 (Sheet 2 of 2)



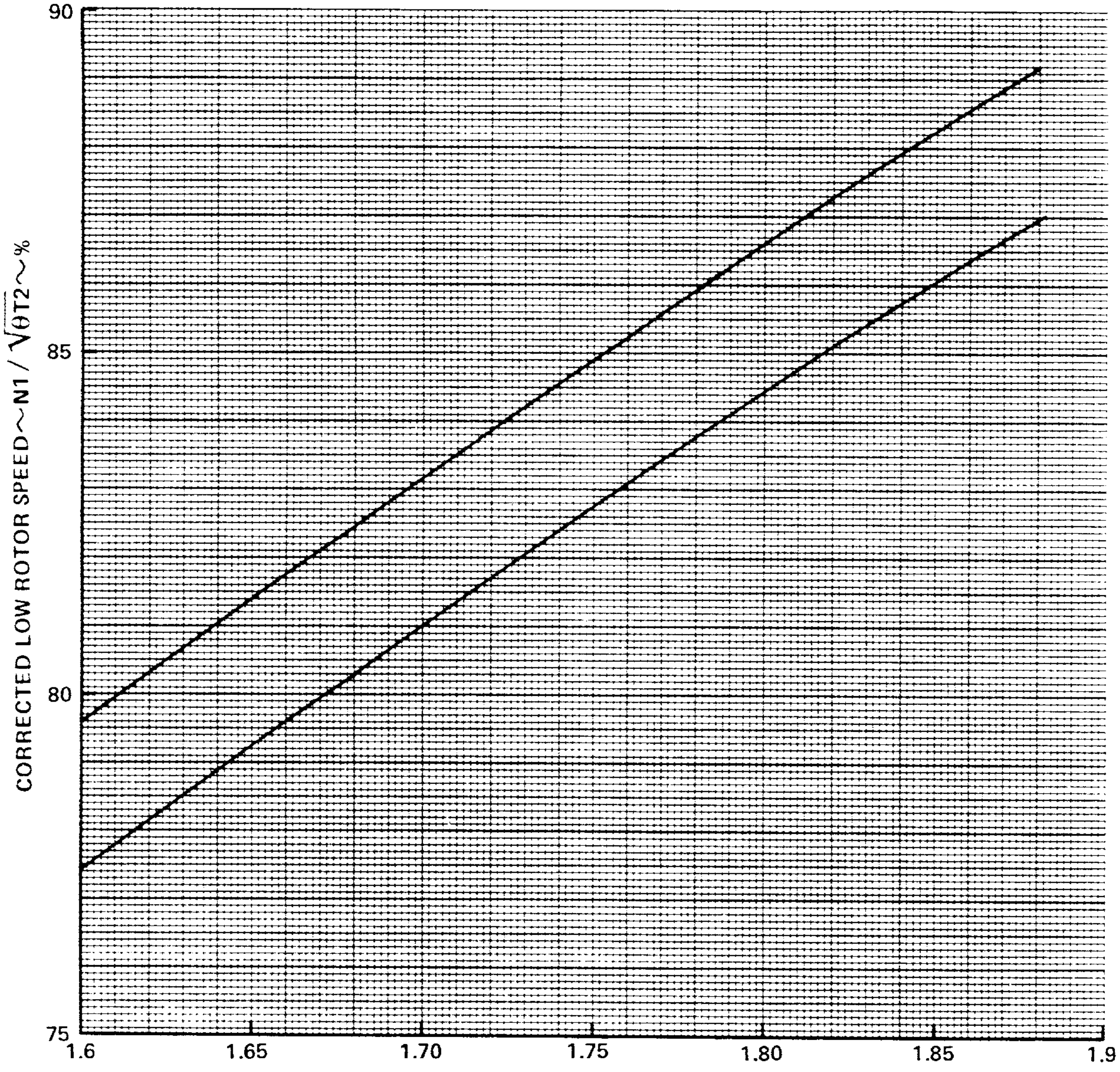
LEFT SIDE VIEW

1. Front Vibration Pickup
2. Rear Vibration Pickup

Location Of Vibration Pickups
Figure 513/72-00-00-990-836



Acceleration Time Limit From Approach Idle
Figure 514/72-00-00-990-838

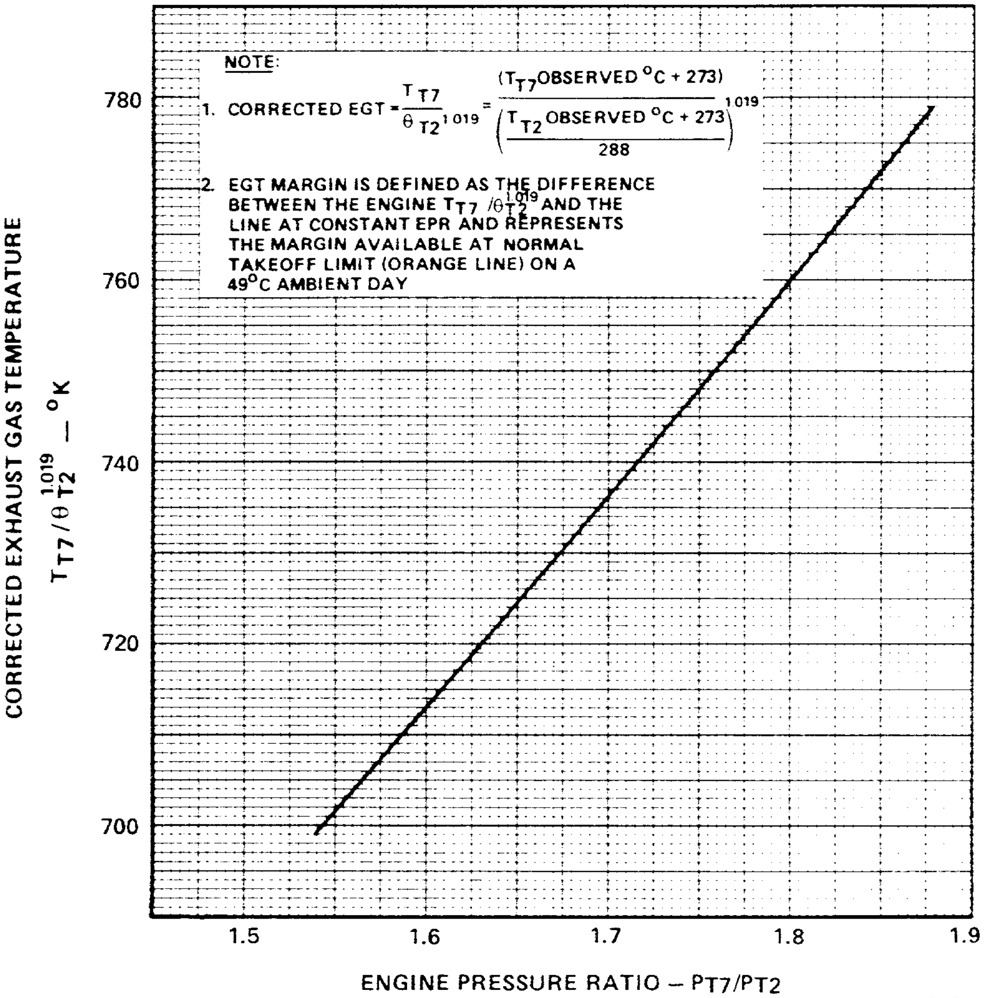

N1 TEST LIMIT FOLLOWING HEAVY MAINTENANCE
NO BLEED OR POWER EXTRACTION
100% N1 = 8219 RPM

PSPE CURVE NO. 1730

L-76395
BBB2-72-169

Low Rotor Speed Limit Curve
Figure 515/72-00-00-990-839

JT8D–209 TURBOFAN
EGT MARGIN CHECK CURVE



NOTE:

1. CORRECTED EGT = $\frac{T_{T7}}{\theta_{T2}^{1.019}} = \frac{(T_{T7}\text{OBSERVED }^{\circ}C + 273)}{\left(\frac{T_{T2}\text{ OBSERVED }^{\circ}C + 273}{288}\right)^{1.019}}$

2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7}/\theta_{T2}^{1.019}$ AND THE LINE AT CONSTANT EPR AND REPRESENTS THE MARGIN AVAILABLE AT NORMAL TAKEOFF LIMIT (ORANGE LINE) ON A 49°C AMBIENT DAY

L–61627
11–80

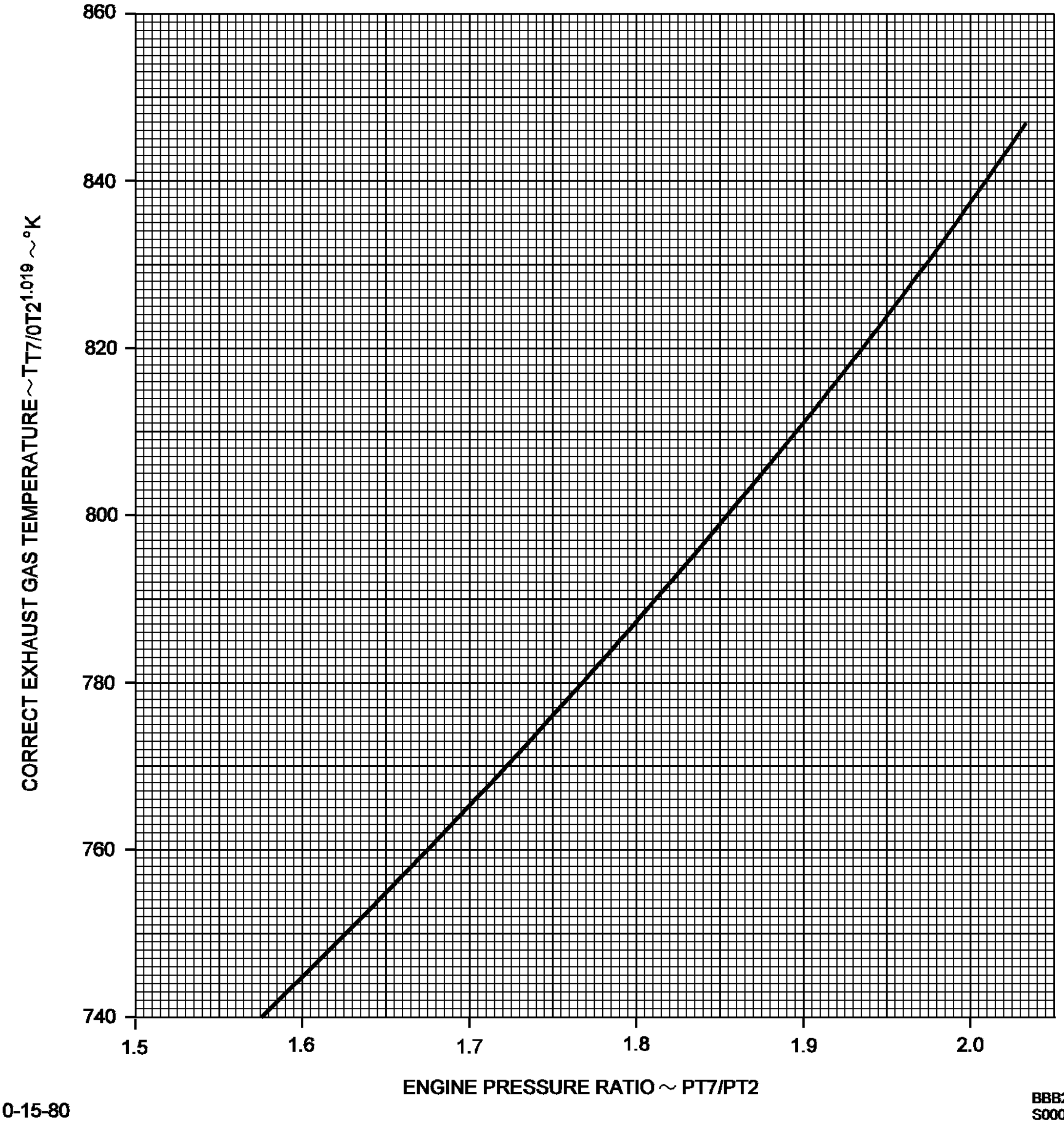
BBB2-72-170

EGT Margin Check Curve
Figure 516/72-00-00-990-840 (Sheet 1 of 3)

JT8D-217, -217A TURBOFAN
EGT MARGIN CHECK

NOTE:

1. CORRECTED EGT= $\dfrac{(T_{T7}\text{ OBSERVED }^{\circ}C + 273)}{\left(\dfrac{T_{T2}{}^{\circ}C + 273}{288}\right)^{1.019}}$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7/0T2}{}^{1.019}$ AND THE LINE AT CONSTANT EPR.
3. A COMPLETE HIGH QUALITY REFURBISHMENT OF BOTH HOT AND COLD SECTION MODULES SHOULD RESULT IN EGT MARGIN OF 15 - 20 °C.



L-73100
0185

BBB2-72-171A
S0006554726V2

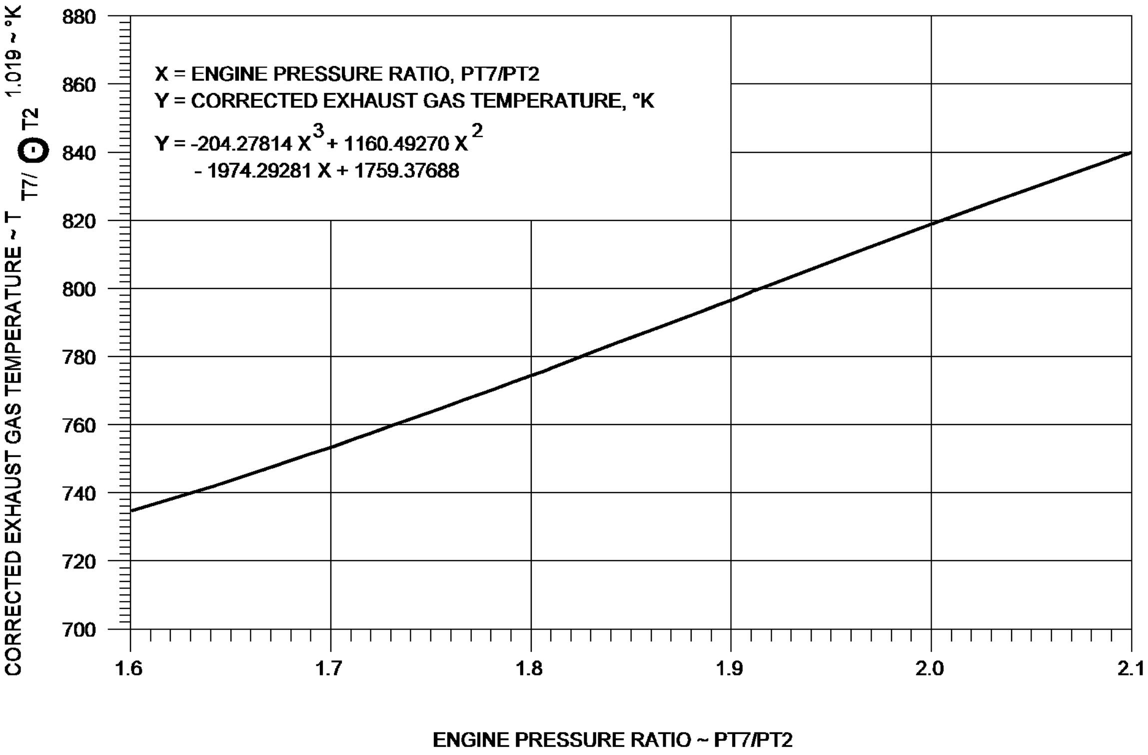
DJ 10-15-80

EGT Margin Check Curve
Figure 516/72-00-00-990-840 (Sheet 2 of 3)

JT8D-217C-219 TURBOFAN
EGT MARGIN CHECK

NOTES:

1. $$\text{CORRECTED EGT} = \frac{(T_{T7}\ \text{OBSERVED}\ °\text{C}+273)}{\left(\frac{T_{T2}\,°\text{C}+273}{288}\right)^{1.019}}$$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7}/\Theta\,T2^{1.019}$ AND THE LINE AT CONSTANT EPR
3. THE EGT LIMIT REPRESENTS AN ENGINE WITH ZERO MARGIN TO THE NORMAL TAKE-OFF LIMIT (ORANGE LINE) ON A 29 °C AMBIENT DAY.



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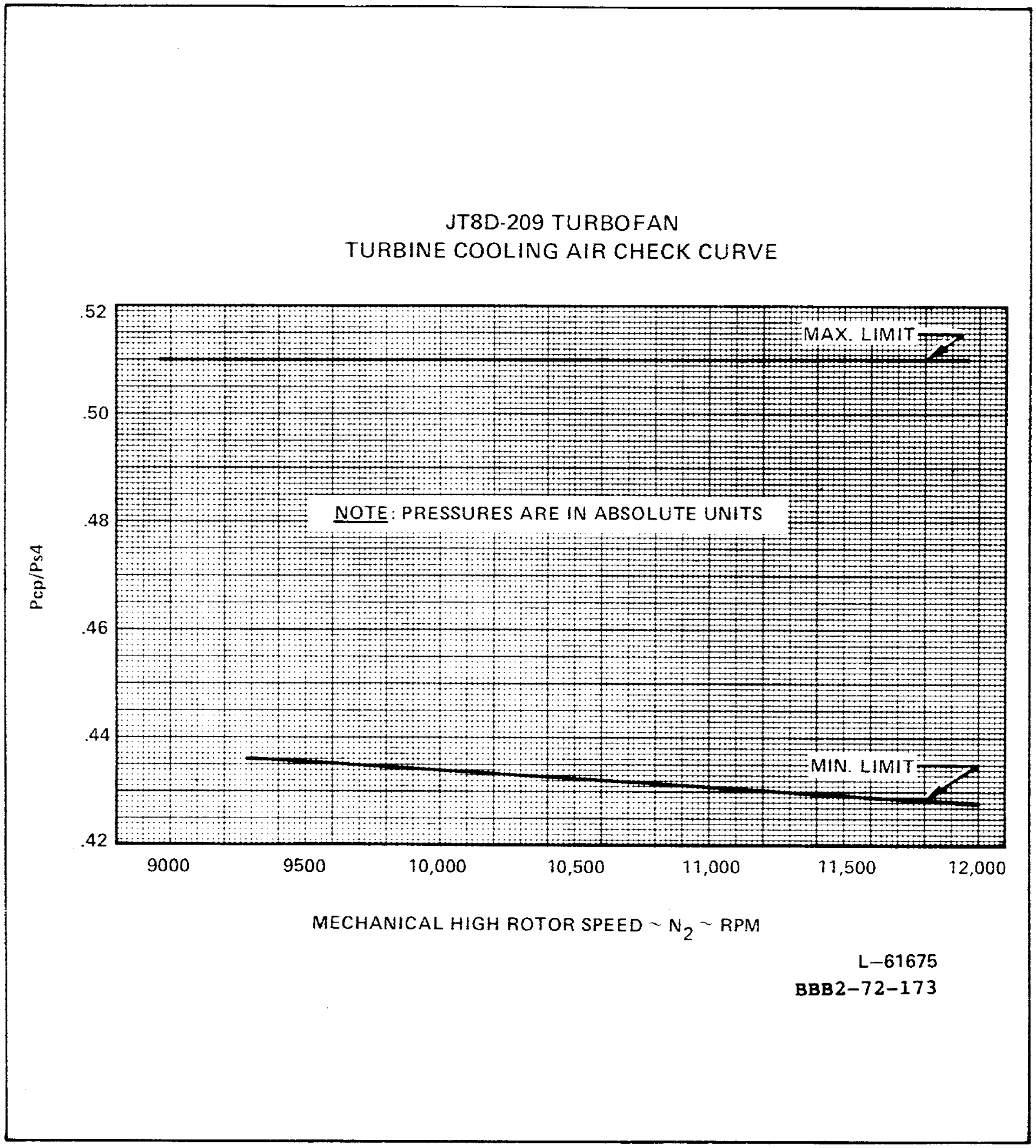
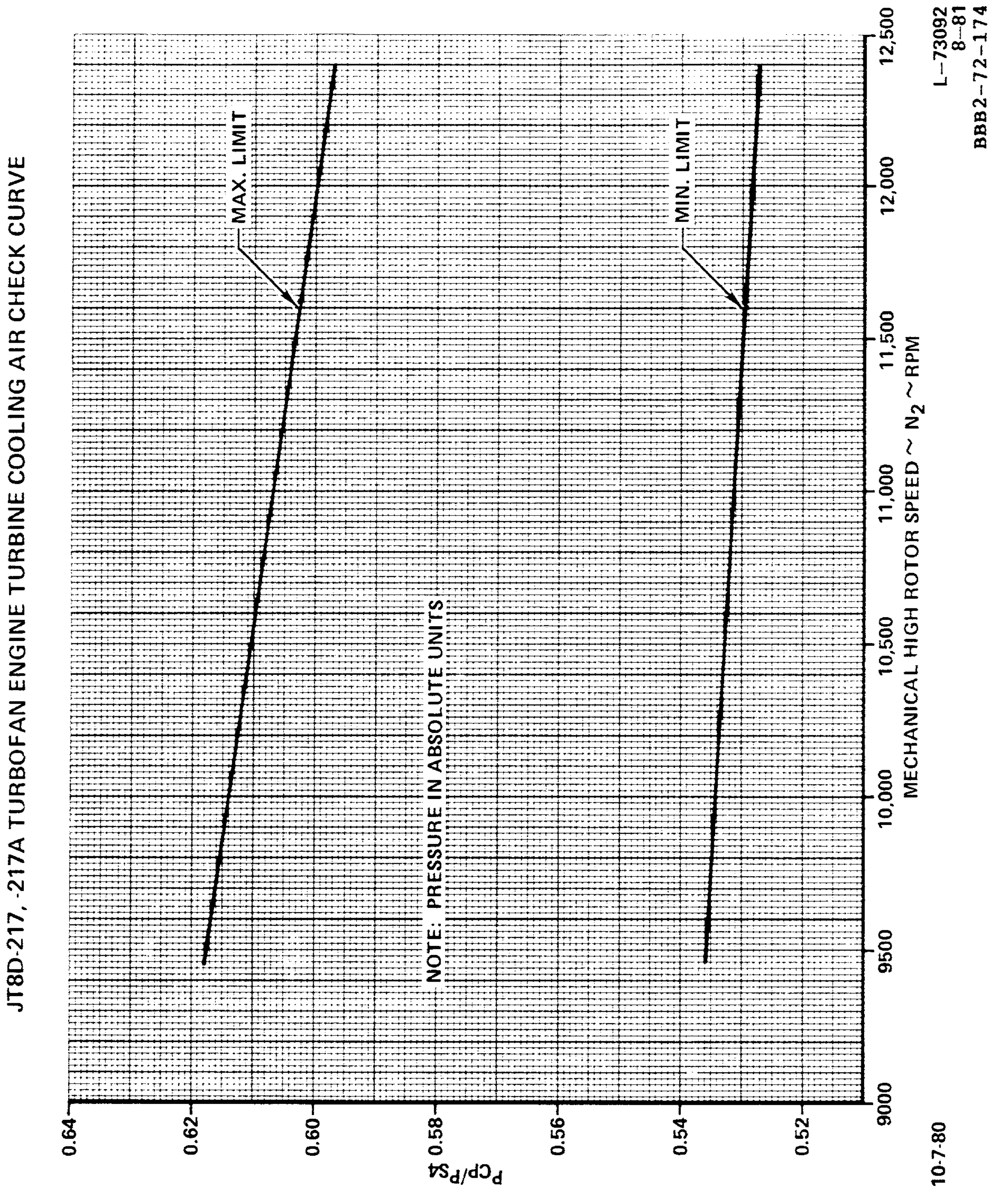
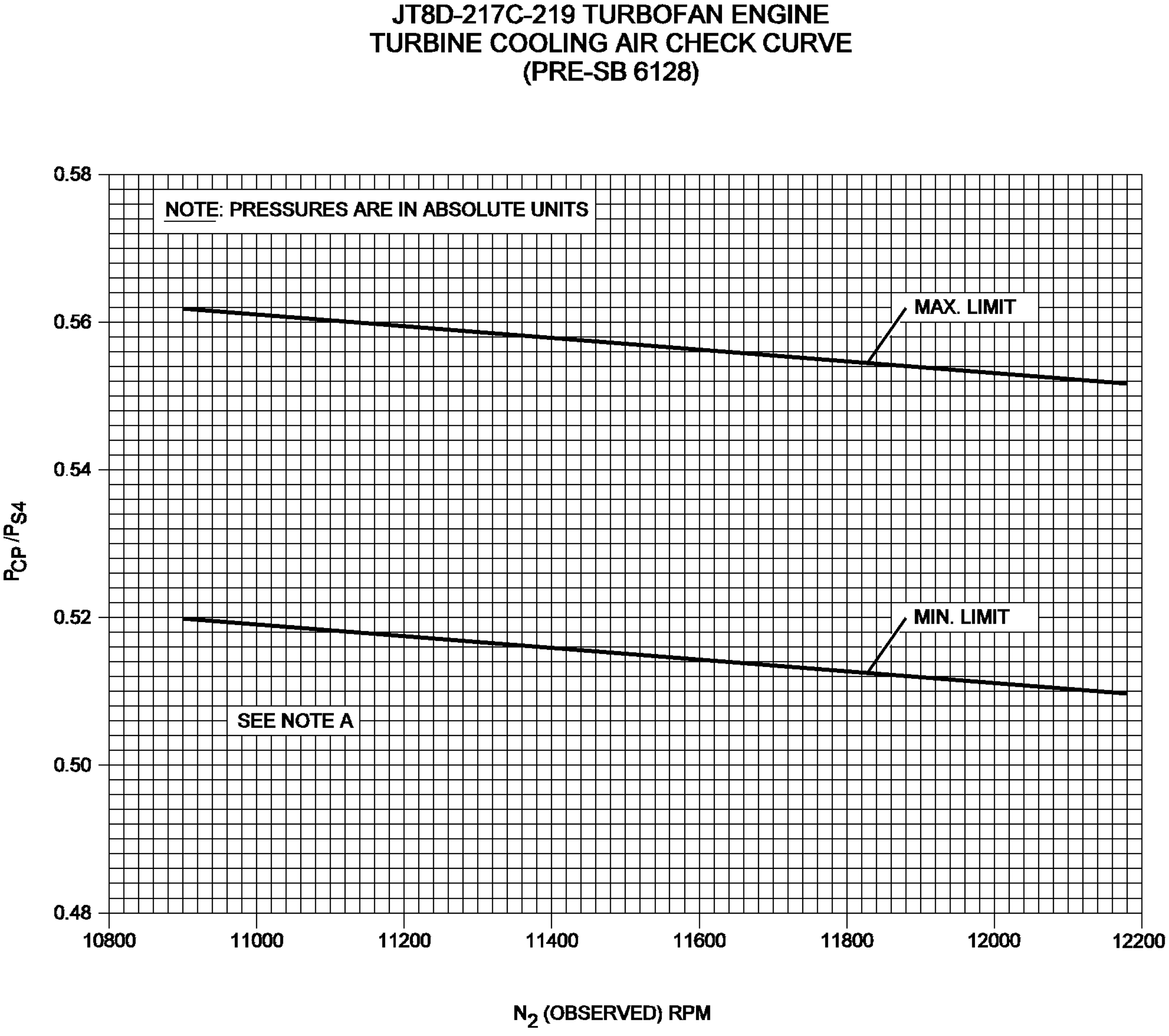
EGT Margin Check Curve
Figure 516/72-00-00-990-840 (Sheet 3 of 3)



Turbine Cooling Air Check Curve
Figure 517/72-00-00-990-841 (Sheet 1 of 5)



Turbine Cooling Air Check Curve
Figure 517/72-00-00-990-841 (Sheet 2 of 5)



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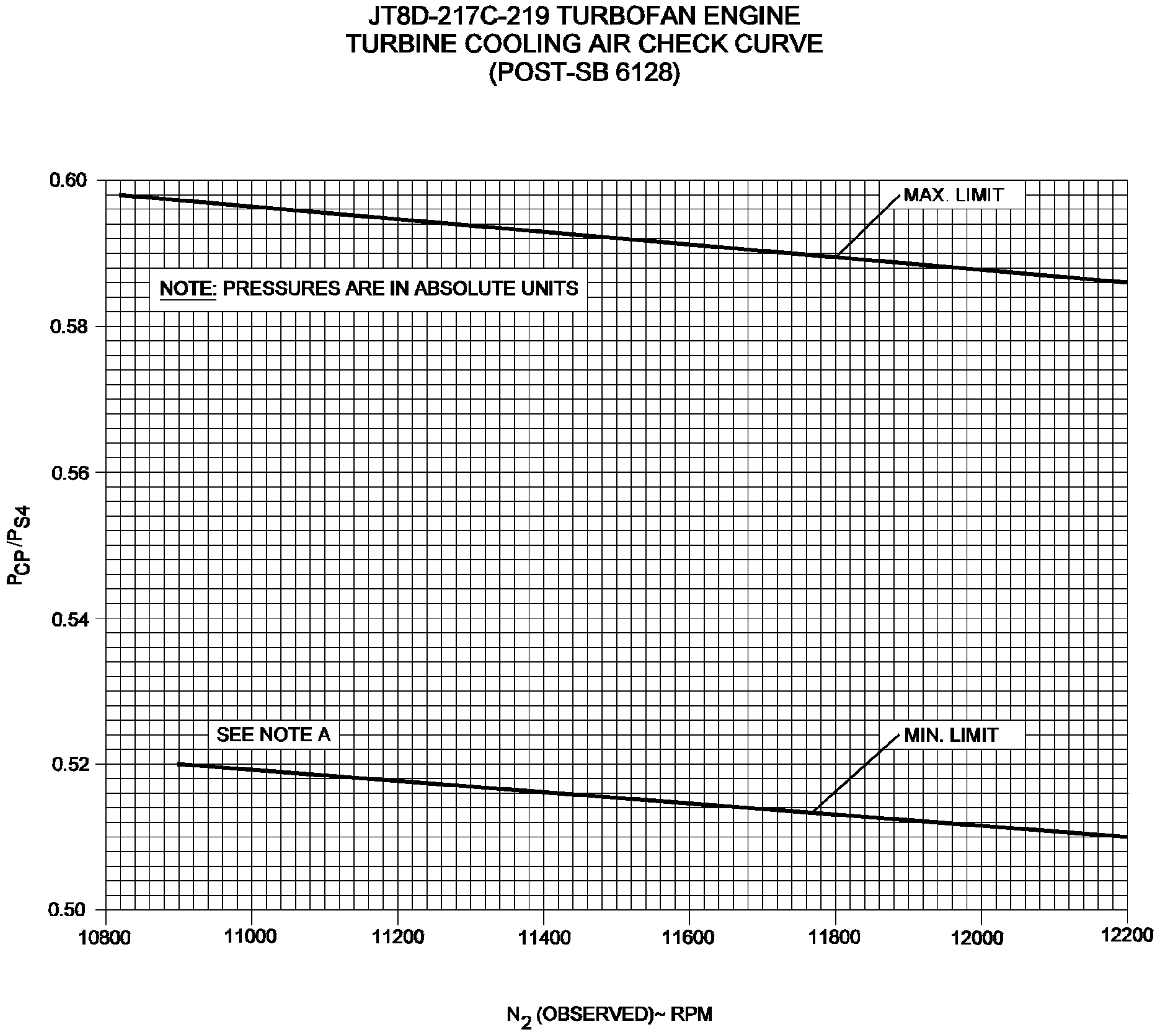
Turbine Cooling Air Check Curve
Figure 517/72-00-00-990-841 (Sheet 3 of 5)



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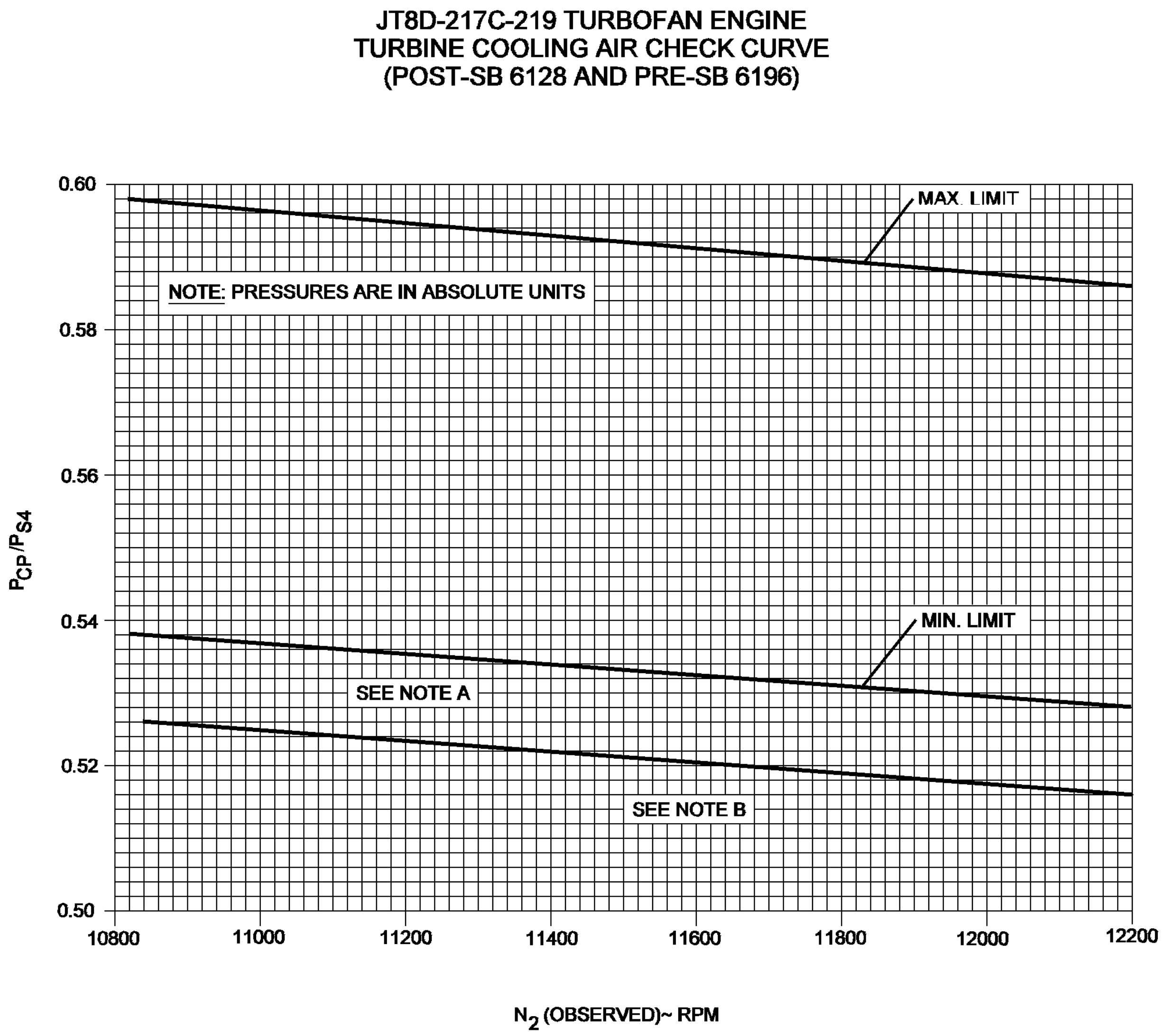
Turbine Cooling Air Check Curve
Figure 517/72-00-00-990-841 (Sheet 4 of 5)



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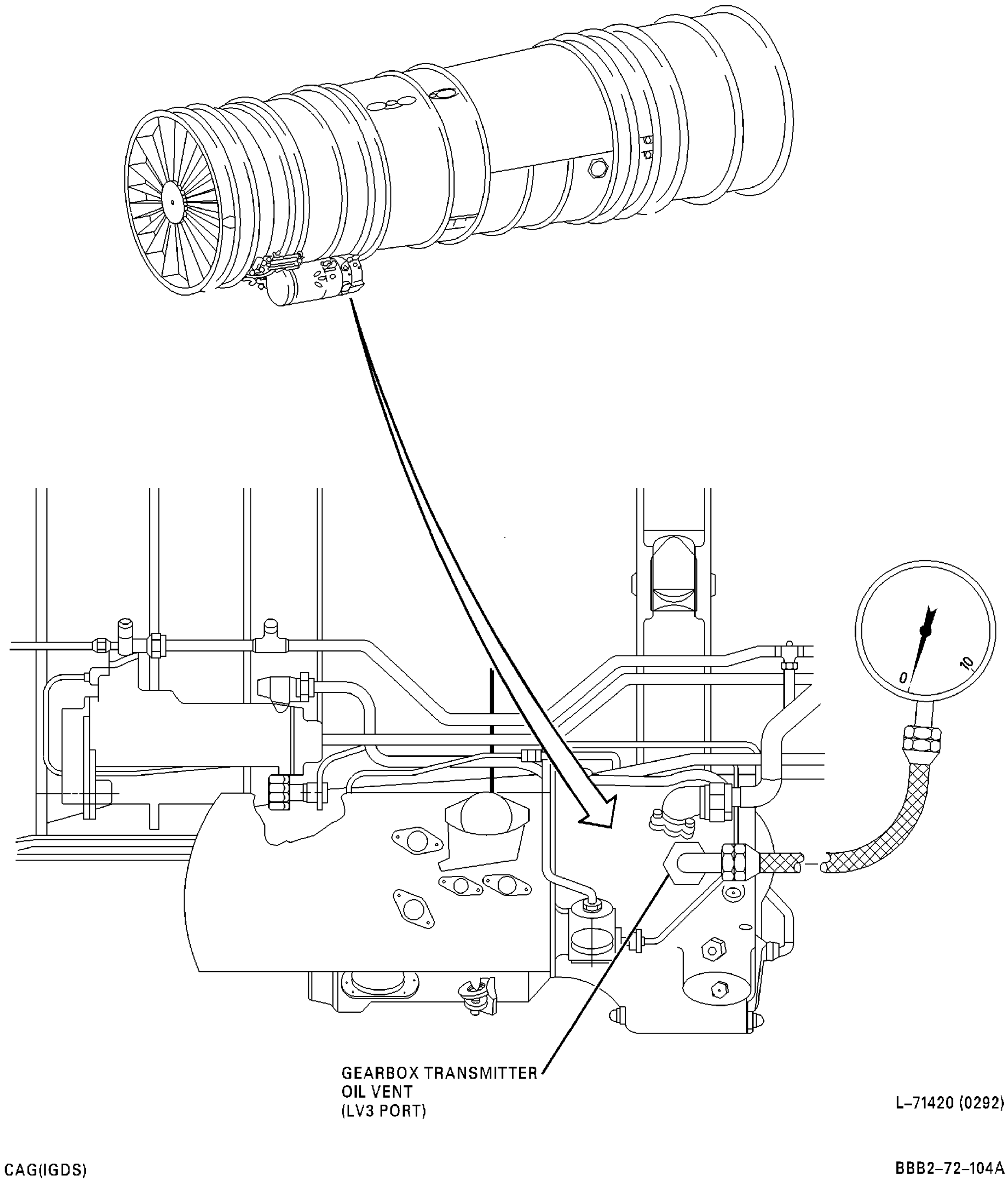
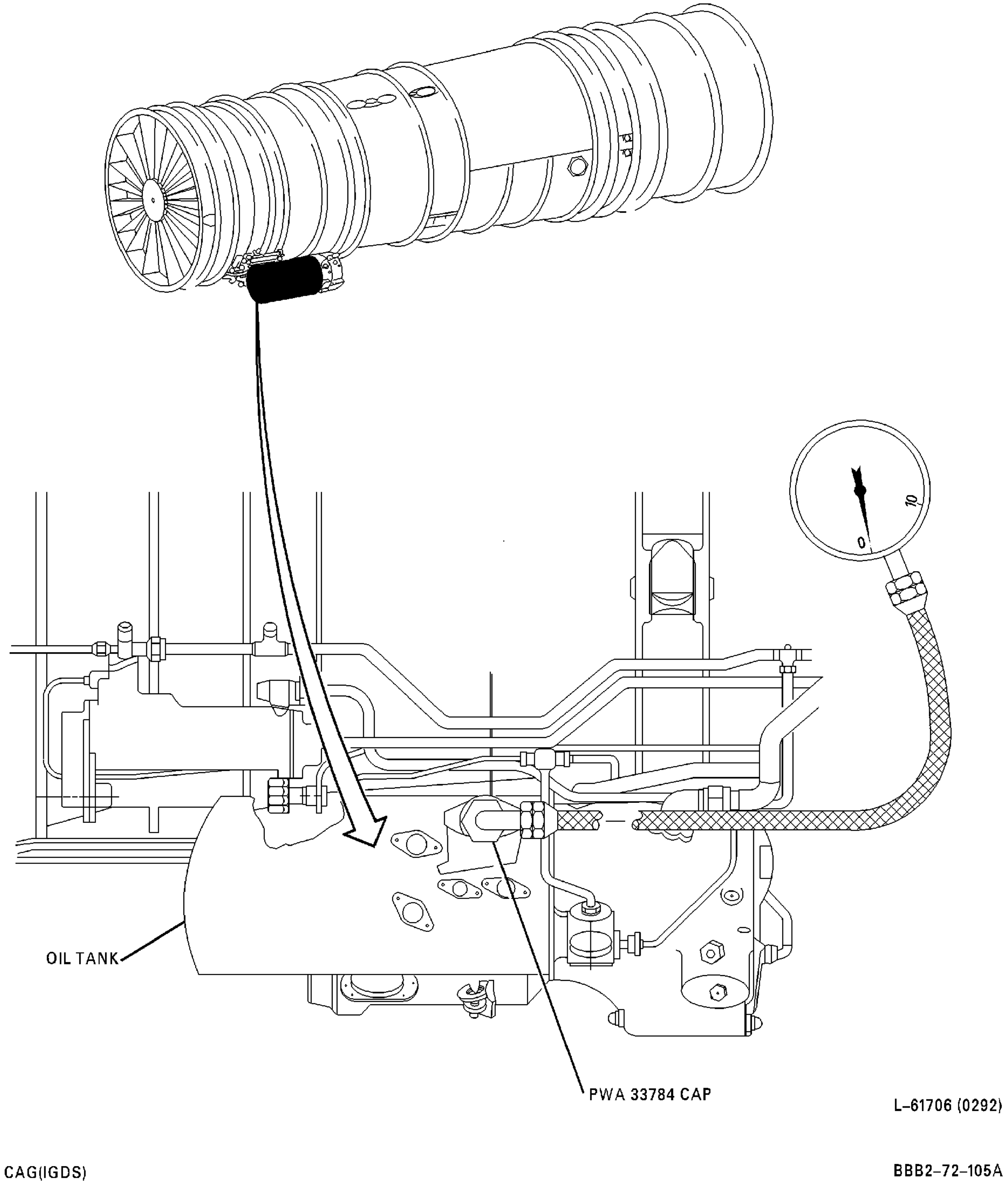
Turbine Cooling Air Check Curve
Figure 517/72-00-00-990-841 (Sheet 5 of 5)



Gearbox Housing Breather Pressure Instrumentation
Figure 518/72-00-00-990-842



Oil Tank Breather Pressure Instrumentation
Figure 519/72-00-00-990-843

7. Engine Deterioration Ground Check (For Installations Not Equipped With In-Flight Monitoring)

(Figure 520)

A. Procedure

(1) Prior to each removal for hot section inspection perform following ground check to detect engine deterioration.

(2) The following instrumentation is necessary for ground check:

(a) Absolute pressure gage to indicate 13th stage air pressure (Ps4). Special fitting is provided on right-hand side of engine at upper end of bleed valve actuation pressure supply line near high pressure (diffuser) service bleed point. Calibrated accuracy of gage should be ± 0.5 psi (25.4 mm Hg) absolute in range between 150 and 175 psi (7757 - 9050 mm HG) absolute. Maximum instrument requirement is 250 psi (12929 mm Hg) absolute.

NOTE: This measurement will indicate PS4 only when operating above bleed valve actuation point dictated by pressure ratio bleed control.

(b) Laboratory quality mercury thermometer to indicate ambient temperature.

(c) Local facilities (such as airport control tower) for indicating barometric pressure.

(d) Absolute pressure gage to indicate P_{t7}. Calibrated accuracy of gage should be ± 0.2 psi (10.3 mm Hg) absolute in range between 0 and 50 psi (2586 mm Hg) absolute.

(e) Instrumentation to check P_{t7} and EGT and provide comparison with cockpit instrumentation of EPR (P_{t7}/P_{t2}) and EGT. If cockpit EGT instrumentation and accurate null-balance test instrumentation cannot be read simultaneously, EGT may be measured at stabilized condition with test instrument and then with cockpit instrument circuit under same stabilized conditions. Respective readings should then be compared. As alternate method, cockpit instrument system may be calibrated with standard test equipment designed for this purpose.

(3) Use following test procedure:

(a) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(b) With all nonessential aircraft airbleed and electrical systems shut off, set engine power to EPR (P_{t7}/P_{t2}) of 1.65.

(c) Warm up engine for five minutes and reset power to EPR of 1.65 as required.

(d) Read and record following:

1) P_{t7}

2) EPR (aircraft instrument)

3) Ps4

4) EGT (accurate null-balance instrument)

5) EGT (aircraft instrument)

6) Percent N_1 (aircraft instrument)

7) Percent N_2 (aircraft instrument)

8) Ambient temperature

9) Barometric pressure

10) Fuel Flow

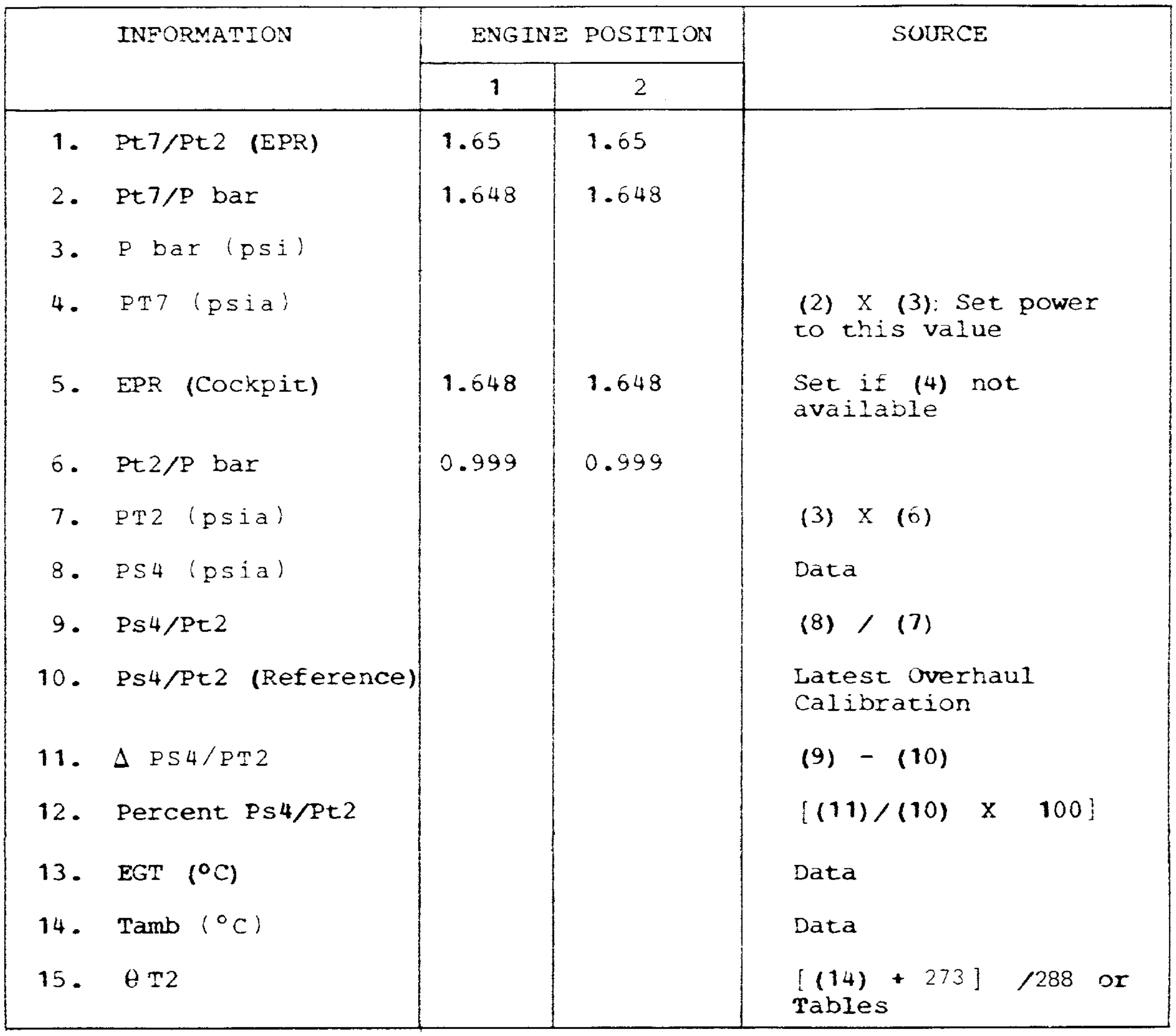
(e) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(f) Use Figure 520, Figure 521 and Figure 522 to process data. Repair consisting of, replacement of 1st stage turbine vanes, combustion chambers, transition ducts, turbine outer air seals, fuel nozzles, etc. may be necessary if test reveals any of following:

1) Reduction of 3.5 percent Ps4/P_{t2} relative to new engine acceptance test, last complete overhaul, or last repair in which 1st stage turbine vane area was rebuilt within engine manual limits.

2) Corrected maximum T_{t7} more than shown in Figure 516.

3) Minus 100 RPM (minus 0.82 percent tachometer) N_2 theta T2 relative to data plate N_2 RPM.



INFORMATION	ENGINE POSITION		SOURCE
	1	2	
1. Pt7/Pt2 (EPR)	1.65	1.65	
2. Pt7/P bar	1.648	1.648	
3. P bar (psi)			
4. PT7 (psia)			(2) X (3): Set power to this value
5. EPR (Cockpit)	1.648	1.648	Set if (4) not available
6. Pt2/P bar	0.999	0.999	
7. PT2 (psia)			(3) X (6)
8. PS4 (psia)			Data
9. Ps4/Pt2			(8) / (7)
10. Ps4/Pt2 (Reference)			Latest Overhaul Calibration
11. Δ PS4/PT2			(9) - (10)
12. Percent Ps4/Pt2			[(11)/(10) X 100]
13. EGT (°C)			Data
14. Tamb (°C)			Data
15. θ T2			[(14) + 273] /288 or Tables

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 520/72-00-00-990-844 (Sheet 1 of 2)

INFORMATION	ENGINE POSITION		SOURCE
	1	2	
15A. $\theta\ T2^{1.019}$			(15) to exponent 1.019 or Figure 505
16. $\sqrt{\theta\ T2}$			$\sqrt{(15)}$ or Fugure 505
17. EGT (°K)			(13) + 273
18. EGT/ $\theta\ T2^{1.019}$ (°K)			(17)/(15A)
19. EGT/ $\theta\ T2^{1.019}$ (°C)			(18) – 273
20. % N2 (Tach.)			Data
21. % N2/ $\sqrt{\theta\ T2}$			(20)/(16)
22. D.P. N2 %			Data Plate
23. % N2/ $\sqrt{\theta\ T2}$ – D.P. N2			(21) – (22)
24. % N1 (Tach.)			Data
25. % N1/ $\sqrt{\theta\ T2}$			(24)/(26)
26. Ref. N1	80.5	80.5	*or latest overhaul calibration
27. % N1/ $\sqrt{\theta\ T2}$ – Ref. N1			(25) – (26)
28. $\delta\ T2$			(7)/14.70 or Figure 516
29. Fuel Flow Wf pph			Data
29A. Kc			Figure 517
30. Wf/Kc X $\delta\ T2$			(29)/[Kc X (28)]
31. Ref. Wf	6980	6980	*or latest overhaul calibration
32. Δ Wf/Kc $\delta\ T2$			(30) – (31)
33. % Wf/Kc $\delta\ T2$			(32)/(31) X 100

*Reference Values given are from O.I. 309 and are good for all new engines. Overhauled engines should use last calibration.

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 520/72-00-00-990-844 (Sheet 2 of 2)

8. Oil Pressure Adjustment

(Figure 523)

NOTE: At ground/descent Idle, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages and does not require adjustment.

A. Engine Preparation

(1) Ensure that engine has been properly serviced and is ready for operation.

(2) Install 0 - 50 PSIG (0.0 - 344.7 kPa) direct reading gage to LP2 tap on main oil pressure manifold and vent to LV3 tap on main accessory gearbox housing.

(3) Start engine and run at IDLE for two to five minutes, to stabilize power level and allow oil temperature to reach 100°F (38°C) minimum.

B. Pressure Relief Valve Adjustment

CAUTION: WHEN REMOVING OUTER PLUG, DO NOT ALLOW INNER PLUG OR VALVE HOUSING TO TURN. LOSS OF OIL AND LOSS OF VALVE SECURITY CAN RESULT FROM LOOSENING OF THESE PARTS.

(1) Hold pressure relief valve inner plug hex firmly with wrench and remove outer plug.

NOTE: Cut lockwire from outer plug only; lockwire from inner plug to valve housing and from valve housing to gearbox should be left intact.

(2) Hold adjusting screw stationary with screwdriver and loosen locknut. If desired, fabricate valve adjusting tool from 7/16 inch deep socket with angled handle welded to side to allow screwdriver to pass through center. Such a tool will allow turning locknut while holding adjusting screw stationary.

(3) Using screwdriver, adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa) with engine at IDLE. Clockwise rotation will increase pressure; counterclockwise rotation will decrease pressure.

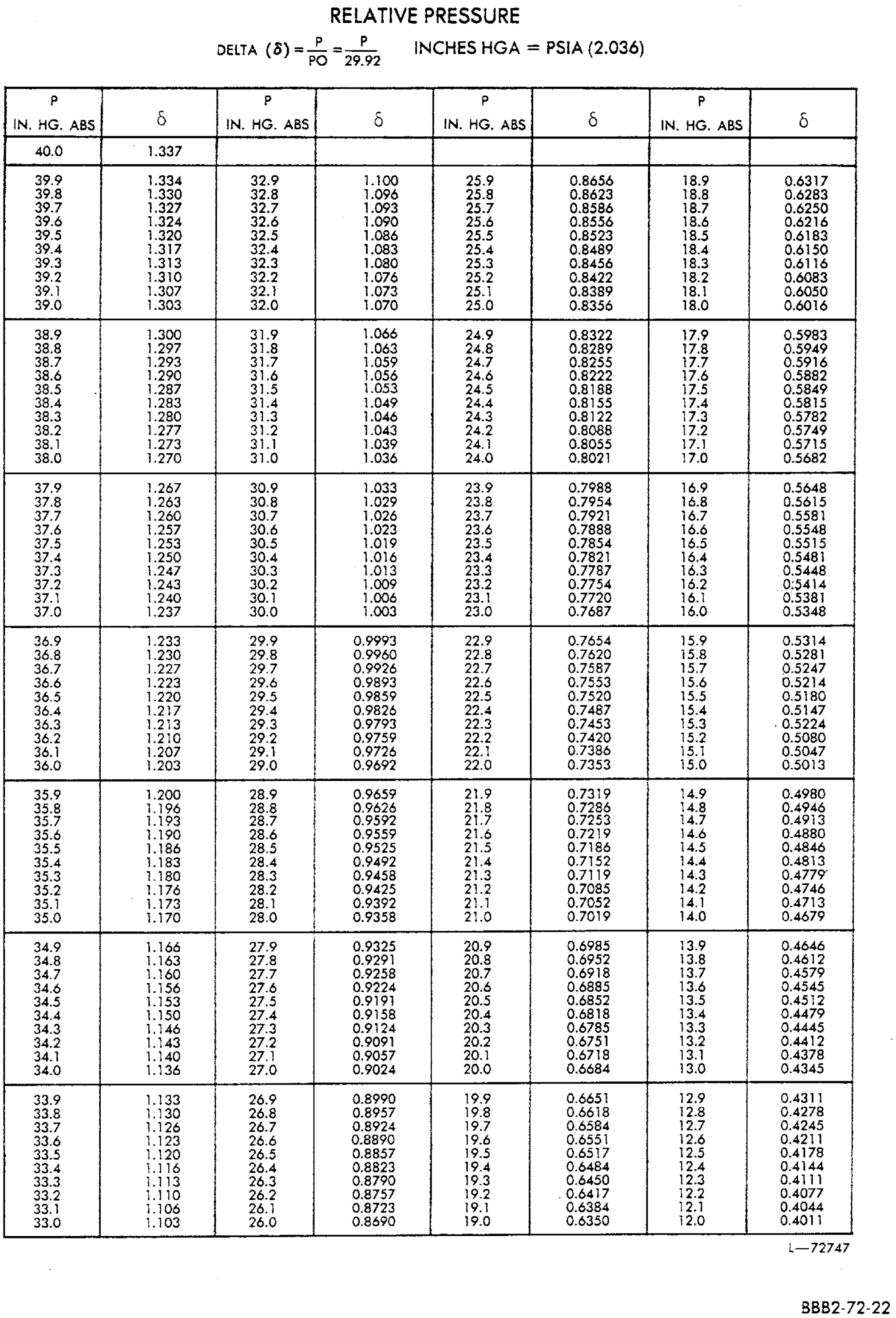
NOTE: One full turn of adjusting screw will change pressure approximately two psi (13.8 kPa).

Key To Figure 523	
1.	Pressure Relief Valve
2.	Locknut
3.	Adjusting Screw
4.	Outer Plug
5.	Packing
6.	Inner Plug
7.	Check This Screw Height After Adjustment (See Text).

CAUTION: AFTER OIL PRESSURE ADJUSTMENT IS COMPLETED, CHECK INDEX 7 DIMENSION IN FIGURE. MEASURED VALUE OF 0.280 INCH (7.112 MM) OR LESS IF NOT CONSIDERED NORMAL AND MAY INDICATE REQUIREMENT FOR OIL SYSTEM TROUBLESHOOTING.

(4) Hold adjusting screw steady and torque locknut. See tool description in Paragraph 8.B.(2).

(5) Install outer plug, with new packing, and torque to 150 - 160 in-lb. (16.948 - 18.078 N·m). Lockwire outer plug to inner plug.



RELATIVE PRESSURE

DELTA $(\delta) = \frac{P}{PO} = \frac{P}{29.92}$ INCHES HGA = PSIA (2.036)

P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ
40.0	1.337						
39.9	1.334	32.9	1.100	25.9	0.8656	18.9	0.6317
39.8	1.330	32.8	1.096	25.8	0.8623	18.8	0.6283
39.7	1.327	32.7	1.093	25.7	0.8586	18.7	0.6250
39.6	1.324	32.6	1.090	25.6	0.8556	18.6	0.6216
39.5	1.320	32.5	1.086	25.5	0.8523	18.5	0.6183
39.4	1.317	32.4	1.083	25.4	0.8489	18.4	0.6150
39.3	1.313	32.3	1.080	25.3	0.8456	18.3	0.6116
39.2	1.310	32.2	1.076	25.2	0.8422	18.2	0.6083
39.1	1.307	32.1	1.073	25.1	0.8389	18.1	0.6050
39.0	1.303	32.0	1.070	25.0	0.8356	18.0	0.6016
38.9	1.300	31.9	1.066	24.9	0.8322	17.9	0.5983
38.8	1.297	31.8	1.063	24.8	0.8289	17.8	0.5949
38.7	1.293	31.7	1.059	24.7	0.8255	17.7	0.5916
38.6	1.290	31.6	1.056	24.6	0.8222	17.6	0.5882
38.5	1.287	31.5	1.053	24.5	0.8188	17.5	0.5849
38.4	1.283	31.4	1.049	24.4	0.8155	17.4	0.5815
38.3	1.280	31.3	1.046	24.3	0.8122	17.3	0.5782
38.2	1.277	31.2	1.043	24.2	0.8088	17.2	0.5749
38.1	1.273	31.1	1.039	24.1	0.8055	17.1	0.5715
38.0	1.270	31.0	1.036	24.0	0.8021	17.0	0.5682
37.9	1.267	30.9	1.033	23.9	0.7988	16.9	0.5648
37.8	1.263	30.8	1.029	23.8	0.7954	16.8	0.5615
37.7	1.260	30.7	1.026	23.7	0.7921	16.7	0.5581
37.6	1.257	30.6	1.023	23.6	0.7888	16.6	0.5548
37.5	1.253	30.5	1.019	23.5	0.7854	16.5	0.5515
37.4	1.250	30.4	1.016	23.4	0.7821	16.4	0.5481
37.3	1.247	30.3	1.013	23.3	0.7787	16.3	0.5448
37.2	1.243	30.2	1.009	23.2	0.7754	16.2	0.5414
37.1	1.240	30.1	1.006	23.1	0.7720	16.1	0.5381
37.0	1.237	30.0	1.003	23.0	0.7687	16.0	0.5348
36.9	1.233	29.9	0.9993	22.9	0.7654	15.9	0.5314
36.8	1.230	29.8	0.9960	22.8	0.7620	15.8	0.5281
36.7	1.227	29.7	0.9926	22.7	0.7587	15.7	0.5247
36.6	1.223	29.6	0.9893	22.6	0.7553	15.6	0.5214
36.5	1.220	29.5	0.9859	22.5	0.7520	15.5	0.5180
36.4	1.217	29.4	0.9826	22.4	0.7487	15.4	0.5147
36.3	1.213	29.3	0.9793	22.3	0.7453	15.3	0.5224
36.2	1.210	29.2	0.9759	22.2	0.7420	15.2	0.5080
36.1	1.207	29.1	0.9726	22.1	0.7386	15.1	0.5047
36.0	1.203	29.0	0.9692	22.0	0.7353	15.0	0.5013
35.9	1.200	28.9	0.9659	21.9	0.7319	14.9	0.4980
35.8	1.196	28.8	0.9626	21.8	0.7286	14.8	0.4946
35.7	1.193	28.7	0.9592	21.7	0.7253	14.7	0.4913
35.6	1.190	28.6	0.9559	21.6	0.7219	14.6	0.4880
35.5	1.186	28.5	0.9525	21.5	0.7186	14.5	0.4846
35.4	1.183	28.4	0.9492	21.4	0.7152	14.4	0.4813
35.3	1.180	28.3	0.9458	21.3	0.7119	14.3	0.4779
35.2	1.176	28.2	0.9425	21.2	0.7085	14.2	0.4746
35.1	1.173	28.1	0.9392	21.1	0.7052	14.1	0.4713
35.0	1.170	28.0	0.9358	21.0	0.7019	14.0	0.4679
34.9	1.166	27.9	0.9325	20.9	0.6985	13.9	0.4646
34.8	1.163	27.8	0.9291	20.8	0.6952	13.8	0.4612
34.7	1.160	27.7	0.9258	20.7	0.6918	13.7	0.4579
34.6	1.156	27.6	0.9224	20.6	0.6885	13.6	0.4545
34.5	1.153	27.5	0.9191	20.5	0.6852	13.5	0.4512
34.4	1.150	27.4	0.9158	20.4	0.6818	13.4	0.4479
34.3	1.146	27.3	0.9124	20.3	0.6785	13.3	0.4445
34.2	1.143	27.2	0.9091	20.2	0.6751	13.2	0.4412
34.1	1.140	27.1	0.9057	20.1	0.6718	13.1	0.4378
34.0	1.136	27.0	0.9024	20.0	0.6684	13.0	0.4345
33.9	1.133	26.9	0.8990	19.9	0.6651	12.9	0.4311
33.8	1.130	26.8	0.8957	19.8	0.6618	12.8	0.4278
33.7	1.126	26.7	0.8924	19.7	0.6584	12.7	0.4245
33.6	1.123	26.6	0.8890	19.6	0.6551	12.6	0.4211
33.5	1.120	26.5	0.8857	19.5	0.6517	12.5	0.4178
33.4	1.116	26.4	0.8823	19.4	0.6484	12.4	0.4144
33.3	1.113	26.3	0.8790	19.3	0.6450	12.3	0.4111
33.2	1.110	26.2	0.8757	19.2	0.6417	12.2	0.4077
33.1	1.106	26.1	0.8723	19.1	0.6384	12.1	0.4044
33.0	1.103	26.0	0.8690	19.0	0.6350	12.0	0.4011

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Relative Pressure
Figure 521/72-00-00-990-845

TEMPERATURE CORRECTION FOR FUEL FLOW

Tt2			Tt2			Tt2		
°C	°F	Kc	°C	°F	Kc	°C	°F	Kc
-40	-40.0	0.8798	-6	21.2	0.9542	28	82.4	1.0286
-39	-38.2	0.8820	-5	23.0	0.9564	29	84.2	1.0308
-38	-36.4	0.8842	-4	24.8	0.9585	30	86.0	1.0329
-37	-34.6	0.8863	-3	26.6	0.9607	31	87.8	1.0351
-36	-32.8	0.8885	-2	28.4	0.9629	32	89.6	1.0373
-35	-31.0	0.8907	-1	30.2	0.9651	33	91.4	1.0395
-34	-29.2	0.8929	0	32.0	0.9673	34	93.2	1.0417
-33	-27.4	0.8951	1	33.8	0.9695	35	95.0	1.0439
-32	-25.6	0.8973	2	35.6	0.9717	36	96.8	1.0461
-31	-23.8	0.8995	3	37.4	0.9739	37	98.6	1.0483
-30	-22.0	0.9017	4	39.2	0.9761	38	100.4	1.0504
-29	-20.2	0.9038	5	41.0	0.9782	39	102.2	1.0526
-28	-18.4	0.9060	6	42.8	0.9804	40	104.0	1.0548
-27	-16.6	0.9082	7	44.6	0.9826	41	105.8	1.0570
-26	-14.8	0.9104	8	46.4	0.9848	42	107.6	1.0592
-25	-13.0	0.9126	9	48.2	0.9870	43	109.4	1.0614
-24	-11.2	0.9148	10	50.0	0.9892	44	111.2	1.0636
-23	- 9.4	0.9170	11	51.8	0.9914	45	113.0	1.0658
-22	- 7.6	0.9192	12	53.6	0.9936	46	114.8	1.0679
-21	- 5.8	0.9214	13	55.4	0.9957	47	116.6	1.0701
-20	- 4.0	0.9235	14	57.2	0.9979	48	118.4	1.0723
-19	- 2.2	0.9257	15	59.0	1.0001	49	120.2	1.0745
-18	- 0.4	0.9279	16	60.8	1.0023	50	122.0	1.0767
-17	1.4	0.9301	17	62.6	1.0045	51	123.8	1.0789
-16	3.2	0.9323	18	64.4	1.0067	52	125.6	1.0811
-15	5.0	0.9345	19	66.2	1.0089	53	127.4	1.0833
-14	6.8	0.9367	20	68.0	1.0111	54	129.2	1.0855
-13	8.6	0.9389	21	69.8	1.0132	55	131.0	1.0876
-12	10.4	0.9410	22	71.6	1.0154	56	132.8	1.0898
-11	12.2	0.9432	23	73.4	1.0176	57	134.6	1.0920
-10	14.0	0.9454	24	75.2	1.0198	58	136.4	1.0942
-9	15.8	0.9476	25	77.0	1.0220	59	138.2	1.0964
-8	17.6	0.9498	26	78.8	1.0242	60	140.0	1.0986
-7	19.4	0.9520	27	80.6	1.0264			

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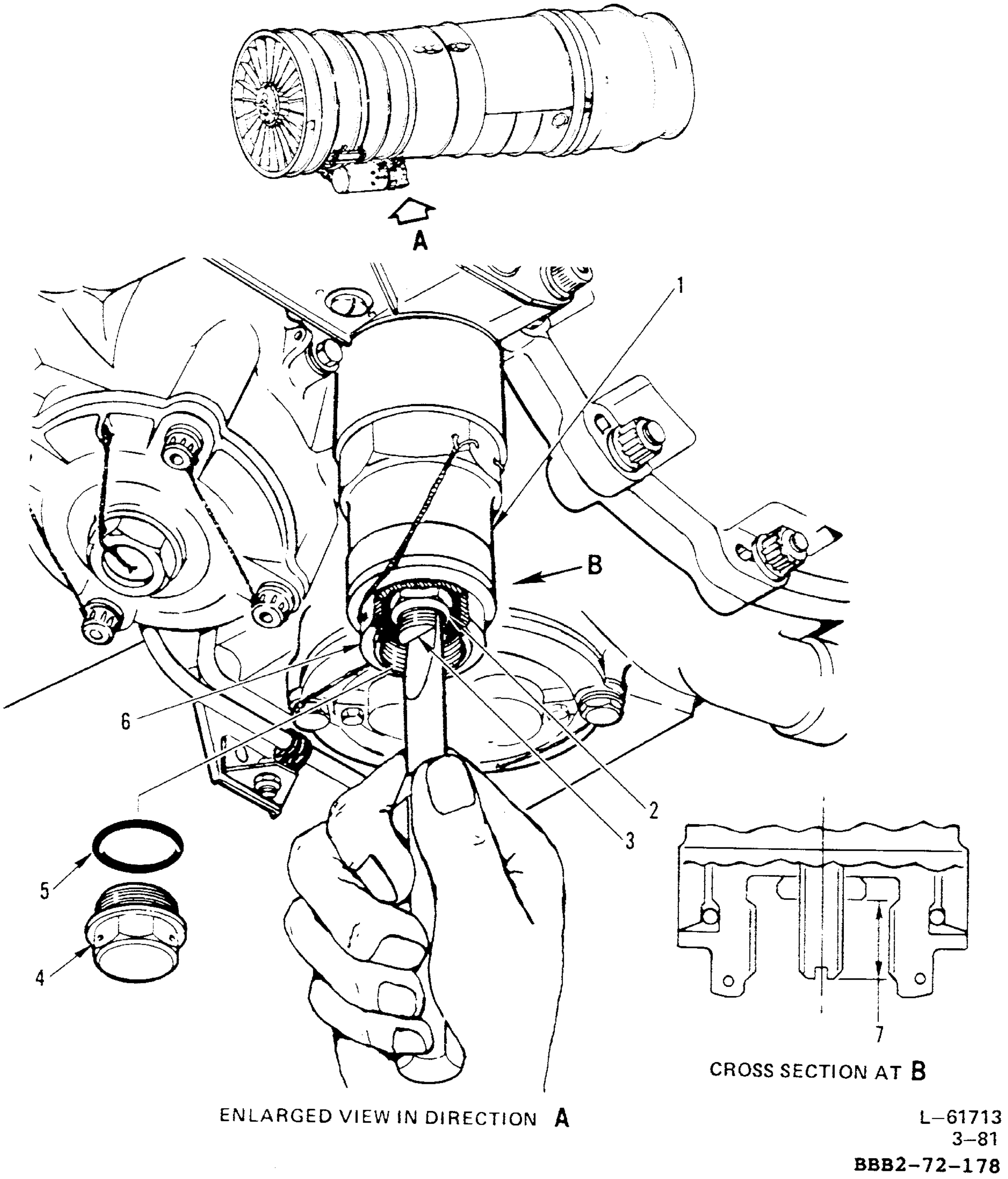
Temperature Correction For Fuel Flow
Figure 522/72-00-00-990-846



Oil Pressure Adjustment
Figure 523/72-00-00-990-847

9. Trim Balance Of Engine Installed In Aircraft

A. On-Wing Trim Balancing - General

CAUTION: APPLICATION OF TRIM BALANCING MUST MEET FOLLOWING PREREQUISITES: TRIM BALANCE IS TO BE USED ONLY ON NEW AND OVERHAULED ENGINES AND ON THOSE REPAIR ENGINES (HEAVY MAINTENANCE) WHICH HAVE HAD LOW COMPRESSOR AND LOW TURBINE ROTORS DISASSEMBLED, INSPECTED, AND REASSEMBLED ACROSS BALANCE MACHINE, EXCEPT AS NOTED BELOW. THOSE ENGINES WITH EXCESSIVE HIGH ROTOR VIBRATION OR LOW ROTOR VIBRATION WHICH EXCEED LIMITS AS SPECIFIED IN PROCEDURE MAY NOT BE TRIM BALANCED.

(1) Engine whose rotating parts are balanced will normally have some residual unbalance which will result in detectable vibration at engine operating condition. This vibration may be minimized by trim balancing, which entails addition of weight positioned to offset residual unbalance in compressor front balance plane and turbine rear balance plane.

NOTE: (Heavy Maintenance) repair engines which do not exceed normal acceptable vibration limits may be trim balanced to lower amplitude, if desired.

B. Equipment For Trim Balance

(1) Vibration Pickups: Phased velocity type, CEC 4-123A or equivalent.

(2) Speed Signal: An exact one-pulse-per revolution is required as the reference signal. Special tachometer and adapter with ratio of 24 to 47 must be mounted in place of any other tachometer or adapter on N_1 tachometer pad. Index rotor by aligning single tooth of tachometer with tip of impulse pickup. Small hole in fact of tachometer is provided for this purpose. In order to reindex rotor after running without having to make above observation, make mark with layout dye on blade and engine case.

Tach. Adapter: Model B1692-2, Ratio 24/47 (Exact)

Vendor: The Electric Tachometer Corporation 68th & Upland Streets Philadelphia, PA 19142, U.S.A.

Pulse Generator: Model HB 163212, one triangular tooth, 0.062 inch (1.588 mm) flat

Vendor: H And B Tool And Engineering Co., 481 Sullivan Ave., South Windsor, CT 06074, U.S.A.

(3) Trim Balance Analyzer: Spectral Dynamics Model SD-119-B, or equivalent.

(a) With vibration data signal (from a velocity, acceleration or non-contacting displacement pickup) and one-pulse-per-revolution reference signal, analyzer provides the following information needed for balancing an engine:

1) Amplitude of vibration

2) Phase angle between reference point and point of maximum unbalance, i.e., location of unbalance.

3) Speed in RPM of engine (N_1).

(b) To provide these operating parameters, balance analyzer accepts signal from vibration pickup and passes it through integrator for conversion to displacement signal. For signal from a displacement pickup or accelerometer, integrator is bypassed.

(c) Displacement signal is then passed through dynamic tracking filter, which is tuned by one-per-revolution signal from tachometer mounted on engine. Pulse-to-sinewave converter uses tachometer signal to provide necessary sinewave for track filter. Converter is phase-locked to tachometer signal for absolute tuning of tracking filter and absolute phase (i.e., balance location) reference. Because it is frequency tuned by speed signal, tracking filter eliminates all frequency signals other than rotor fundamental. Output of tracking filter is displayed as displacement.

(d) Difference in angular degrees between vibration signal (at one-per-revolution tuning frequency) and one-per-revolution reference frequency derived from tachometer through converter is measured by phase meter. Output of phase meter is displayed as phase. Output of pulse-to-sinewave converter is multiplied by 60 factor and displayed as speed in RPM.

C. Setup Of Equipment

(Figure 524)

(1) Install vibration pickups. (Figure 513)

(2) Check vibration pickups to ensure that they are in phase (positive outward displacement gives positive voltage output).

(3) Install special tachometer adapter and reference signal generator in place of engine adapter (if any) and N_1 tachometer.

(4) With generator in "firing position", reference front compressor (low) rotor to engine case using layout dye.

NOTE: Turn rotor in direction of engine rotation to take up backlash of tachometer drive, that is, clockwise (counterclockwise facing engine fan inlet case).

(5) Set up and operate balance analyzer per manufacturer's instructions.

D. Trim Balance Procedures

(Figure 525), (Figure 526), (Figure 527), (Figure 528)

(1) The following procedure establishes a uniform method of approaching trim balance. Phase angle lag and sensitivity data must be determined as a result of trim balance experience. No data is currently available.

(a) Definition of Terms

1) 1EL - The low speed rotor fundamental vibration amplitude.

2) 1EH - The high speed rotor fundamental vibration amplitude.

3) Cw - Calibration weight (serially numbered Cw1, Cw2, etc.) of stainless steel wire used to balance engine. Replaced by equivalent PN balance weight after trim balance.

4) Class - Category into which engine is placed based on prebalance vibration survey. (No data is currently available.)

5) Phase Angle - Phase meter reading. Phase angle by which integrated vibration signal lags reference signal.

6) Phase Angle Lag - Calculated angle indicating lag between passing of unbalance weight and response signal.

7) Assumed Phase Angle Lag - Weighted average of phase angle lags determined from previous balance attempts. Also, correction angle used in "one-shot" method.

8) VD - Vector difference from Point A to Point C.

(b) Trim Balance Sequence

1) Conduct prebalance vibration survey to determine suitability of engine for trim balance and to provide basis for classification.

2) Run "As Is" speed points as prescribed for class engine being balanced.

3) Run "As Is" data, plot A vector on polar paper, angle being laid out counter to engine rotation from 12 o'clock location. Draw R vector equal and opposite A vector. (Figure 525)

4) Apply assumed phase angle lag given for class to which engine has been assigned. Assumed phase angle lag is laid off from R in direction of rotation and indicates angular location of Cw1.

5) Apply assumed sensitivity given in respective trim balance procedures assigned engine class. Multiply amplitude of vector A and sensitivity value to give oz-in required for Cw1.

6) Install Cw1 which may be either stainless steel wire or permanent weight as described previously. See Figure 524 or Figure 527 for computation of wire necessary to correct imbalance. Wire weight is installed on nearest blade to location to that designated by steps outlined in Paragraph 9.D.(1)(b)4) above.

7) Rerun engine as in Paragraph 9.D.(1)(b)2) above repeating each speed point within ± 0.2 rev/sec on counter at time base of 10 sec. Record all data.

8) In conjunction with Paragraph 9. above observe O/A (overall) mils vibration throughout engine speed range to determine if all vibration is within acceptance limits.

9) If engine is acceptable, replace wire trial weight with equivalent weight in 1st stage compressor hub, when applicable. No changes are required if no wire weight was used.

10) If engine is unacceptable, calculate and apply Cw2 as described in specific counterweight installation procedure. All weight runs (Cw1, Cw2 ... Cwn) are calculated with respect to "As Is" data.

11) Continue to trim balance engine as required.

12) Complete trim balance report, shown in Figure 528, and file report with engine records.

(2) Hypothetical Example of Vector Balance Method

(a) Assume:

Vibration survey has shown need to trim balance (± 2.0 mils) (0.05 mm) at 6000 N_1. Engine is classified as "Class X." (Acceptance limits ± 1 mil) (0.03 mm). Procedure calls for a compressor trim at 6000 N_1 RPM, assumed phase angle lag of 130 degrees and sensitivity of 1.0 oz-in/mil (720 g.mm/0.03 mm).

(b) Record inlet pickup phase angle and amplitude at 6000 N_1 RPM. In this example let ± 2.0 mil (0.05 mm) at 300 degrees be the recorded data for run No. 1.

(c) Plot vector A (± 2.0 mil) (0.05 mm) at 300 degrees on polar paper. Lay out angle counter to engine rotation from 12 o'clock location. Draw vector R equal and opposite vector A. (See plot on Figure 525).

(d) Apply assumed phase angle lag (130 degrees) laying it off from R in direction of rotation. This indicates that Cw1 should be applied at 350 degrees as measured from 12 o'clock reference location counter to engine rotation.

(e) Apply assumed sensitivity. Multiple amplitude of A vector (± 2.0 mil) (0.05 mm) by assumed sensitivity (1.0 oz-in/mil) (720 g.mm/0.03 mm). Magnitude of Cw1 should be 2 oz-in (1440 g.mm).

(f) Install Cw1. Wire weight may be installed on nearest blade to 350 degrees. In this example let blade No. 2, shown on plot, be chosen (349 degrees).

(g) Rerun balance point and record phase angle and amplitude resulting from addition of Cw1. Run No. 2.

(h) In conjunction with previous Paragraph 9.D.(2)(g), observe O/A mils throughout engine speed range to determine if all vibration is within acceptance limits.

(i) Let data from Run No. 2 be ± 1.3 mils (0.03 mm) at 20 degrees. Plot data as vector C on polar paper. Lay out angle counter to engine rotation from 12 o'clock location.

(j) Plot Vector Difference (VD) by subtracting vector A from vector C. Draw VD from A to C, arrow pointing to C. Translate VD vector to origin of diagram. In this example VD is ± 2.2 mils (0.06 mm) at 84 degrees. VD represents effect of Cw1 alone, both in magnitude and direction. To eliminate unbalance (A vector), VD must bed rotated and adjusted in length to coincide with R vector.

(k) Calculate location and size of required balance weight, Cw2.

1) Size of correction weight = size of trial

$$\text{weight} \quad \times \quad \frac{\text{A mils}}{\text{VD mils}}$$

$$\text{Cw2} = 2 \quad \times \quad \frac{2}{2.2} = 1.82 \text{ oz-in.}$$

2) Location of correction weight: In this example, angular amount between VD (84 degrees) and R (120 degrees) is 36 degrees counter to engine rotation. Remove Cw1, move from its location 36 degrees counter to engine rotation to 25 degrees. Apply Cw2 (1.82 oz-in.) (1310 g.mm) at 25 degree (blade No. 32). This should cause VD to coincide with R.

(l) Above procedure can be repeated using second correction weight as new calibration weight. Data from new weight and "As-Is" data can be used to calculate third correction weight and thereby refine balance.

(m) Determine phase angle lag and vibration sensitivity. (Although not required for any specific engine balance, average values calculated from several engine balances are considered valuable guide for follow-on balance jobs).

1) Phase Angle Lag: Unbalance vectors are measured in terms of amplitude and phase angle (phase meter reading) and are plotted referenced to 12 o'clock location in direction counter to rotation to indicate "lag". Normal plotting procedure locates reference point at top of engine vertical centerline designated as 12 o'clock. this point is shown on the plot as 0 degrees.

Balance weights are located on rotor after rotor has been turned (indexed) to locate pulse generator tooth directly under pulse pickup. Angular location of the weight is then measured in direction counter to rotation referenced to 12 o'clock.

To determine phase angle lag, unbalance vectors and weight locations must be given common frame of reference. Angular location corresponding to 12 o'clock is taken as common reference point. Phase angle lag is angle by which response (VD) lags calibration weight. Graphically, it is angle from calibration weight to VD measured counter to engine rotation. In this example, phase lag is 96 degrees.

2) Sensitivity: Sensitivity can be calculated at any given speed point by dividing weight amplitude (Cw1 = 2.0 oz-in.) (1440 g.mm) by measured response (VD - ± 2.2 mils) (0.06 mm). In this example calculated sensitivity is 0.91 oz-in. per mil (655 g.mm per 0.03 mm).

(n) The purpose of calculating phase angle lag and sensitivity is to provide information to assist in future balances. Weighted average of these data for number of balances provide assumed phase angle lag and assumed sensitivity which, when applied to "As Is" data, established "one shot" balance method. In this example let assumed phase angle lag equal 95 degrees. After plotting information described in Paragraph 9.D.(2)(a) the 95 degree angle is now laid out from R vector in direction of engine rotation and establishes Cw1 location. Amount of weight required is established by multiplying A vector amplitude (+ mils) (+ mm) by sensitivity (oz-in./mil) (g.mm/mm) which, for this example, gives 1.82 oz-in. (1310 g.mm) required. It can now be seen that engine would be balanced by this Cw1 and no further runs are necessary.

E. Trim Balance Limits And Procedures

(1) Trim Balance Limits

(a) Engines that experience vibration at N_1 rotational frequency at inlet case and/or exhaust duct up to and including 0.002 inch single amplitude may be trim balanced to bring them within acceptable limits.

(b) Maximum correction (all trim weights) for trim balance of the front compressor at the front plane must be a vector sum of no more than 7.0 oz-in. (5040. g.mm). The total number of trim weights used on the inner balance rib of the front hub must not be more than five.

(c) Maximum correction (all trim weights) for trim balancing front compressor drive turbine at rear plane shall not exceed total vector sum of 10.5 oz-in. when combined with weights previously installed while balancing turbine rotor. Previously installed weights may be moved or replaced, but total number of weights used on turbine rotor assembly shall not exceed five and total vector sum shall not exceed 10.5 oz-in. (7560 g.mm).

(d) After completing installation of final trim balance weights, conduct vibration survey to ensure that vibration levels are within acceptance limits.

(2) Trim Balance Weight Installation

(a) Front Plane

1) Remove front accessory drive group. (PAGEBLOCK 72-21-00/401)

2) Remove retaining ring holding front accessory drive gearshaft in front hub. Engage PWA 45009 Puller behind gearshaft gearteeth and remove gearshaft carefully with knocker action.

3) Find the applicable counterweight (0 - 5) as shown in Figure 529.

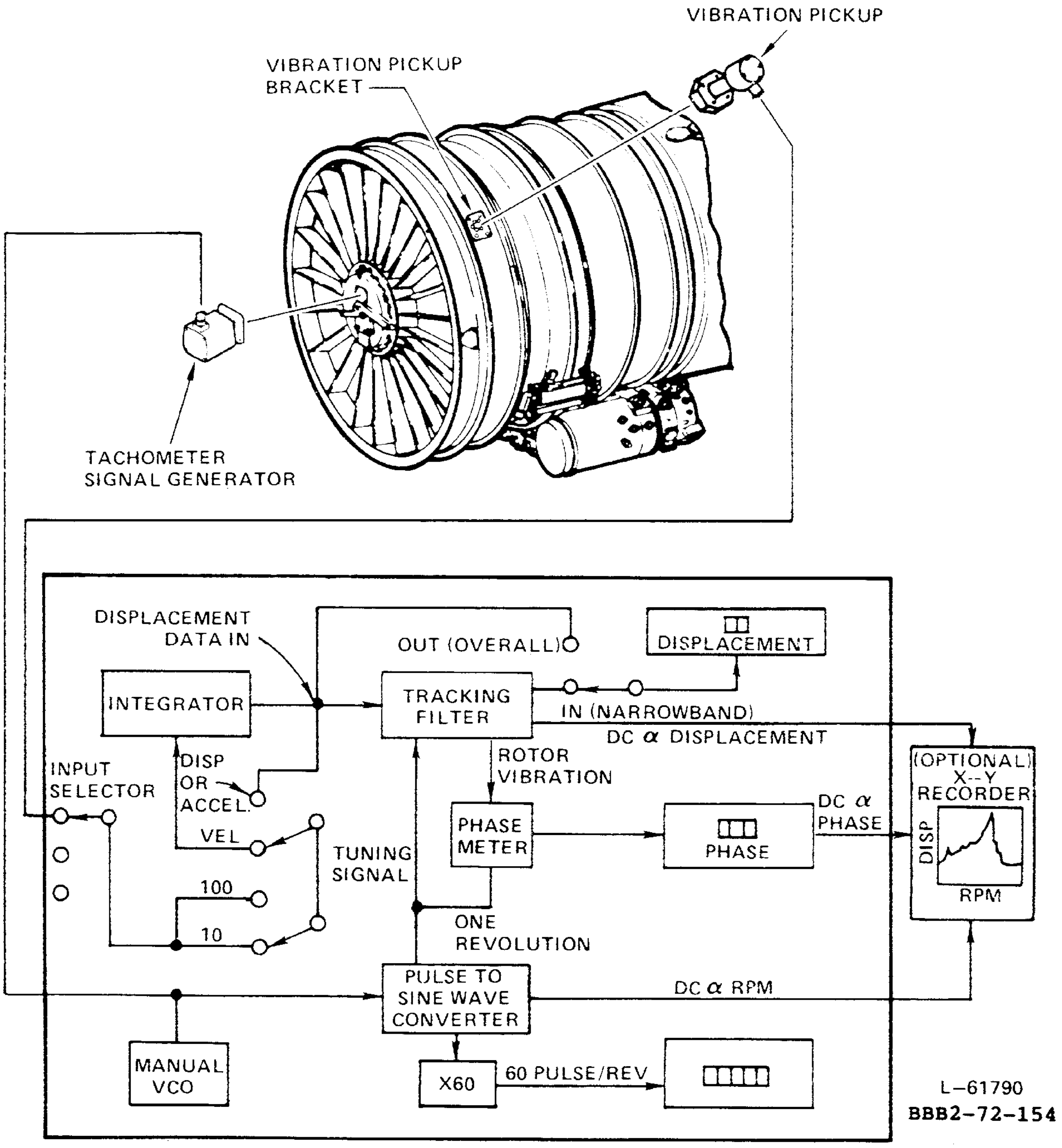
4) Install counterweight inside front hub on balancing rib as close to required angular location as possible. Compress counterweight shank against spring pressure and release shank when weight straddles balancing rib and hook section of shank is in line with hole in rib. Figure 529

5) Install a packing, lubricated with PWA 36500 Assembly Fluid, on the front accessory drive gearshaft and install the shaft on the front hub. Hold the gearshaft in position with a retaining ring.

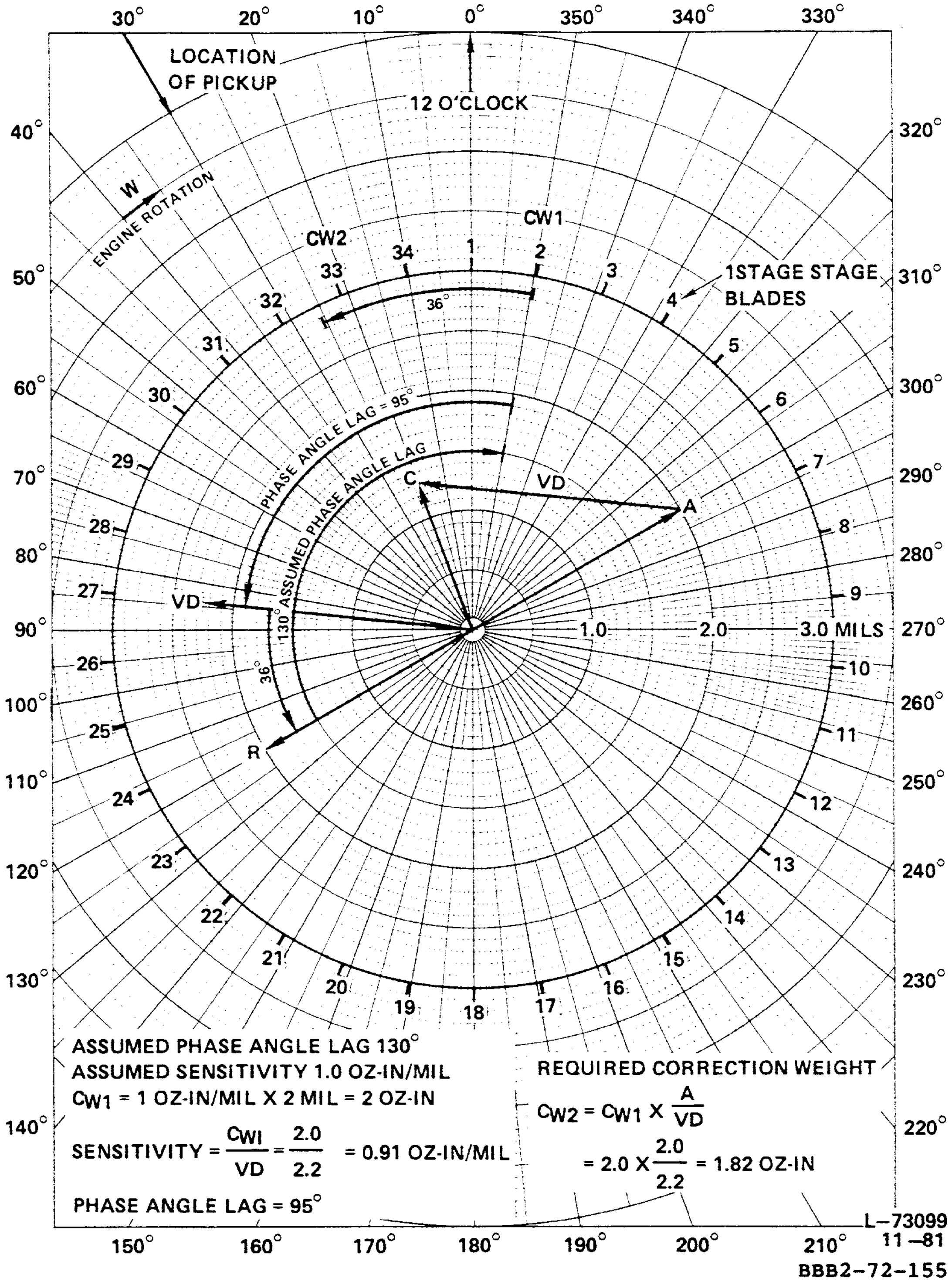
6) Install front accessory group. (PAGEBLOCK 72-21-00/401)

(b) Rear Plane

1) Remove the fan and turbine exhaust duct (mixer) for access to the rear of the turbine.
2) Add counterweights (or remove and replace counterweights found on the rear of the 4th stage turbine disk). Refer to the limits in Paragraph 9.E.(1). (Figure 530)
3) Attach counterweights with rivets (rivet heads pointed to the disk surface). Flare the rivet ends to 0.125 inch (3.175 mm) diameter minimum (PWA 46320 Riveter is available to do this).
4) Install the fan and turbine exhaust duct (mixer).



Instrumentation Block
Figure 524/72-00-00-990-848



ASSUMED PHASE ANGLE LAG 130°
ASSUMED SENSITIVITY 1.0 OZ-IN/MIL
C_{W1} = 1 OZ-IN/MIL X 2 MIL = 2 OZ-IN

SENSITIVITY = $\frac{C_{WI}}{VD} = \frac{2.0}{2.2}$ = 0.91 OZ-IN/MIL

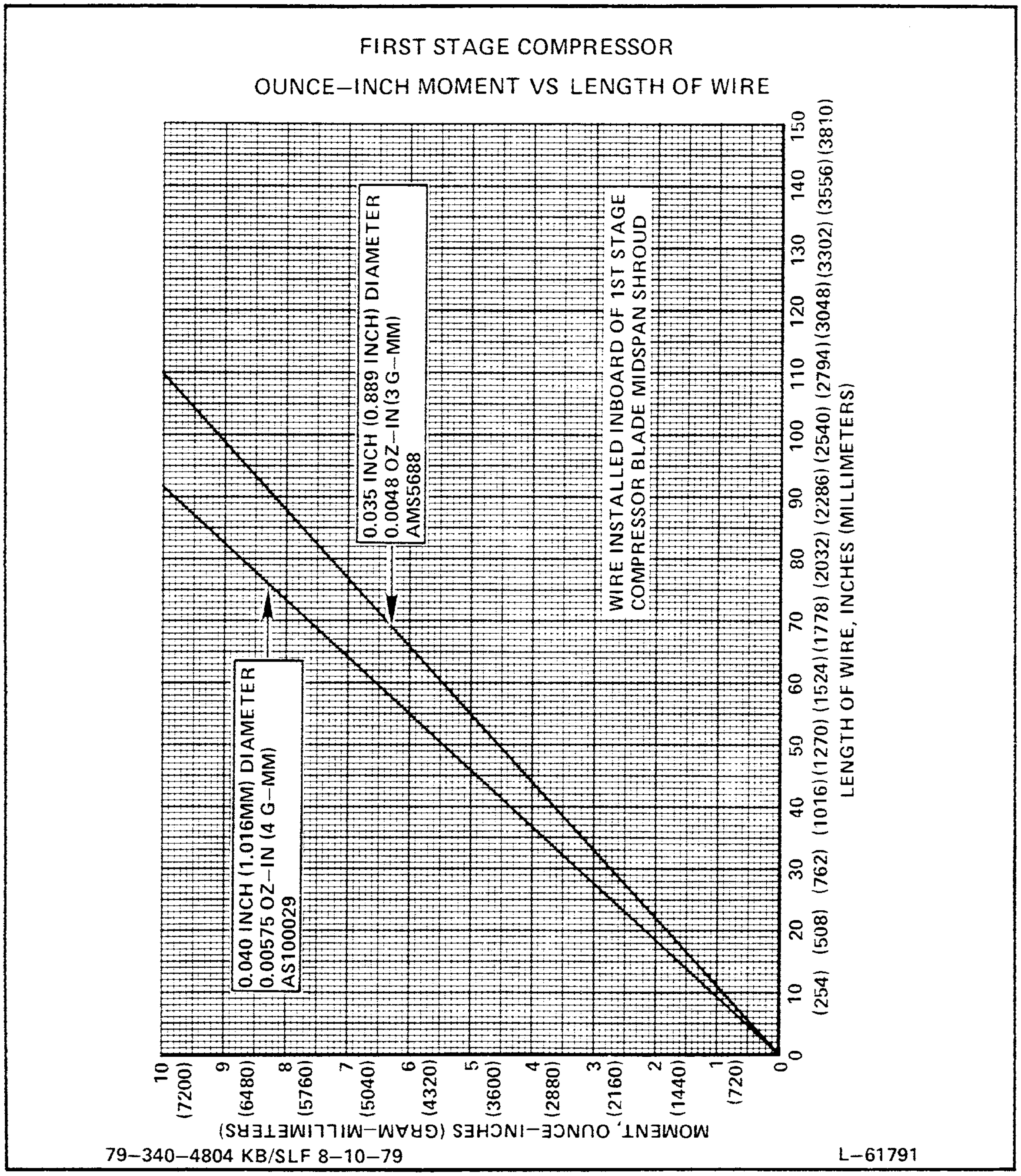
PHASE ANGLE LAG = 95°

REQUIRED CORRECTION WEIGHT

$$C_{W2} = C_{W1} \times \frac{A}{VD}$$

$$= 2.0 \times \frac{2.0}{2.2} = 1.82 \text{ OZ-IN}$$

Trim Balance Calculation Diagram
Figure 525/72-00-00-990-849



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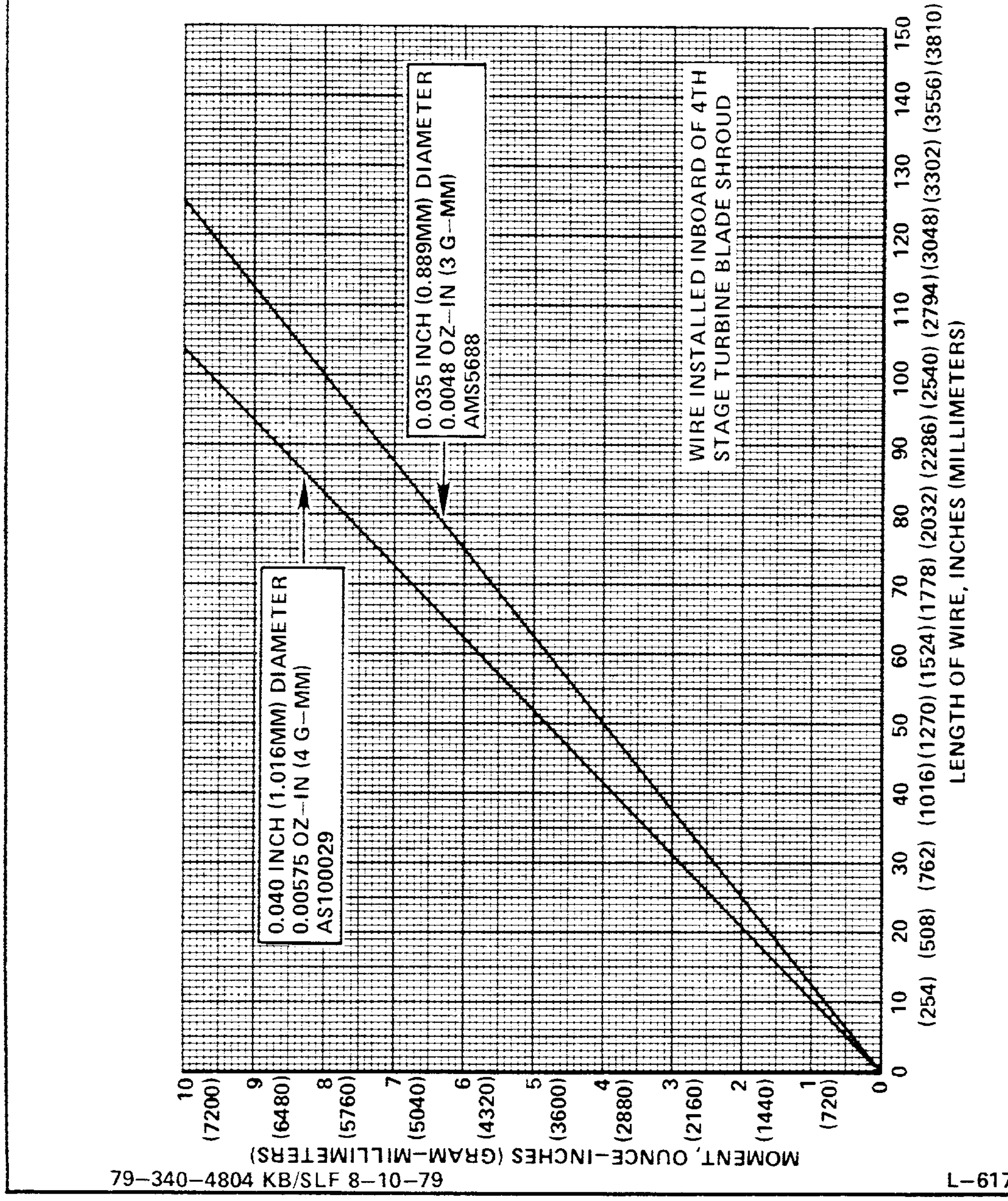
Ounce-Inch Moment Vs. Length Of Wire (First Stage Compressor)
Figure 526/72-00-00-990-850

FOURTH STAGE TURBINE

OUNCE–INCH MOMENT VS LENGTH OF WIRE



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L–61792

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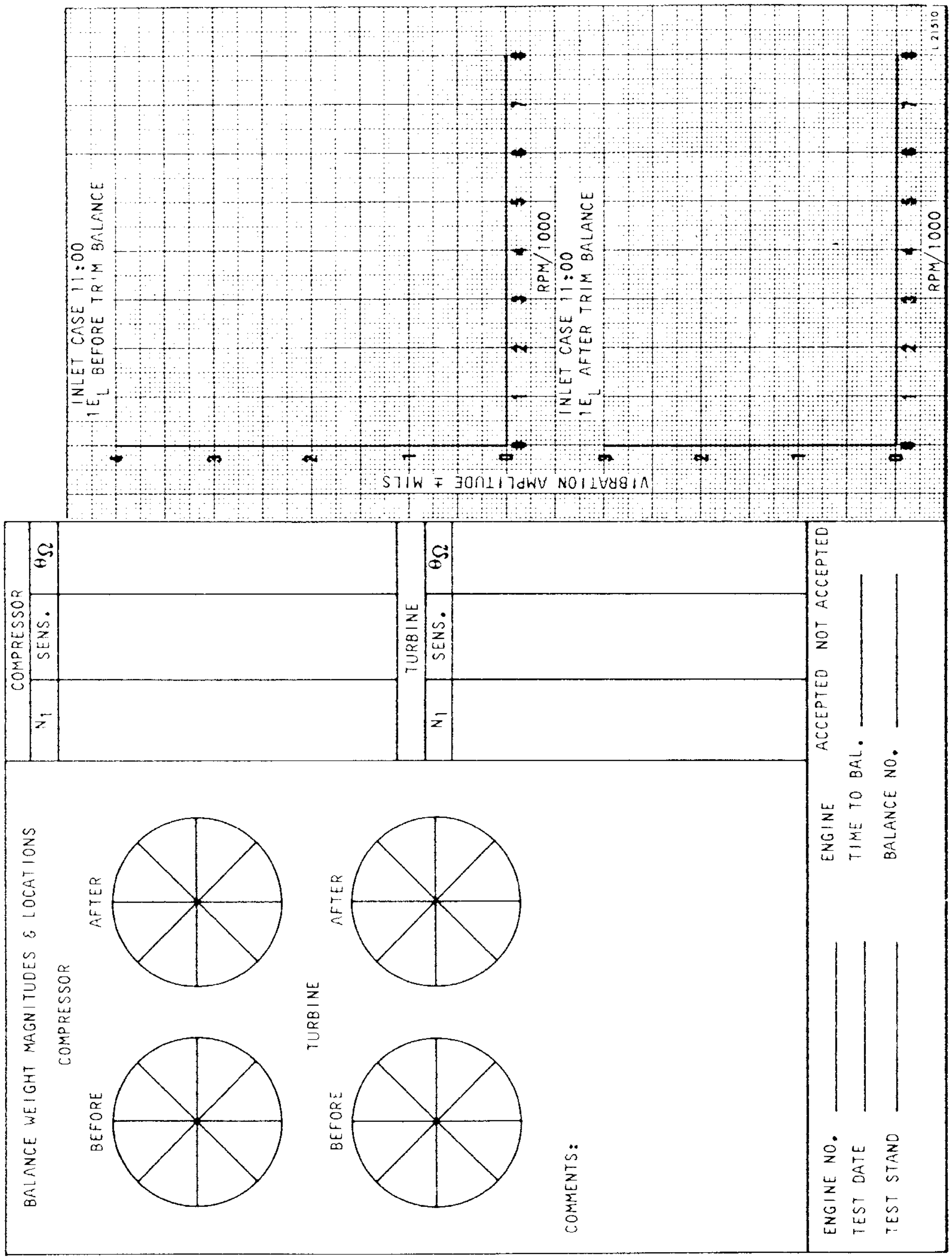
Ounce-Inch Moment Vs. Length of Wire (Fourth Stage Turbine)
Figure 527/72-00-00-990-851



JT8D TRIM BALANCE REPORT

BALANCE WEIGHT MAGNITUDES & LOCATIONS

COMMENTS:

ENGINE NO. ______

TEST DATE ______

TEST STAND ______

ENGINE ACCEPTED NOT ACCEPTED

TIME TO BAL. ______

BALANCE NO. ______

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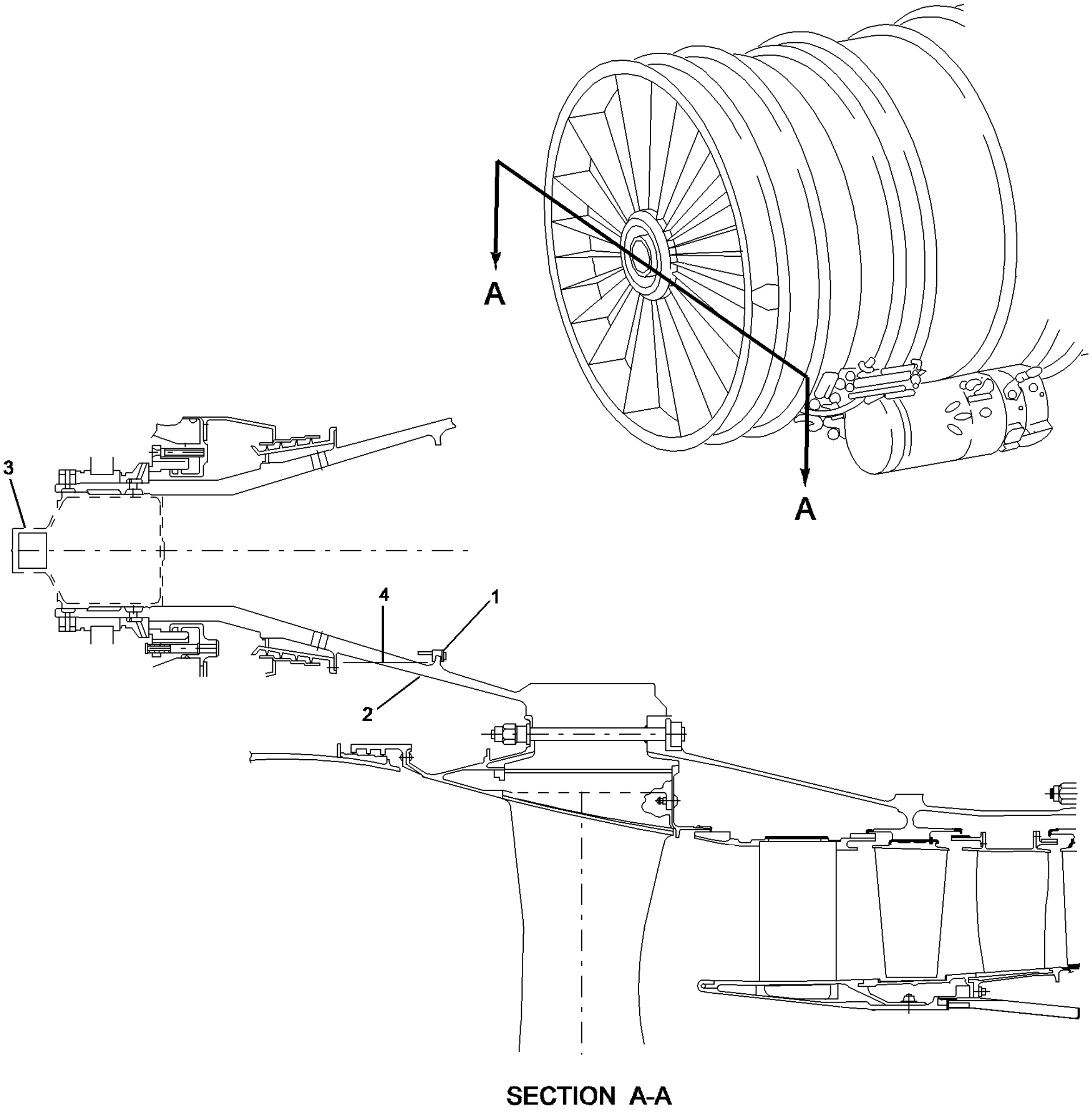
Trim Balance Report
Figure 528/72-00-00-990-852



LEGEND:

1. COUNTERWEIGHT PN 658339, 658341 (CLASS 1 OR 2) OR 761787, 0 - 5 AS REQUIRED
2. FRONT COMPRESSOR FRONT HUB
3. GEARSHAFT (REMOVED FOR ACCESS)
4. 4.000 in. (101.600 mm) BALANCING RADIUS (REFERENCE)

L-83887

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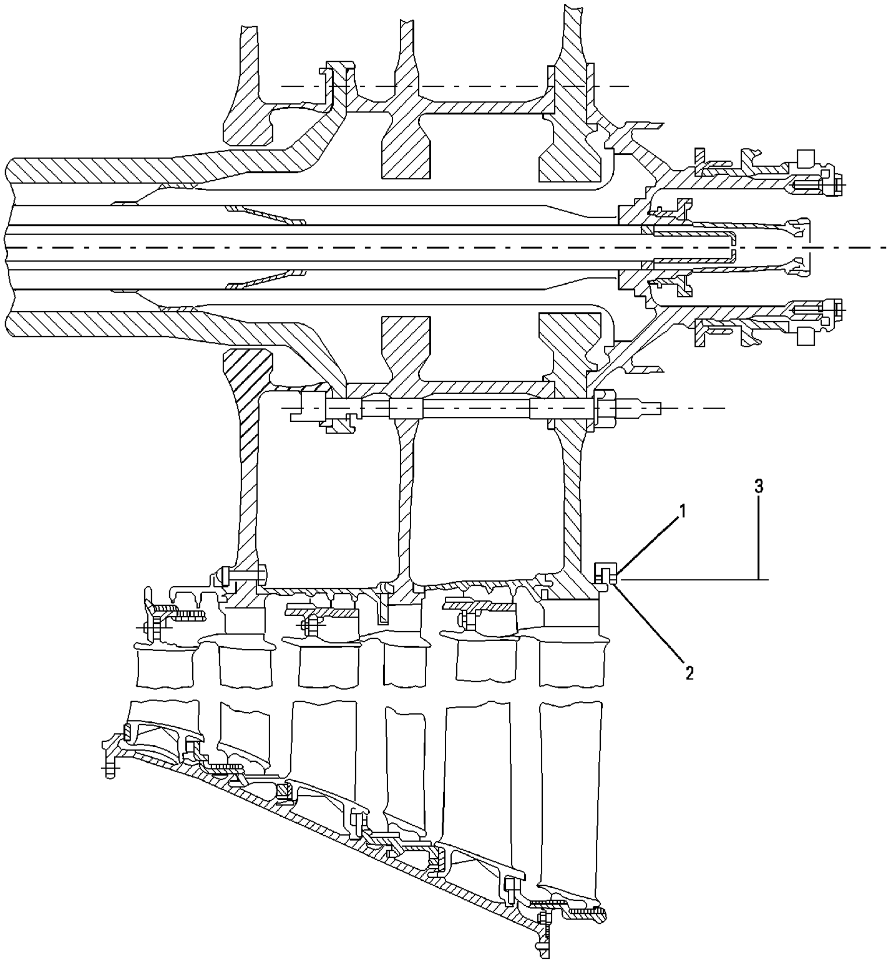
S0006554749V2

Front Compressor Trim Balancing
Figure 529/72-00-00-990-853



1. PN 534492, 584943, OR 584994 COUNTERWEIGHTS. SELECT CLASS AS NECESSARY AND INSTALL, REMOVE, OR REPLACE BY THE LIMITS IN THE TEXT. IT IS PERMITTED TO INSTALL PN 534492 EITHER SIDE OF THE DISK FLANGE.
2. RIVET (PN 4028248) (USE WITH PN 584943 OR 584944).
3. 7.715 INCHES (195.961 MM) BALANCE RADIUS (REFERENCE)

L-84125

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Rear Turbine Trim Balance
Figure 530/72-00-00-990-854

10. Fuel Control Starting Schedule Adjustment

A. General

(1) Fuel control removals have occurred on engines that had what could become "hot starts" and also on engines which had slow acceleration. Experience shows that fuel control linkages can have wear or part movement which can cause changes in the starting flow schedule, in either the rich or the lean direction. A rich change in fuel flow can cause hot starts. A lean change in fuel flow can cause slow acceleration. Adjustments to the fuel control to put the start schedule back in its initial calibration limits, as specified in the Component Maintenance Manual (CMM), can decrease the number of fuel control removals which are the result of possible hot start or slow acceleration.

(2) It is possible to do this adjustment on a fuel control only two times, in the upward or downward direction. If a fuel control continues to be part of a hot start or slow acceleration problem, remove the control for approved component repair or calibration.

(3) This procedure is approved for all dash numbers of Hamilton Standard (HSD) PN 769606 fuel controls.

(4) Before fuel control adjustment, do all other applicable procedures in PAGEBLOCK 72-00-04/101 to make sure that there are no other possible causes of the hot start or slow acceleration problem.

(5) Adjustments to the fuel control other than what is specified in the procedures in this section are not permitted.

B. Procedure

(Figure 531), (Figure 532), (Figure 533), (Figure 534)

CAUTION: DO NOT USE AN ABSOLUTE PRESSURE GAGE TO MEASURE PRIMARY FUEL PRESSURES. THIS TYPE OF GAGE WILL NOT GIVE CORRECT READINGS FOR THIS PROCEDURE.

(1) Attach a gage, STD-14581 to the pressurizing and dump valve FP4 port as shown in (Figure 531).

(2) Wet motor the engine for ten (10) seconds minimum after the N_2 speed becomes stable.

(3) Measure the fuel pressure at the FP4 port.

(4) Record the engine speed and the ambient atmospheric pressure (in inches Hg).

(5) Use Figure 532 to convert the primary fuel pressure at the FP4 port to fuel flow (primary fuel pressure versus primary nozzle pressure).

(6) Find the nominal fuel flow (Wf) for the N_2 speed from the applicable starting schedule. (Figure 533, Sheets 1 thru 10)

(7) Add and subtract 30 PPH to get a plus or minus 30 PPH acceptance band.

(8) If the fuel flow (Wf) in Paragraph 10.B.(5) is in the band of fuel flow (Wf) set in Paragraph 10.B.(6), do not adjust the fuel control.

(9) If the fuel flow (Wf) in Paragraph 10.B.(5) is more than the higher fuel flow (Wf) set in Paragraph 10.B.(7), turn the throttle valve position adjustment counterclockwise to decrease the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(10) If the fuel flow (Wf) in Paragraph 10.B.(5) is less than the lower fuel flow (WF) set in Paragraph 10.B.(7), turn the throttle valve position adjustment clockwise to increase the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(11) Adjust the throttle valve position adjustment as follows: (Figure 510)

(a) Remove the screw and plate from the fuel control as shown in Figure 534.

(b) Use a 3/32 inch hex wrench to turn the adjustment in the necessary direction.

NOTE: The adjustment has a limit of 230 PPH for a fuel control between bench calibrations (this will be approximately 0.3 turn). This adjustment will make a change of 800 PPH per turn. Make the last adjustment in a clockwise direction. To get a decrease in fuel flow, turn the adjustment counterclockwise one eighth (1/8) turn past the necessary position, then turn it clockwise to the necessary position.

(c) Install the plate and attach it with the screw and washer after the adjustment is completed.

(12) After all adjustments, do this procedure to make sure that the schedule mechanism is stable:

(a) Get the engine to a stable motoring speed.

(b) Set the condition lever to ON for ten (10) seconds and record the primary nozzle pressure at the P&D valve FP4 port.

(c) Set the condition lever to OFF for ten (10) seconds.

(d) Do Paragraph 10.B.(12)(b) and Paragraph 10.B.(12)(c) again.

(e) Do Paragraph 10.B.(12)(b) again.

(f) If the pressure recorded in Paragraph 10.B.(12)(e) is not plus or minus 2 psi of the pressure recorded in Paragraph 10.B.(12)(d), stop the motoring procedure and do Paragraph 10.B.(12)(a) thru Paragraph 10.B.(12)(e) again.

(g) Use Figure 532 to convert primary nozzle pressures recorded in Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) to fuel flow (Wf).

(h) The average of the fuel flow (Wf) readings from Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) will usually be plus or minus 25 PPH from the nominal fuel flow (Wf) in Paragraph 10.B.(6). If the average fuel flow (Wf) is more than this limit, adjust the starting fuel flow (Wf) and do all of Paragraph 10.B.(12) again.

NOTE: It is possible to do an engine run to Idle as an alternate to Paragraph 10.B.(12)(b) thru Paragraph 10.B.(12)(e), with only one pressure measured during a motoring procedure.

(13) Make sure that an increase or decrease in starting fuel flow (Wf) shows on the flight deck indicator as well as during the primary pressure flow check at the P&D valve. If the two indications are not the same, this can be a result of contamination in the primary fuel nozzles, or a problem with the flight deck instrumentation.

(14) After the adjustment, make sure that the necessary fuel control trim parameters are in limits. These parameters will include Idle and Part Power trim limits, and Takeoff, acceleration, and deceleration checks. Refer to the airframe manufacturer's trim information.

(15) Sample Calculation

(a) Sample A

1) Conditions:

a) 22 percent N_2 motoring speed

b) Fuel: Jet A

c) Pamb: 29.92 inches Hg

d) Primary fuel nozzle pressure measured at 100 PSIG

(b) Sample B

1) From Figure 533 (for -7 and -08 fuel controls) the nominal fuel flow (Wf) for 22 percent N_2 at 29.92 inches hg ambient pressure will be 730 PPH.
2) Add and subtract 30 PPH as shown in Paragraph 10.B.(7):

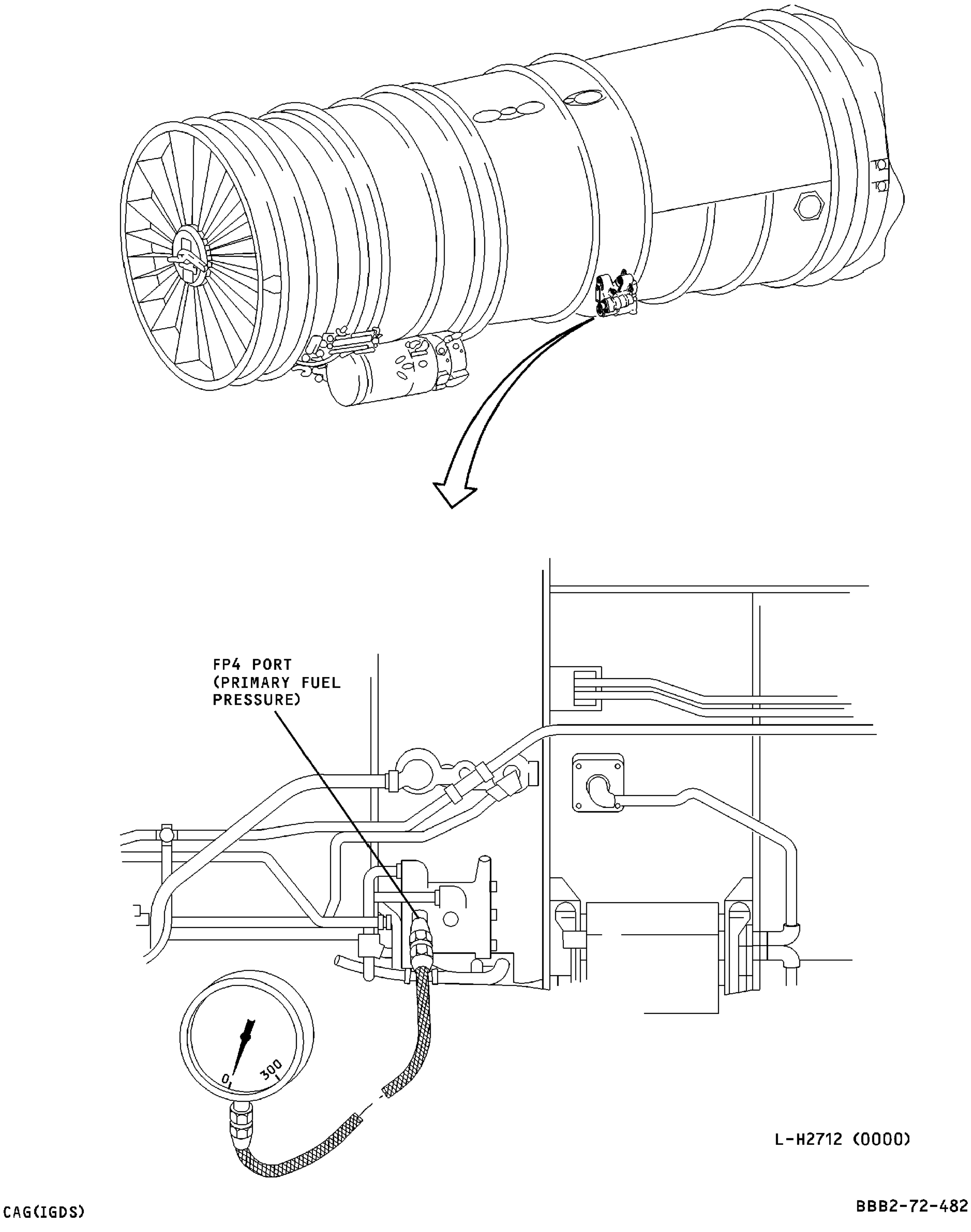
   730 + 30 = 760 pph

   730 - 30 = 700 pph

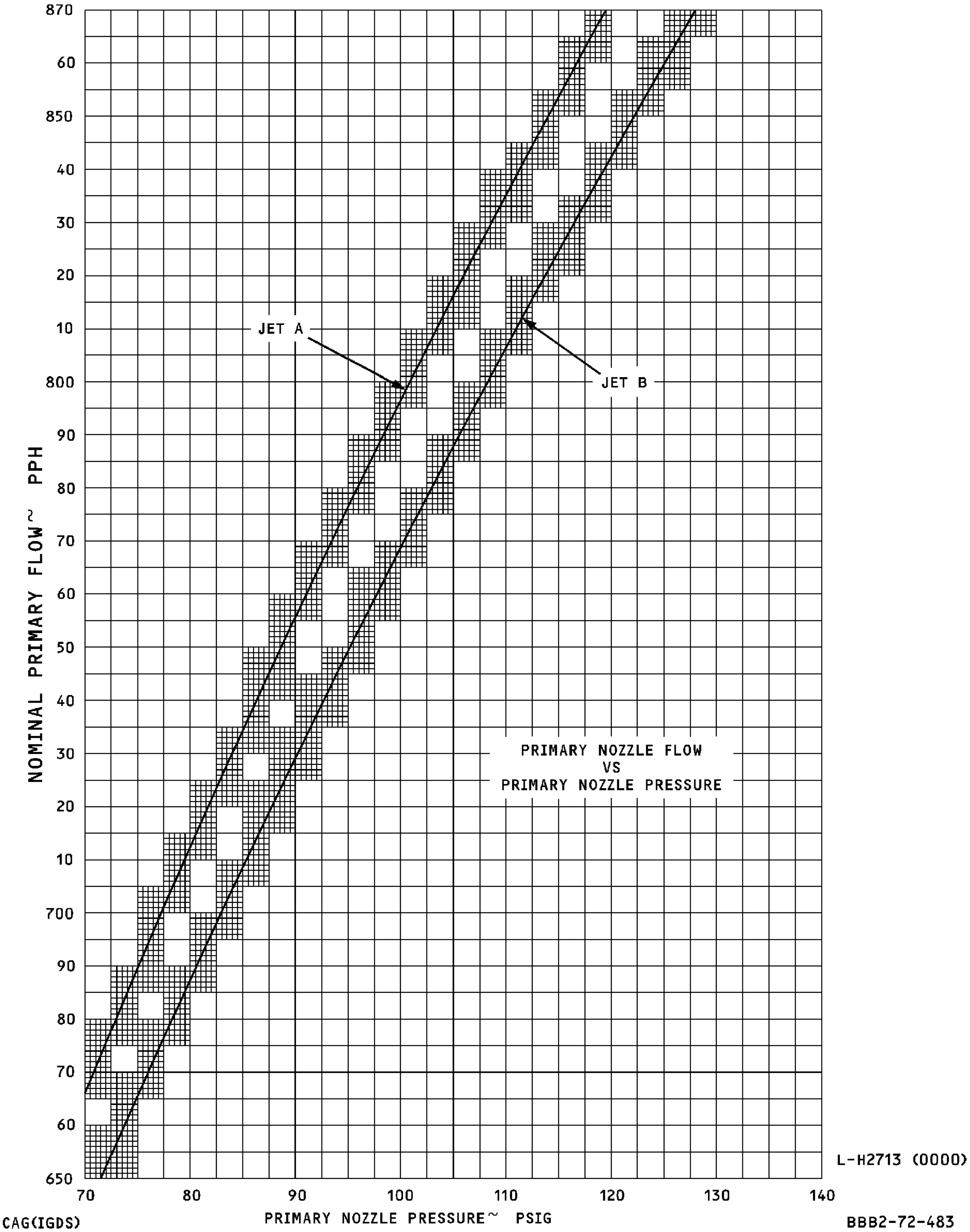
3) In this example the fuel flow (Wf) from Paragraph 10.B.(15)(a) is more than the higher fuel flow (Wf) in Paragraph 10.B.(15)(b). Therefore, it will be necessary to decrease the flow to 730 ±25 PPH. Turn the throttle valve position adjustment counterclockwise to get a primary nozzle pressure of 84 PSIG. Make the last adjustment in a clockwise direction as shown in Paragraph 10.B.(9). Refer to Table 510 for typical adjustment limits.

Table 510 Fuel Control Fuel Flow Adjustment

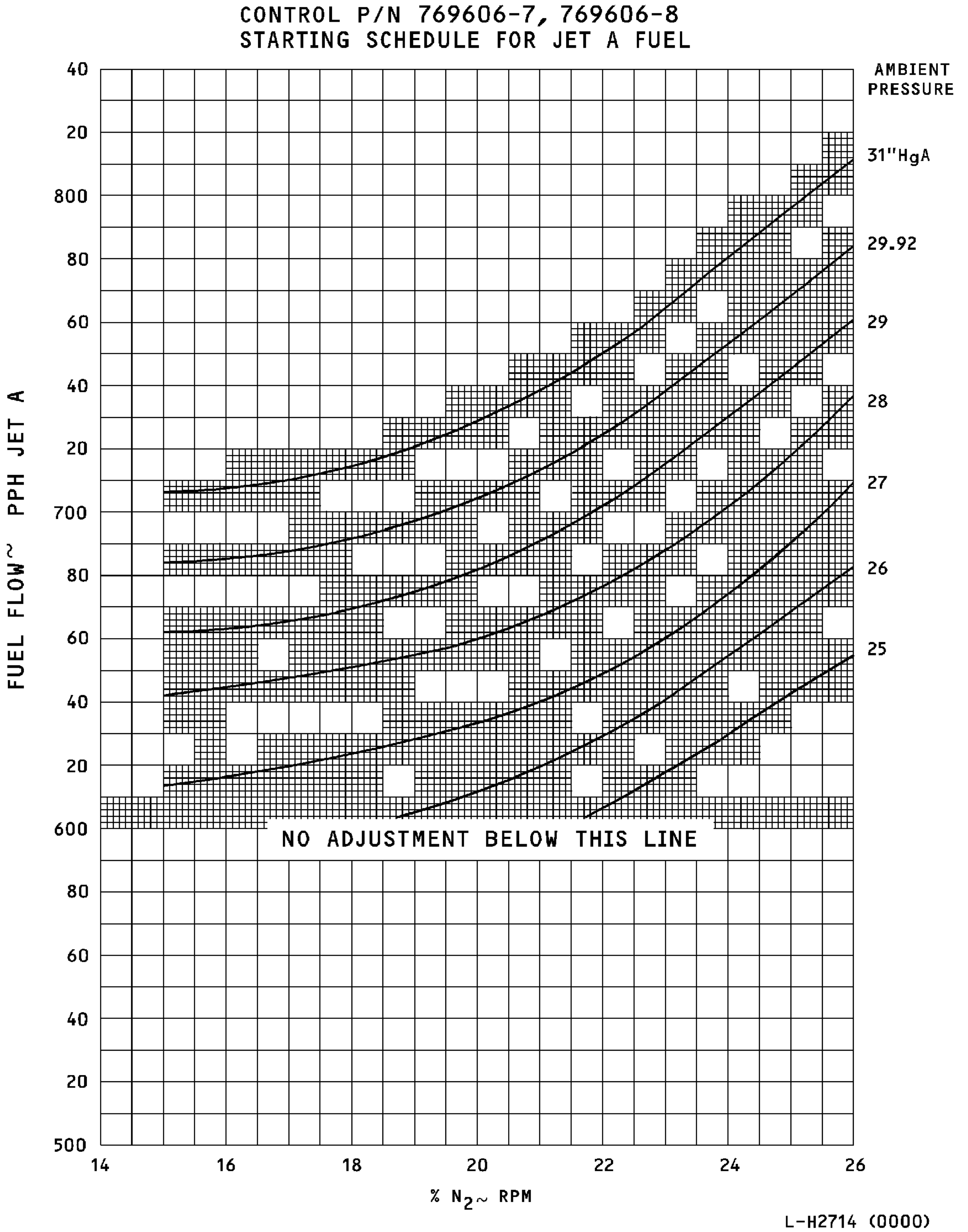
Fuel Control Throttle Valve Position Adjustment Turns	Fuel Flow (Wf) Difference (PPH)
Clockwise:	
1/16	50
1/8	100
3/16	150
1/4	200
5/16	250
3/8	300
Counterclockwise:	
1/16	-50
1/8	-100
3/16	-150
1/4	-200
5/16	-250
3/8	-300



Pressurizing and Dump Valve
Figure 531/72-00-00-990-855



Fuel Pressure to Flow Conversion
Figure 532/72-00-00-990-856



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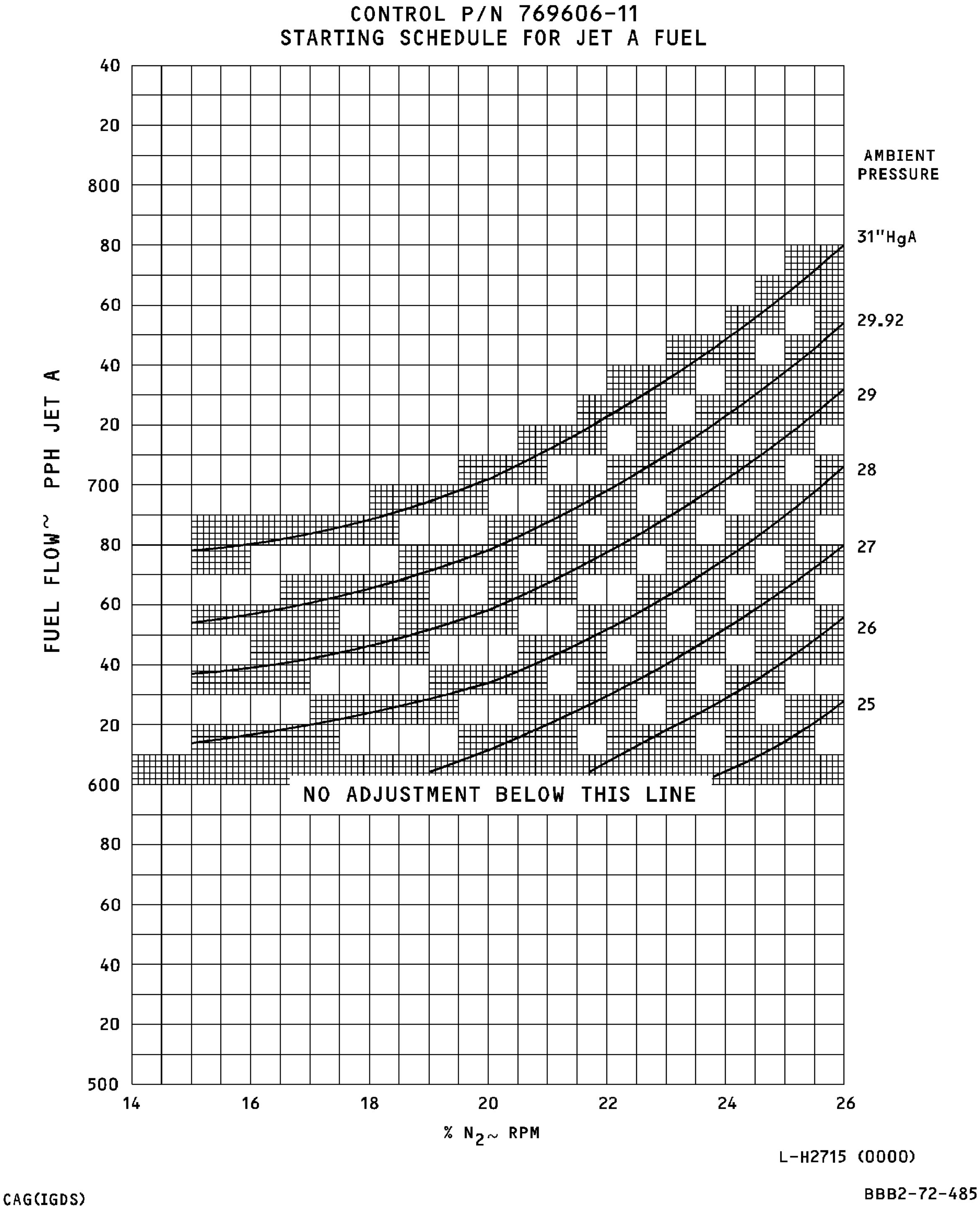
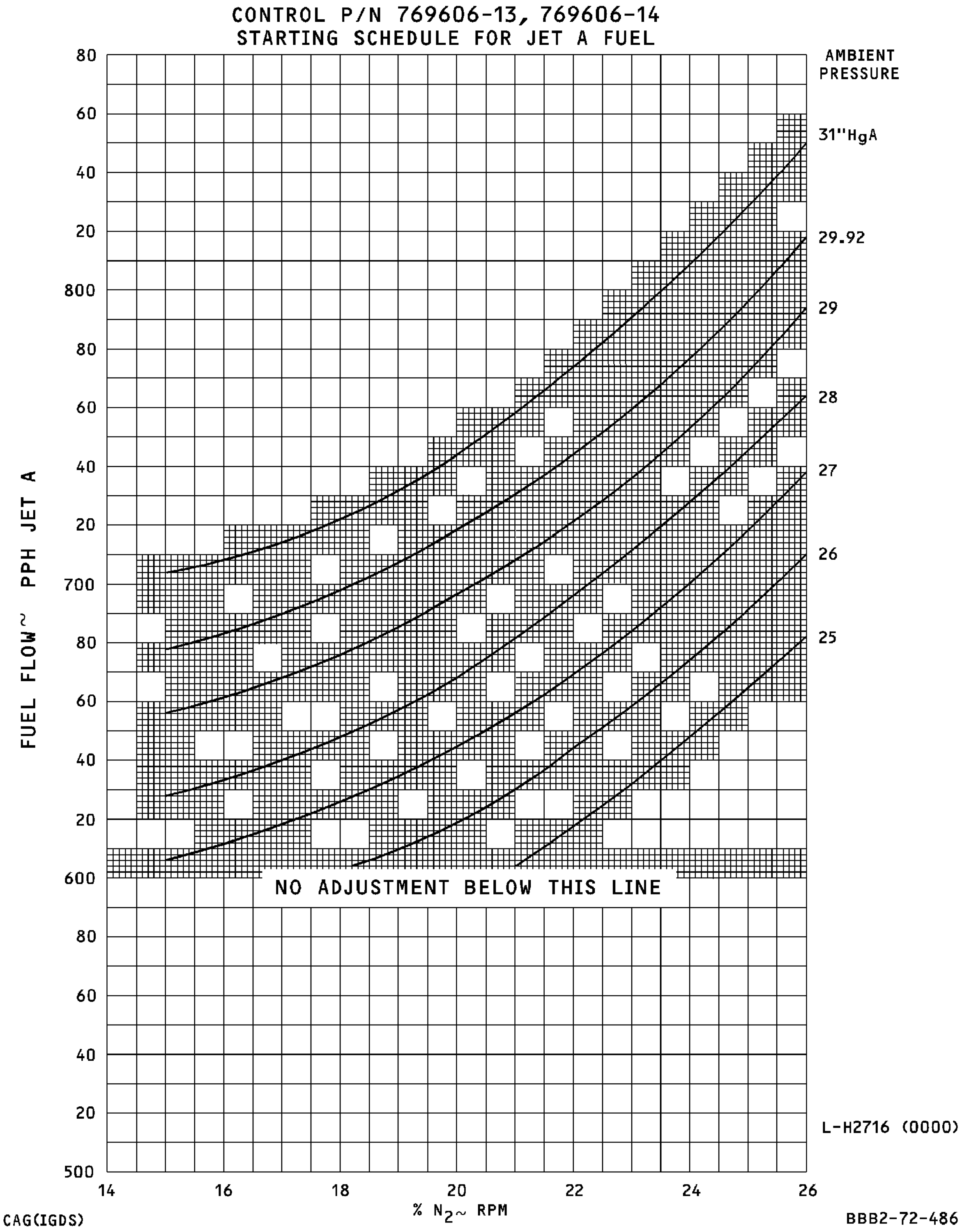
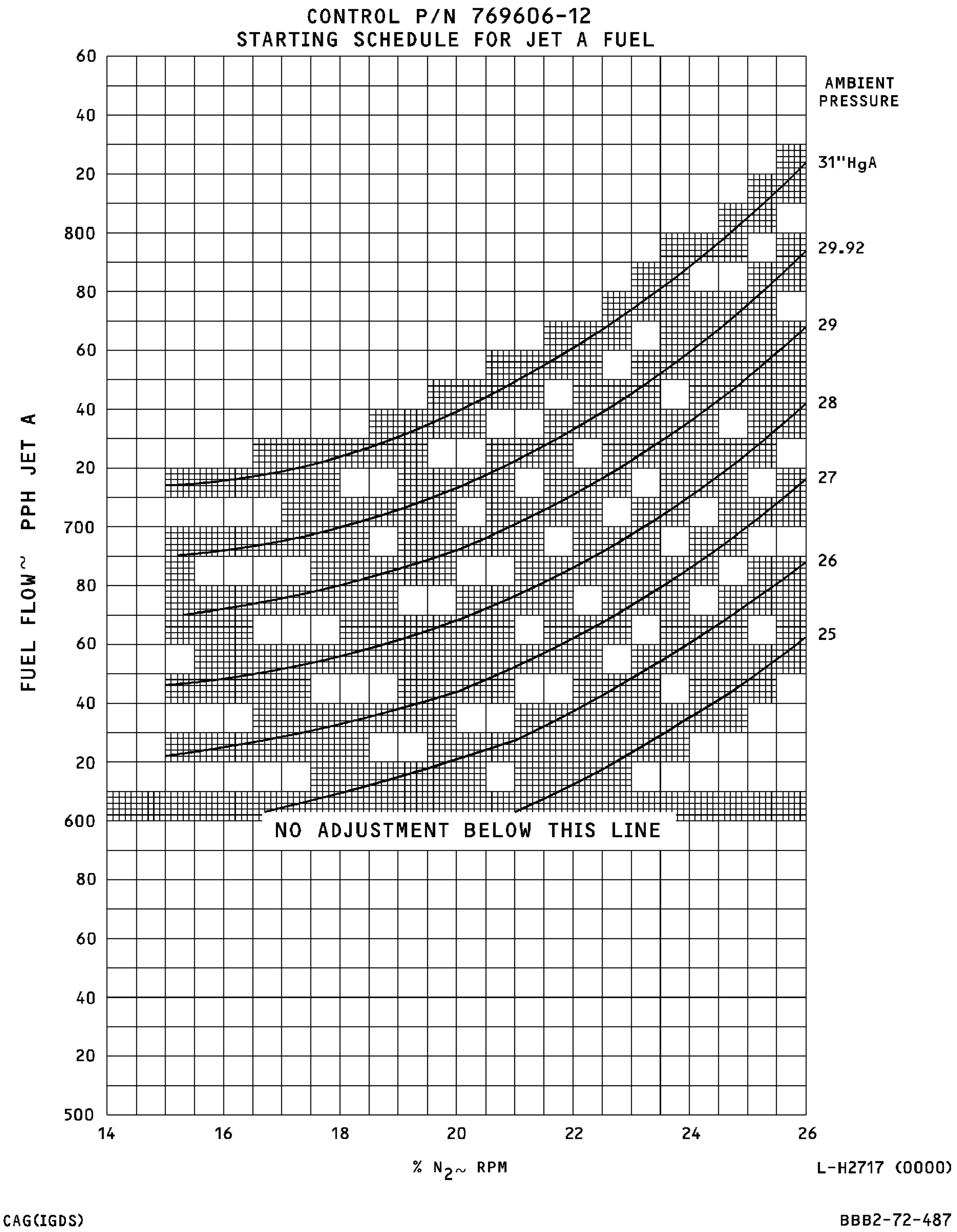
Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 1 of 10)



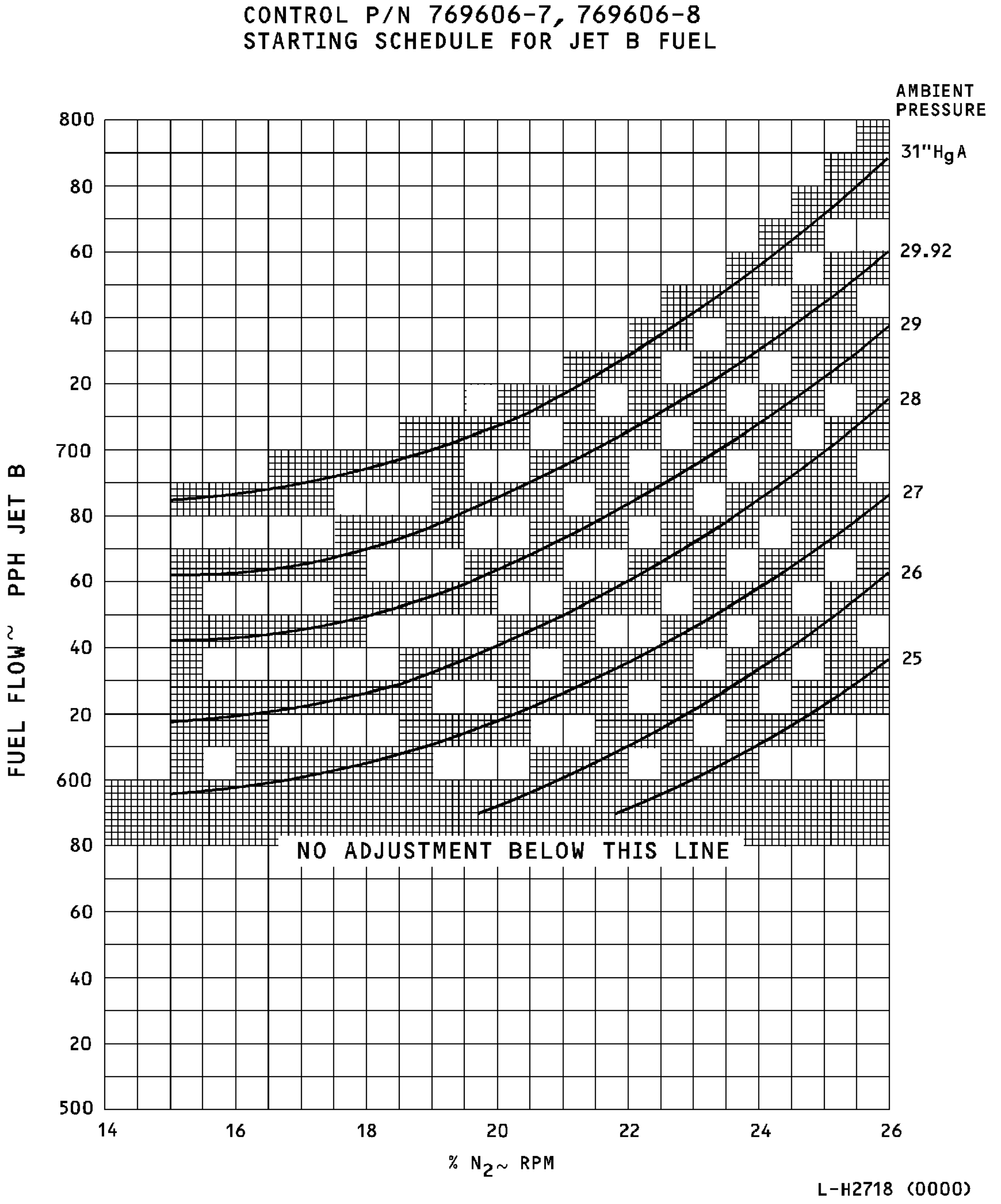
Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 2 of 10)



Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 3 of 10)



Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 4 of 10)



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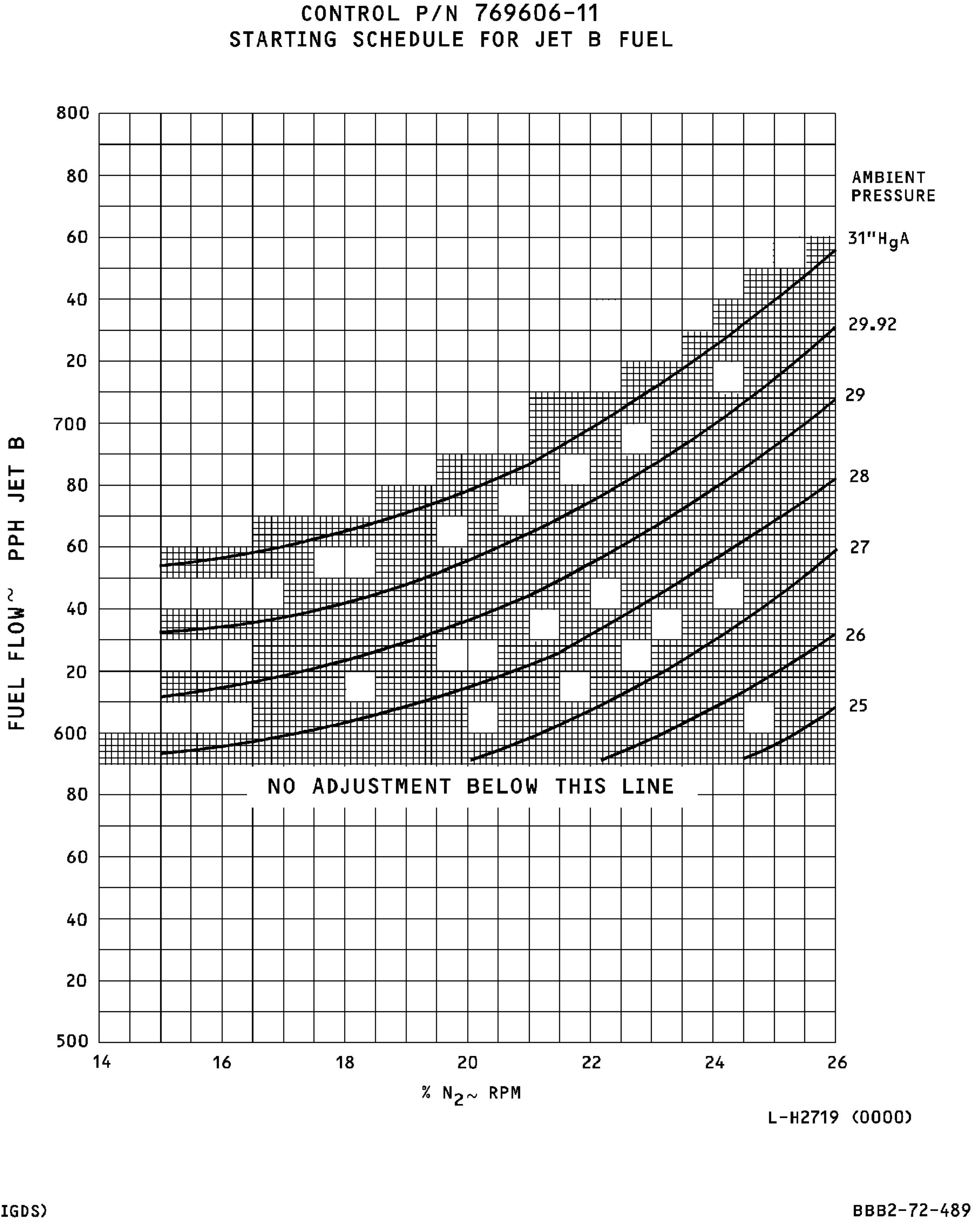
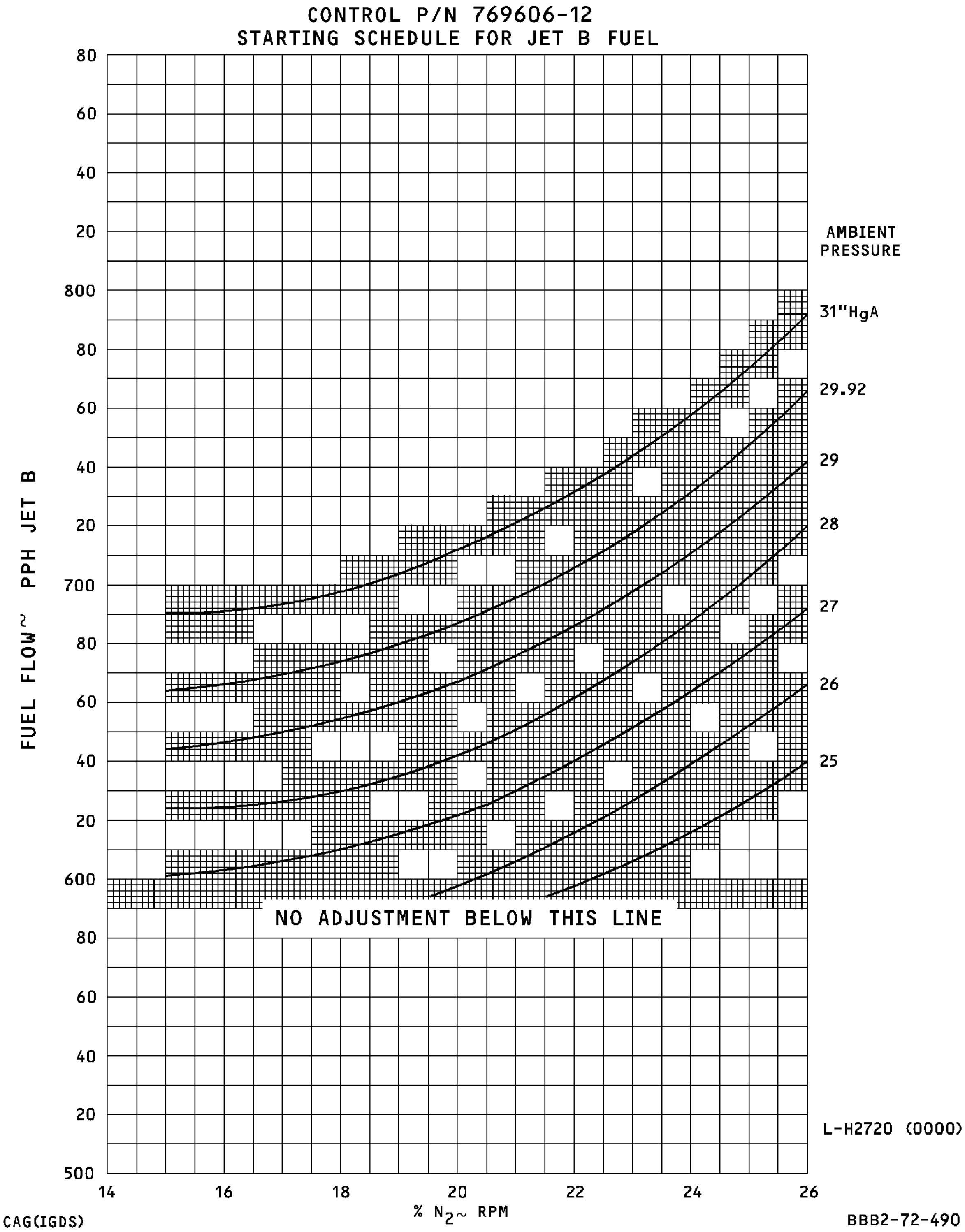
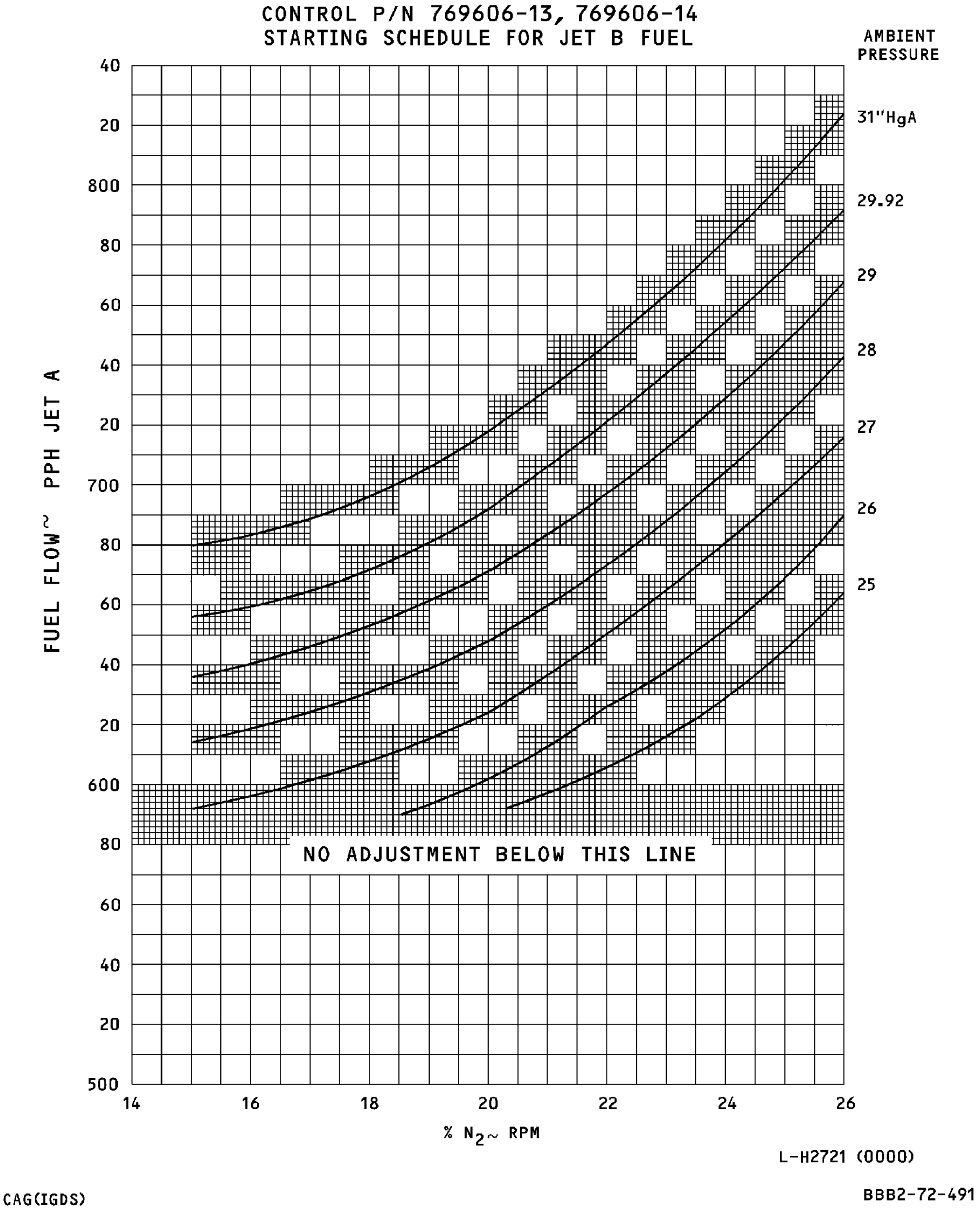
Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 5 of 10)



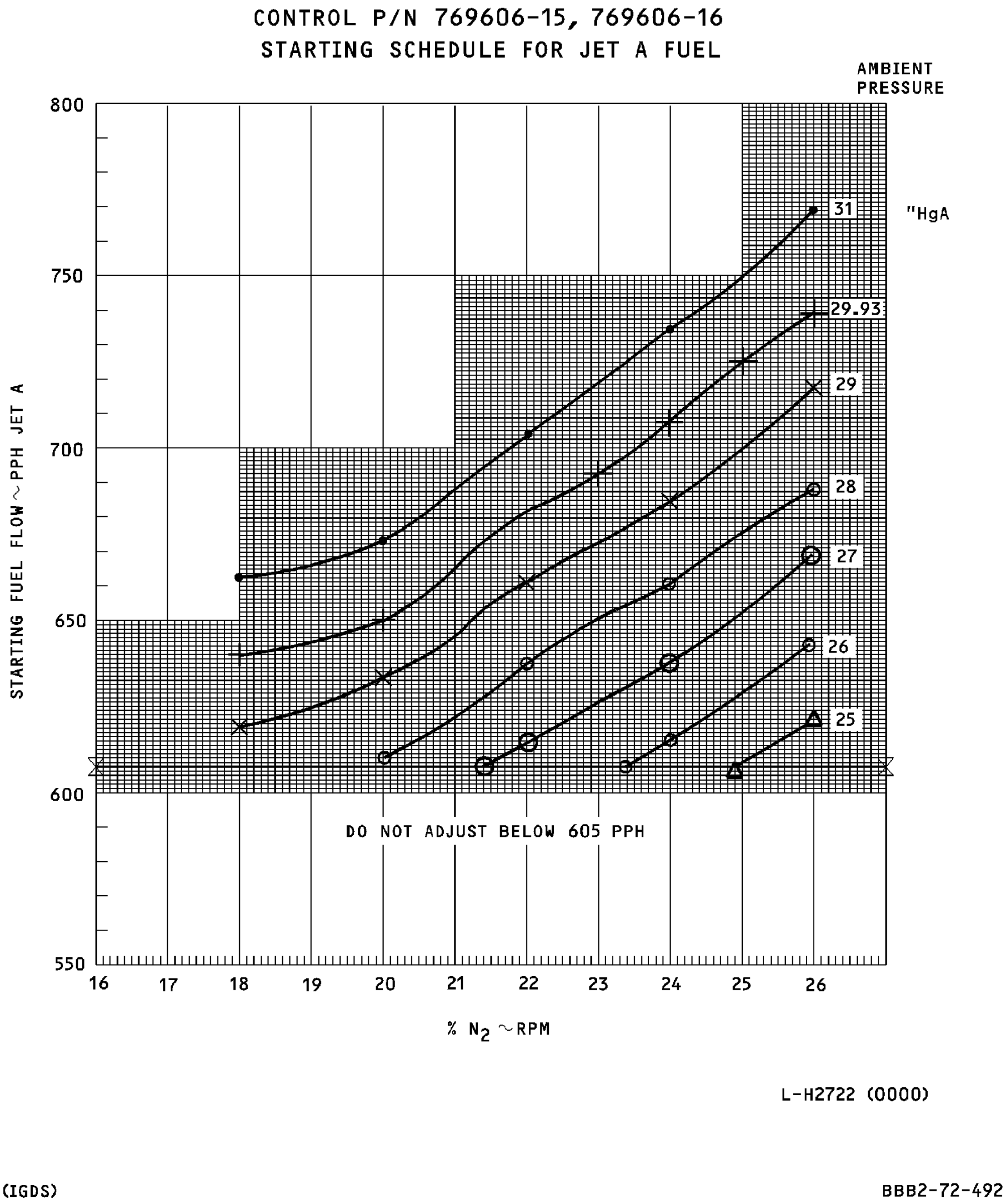
Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 6 of 10)



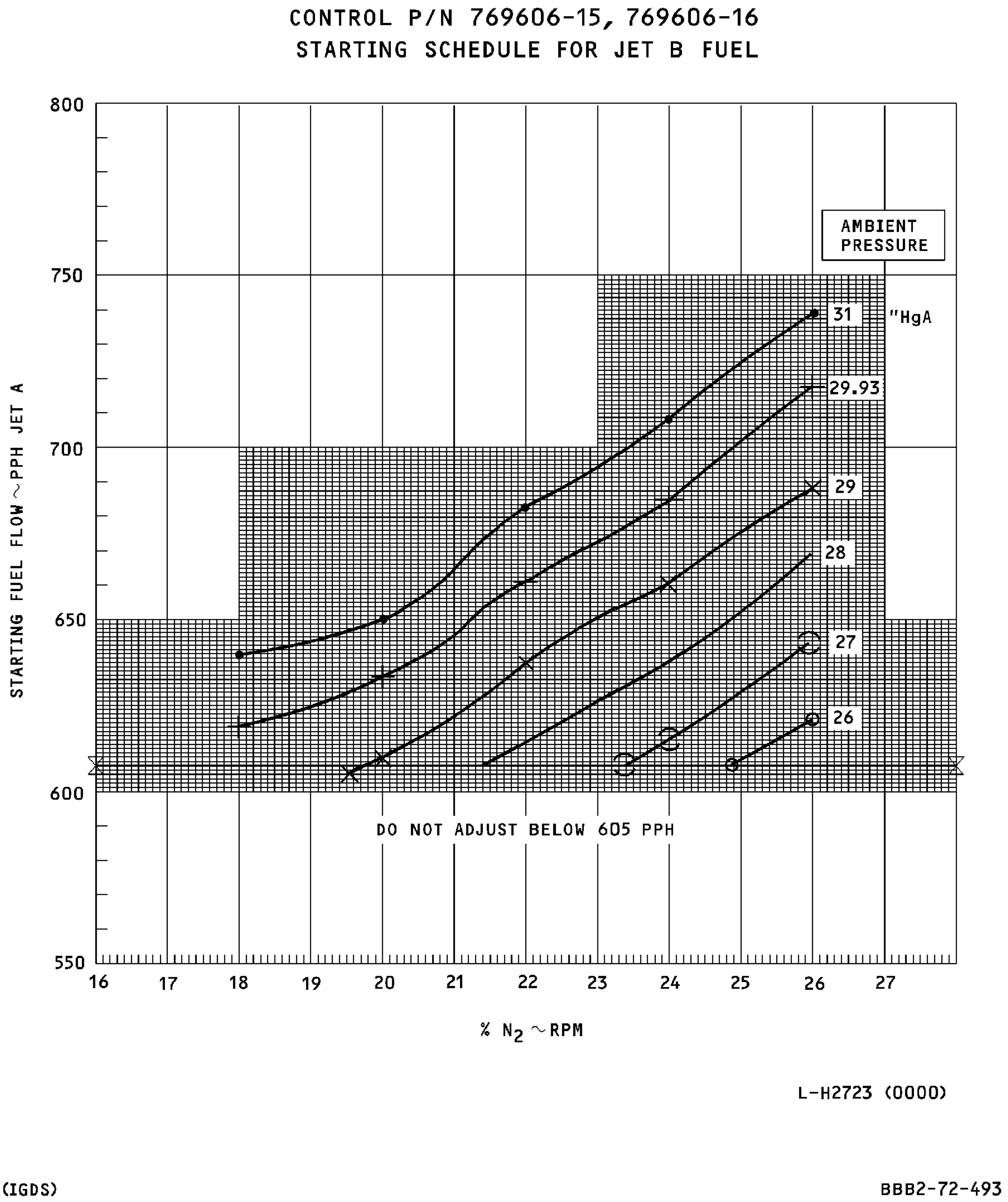
Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 7 of 10)



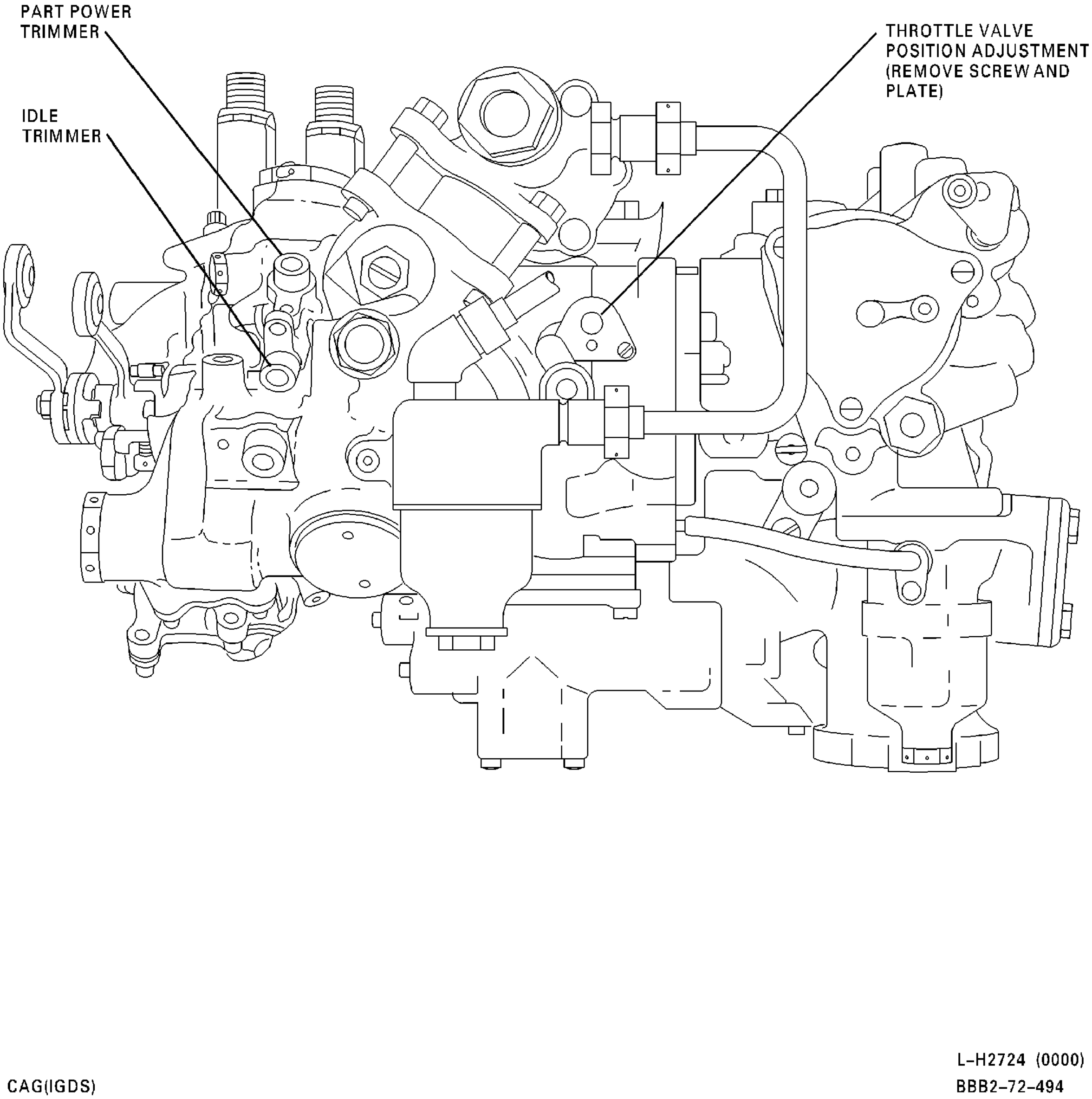
Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 8 of 10)



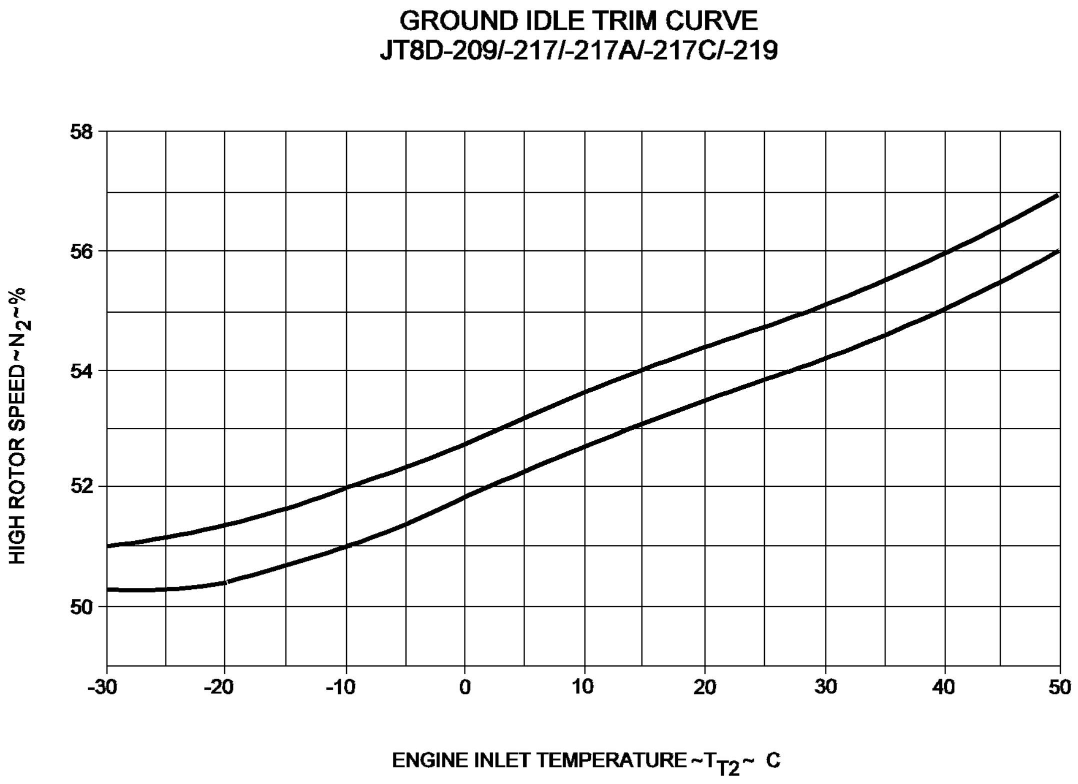
Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 9 of 10)



Starting Schedule Limits
Figure 533/72-00-00-990-857 (Sheet 10 of 10)



Fuel Control Adjustment
Figure 534/72-00-00-990-858



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Engine Idle Trim Curve
Figure 535/72-00-00-990-C47

ENGINE GENERAL - ADJUSTMENT/TEST

1. Engine Ground Safety Precautions

A. General

(1) The operating characteristics of jet engine powered aircraft have changed the ground safety picture. To prevent injury to persons and damage to property, handling and working procedures must be modified to meet new exposures. On piston engine aircraft the propeller was carefully avoided. In the case of the jet engine powered aircraft, one must avoid not only the engine intake ducts, but also the exhaust nozzle where hot, high velocity exhaust gases are discharged. Listed below are some of the general safety items which shall be supplemented according to the needs of the job, to prevent accidents.

B. The Air Intake (Figure 501)

WARNING: ALL PERSONNEL MUST AVOID HAZARD AREAS AROUND THE POWER PLANT AND REMAIN OUTSIDE OF ENGINE SAFETY BARRIER, IF USED, DURING GROUND RUNNING OPERATIONS. THE ENGINE IS CAPABLE OF DEVELOPING ENOUGH SUCTION AT THE INLET TO PULL A PERSON UP TO OR PARTIALLY INTO THE INLET WITH POSSIBLE FATAL RESULTS. THEREFORE, WHEN APPROACHING ANY TYPE OF JET ENGINE, PRECAUTIONS MUST BE TAKEN TO KEEP CLEAR OF THE INLET AIR STREAM. THE SUCTION NEAR THE INLET CAN ALSO PULL IN HATS, GLASSES, LOOSE CLOTHING AND WIPE-RAGS FROM POCKETS. ANY LOOSE ARTICLES MUST BE MADE SECURE OR REMOVED BEFORE WORKING AROUND THE ENGINE.

C. Exhaust Characteristics (Figure 501)

(1) Velocity. At high engine speeds the exhaust may pick up and blow loose dirt, sizeable stones, sand and debris a distance of several hundred feet. Therefore, due caution must be used in parking the aircraft for run-up to avoid injury to persons or damage to property or other aircraft. A blast fence is suggested if the engines are going to be run-up for trim and power adjustment in an area where there is not sufficient space available for dissipation of the exhaust blast.

(2) Temperature. High temperature will be found up to several hundred feet from exhaust nozzle depending on wind conditions. Closer to engine, exhaust temperature is high enough to deteriorate bituminous pavement, therefore, concrete aprons are suggested for run-up areas. Occasionally when a jet engine is started, excess fuel that has accumulated in the tailpipe ignites and long flames are blown out of exhaust nozzle. Possibility of this hazard must be watched and all flammable materials kept in the clear.

(3) Toxicity. Tests have indicated that carbon monoxide content is low but other gases are present which have disagreeable odor and are irritating in effect. Exposure will usually cause watering or burning sensation of the eyes. Less noticeable but important is respiratory irritation which may be caused. For both these reasons exposure must be avoided, particularly in confined spaces or pockets where concentration may build up.

D. Engine Cool Down

WARNING: USE APPROPRIATE HAND PROTECTION WHEN WORKING AROUND ENGINE AREAS WHICH ARE LIKELY TO BE HOT.

(1) After engine operation no work or inspection shall be done on tailpipe for at least one-half hour, preferably longer. All other parts may usually be worked upon without danger.

(2) Certain parts of the engine which contain or are exposed to high compressor air, like fuel deicing air tubing and anti-icing air tubing, may be hot immediately after engine shutdown. The use of insulated gloves is recommended whenever work must be performed on the engine in the vicinity of such parts soon after engine shutdown.

E. Engine Noise

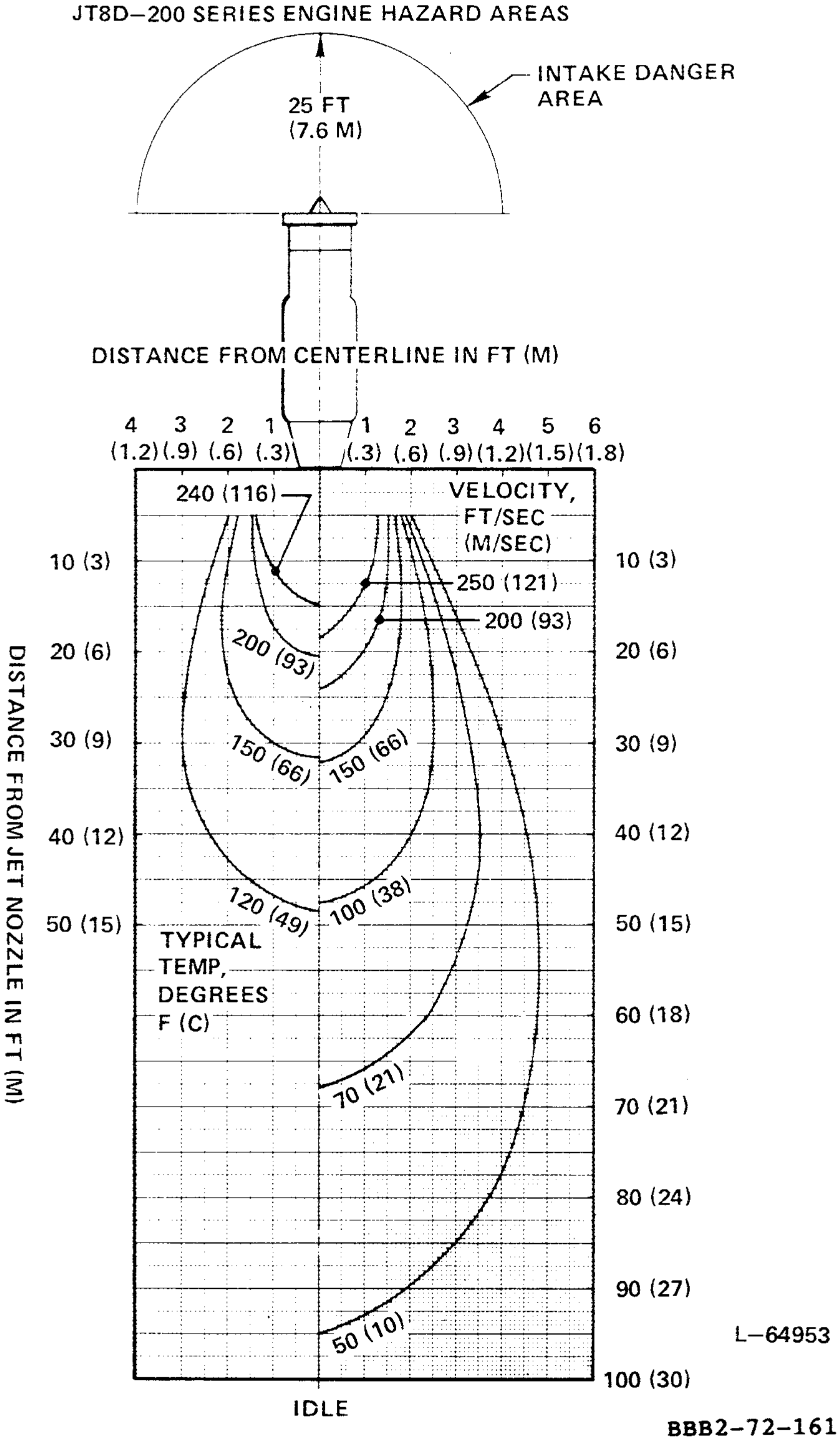
(1) Jet engines typically produce noise capable of causing temporary, as well as permanent, loss of hearing. Even short exposures to extreme noise may result in damage to ears and all personnel must use some means of protection. Noise can effect ear mechanism in such a way as to cause unsteadiness or inability to walk or stand without reeling. Therefore, use of cup type ear protection is recommended. If engines are to be serviced from aero-stands or platforms these shall be equipped with protective railings to prevent falls.

WARNING: THE JT8D ENGINE IGNITION SYSTEM IS CHARACTERISTICALLY HIGH IN ENERGY. THE NATURE OF THE SYSTEM IS SUCH AS TO RENDER IT A HAZARDOUS, POSSIBLY FATAL, SOURCE OF ELECTRICAL SHOCK UNLESS NECESSARY PRECAUTIONS ARE EXERCISED. DO NOT TOUCH IGNITER PLUGS WHEN IGNITION IS ON. DO NOT TEST IGNITION SYSTEM WHEN PERSONNEL MAY BE IN CONTACT WITH IGNITER PLUGS OR WHEN FLAMMABLE MATERIALS ARE NEARBY.

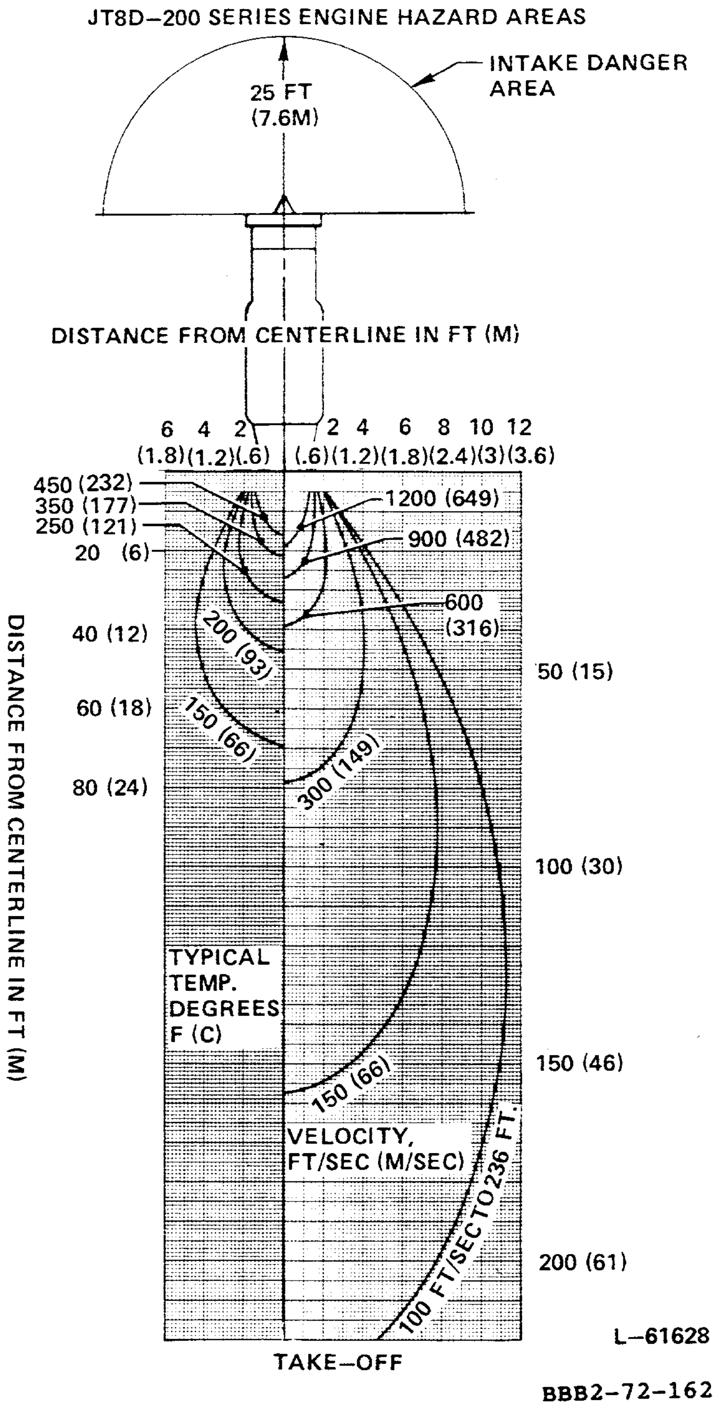
F. Engine Ignition

G. Fuel And Lubricating Oils

(1) All fuels and lubricating oils tend to dry the skin. Precautions shall be taken to avoid contact as much as possible.



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-859 (Sheet 1 of 2)



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-859 (Sheet 2 of 2)

2. Testing Information

A. General

(1) Pratt & Whitney strongly recommends that the measurement and setting of engine thrust be accomplished by use of turbine discharge pressure and compressor inlet pressure as the primary parameters, while using engine speed, tailpipe temperature, and fuel flow as secondary parameters to monitor engine condition, and as limits. Engine speed (low and high compressor RPM) is not a sufficiently accurate indicator of thrust, to provide adequate control of engine thrust and internal conditions under normal service operation. Therefore, the engine fuel control is adjusted in order to obtain desired turbine discharge pressure (P_{t7}) or engine pressure ratio (P_{t7}/P_{t2}) shown on applicable engine trim curves. Turbine discharge pressure or pressure ratio overshoot, or higher than normal reading, may be noted when power lever is first advanced to PART THRUST stop on a cold engine. For accurate indication of engine thrust during engine test or trimming, engine must be allowed to stabilize.

NOTE: It is suggested that a remote fuel control trimmer such as is available from Lear Siegler Inc. be employed when trimming engine.

(2) Whenever trimming engines installed in aircraft, aircraft manufacturer's trim curves, corrected for specific inlet duct loss, must be used.

NOTE: The procedures contained in Chapter 72 are the engine manufacturer's originated data. However, for engine operational and trimming data, refer to SUBJECT 71-00-00.

(3) Symbols have been designated for the various stations within the engine, and the external working pressures and temperatures. These variables are listed in Table 501 below:

Table 501 Engine Station Symbols

TAMB	Compressor Ambient Temperature
PAMB	Compressor Inlet Ambient Pressure
N_1	Low Pressure Compressor RPM
N_2	High Pressure Compressor RPM
Ps3	Intercompressor Static Pressure
Ps4	Bleed Annulus Static Pressure
P_{t2}	Compressor Inlet Total Pressure
T_{t7}	Turbine Discharge Total Temperature
P_{t7}	Turbine Discharge Total Pressure
P_{t7}/PAMB	Engine Pressure Ratio
PBAR	True Barometric Pressure

(4) The extent of repair and replacement will vary with each engine; therefore, the degree of test necessary to demonstrate satisfactory repair will vary also. To minimize ground running and to conserve fuel, this section provides five ground test procedures which are related to the extent of repair or replacement. Before attempting to test an engine after repair, the applicable sections of the Table Table 507 must be consulted to determine the test required for any given engine repair.

(5) The Engine Check Chart provides the general operating condition limits and references to the necessary test curves for testing an installed engine. The ratings listed in the Engine Check Chart are described as follows and are obtained by positioning the power lever to a predetermined turbine discharge pressure (P_{t7}):

(a) Maximum Takeoff - This is the maximum thrust certified for takeoff. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. In the event of an engine out situation this rating is provided by the Reserve Takeoff Thrust mechanism when operating at the Normal Takeoff rating. This rating is time-limited to a total of five (5) minutes including the time spent at the Normal Takeoff Rating.

(b) Normal Takeoff - The Normal Takeoff Rating is the maximum thrust normally set for takeoff operation. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. The rating is time limited to five (5) minutes.

(c) Maximum Continuous - The Maximum Continuous Rating is the maximum thrust certified for continuous use. For the purpose of P&W service policy coverage and prolonging engine life, this rating should be used, at the pilot's discretion, only when required to ensure safe flight. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(d) Maximum Climb - Maximum Climb thrust is the maximum thrust approved for normal climb. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(e) Maximum Cruise - This is the maximum thrust approved for cruising. The Maximum Cruise is obtained in the same manner as Maximum Climb or Maximum Continuous thrust.

(f) Idle - This is not an engine rating but, rather, a power lever position suitable for minimum thrust operation on the ground or in flight. It is obtained by positioning the power lever in the IDLE detent or the IDLE stop position.

(g) Reverse - Reverse thrust will be obtained at power lever positions below IDLE.

B. Operating Limits and Performance Data

(1) JT8D-209: See Table 502.

Table 502 Engine Check Chart For JT8D-209

Oil: PWA 521			**FUEL: SB 2016**	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Maximum Takeoff	5 (3)	1058°F (570°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Continuous	Continuous	986°F (530°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Climb	Continuous	959°F (515°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Cruise	Continuous	941°F (505°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

Table 502 Engine Check Chart For JT8D-209 (Continued)

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting			(9)	
Ground		932°F (500°C) (6)		
Flight		1058°F (570°C)(6)		
Acceleration T.O. (4)		1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.J. for procedures related to oil temperature.

C. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-209

   (a) Normal Takeoff power level engine speed limits.

      1) Maximum permissible operating speeds are 7,850 RPM (95.5 percent) for N_1 and 12,150 RPM (99.2 percent) for N_2.

      2) Engines run at speeds between 7,850 - 8,150 RPM (95.5 - 99.2 percent) N_1 or 12,150 - 12,370 RPM (99.2 - 101.0 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) function and determine cause and correct problem prior to reactivating ART (RTT) function.

      3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

   (b) Maximum Takeoff power level engine speed limits.

      1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,370 RPM (101.0 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.C.(1)(a)1) or Paragraph 2.C.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If visual inspection reveals physical damage, or if N_1 speed exceeds 8,450 RPM (102.8 percent), or if N_2 speed exceeds 12,550 RPM (102.5 percent) proceed as follows:

1) Remove high and low compressors and perform complete overhaul inspection.

2) Inspect all turbine disks for growth and hardness.

3) Inspect all turbine blades for stretch.

4) Inspect all disks and blades by fluorescent penetrant.

D. Overtemperature

(Figure 502), (Figure 503), (Figure 504)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition. (Figure 502), (Figure 503), (Figure 504)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C (see Figure 506 or Figure 507), it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time at peak temperature.

(5) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

E. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near or above maximum values listed above shall be investigated promptly.

F. Operating Limits and Performance Data

(1) JT8D-217, JT8D-217A, JT8D-217C, JT8D-219: See Table 503.

Table 503 Engine Check Chart For JT8D-217, -217A, -217C, -219

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			Operating Limits	
Thrust Setting	Time Limit (Minutes)	Max. Observed Exhaust Gas Temp. °F/(°C)	Oil Pressure (PSIG) Normal (7) (8)	Maximum Oil Temperature °F(°C) (10)
Maximum Takeoff	5 (3)	1157°F (625°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1094°F (590°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

Table 503 Engine Check Chart For JT8D-217, -217A, -217C, -219 (Continued)

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			Operating Limits	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting Ground Flight		932°F (500°C) 1157°F (625°C)(6)	(9)	
Acceleration (Maximum Takeoff) (4)	2	1166°F (630°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Acceleration (Normal Takeoff)	2	1103°F (595°C)		

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.J. for procedures related to oil temperature.

G. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-217

   (a) Normal Takeoff power level engine speed limits.

      1) Maximum permissible operating speeds are 7,770 RPM (94.5 percent) for N_1 and 12,285 RPM (100.3 percent) for N_2.

      2) Engines run at speeds between 7,770 - 8,150 RPM (94.5 -99.2 percent) N_1 or 12,285 - 12,550 RPM (100.3 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

      3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

   (b) Maximum Takeoff power level engine speed limits.

      1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond permissible limits in Paragraph 2.G.(1)(a)1) or Paragraph 2.G.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,584 RPM (102.8 - 104.4 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is continued-in-service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.G.(1)(e) below if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.G.(1)(e) below if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.G.(1)(e) below if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241.

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6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

   a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection (SUBJECT 72-23-00) .

   b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade (Figure 508).

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

   b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is returned to service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,584 RPM (104.4 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(2) JT8D-217A, -217C

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,080 RPM (98.3 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,080 - 8,350 RPM (98.3 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,459 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12.675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.G.(2)(a) or Paragraph 2.G.(2)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.G.(2)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.G.(2)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.G.(2)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241.

(PAGEBLOCK 72-00-00/601 Config 1)

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

   a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

   b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade (Figure 508).

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th (JT8D−217A) or 4th stage (JT8D−217C) turbine blades before the engine is returned to service.

   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

   b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is continued-in-service.

10) Visually examine the 4th stage turbine blades to make sure that no blade shrouds are missing. Repair any 4th stage turbine with missing shrouds before the engine is continued-in-service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(3) JT8D-219

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,120 RPM (98.8 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,120 - 8,350 RPM (98.8 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.G.(3)(a) or Paragraph 2.G.(3)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.G.(3)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.G.(3)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.G.(3)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241.

(PAGEBLOCK 72-00-00/601 Config 1)

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 508)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 4th stage turbine blades before the engine is returned to service.

   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

   b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

H. Overtemperature

(Figure 502)

(Figure 503)

(Figure 504)

WJE 401-404, 412, 414

(Figure 505)

WJE 401-404, 412, 414-427, 429, 861-866, 868, 869, 871, 872, 891

(Figure 506)

(Figure 507)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition.

(Figure 502)

(Figure 503)

(Figure 504)

WJE 401-404, 412, 414

(Figure 505)

WJE 401-404, 412, 414-427, 429, 861-866, 868, 869, 871, 872, 891

(Figure 506)

(Figure 507)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C (see Figure 506 or Figure 507), it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.
2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time peak temperature.

(5) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below Idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

I. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near, or above maximum values listed above shall be investigated promptly.

Table 504

KEY TO Figure 506

CHART ZONE	ACTION
A	Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B. An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.
	NOTE: A 25 flight hour fly back interval is permitted before doing Zone B corrective action. Another excursion into Zone A during the fly back interval requires the completion of Zone B corrective action before the next flight. Subsequent excursions into Zone A get Zone B corrective action.
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Disassemble the engine hot section and do full overhaul inspection.
	NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.
	or Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the procedures specified for Zone D.
D	Disassemble the engine hot section and do full overhaul inspection.
	NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.

Table 504 (Continued)

KEY TO Figure 506	
CHART ZONE	ACTION
F	Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated. If an engine goes into Zone F four times since the last time the engine hot section got full disassembly and inspection, and an external cause for the overtemperature is not found, a borescope inspection (refer to Inspection/Check-01) can often find the problem (an internal condition can be the cause of the overtemperature).
G	No action necessary

NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades.

NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades.

NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.

Table 505

KEY TO Figure 507	
CHART ZONE	ACTION
A	De-energize the ART system and find the cause of the overtemperature. Correct the cause before the ART system is energized. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B. An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.

Table 505 (Continued)

KEY TO Figure 507

CHART ZONE	ACTION
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Disassemble the engine hot section and do full overhaul inspection.
	NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.
	or Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D. Total time in this zone must not be more than 30 seconds per event. An engine above these limits must get the procedures specified for Zone D.
D	Disassemble the engine hot section and do full overhaul inspection.
	NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.
G	No action necessary
	NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades. NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades. NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.

J. Oil Inlet Overtemperature Limits and Procedures.

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

(2) After complying with the above and providing no engine damage is indicated, engine may be continued in service.

(3) If oil-in temperature exceeds 325°F (165°C) for any interval, remove engine to overhaul and inspect all main and accessory drive bearings for hardness and condition. All main shaft seals shall be inspected for condition.

K. Engine Windmilling or Oil Pressure Interruption/Low Oil Pressure

NOTE: You must record operating conditions before and after any oil pressure interruption, low oil pressure indication, engine shutdown and windmilling to find classification of windmilling.

NOTE: The classification of windmilling is based on time and oil pressure. Although the engine must show continuous oil pressure after shutdown, the oil pressure after in-flight shutdown (IFSD) (after the engine becomes stable) is what is used for the classification of the windmilling. Because oil pressure is a function of ram air, this pressure will usually decrease to less than 10 psi (68.9 kPa) during the descent and approach phases. Also the oil pressure can show zero when the ram air can no longer cause sufficient oil pump rotation (during landing, rollout, and taxi). These conditions are acceptable and do not change the classification of windmilling.

(1) Engine Windmilling

(a) Inspect all engines that have windmilled as a result of shutdown in flight.

NOTE: Operator must also do all corrective actions necessary to find cause of in flight engine shutdown.

(b) If an engine windmilled for 30 minutes or less, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can continue in service after satisfactory inspection of main oil filter and chip detectors (if installed), servicing of engine and ground run-up.

NOTE: Ground run-up is a normal start, followed by five minutes at idle then a normal shutdown.

Chip detectors are optional equipment. If installed, they are part of windmilling inspection procedure.

(c) If an engine windmills for more than 30 minutes but less than 60 minutes, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can be continued in service after satisfactory examination of main oil filter and chip detectors (if installed), servicing of engine and ground run-up. In addition, use a Spectrometric Oil Analysis Program (SOAP) requesting concentrations of Iron (Fe), Vanadium (V) and Molybdenum (Mo) as indicators of main shaft bearing distress. Refer to JT8D Oil Monitoring Guide (P&W Part Number 821432), Section "G" for more information on SOAP. Do main oil filter, chip detectors (if installed) and SOAP inspection after first flight, at 15 hours, at 50 hours and at 100 hours. Do any corrective action required.

NOTE: JT8D Oil Monitoring Guide - Part No. 821432

This guide describes the inspections and tests that can be done to the engine oil to find if there is something that should be done before it leads to an untimely removal of the engine. This guide will show various inspections and tests, in its own section that will identify and describe each, as well as provide information as to the results that will be found and how to understand them to best maintain the engine. For this purpose, the guide also includes tables and illustrations that give guidelines or samples of “limits” used in the field for various analysis techniques.

(d) If an engine windmilled for more than 60 minutes with more than 10 psi (68.9 kPa) of continuous oil pressure after engine shutdown or engines that windmilled for any length of time with 10 psi (68.9 kPa) or less oil pressure after shutdown, operator must disassemble it for an Oil System Components Inspection.

NOTE: Oil System Components Inspection includes a visual and dimensional inspection of all Bearings (Main and Accessory), seals and gears in both Engine and Main Accessory Gearbox. Do a careful inspection of No. 2, 3, 4 and 5 bearings. Bearing cages must not show excessive wear. No ball or roller skidding, loss of hardness or shape because of overheating is permitted. Acceptable parts may be continued in service.

(2) Oil Pressure Interruption/Low Oil Pressure

CAUTION: ANY POWER OPERATION AT OR ABOVE IDLE WITH OIL PRESSURE OF 34 PSI (234.4 KPA) OR LESS REQUIRES ENGINE TO BE DISASSEMBLED FOR AN OIL SYSTEM COMPONENTS INSPECTION.

(a) Be careful to operate engine with sufficient oil pressure.

L. Breather Pressure

(1) General

(a) Breather pressure is differential between gearbox internal pressure and pressure at gearbox breather discharge port.

(b) Prior to checking breather pressure, it is important to remove all hardware for gearbox breather port, including short breather outlet duct. Experience has shown that this duct affects reading obtained, and correction factors have been unreliable.

(2) Limits

(a) During acceptance test, breather pressure as determined by the differential between engine accessory gearbox pressure and the pressure measured in the disposal system immediately adjacent to the accessory gearbox discharge port shall not exceed 1.8 psi (12.4 kPa). Allow engine to remain at Normal Takeoff two minutes minimum. Record the breather pressure (see NOTE below). Bring the engine power back to idle. Shut the engine down.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

NOTE: Engines with breather pressure tests conducted using continuous permanent recording equipment may be continued in service if the steady state limit of 1.8 psi (12.4 kPa) is exceeded for not more than 30 seconds and the pressure level does not exceed 3.0 psi (20.7 kPa). An engine accepted to this additional limit must be put on watch and a repeat test conducted every 50 cycles thereafter.

M. Fuel and Oil Leakage Limits

(1) Fuel or oil leakage from overboard drains, accessory drive seal drains, or No. 6 bearing sump is acceptable provided leakage is within the following limits:

Table 506

Location	Fluid	Allowable Leakage
Gearbox Starter Drive Overboard Drain	Oil	10 cc/hr
Gearbox Hydraulic Pump Drive Overboard Drain	Oil	10 cc/hr
No. 1, 2 And 3 Bearing Fluid Seal Drain	Oil	0.5 cc/min (10 drops per min) from each drain.
No. 4 Bearing Air Check Valve	Oil	Oil leakage from check valve at Idle power is normal.
Fuel Pump Drive Overboard Drain	Oil	10 cc/hr
Fuel Pump Drain	Fuel	60 cc/hr with engine running or shut down
Fuel Control Drain	Fuel	None
P&D Valve	Fuel	None
Exhaust Case - No. 6 Bearing Sump	Oil	Oil wetness not resulting in oil puddling within 20 minutes after engine shutdown.
Combustion Chamber Drain	Fuel	1. No leakage with engine running. 2. 90 cc maximum one time upon engine shutdown. 3. 60 cc/hr maximum after engine shutdown.
Combustion Chamber Drain and/or Wet 1st Stage Turbine Vanes/Blades	Oil	1. For engines without SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed: NOTE: Oil leakage from the combustion chamber drain and/or wet 1st stage turbine vanes/ blades is not permitted if the engine is post SB A6196 - Improved No 5. bearing oil return and compartment sealing. a. Be sure the condition seen is oil leakage and not fuel leakage. b. Operate the engine at idle for five minutes, then approximately cruise power or 1.8 EPR for five minutes, then at idle again for five minutes. Then shut down. c. After engine shutdown look for oil leakage from the combustion chamber drain (when it occurs, leakage usually starts ten minutes or less after shutdown). d. Engine removal for repair is necessary if oil leakage from the combustion chamber drain is more than 40 drops (or 2.0 cc), per minute. If oil leakage from the drain is less than 40 drops (or 2.0 cc), the engine can return to service with these limits: 1) Do a breather pressure test (must be in limits). 2) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection).

Table 506 (Continued)

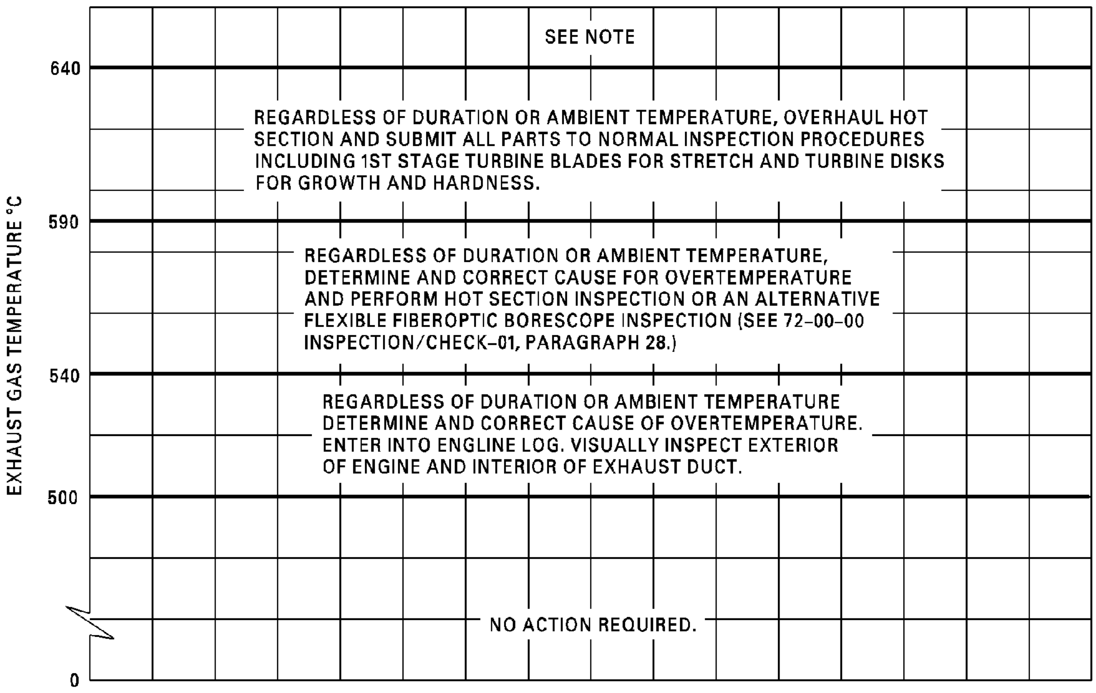
Location	Fluid	Allowable Leakage
		3) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 2. For engines with SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed: a. Be sure the condition observed is oil leakage and not fuel leakage. b. Do a visual inspection of the No. 4 - 5 scavenge oil temperature indicators as specified in SB A5944/SB 6101. c. If indicator color has changed, do corrective action as specified in SB A5944/SB 6101. d. If indicator color did not change, return engine to service with these limits: 1) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection). 2) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 3) Monitor the SB A5944/SB 6101 indicators at the intervals given in SB A5944/SB 6101.

(2) If leakage is found outside of the above limits the problem shall be repaired and the engine further tested using the following as a guide.

  (a) For overboard drain leakage, run engine for five minutes at Max. Continuous and five minutes at Normal Takeoff.

  (b) For accessory drive seal leakage and parting surface leakage, run engine for ten minutes at Max. Continuous and five minutes at Normal Takeoff.

JT8D–209, –217,–217A –217C, –219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, OVERHAUL HOT SECTION AND SUBMIT ALL PARTS TO NORMAL INSPECTION PROCEDURES INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND TURBINE DISKS FOR GROWTH AND HARDNESS.

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, DETERMINE AND CORRECT CAUSE FOR OVERTEMPERATURE AND PERFORM HOT SECTION INSPECTION OR AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE 72–00–00 INSPECTION/CHECK–01, PARAGRAPH 28.)

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE. ENTER INTO ENGLINE LOG. VISUALLY INSPECT EXTERIOR OF ENGINE AND INTERIOR OF EXHAUST DUCT.

NO ACTION REQUIRED.

NOTE:

FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR–COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

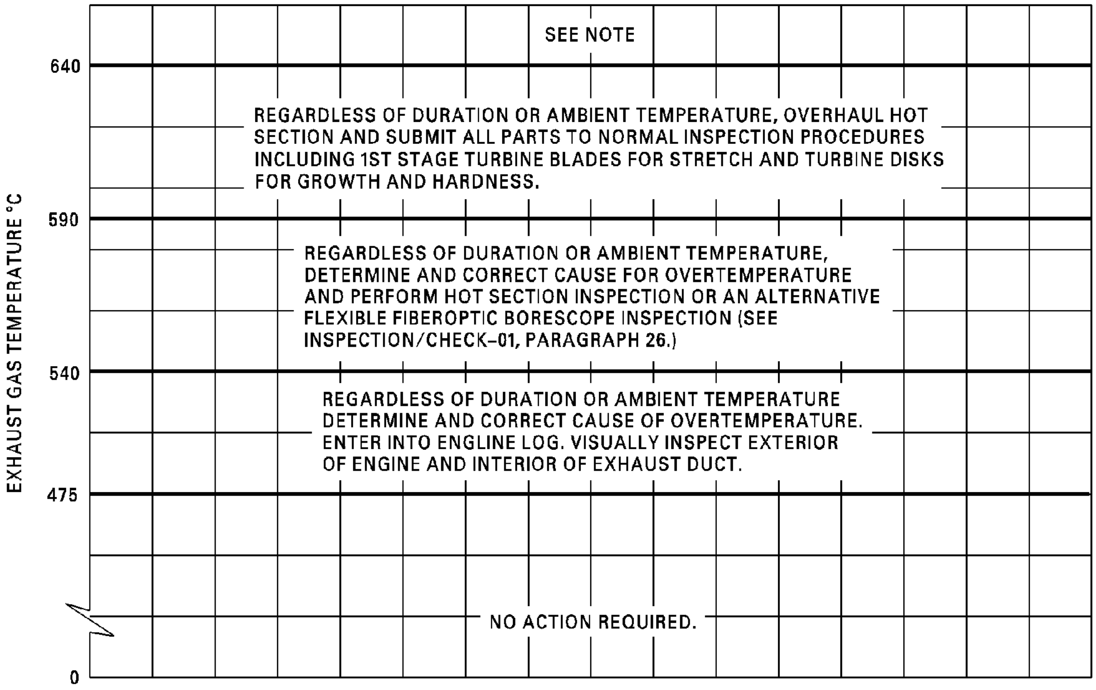
L–89085 (0299)

CAG(IGDS)

BBB2–72–40F

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 502/72-00-00-990-860 (Sheet 1 of 2)

JT8D-209, -217,-217A -217C, -219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



NOTE:

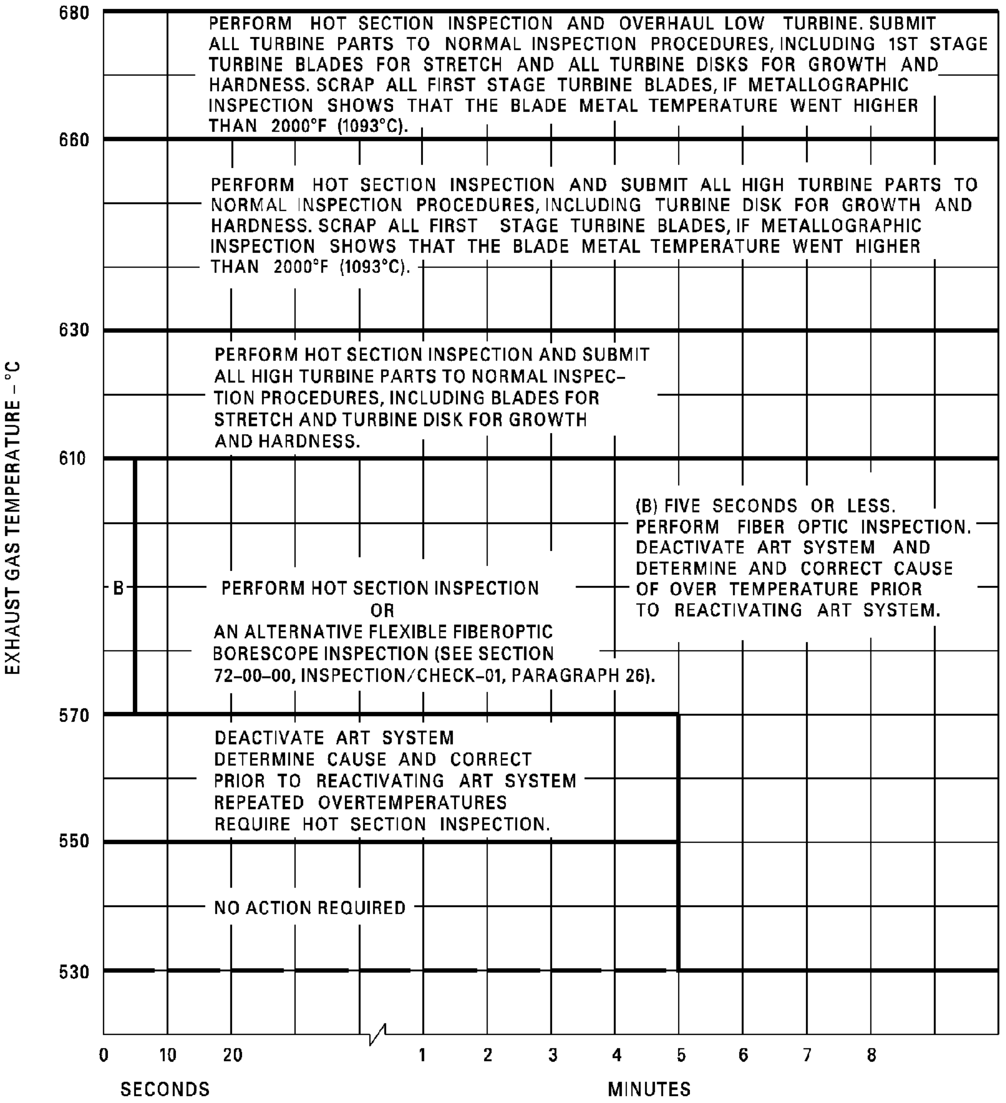
FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

CAG(IGDS)

BBB2-72-558A

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 502/72-00-00-990-860 (Sheet 2 of 2)

JT8D-209
NORMAL TAKEOFF
OVERTEMPERATURE LIMITS AND INSPECTION



PERFORM HOT SECTION INSPECTION AND OVERHAUL LOW TURBINE. SUBMIT ALL TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND ALL TURBINE DISKS FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING TURBINE DISK FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING BLADES FOR STRETCH AND TURBINE DISK FOR GROWTH AND HARDNESS.

PERFORM HOT SECTION INSPECTION
OR
AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE SECTION 72-00-00, INSPECTION/CHECK-01, PARAGRAPH 26).

(B) FIVE SECONDS OR LESS. PERFORM FIBER OPTIC INSPECTION. DEACTIVATE ART SYSTEM AND DETERMINE AND CORRECT CAUSE OF OVER TEMPERATURE PRIOR TO REACTIVATING ART SYSTEM.

DEACTIVATE ART SYSTEM
DETERMINE CAUSE AND CORRECT PRIOR TO REACTIVATING ART SYSTEM
REPEATED OVERTEMPERATURES REQUIRE HOT SECTION INSPECTION.

NO ACTION REQUIRED

NOTE:

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

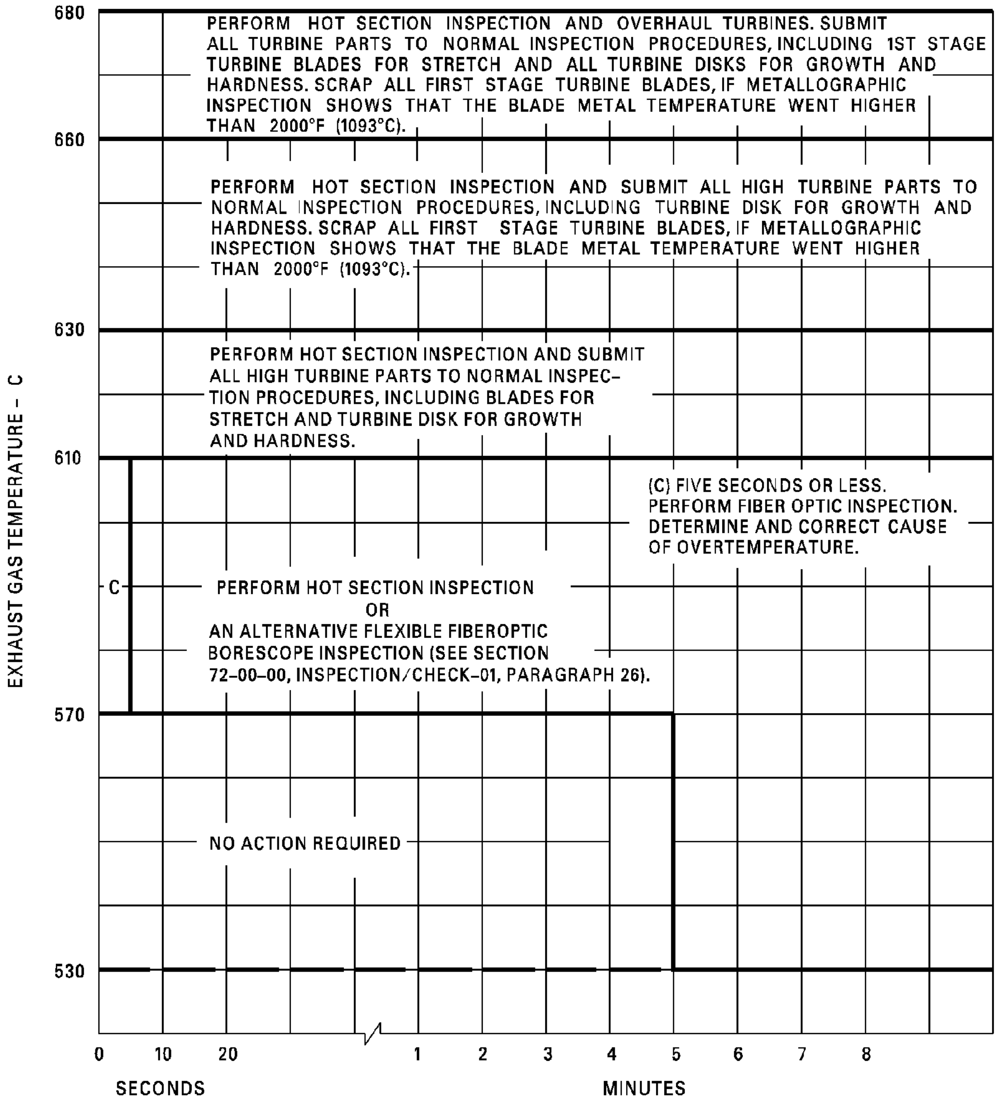
L-89086 (0299)

CAG(IGDS)

BBB2-72-163C

Normal Takeoff Overtemperature Limits and Inspection Procedures
Figure 503/72-00-00-990-861

JT8D–209
MAXIMUM TAKEOFF AND AIR STARTING
OVERTEMPERATURE LIMITS AND INSPECTION



NOTE:

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR–COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

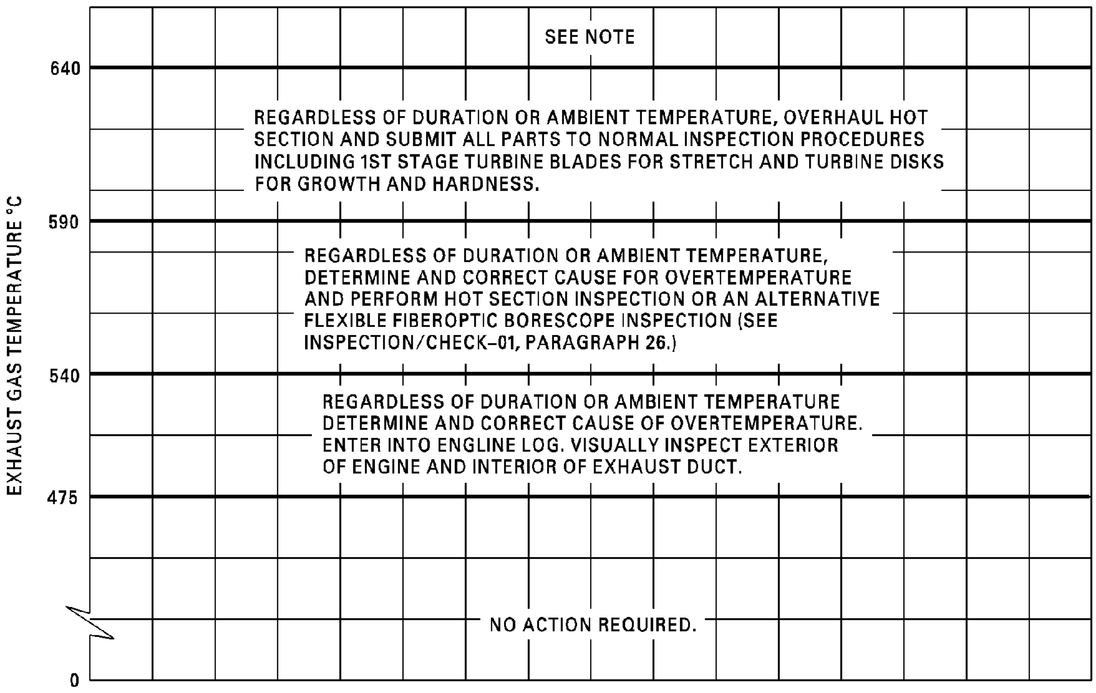
L–89087 (0299)

CAG(IGDS)

BBB2–72–164C

Maximum Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 504/72-00-00-990-862

JT8D-209, -217,-217A -217C, -219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, OVERHAUL HOT SECTION AND SUBMIT ALL PARTS TO NORMAL INSPECTION PROCEDURES INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND TURBINE DISKS FOR GROWTH AND HARDNESS.

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, DETERMINE AND CORRECT CAUSE FOR OVERTEMPERATURE AND PERFORM HOT SECTION INSPECTION OR AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE INSPECTION/CHECK-01, PARAGRAPH 26.)

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE. ENTER INTO ENGLINE LOG. VISUALLY INSPECT EXTERIOR OF ENGINE AND INTERIOR OF EXHAUST DUCT.

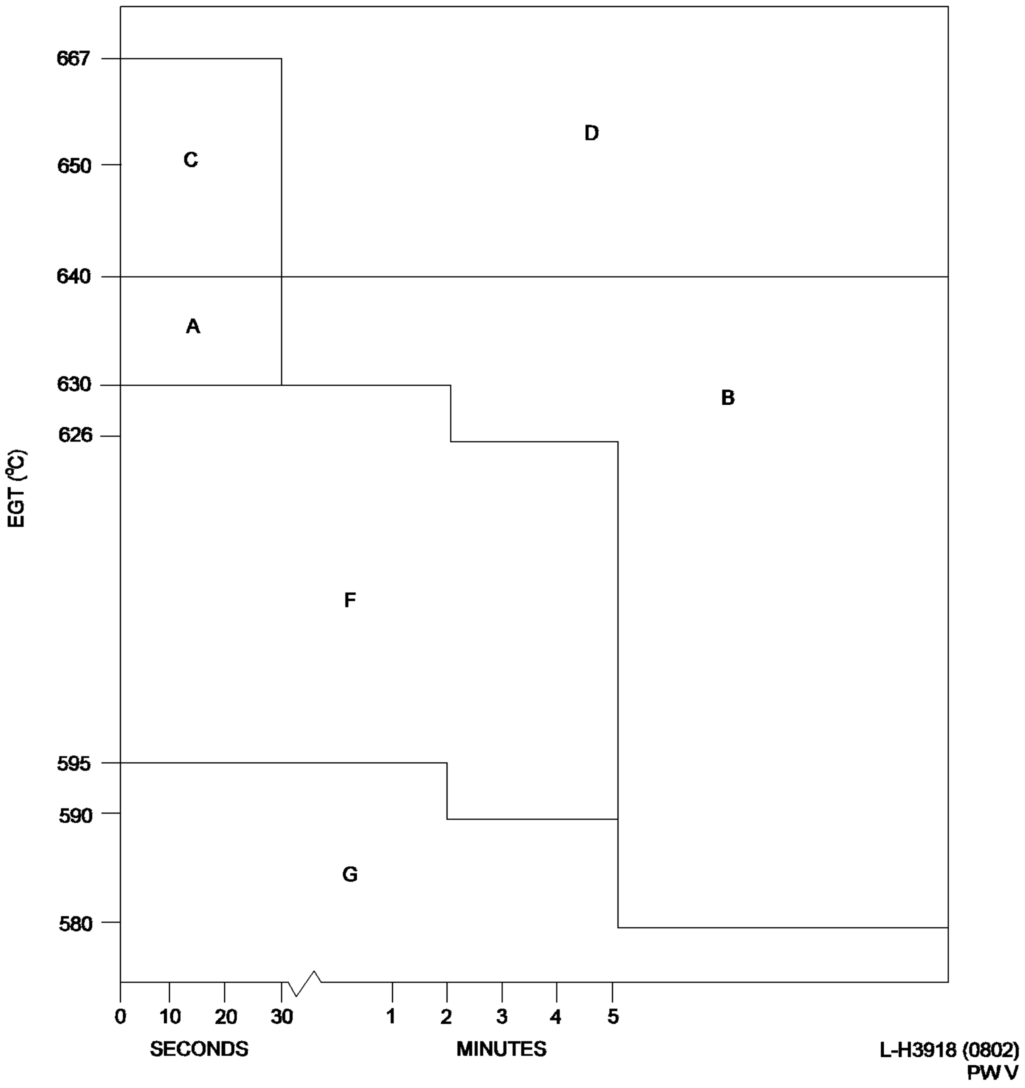
NOTE:

FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

CAG(IGDS) BBB2-72-558A

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 505/72-00-00-990-866

JT8D-217, -217A, -217C, -219
NORMAL TAKEOFF AND AIR STARTING
OVERTEMPERATURE LIMITS AND INSPECTION



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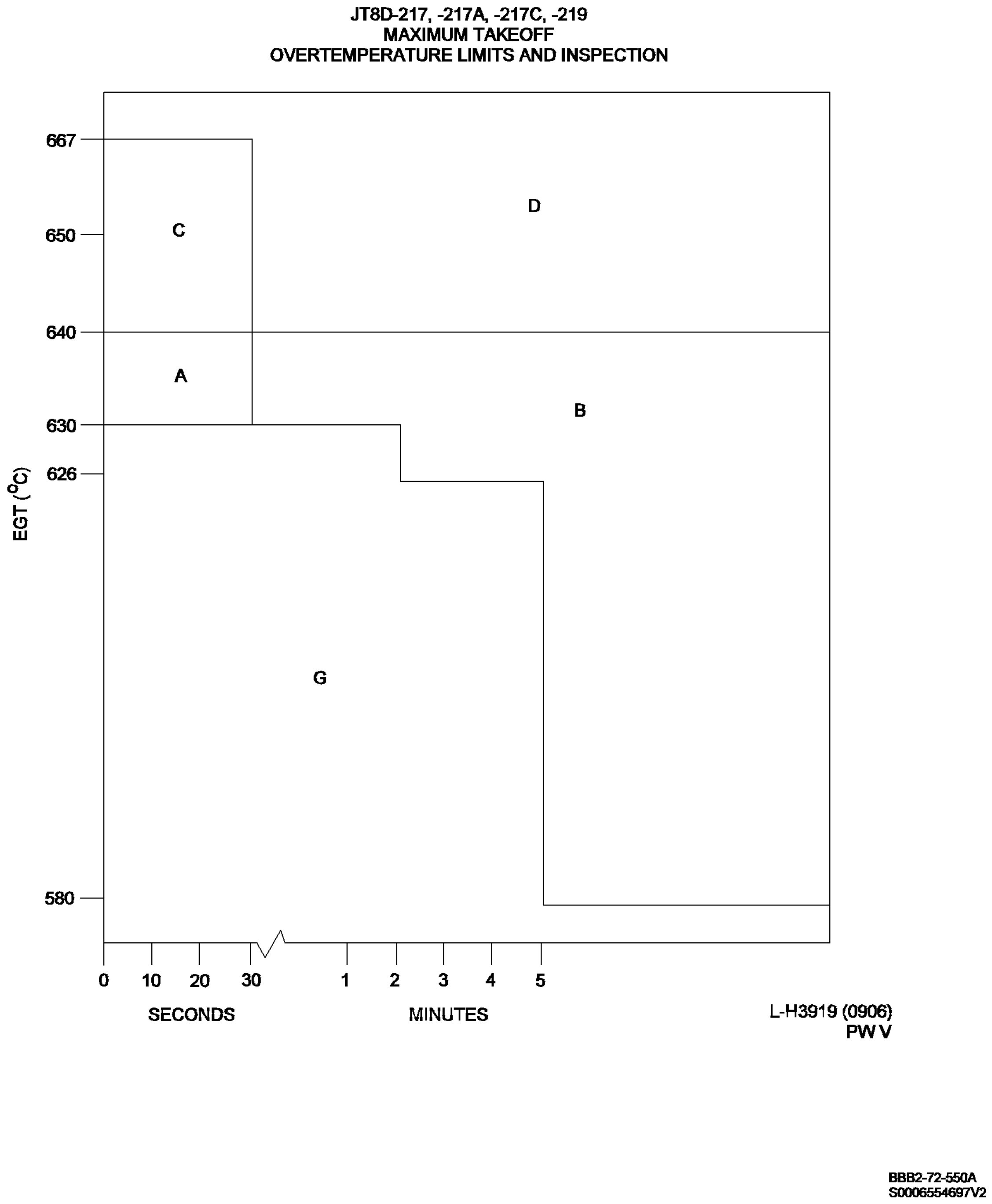
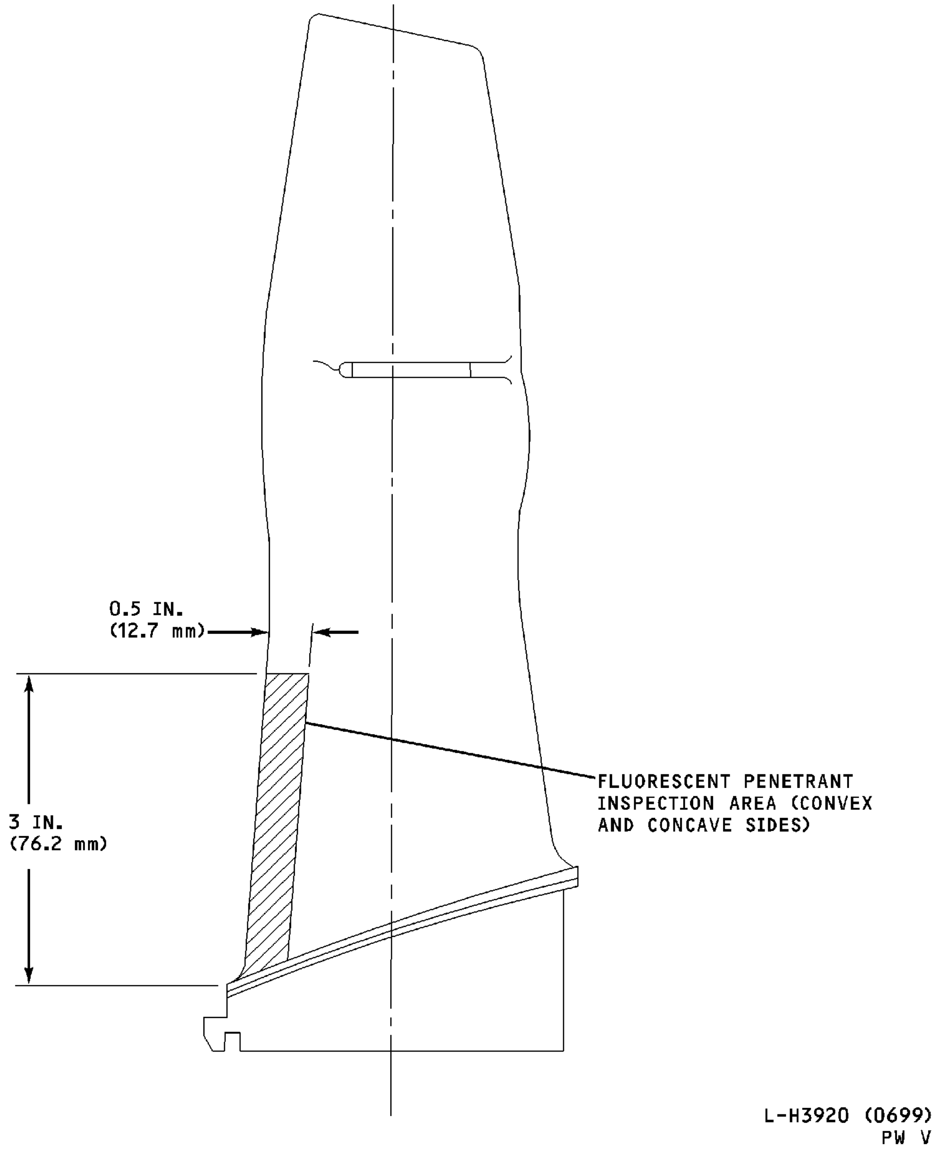
Normal Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 506/72-00-00-990-863



Maximum Takeoff Overtemperature Limits and Inspection Procedures
Figure 507/72-00-00-990-864



First Stage Compressor Blade Inspection Zone
Figure 508/72-00-00-990-865

3. Inspection Prior To Test

A. Fuel System Inspection

(1) Fuel System

(a) Visually check all fuel system tubes and components for security and leakage.

(b) Remove, clean if necessary and install the fuel pump filters.

(c) Remove, clean if necessary and install the fuel control filters.

(d) Check the fuel system for the presence of water.

(e) Service the fuel system with an approved fuel conforming to SB 2016.

NOTE: The engine should be ground tested and trimmed using the same grade fuel as used for flight operations. Slight variations for any given lever position will result if alternate fuels are used.

B. Oil System Inspection

(1) Oil System

(a) Remove, disassemble, clean, and reinstall the main oil strainer. Replace filter if cartridge type.

(b) Visually check all of the oil system tubes and components for security and leakage.

(c) Fill the oil tank with an approved oil conforming to Specification 521 Synthetic Oil.

NOTE: Approved oils are listed in Turbojet Engine Service Bulletin No. 238.

CAUTION: UP TO TWO GALLONS OF OIL MAY BE IN THE SCAVENGE SECTIONS; THEREFORE, OIL MUST NOT BE ADDED TO THE TANK UNTIL THE SCAVENGE SECTIONS ARE CLEANED. IF THE ABOVE PROCEDURE IS NOT FOLLOWED, EXCESSIVE OIL MAY BE ADDED WHICH WILL RESULT IN A BUILDUP OF SUFFICIENT INTERNAL PRESSURE TO RUPTURE THE TANK DURING ENGINE OPERATION.

(d) If oil is required after starting the engine, the engine shall be operated for approximately one minute at IDLE speed. This is required to make certain that any oil which may be in the scavenge section of the engine is returned to the tank, thereby assuring an accurate oil level check.

C. Electrical System Inspection

(1) Electrical System

(a) Check the ignition system components for security.

WARNING: BECAUSE THE VOLTAGE TO THE SPARK IGNITERS IS DANGEROUSLY HIGH, THE IGNITION SWITCH MUST BE IN THE "OFF" POSITION BEFORE REMOVAL OF ANY OF THE IGNITION SYSTEM COMPONENTS. APPROXIMATELY THREE MINUTES OF TIME MUST ELAPSE BETWEEN THE OPERATION OF THE IGNITION SYSTEM AND THE REMOVAL OF COMPONENTS WHEN A SPARK IGNITER LEAD IS DETACHED FROM A SPARK IGNITER, TOUCH THE END OF THE LEAD TO THE SHELL OF THE IGNITER TO DISSIPATE THE RESIDUAL ENERGY.

(b) Remove both spark igniters; check and reinstall.

D. Instrumentation System Inspection

(1) Instrumentation System

(a) Check engine instrumentation for security and general condition.

(b) Inspect the pressure sensing probes for security.

(c) Visually check all indicating thermocouples for security.

(d) Check the thermocouple harness and all lead insulations and shields for chafing and security.

E. Engine Controls Inspection

(1) Engine Controls

(a) Check the power lever for full travel, ease of movement and security.

NOTE: To prevent dilution of the bearing lubrication medium, protect the prepacked bearings used in the power cross shaft assembly during any washing process. The same precautions must be taken when fuel lines near this assembly are disconnected and fuel is, or may be, in these lines.

(b) Inspect the compressor bleed valve, override control, pressure ratio bleed control, and the air tubes for security.

F. Run-Up Area and Engine Inlet Duct Inspection

(1) Run-Up Area and Engine Inlet Duct

(a) Prior to starting the engine, the inlet must be thoroughly inspected and cleaned of possible loose nuts, bolts, tools and other objects which could cause engine damage and possible subsequent failure.

(b) Examine the inlet and exhaust areas to ensure against the presence of foreign objects which could, under some circumstances, enter the engine.

4. Engine Test Procedure

A. Starting Procedure for Pneumatic and Combustion Starters. (GENERAL, SUBJECT 71-00-00, Page 501)

B. Satisfactory Start. (GENERAL, SUBJECT 71-00-00, Page 501)

C. Unsatisfactory Start. (GENERAL, SUBJECT 71-00-00, Page 501)

D. Unsatisfactory Start Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

E. Clear Engine Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

F. Determination of Corrected N_2 Speed. (Figure 509 and Figure 510)

(1) Corrected N_2 speed is determined as shown in Figure 509.

(2) JT8D engine experience indicates a recommended high rotor data plate speed deterioration limit of plus 1.8 percent minus 0.8 percent corrected RPM be established.

G. Max. Observed Exhaust Gas Temperature & Spread Check.

(1) A check of the exhaust gas measurement system shall be made following a stabilization at Normal Takeoff power. Remove four screws and cover from thermocouple cable junction box located at 7 o'clock on rear rail of turbine exhaust outer duct. Remove nine nuts, chromel bus bar and two leads. Position PWA 45563 Adapter on the studs and secure with nuts previously removed. Torque nuts to 15 - 18 in-lb. (1.695 - 2.034 N·m), then connect instrumentation. Maximum allowable T_{t7} for any single probe reading is the maximum limit with averaging harness plus 110°F (61°C). Readings from each T_{t7} probe shall be recorded and maximum acceptable spread shall not exceed 230°F (127.8°C). Remove PWA 45563 Adapter, reinstall two leads, chromel bus bar and nine nuts. Torque nuts to 15 -18 in-lb. (1.695 - 2.034 N·m), then install and secure junction box cover.

(2) The JT8D Part Power Trim temperature spread check shall not exceed 230°F (127.8°C).

H. Shutdown Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

I. Anti-Surge Bleed Operation Limits Refer to Paragraph 6.F..

N2 CORRECTION

(1) Corrected N2 (%) $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}}$

Where: $\sqrt{\theta} = \sqrt{\dfrac{\text{Compressor Inlet Temperature}^{\circ}\text{K}}{288}}$

(2) From the Inlet Temperature Correction Factor Chart determine N2 correction factor ($\sqrt{\theta}$) for compressor inlet temperature -

(3) Divide observed N2 speed by $\sqrt{\theta}$ -

Example: Inlet temperature = 30°C (86°F)

$\sqrt{\theta}$ (From the Inlet Temperature Correction Factor Chart) = 1.026

Observed N2 = 87.5%

Corrected N2 $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}} = \dfrac{87.5\%}{1.026} = 85.3\%$

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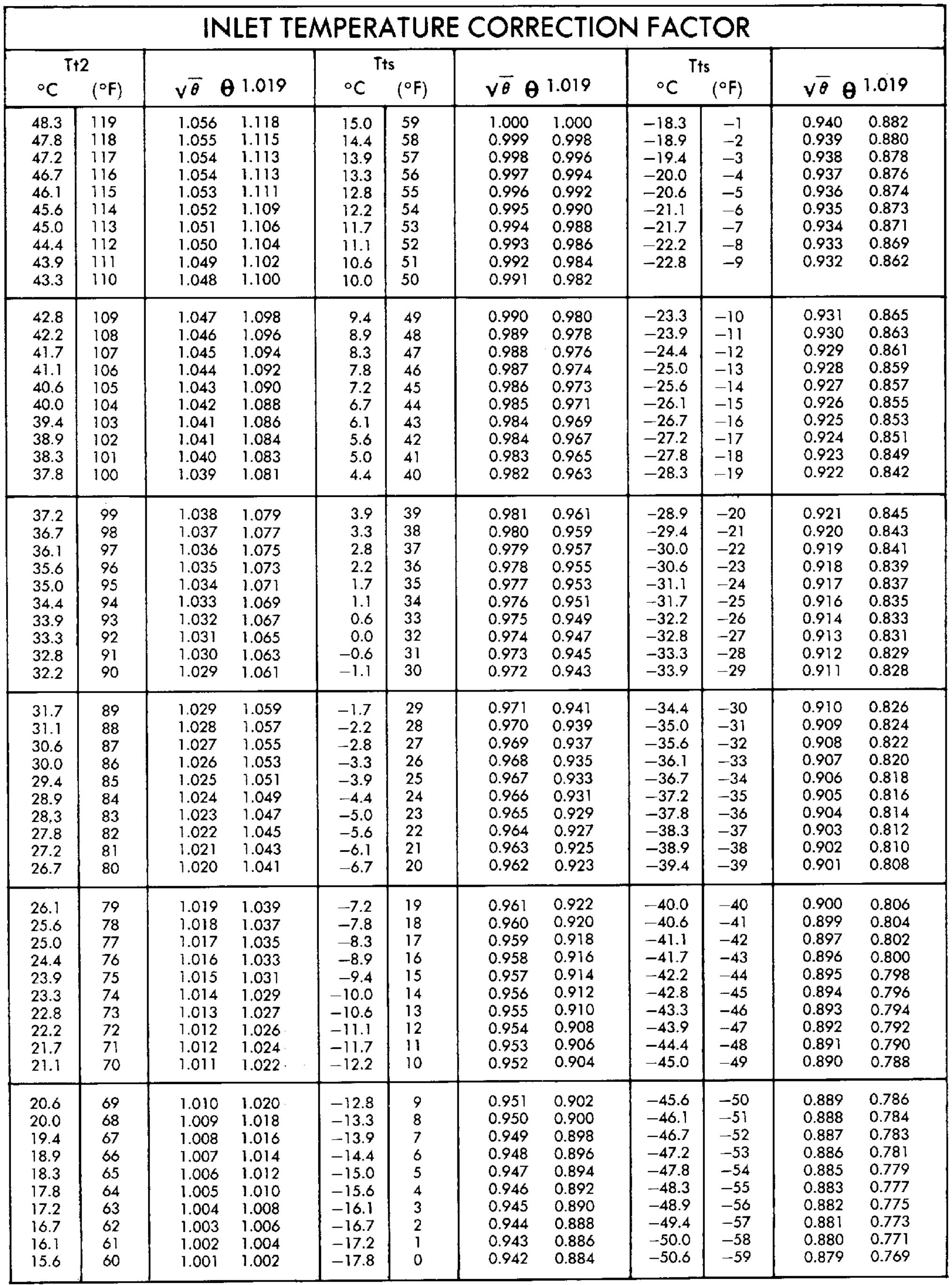
Rotor Speed Correction
Figure 509/72-00-00-990-867



INLET TEMPERATURE CORRECTION FACTOR

Tt2				Tts				Tts			
°C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	°C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	°C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$
48.3	119	1.056	1.118	15.0	59	1.000	1.000	−18.3	−1	0.940	0.882
47.8	118	1.055	1.115	14.4	58	0.999	0.998	−18.9	−2	0.939	0.880
47.2	117	1.054	1.113	13.9	57	0.998	0.996	−19.4	−3	0.938	0.878
46.7	116	1.054	1.113	13.3	56	0.997	0.994	−20.0	−4	0.937	0.876
46.1	115	1.053	1.111	12.8	55	0.996	0.992	−20.6	−5	0.936	0.874
45.6	114	1.052	1.109	12.2	54	0.995	0.990	−21.1	−6	0.935	0.873
45.0	113	1.051	1.106	11.7	53	0.994	0.988	−21.7	−7	0.934	0.871
44.4	112	1.050	1.104	11.1	52	0.993	0.986	−22.2	−8	0.933	0.869
43.9	111	1.049	1.102	10.6	51	0.992	0.984	−22.8	−9	0.932	0.862
43.3	110	1.048	1.100	10.0	50	0.991	0.982				
42.8	109	1.047	1.098	9.4	49	0.990	0.980	−23.3	−10	0.931	0.865
42.2	108	1.046	1.096	8.9	48	0.989	0.978	−23.9	−11	0.930	0.863
41.7	107	1.045	1.094	8.3	47	0.988	0.976	−24.4	−12	0.929	0.861
41.1	106	1.044	1.092	7.8	46	0.987	0.974	−25.0	−13	0.928	0.859
40.6	105	1.043	1.090	7.2	45	0.986	0.973	−25.6	−14	0.927	0.857
40.0	104	1.042	1.088	6.7	44	0.985	0.971	−26.1	−15	0.926	0.855
39.4	103	1.041	1.086	6.1	43	0.984	0.969	−26.7	−16	0.925	0.853
38.9	102	1.041	1.084	5.6	42	0.984	0.967	−27.2	−17	0.924	0.851
38.3	101	1.040	1.083	5.0	41	0.983	0.965	−27.8	−18	0.923	0.849
37.8	100	1.039	1.081	4.4	40	0.982	0.963	−28.3	−19	0.922	0.842
37.2	99	1.038	1.079	3.9	39	0.981	0.961	−28.9	−20	0.921	0.845
36.7	98	1.037	1.077	3.3	38	0.980	0.959	−29.4	−21	0.920	0.843
36.1	97	1.036	1.075	2.8	37	0.979	0.957	−30.0	−22	0.919	0.841
35.6	96	1.035	1.073	2.2	36	0.978	0.955	−30.6	−23	0.918	0.839
35.0	95	1.034	1.071	1.7	35	0.977	0.953	−31.1	−24	0.917	0.837
34.4	94	1.033	1.069	1.1	34	0.976	0.951	−31.7	−25	0.916	0.835
33.9	93	1.032	1.067	0.6	33	0.975	0.949	−32.2	−26	0.914	0.833
33.3	92	1.031	1.065	0.0	32	0.974	0.947	−32.8	−27	0.913	0.831
32.8	91	1.030	1.063	−0.6	31	0.973	0.945	−33.3	−28	0.912	0.829
32.2	90	1.029	1.061	−1.1	30	0.972	0.943	−33.9	−29	0.911	0.828
31.7	89	1.029	1.059	−1.7	29	0.971	0.941	−34.4	−30	0.910	0.826
31.1	88	1.028	1.057	−2.2	28	0.970	0.939	−35.0	−31	0.909	0.824
30.6	87	1.027	1.055	−2.8	27	0.969	0.937	−35.6	−32	0.908	0.822
30.0	86	1.026	1.053	−3.3	26	0.968	0.935	−36.1	−33	0.907	0.820
29.4	85	1.025	1.051	−3.9	25	0.967	0.933	−36.7	−34	0.906	0.818
28.9	84	1.024	1.049	−4.4	24	0.966	0.931	−37.2	−35	0.905	0.816
28,3	83	1.023	1.047	−5.0	23	0.965	0.929	−37.8	−36	0.904	0.814
27.8	82	1.022	1.045	−5.6	22	0.964	0.927	−38.3	−37	0.903	0.812
27.2	81	1.021	1.043	−6.1	21	0.963	0.925	−38.9	−38	0.902	0.810
26.7	80	1.020	1.041	−6.7	20	0.962	0.923	−39.4	−39	0.901	0.808
26.1	79	1.019	1.039	−7.2	19	0.961	0.922	−40.0	−40	0.900	0.806
25.6	78	1.018	1.037	−7.8	18	0.960	0.920	−40.6	−41	0.899	0.804
25.0	77	1.017	1.035	−8.3	17	0.959	0.918	−41.1	−42	0.897	0.802
24.4	76	1.016	1.033	−8.9	16	0.958	0.916	−41.7	−43	0.896	0.800
23.9	75	1.015	1.031	−9.4	15	0.957	0.914	−42.2	−44	0.895	0.798
23.3	74	1.014	1.029	−10.0	14	0.956	0.912	−42.8	−45	0.894	0.796
22.8	73	1.013	1.027	−10.6	13	0.955	0.910	−43.3	−46	0.893	0.794
22.2	72	1.012	1.026	−11.1	12	0.954	0.908	−43.9	−47	0.892	0.792
21.7	71	1.012	1.024	−11.7	11	0.953	0.906	−44.4	−48	0.891	0.790
21.1	70	1.011	1.022	−12.2	10	0.952	0.904	−45.0	−49	0.890	0.788
20.6	69	1.010	1.020	−12.8	9	0.951	0.902	−45.6	−50	0.889	0.786
20.0	68	1.009	1.018	−13.3	8	0.950	0.900	−46.1	−51	0.888	0.784
19.4	67	1.008	1.016	−13.9	7	0.949	0.898	−46.7	−52	0.887	0.783
18.9	66	1.007	1.014	−14.4	6	0.948	0.896	−47.2	−53	0.886	0.781
18.3	65	1.006	1.012	−15.0	5	0.947	0.894	−47.8	−54	0.885	0.779
17.8	64	1.005	1.010	−15.6	4	0.946	0.892	−48.3	−55	0.883	0.777
17.2	63	1.004	1.008	−16.1	3	0.945	0.890	−48.9	−56	0.882	0.775
16.7	62	1.003	1.006	−16.7	2	0.944	0.888	−49.4	−57	0.881	0.773
16.1	61	1.002	1.004	−17.2	1	0.943	0.886	−50.0	−58	0.880	0.771
15.6	60	1.001	1.002	−17.8	0	0.942	0.884	−50.6	−59	0.879	0.769

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Inlet Temperature Correction Factor Chart
Figure 510/72-00-00-990-868

5. Repair/Test Reference

(Table 507)

A. General

(1) Repair/test reference table lists various repairs, replacements and reinstallations and corresponding test to be performed following these actions. When more than one maintenance action has been done, combine different features of two or more tests, eliminate duplication, and perform resultant test during one period of operation. Where multiple tests each require single power setting, higher power setting shall be used.

(2) In order to achieve high degree of accuracy, it is recommended that all tests be conducted in P&W approved indoor test facility previous to installing engine in aircraft. However, in cases where such test facility was not available or if operator prefers to test engine on aircraft, test requirements are indicated in Table 507.

(3) It should be understood that quality of test data from an on-the-wing engine test may not be as accurate as data generated from indoor engine test facility. While quality of on-the-wing test data should be sufficient to determine if engine is acceptable, operator should be willing to sacrifice certain degree of troubleshooting or trend monitoring capability when relying on installed engine data.

Table 507 Repair/Test Reference

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Accessory Drive Seals	A
Anti-icing Air Shutoff Actuator And Valve	*[2]
Average Pressure Probe P_{t7} (8 Required)	B
Combustion Area Inspection	B
Combustion Chambers	B
Combustion Chamber Duct	F
Combustion Chamber Inner Case	F
Combustion Chamber And Turbine Fan Ducts	C
Compressor Inlet Duct	A
Compressor Inlet Group	A
Compressor Inlet and Front Compressor Section	B, I
Compressor Intermediate Group	F
Constant Speed Drive/Alternator Drive Oil Seal	A
Differential Fluid Pressure Switch	C
Diffuser Group	F
Diffuser Outer Fan Duct Group	C
Eighth Stage Bleed Valve	E
Engine Exhaust Case Section	G
Engine Oil Tank	A
Engine Oil Tank Drain Valve	None

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Fan Exhaust (Mixer) Rear Outer Duct	None
Fan Exhaust Outer Rear (Transition) Duct	None
Fan And Turbine Exhaust Duct (Mixer)	None
Fan Exit Stator Segments	None
First Stage Compressor (Fan) Blades	I(4)
First Stage Compressor Disk And Blade Assembly (Fan)	G(5), I(4)
First Stage Turbine Vanes (Through Hot Section With Turbines Installed)	B, H
First Stage Turbine Vanes (Turbines Removed)	F
Front Accessory Drive Group	A
Front Compressor Drive Turbine Group	F
Front Compressor Drive Turbine Group And Engine Exhaust Case Section Group	F
Front Compressor Drive Turbine Rotor And Stator Assembly	F
Front Compressor Rotor And Stator Assembly	G, I
Front Fan Case	A
Fuel Control (Replacement Fuel Control)	D, H
Fuel Control Condensation Trap	None
Fuel Control Main Filter	C
Fuel Deicing Air Shutoff Actuator And Valve	*[2]
Fuel Deicing Heater Assembly	C
Fuel Nozzle And Support Assemblies	B, H
Fuel Manifold Assembly	B, H
Fuel/Oil Cooler And Seals	C (6)
Fuel/Oil Cooler Bypass Valve And Seals	C (6)
Fuel/Oil Cooler Inlet Tube And Seals	C (6)
Fuel/Oil Cooler Outlet Sensing Tube And Seals	C (6)
Fuel Pressurizing And Dump Valve	C(3)
Fuel Pressurizing And Dump Valve Strainer	C
Fuel Pump (Same Fuel Control)	B(2), H
Fuel Pump Drive Oil Seal	A
Fuel Pump Filter	C
Fuel Pump And Fuel Control Package (Different Fuel Control)	D(2), H
Gearbox Coupling (Constant Speed Drive)	A
Gearbox Deairator Oil Seal	A
Hydraulic Pump Drive Oil Seal	A

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Igniter Plug (2 Required)	*[1]
Ignition Cable (2 Required)	*[1]
Ignition Exciter	*[1]
Main Accessory Gearbox Assembly (Same Fuel Control)	B
Main Accessory Gearbox Group (Same Fuel Control) (And Fuel Control Connecting Linkage)	B
Main Gearbox Drive Bevel Gearshaft And Bearings	B
Main Oil Filter (Strainer) And Seals	C (6)
Main Oil Pump And Seals	C (6)
N_1 Tachometer Drive Oil Seal	A
N_2 Tachometer Drive Gearshaft Oil Seal	A
No. 1 Bearing	G, I
No. 1 Bearing Air Sealing Ring And Seal Assembly	G, I
No. 1 Bearing Oil Scavenge Pump	A
No. 2 Bearing	F
No. 2 Bearing Seal Assembly	G, I
No. 3 Bearing And Seal	F
No. 4 Bearing	F
No. 4 Bearing Seal Assembly	F
No. 4 Bearing Sealing Ring	F
No. 4 And 5 Bearing Oil Pressure/Scavenge Tube (External) And Seals	A
No. 4 And 5 Bearing Oil Breather Tube (External) And Seals	B
No. 4 And 5 Bearing Oil Scavenge Pump	F
No. 4 1/2 Bearing, Seals And Seal Spacers	F
No. 5 Bearing And Seal Assembly	F
No. 6 Bearing And Seals	G, I
No. 6 Bearing Oil Scavenge Pump	A
Oil Filter Pressure Relief Valve And Seals	C (6)
Oil Pressure Relief Valve Assembly	C(1), (6)
Power Lever Cross Shafts	B
Pressure Ratio Bleed Control	E
Rear Compressor And Diffuser Section	F
Rear Compressor Drive Turbine Rotor And Shaft Assembly	F
Rear Compressor Drive Turbine Group	F

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Rear Compressor Exit Stator Assembly	F
Rear Compressor Through The Rear Compressor Drive Turbine Section	F
Rear Compressor Rotor And Stator Assembly	F
Rear Fan Case	G
Starter Drive Gearshaft Coupling	A
Starter Drive Oil Seal	A
Thermocouple - T_{t7} (8 Required)	None
Thermocouple Box And Cable Assembly - T_{t7}	None
Total Pressure Probe - P_{t2}	E
Turbine Exhaust Cone And Duct	None
Turbine Nozzle Group	F
Turbine Shaft Inner Heat shield Assembly	F
Turbine Shaft Outer Heat shield Assembly	F
13th Stage Bleed Valve	E
13th Stage Compressor Sealing Ring	F
(1) When engine oil pressure adjustment is required, install 0 - 50 PSIG (0.0 - 344.7 kPa) direct-reading gage to LP2 tap on main oil pressure manifold, vented to LV3 tap on main accessory gearbox housing. Adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa at Idle. 100°F (38°C) oil temperature is recommended during oil pressure adjustment. See Paragraph 8..	
(2) After replacing fuel pump and performing engine test run, torque fuel pump quick-disconnect nut per PAGEBLOCK 73-00-00/601.	
(3) During and after this test, carefully inspect for fuel leakage at fuel manifold inlet tube to P&D valve tube end fittings. No Leakage is permitted.	
(4) See the locations that follow for a 24 hour flyback time limit permitted before the vibration check is necessary: (a) Section PAGEBLOCK 72-00-00/601 Config 1 - Inspect First Stage Compressor Blades. (b) Section PAGEBLOCK 72-33-21/401 - Replace First Stage Compressor Blades. (c) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.	
(5) See the location that follows for a 24 hour flyback time limit permitted before the breather pressure check is necessary: (a) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.	
(6) Test A (Ground Check at Idle) is an option to Test C for leak check of these replaced parts, but Test A will not give the increased oil pressure that is typical during engine accelerations. If an oil leak problem is possible, use Test C (with the thrust level modification specified for leak check) to see if there are oil leaks.	

*[1] Aural Check Igniter Firing With Engine Not Running.

*[2] Observe Valve Position While Actuating Valve with Engine Not Running.

6. Test For Repaired Engines

A. When cleaning engines prior to test, following precautions must be taken.

CAUTION: IF FUEL LINES ARE TO BE DISCONNECTED, PRE-PACKED BEARINGS IN THE AREA MUST BE PROTECTED FROM ANY LOST FUEL.

(1) Protect all prepacked bearings, such as cross-shaft or control rod linkage bearings.

(2) Protect pressure ratio bleed control.

(3) Protect silicone rubber shock mounts on oil tank and oil tank strap. Wash down area as soon as possible after washing with cleaning solution.

B. Test A - Ground Check at Idle

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Allow engine to run at IDLE for minimum of three minutes for oil system repair/replacement as required for oil temperature to reach 100°F (38°C).

(4) Shut down. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.M..

C. Test B - Ground Check at Normal Takeoff

(1) Inspect and clean engine test area.

(2) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Operate engine at IDLE until readings have stabilized and oil temperature reaches minimum of 100°F (38°C).

(4) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(5) Stabilize for three minutes at Normal Takeoff.

(6) Check that oil pressure, oil temperature and EGT are within limits of Table 503

(7) Retard power lever to IDLE and operate engine for five minutes.

(8) Shut down engine (GENERAL, SUBJECT 71-00-00, Page 501) and perform normal engine inspection procedures. (GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 72-00-00/201)

NOTE: It is not necessary to inspect the oil filter if the oil system was not disturbed and no oil wetted components were replaced during the maintenance action.

D. Test C - Ground Check at 3000 lb/hr (1360 kg) Fuel Flow

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start engine GENERAL, SUBJECT 71-00-00, Page 501 and allow to stabilize at idle for minimum of three minutes.

(3) Advance power lever as necessary until minimum of 3000 lb/hr of fuel flow is observed. Maintain for minimum of two minutes.

(4) After completion of check, return power lever to IDLE.

(5) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.M..

E. Test D - Part Power Trim Check. (GENERAL, SUBJECT 71-00-00, Page 501)

F. Test E - Ground Check for Bleed System Operation. (Figure 511)

NOTE: This check is only applicable to the engine surge bleed system. With engines which have a 6th stage bleed system, refer to PAGEBLOCK 72-00-03/101 for a functional check. It is not possible to do a ground check of the 6th stage bleed system because the bleed closure and opening does not give a satisfactory engine parameter change.

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Run engine at IDLE until oil temperature reaches 100°F (38°C) minimum.

(4) Slowly accelerate engine and record N_1 speed at which anti-surge bleed valves close. Bleed closing is indicated by sudden increase in EPR.

(5) Slowly decelerate engine from stabilized point just above bleed valve closing and record N_1 speed at which anti-surge bleed valves open. Bleed valve opening is indicated by sudden decrease in EPR.

(6) Check bleed valve opening and closing per Figure 511.

(7) Retard power lever to Idle and shut down engine.

(8) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.M..

(9) If anti-surge bleed valves do not open and close within limits of Figure 511, refer to PAGEBLOCK 72-00-03/101.

G. Test F - Acceptance and Performance

(1) Instrumentation Required

(a) N_1 - cockpit

(b) N_2 - cockpit

(c) EGT - cockpit

(d) EPR - cockpit

(e) Fuel Flow - cockpit

(f) Oil pressure - cockpit

(g) Oil temperature - cockpit

(h) PCP - external instrumentation - 0 - 200 psi (0.0 - 1379.0 kPa) range, measured at PCP fitting located on left side of engine diffuser case high pressure service bleed port near PS3 filter.

(i) PS4 - external instrumentation - 0 - 300 psi (0.0 - 2068.4 kPa) range, measured at PS4 fitting located on right side of engine diffuser case high pressure service bleed port at upper end of bleed valve actuation pressure supply line.

(j) P_{t7} - external instrumentation - 0 - 50 psi (0.0 - 344.7 kPa) range measured at P_{t7} line test fitting.

(k) Breather pressure - external instrumentation - 09 - 30 psi (0.0 - 206.8 kPa) range. Refer to Paragraph 6.H. for installation.

(l) Ambient temperature - Laboratory Quality Mercury Thermometer

(m) Ambient pressure - Local facilities

(n) Install vibration pickups at locations indicated in Figure 512. Connect to vibration monitoring instrumentation, including low frequency (40 cps) filter.

(2) To ensure accuracy of P_{t7} system, pressure check system as follows:

(a) Connect PWA 46415 (formerly 45513) Adapter to P_{t7} manifold outlet and attach source of dry, filtered compressed air, with PWA 21875 Regulator.

(b) Apply 35 - 45 PSIG (241.3 - 310.3 kPa) air pressure to P_{t7} system.

(c) Use soap and water solution, check each connection in manifold and at probes for leakage. No leakage is permitted.

(d) Disconnect and remove test equipment and reconnect manifold outlet.

(3) Verify proper exhaust nozzle area as specified by airframe manufacturer.

NOTE: Engine bleed and electrical loads must be minimized during test. Fuel heater, generator, air conditioning packs, anti-icing and low pressure airbleed must be off. However, generator cooling airbleed and hydraulic pumps shall be set as "low" or "no load".

(4) Inspect and clean engine test area.

(5) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Operate engine at idle for two minutes until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(7) Shut down engine and conduct Part Power Trim check per GENERAL, SUBJECT 71-00-00, Page 501.

(8) Service engine oil system and record oil level.

(9) Restart engine.(GENERAL, SUBJECT 71-00-00, Page 501) Inspect engine for evidence of fuel or oil leak.

(10) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(a) During acceleration, check that operation of anti-surge bleed valves is within limits of Figure 511, or applicable limits in airframe manufacturer's maintenance manual. If bleed valve operation is not within limits of Figure 511, refer to PAGEBLOCK 72-00-03/101.

(b) During acceleration, mark point on power lever pedestal where EPR is 0.03 EPR ratios above bleed closing point and preserve this mark for deceleration bleed control system check.

(c) Monitor engine vibration during acceleration to Normal Takeoff.

(d) Stabilize for three minutes at Normal Takeoff. Record a full set of the readings per Paragraph 6.G.(1) and make a mark to record the power lever position. Calculate 95 percent of Normal Takeoff N_2 and keep this result for the acceleration check.

(e) Check operation of fuel deicing system during this Normal Takeoff running. Open deicing air valve and observe change in fuel temperature using cockpit instrumentation. Fuel temperature must increase minimum of 104°F (58°C) in less than one minute after valve is opened. Do not adjust power lever for resultant loss of EPR. Do not allow fuel temperature to exceed 176°F (80°C). Close fuel deicing air valve.

(f) During Takeoff running, actuate engine anti-icing system. EPR should decrease by 0.08 - 0.11 ratio, when engine anti-icing air is turned on. Do not adjust power lever for resultant loss of EPR. Close engine anti-icing valves.

(11) Retard power lever to Descent/Ground Idle and deenergize idle select solenoid. Stabilize for seven minutes. Adjust idle speed to limits specified by airframe manufacturer.

(12) Operate the engine at Approach Idle for five minutes. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, calculate Normal Takeoff EPR and do the procedure again from Paragraph 6.G.(13).

(13) Advance power lever slowly (in 30 seconds minimum) to Normal Takeoff EPR determined in Paragraph 6.G.(10) and stabilize for no more and no less than 60 seconds.

(14) Retard the power lever to Approach Idle, and in not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the mark made on the quadrant in Paragraph 6.G.(10)(d), in not more than one second.

(15) Record with a stop watch the time from when the power lever starts to move to when the engine gets to the 95 percent N_2 limit as calculated in Paragraph 6.G.(10)(d).

(16) Go back to Approach Idle and do Paragraph 6.G.(12) thru Paragraph 6.G.(14) two times again.

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(17) Calculate the average of all three acceleration times and compare this average to the limit curve calculated by the airframe manufacturer for this procedure.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in this maintenance procedure (in which a stop watch is used) are to make sure that the acceleration time is accurately calculated, with the same result each time. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Takeoff N_2) as calculated from test cell procedures.

(18) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

(19) Retard power lever to EPR = 1.75. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(20) Retard power lever to EPR = 1.65. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(21) Advance power lever to EPR = 1.8. Stabilize for 30 seconds then snap power lever in one second or less to point on pedestal marked in Paragraph 6.G.(10)(b) just above bleed closing point. Deceleration bleed system is operating normally if bleed valve supply pressure (PS4) drops to near ambient pressure and then increases to normal PS4 pressure.

(22) Retard power lever to Idle. During deceleration, monitor engine vibration. Also check that anti-surge bleed valves open within limits of Figure 511.

(23) Conduct functional check of reverse thrust system per airframe manufacturer's maintenance manual instructions.

(24) Perform functional check of Reserve Takeoff Thrust system as specified by airframe manufacturer's instructions.

(25) Shut down engine and perform normal engine inspection procedures as specified by airframe manufacturer, including oil filter inspection. (GENERAL, SUBJECT 71-00-00, Page 501)

(26) Service engine oil tank as necessary. Record amount of oil added.

(27) Compute oil consumption for acceptance test. Oil consumption shall not exceed 0.1 gal/hr.

(28) Corrected N_1 vs EPR should be checked per Figure 514. This curve is designed to verify accuracy of the EPR system. During Takeoff and part power, record N_1 speed, EPR and T_{t2} at both part power and Takeoff after engine has stabilized. Check corrected N_1 according to Figure 514.

  (a) Engines which plot in band of Figure 514 are acceptable if all other operating limits are met.

(b) Engine plotting above band should be investigated for cause of high N_1. Troubleshooting must include leak check of P_{t7} indicating system. If no leaks are found, following items may also be investigated for cause of high N_1:

1) Inspect fan for FOD, blended blades.

2) Check N_1 indication system.

3) Waterwash engine per airframe manufacturer's instructions.

(c) If none of above items reduce high N_1 condition but all other operating limits are met, engine is acceptable. However, high N_1 condition may result in N_1 redline limiting situation on hot days.

(d) Engines which plot below band should be checked for N_1 indicating system problems and proper size exhaust nozzle. If N_1 indicating system is not cause of low N_1 speed, but all other engine operating limits are met, engine is acceptable.

(29) EGT shall be within recommended guidelines as specified in Figure 515. Available EGT margin at Normal Takeoff rating may be determined by calculating corrected EGT from data point observed EGT and TAMB as shown in notes on Figure 515 and computing difference relative to curve in Figure 515 at constant EPR.

(30) Oil pressure and oil temperature shall not exceed limits as specified in Table 503.

(31) Measure and record the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) and compare it to the limits in Figure 516.

FIGURE 72-00-00-990-874	NOTE
Sheet 3	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 4	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 5	A. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is in the range shown (between the Minimum limit and the lower limit), do the sub-idle leak check specified in the test.
	B. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is less than the lower limit, it will be necessary to remove the engine for disassembly and corrective action.

(a) If a JT8D-217C/219 engine (which is post-SB 6128 and pre-SB 6196) has a Pcp/Ps4 ratio less than the Minimum limit, do a sub-idle leak test as follows:

NOTE: The Minimum limit is in Figure 516, Sheet 5.

1) Attach containers to the No. 4 bearing scupper drain and the No. 5 bearing area (combution section) drain.

NOTE: For all engines a Pcp transducer (with an accuracy of ±0.1 psig) will be necessary to measure the low Pcp values at idle and lower accurately. You must not do an engine shutdown during the test procedure.

2) Do the usual acceptance test as specified in this section (but do not do an engine shutdown when the test is completed). Adjust the idle trim N2 to 46 percent (+0, -0.2 percent) and the maximum oil pressure to 50.0 psig (344.7 kPa) (-0, +0.5 psi (3.4 kPa)). Operate the engine at Idle for 20 minutes. Increase the Idle N2 to the Figure 534 limits, then do an engine shutdown.

a) Record the Pcp on all data points at idle or lower with the transducer specified above. If it is difficult to trim to low idle, or if the idle speed does not stay stable, tell Pratt & Whitney Engineering immediately.

3) After the test, look for streaks in the tailpipe and remove the drain bottles (record what is found in them). Attach new bottles, then (after an hour) remove these bottles and record what is in them.

4) Do a borescope inspection of the 1st stage turbine vane area (through the igniter plug ports) and look for wet surfaces or puddles of oil. Record the inspection results.

5) If no oil leaks are found, the engine is satisfactory. If oil leaks are found, remove the engine for disassembly to correct the leaks.

(32) Breather pressure shall not exceed limit given in Paragraph 2.L.(2).

(33) Vibration shall not exceed limits given in Table 508.

NOTE: If the engine vibration is above the limits, the operator can trim balance the engine on the aircraft to decrease vibration levels. However, trim balance only those engines on which the fan is replaced. See Paragraph 7..

Table 508 Acceptance Limits Vibration Amplitudes

Pickup Location	Single Amplitude	Double Amplitude
INLET SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
REAR SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
NOTE: The limits in this table are valid only when vibration pickups are mounted at locations specified and only when the low frequency filter (40 CPS) is selected in the vibration monitoring circuit.		

H. Test G - Breather Pressure Check (Figure 517 and Figure 518)

(1) Disconnect airframe breather duct from engine gearbox and leave gearbox port open.

(2) On engines with oil pressure transmitter vented to gearbox, disconnect airframe vent tube from gearbox LV3 fitting and remove fitting from gearbox port. On engines with oil pressure transmitter vented to ambient, remove fitting from gearbox LV3 port.

(3) Connect 0 - 10 PSIG (0.0 - 68.9 kPa) gage to LV3 port with the gage held above the LV3 port at all times (loops in the gage line can collect oil and cause false readings). Gage should be maximum-indication type with dial marker. Wire equipment securely to protect it from vibration. (Figure 517)

NOTE: If desired, PWA 33784 Cap may be used to obtain breather pressure measurement. Make sure the gage is held above the oil tank cap at all times to keep loops out of the gage line. See Figure 518. Breather pressure measured at this location will approximate breather pressure at gearbox LV3 port. If pressure reading obtained in the following procedure is close to or higher than limits given, procedure should be repeated with pressure gage connected to gearbox LV3 port.

WARNING: OBSERVE PROPER SAFETY PRECAUTIONS AROUND RUNNING ENGINE. WEAR EAR PROTECTORS AND STAY CLEAR OF ENGINE HAZARD AREAS. SEE "ENGINE GROUND SAFETY PRECAUTIONS" FOR ENGINE HAZARD DESCRIPTION.

(4) Start engine and operate at Idle for five minutes. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Slowly accelerate (60 seconds) to Normal Takeoff power (accelerate slowly to avoid possible overshoot on 0 - 10 psi (0.0 - 68.9 kPa) gage).

(6) After engine has stabilized at Normal Takeoff (two minutes minimum), retard engine power to Idle and record breather pressure.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

(7) Compare recorded breather pressure with maximum limit given in Paragraph 2.L.(2).

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

CAUTION: DO NOT RETURN ENGINE TO SERVICE IF IT HAS HIGH BREATHER PRESSURE. HIGH BREATHER PRESSURE IS AN INDICATION THAT HIGH TEMPERATURE, HIGH PRESSURE AIR MAY BE LEAKING INTO A BEARING COMPARTMENT, CREATING A POTENTIALLY DANGEROUS SITUATION.

(9) If observed breather pressure is not within limits, investigate and correct as necessary. Remove engine for inspection if necessary.

NOTE: If pressure reading from oil tank mounted gage fitting is close to limits, repeat engine test with gage mounted at gearbox. See Note after Paragraph 6.H.(3).

(10) Remove test equipment and reinstall engine fittings.

I. Test H - Acceleration Check

(1) Make sure the engine test area is clean.

(2) Start the engine (use the approved aircraft maintenance procedures).

(3) Set the flight deck switches in the correct positions to make sure that there is no engine air bleed or power extraction.

NOTE: Make sure that test instruments are kept sufficiently cool during the test procedure.

(4) Operate the engine at Idle until indications are stable and the oil temperature is at 100°F (38°C) minimum.

(5) Set the Approach Idle switch to On. Engine N_2 must increase to Approach Idle level.

(6) Operate the engine at Approach Idle for five minutes, until the N_2 is stable.

(7) Calculate the Normal Takeoff EPR limit from barometric pressure and temperature (refer to the airframe manufacturer's data).

(8) Advance the power lever slowly (in 30 seconds minimum) to the Normal Takeoff EPR limit calculated in Paragraph 6.I.(7). Keep the engine at this power level for no more and no less than 60 seconds.

(9) With the engine at Normal Takeoff EPR, make a mark to record the power lever position. Record EPR, N_1, EGT, and N_2. Calculate and record 95 percent of N_2 (as seen on the flight deck instrument).

(10) Retard the power lever to Approach Idle. In not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the Normal Takeoff mark made on the quadrant in Paragraph 6.I.(9) in not more than one second. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, then do the procedure again from Paragraph 6.I.(7).

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(11) Record with a stop watch the time from when the power lever started to move to when the engine gets to the 95 percent N_2 limit calculated in Paragraph 6.I.(9).

(12) Go back to Approach Idle and do Paragraph 6.I.(6) thru Paragraph 6.I.(11) two times again.

(13) After three accelerations are completed, retard the power lever to Idle and do the approved airframe powerplant shutdown procedure.

(14) Calculate the average of all three acceleration times. Compare this average to the limit curve given by the airframe manufacturer.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in the maintenance procedure in this manual (in which a stop watch is used and an average is calculated) are to keep variations to a minimum in this less accurate procedure. This average time value will give results that are as much the same each time as the more accurate test cell procedure. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Normal Takeoff N_2) as calculated from test cell procedures.

(15) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

J. Test I - Vibration Check

(1) Install vibration pickups at locations indicated in Figure 512. Connect pickups to vibration monitoring instrumentation, including low frequency filter (40 CPS).

(2) Inspect and clean test area.

(3) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(4) Operate engine at Idle until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(5) Make a slow (two to three minute) acceleration from Idle to Normal Takeoff EPR as specified by airframe manufacturer for ambient conditions. Monitor inlet and rear case vibration during acceleration. Record peak observed inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

(6) Stabilize 30 seconds at Normal Takeoff EPR.

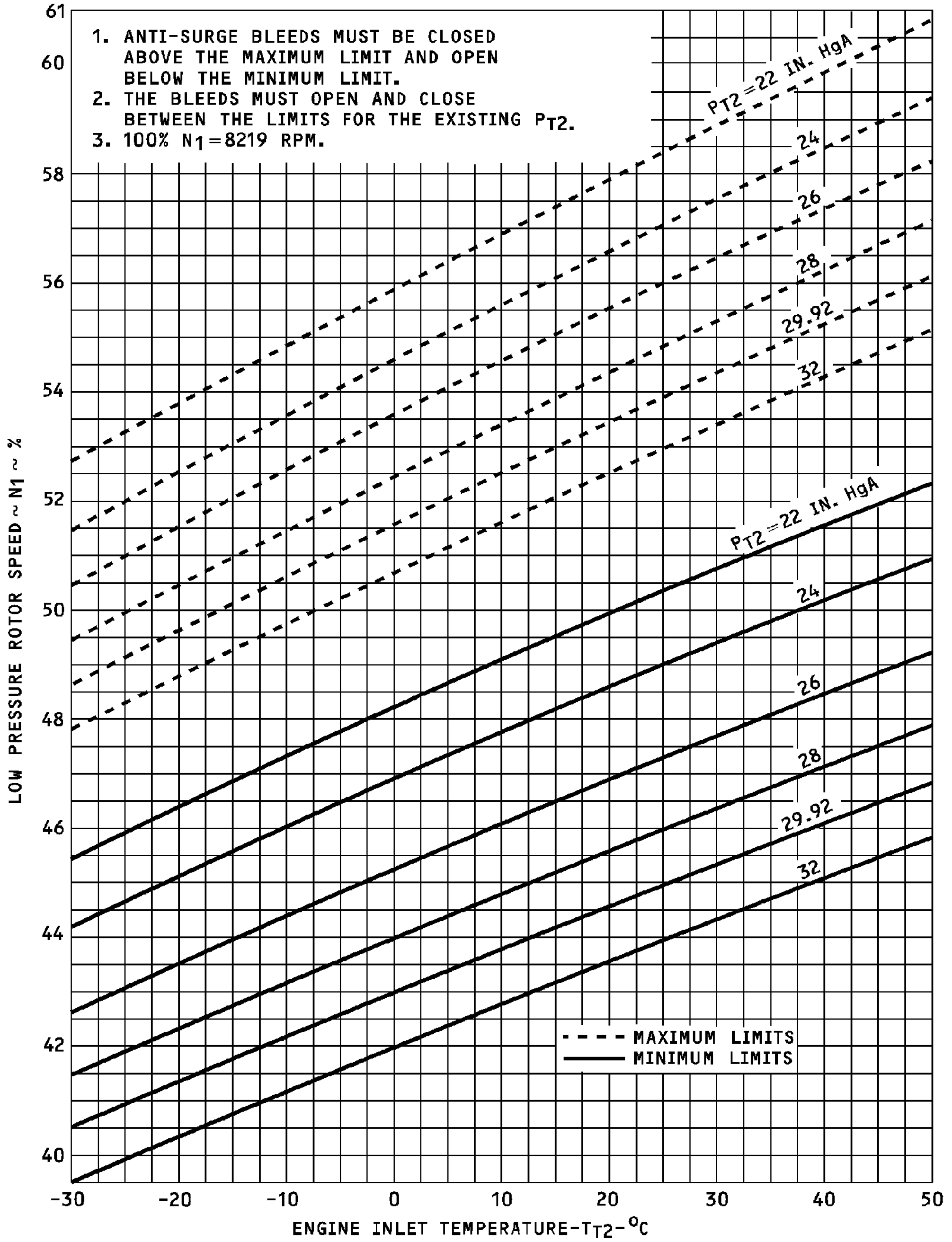
(7) Retard power lever slowly (two to three minutes) to Idle. Monitor inlet and rear case vibration during deceleration. Record Peak inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(9) Peak vibration shall not exceed limits in Table 508.

NOTE: The operator can trim balance repaired engines on the aircraft to decreased vibration levels. See Paragraph 9..

JT8D-209,-217,-217A,-217C,-219 TURBOFAN ENGINE
ANTI-SURGE BLEED CHECK CURVE (INCORPORATING PN 783955 PRBC)



1. ANTI-SURGE BLEEDS MUST BE CLOSED ABOVE THE MAXIMUM LIMIT AND OPEN BELOW THE MINIMUM LIMIT.
2. THE BLEEDS MUST OPEN AND CLOSE BETWEEN THE LIMITS FOR THE EXISTING P_{T2}.
3. 100% N_1 = 8219 RPM.

13 AUG 80

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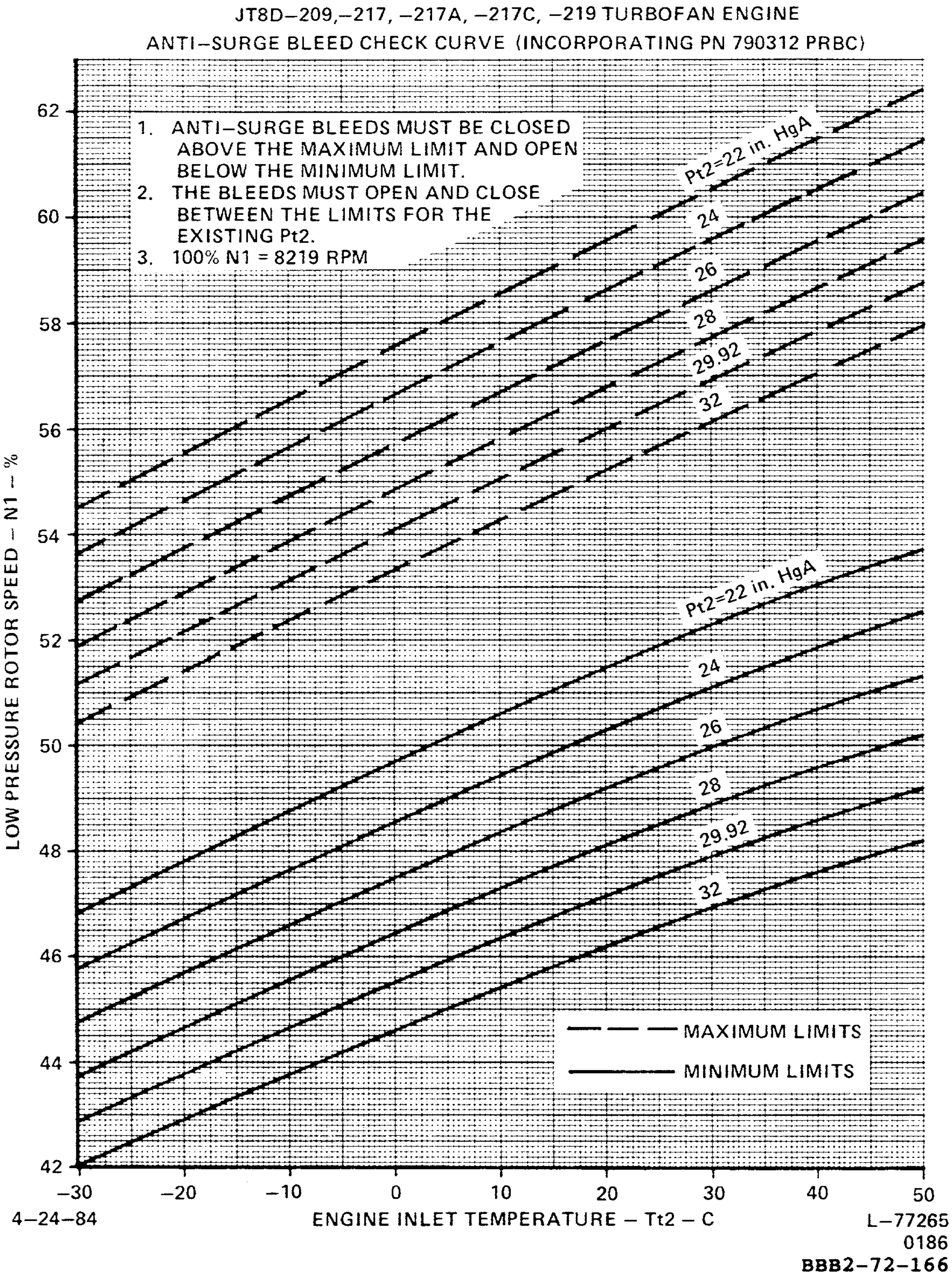
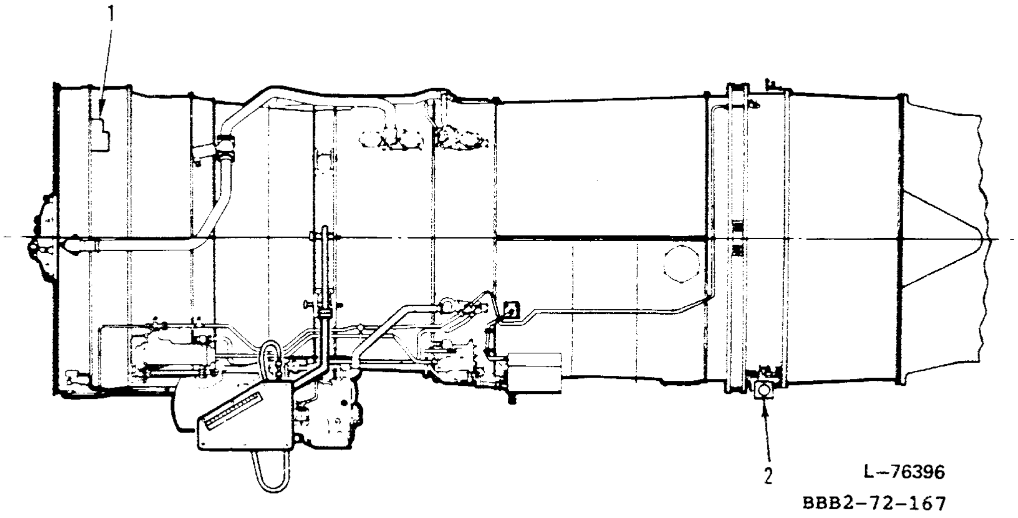
Anti-Surge Bleed Chart
Figure 511/72-00-00-990-869 (Sheet 1 of 2)



JT8D–209,–217, –217A, –217C, –219 TURBOFAN ENGINE
ANTI–SURGE BLEED CHECK CURVE (INCORPORATING PN 790312 PRBC)

1. ANTI–SURGE BLEEDS MUST BE CLOSED ABOVE THE MAXIMUM LIMIT AND OPEN BELOW THE MINIMUM LIMIT.
2. THE BLEEDS MUST OPEN AND CLOSE BETWEEN THE LIMITS FOR THE EXISTING Pt2.
3. 100% N1 = 8219 RPM

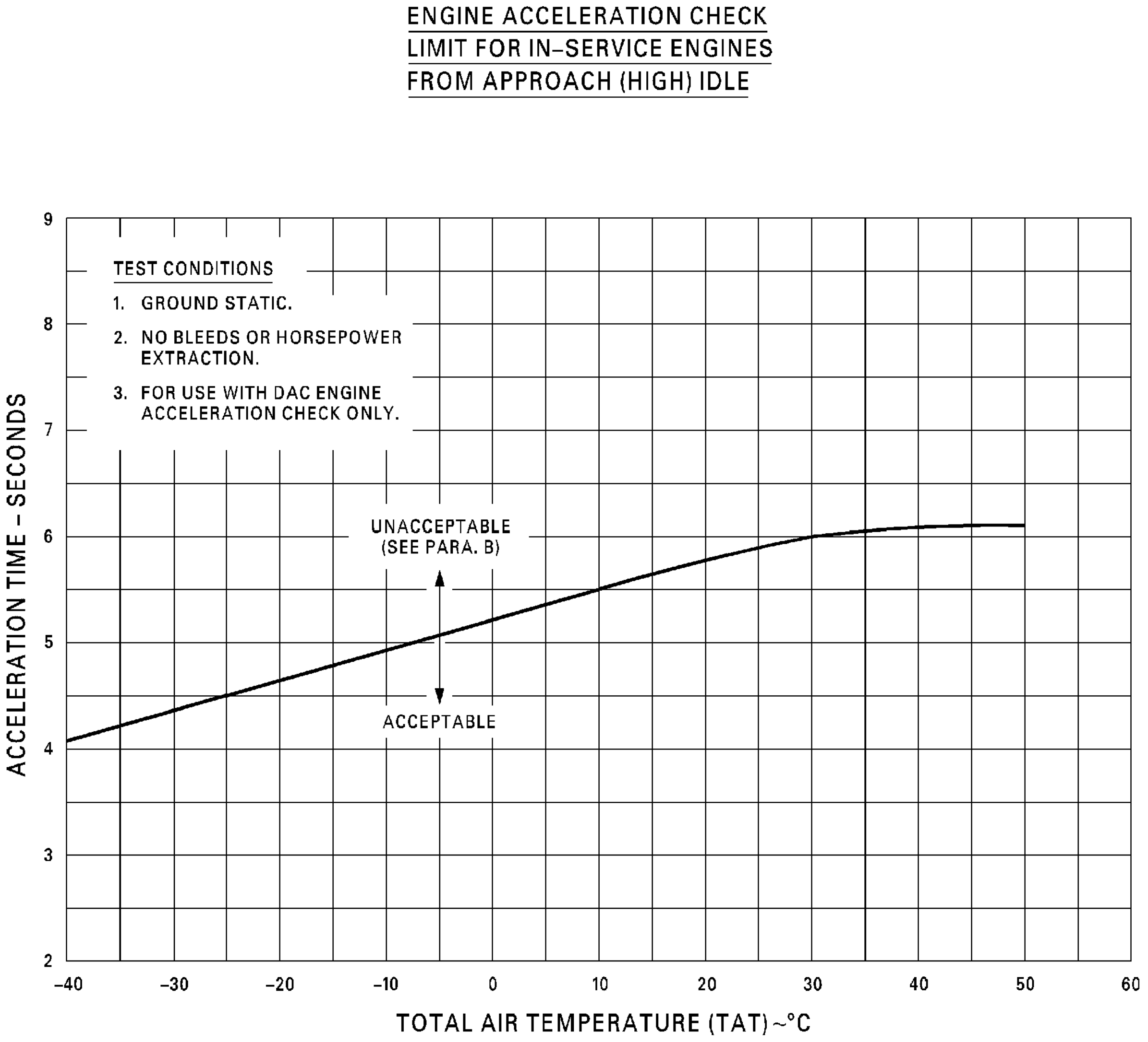
Anti-Surge Bleed Chart
Figure 511/72-00-00-990-869 (Sheet 2 of 2)



LEFT SIDE VIEW

1. Front Vibration Pickup
2. Rear Vibration Pickup

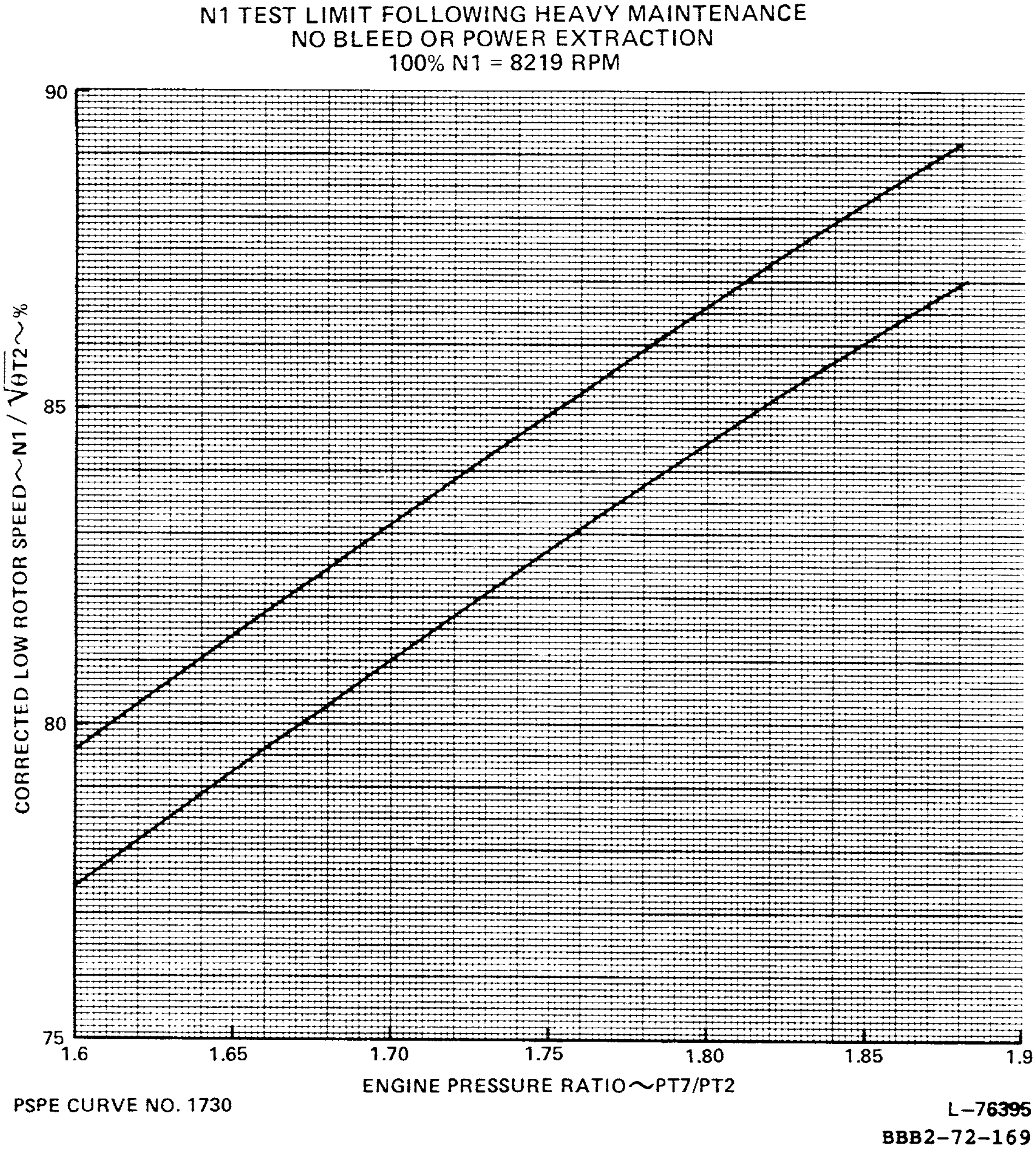
Location Of Vibration Pickups
Figure 512/72-00-00-990-870



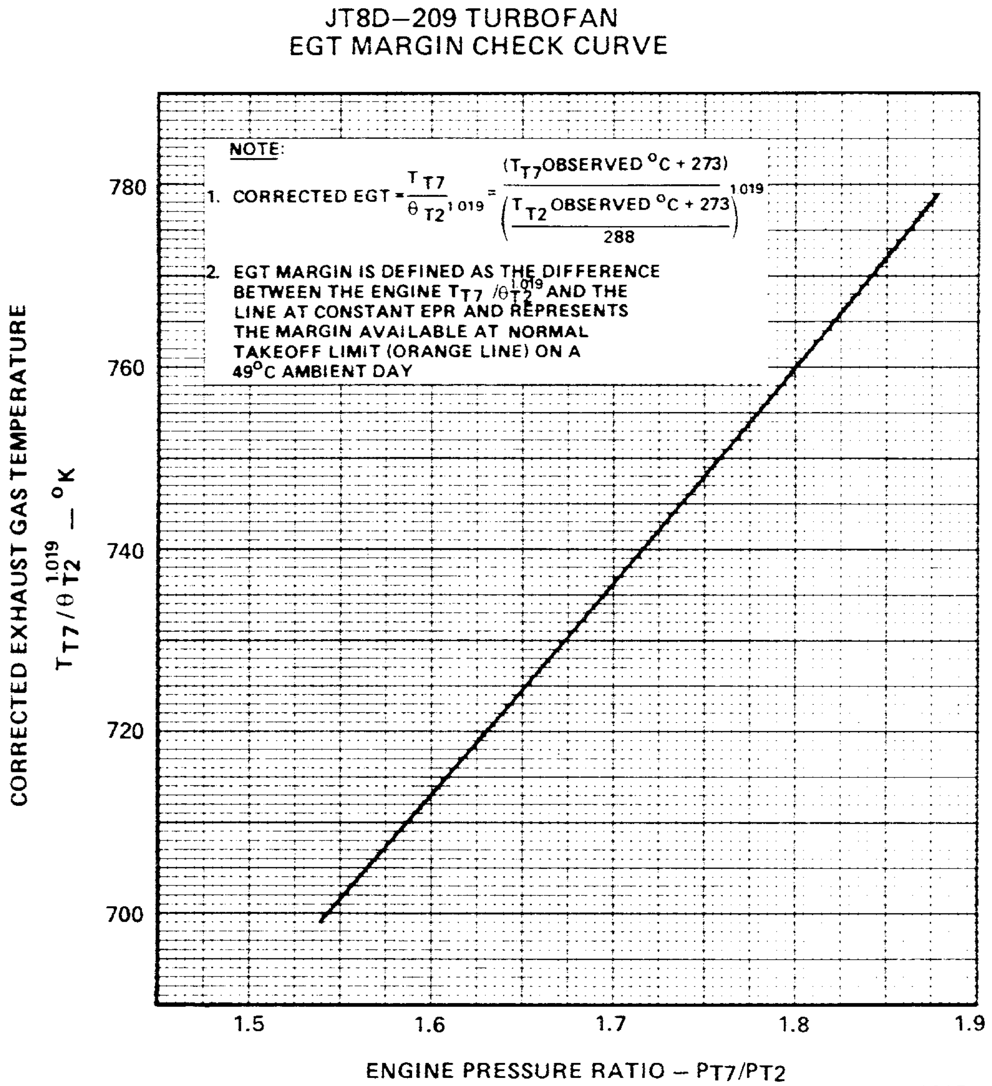
CAG(IGDS)

BBB2–72–468

Acceleration Time Limit From Approach Idle
Figure 513/72-00-00-990-872



Low Rotor Speed Limit Curve
Figure 514/72-00-00-990-871



JT8D–209 TURBOFAN
EGT MARGIN CHECK CURVE

NOTE:

1. CORRECTED EGT $= \dfrac{T_{T7}}{\theta_{T2}^{1.019}} = \dfrac{(T_{T7}\text{OBSERVED }^{\circ}C + 273)}{\left(\dfrac{T_{T2}\text{ OBSERVED }^{\circ}C + 273}{288}\right)^{1.019}}$

2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7}/\theta_{T2}^{1.019}$ AND THE LINE AT CONSTANT EPR AND REPRESENTS THE MARGIN AVAILABLE AT NORMAL TAKEOFF LIMIT (ORANGE LINE) ON A 49°C AMBIENT DAY

L–61627
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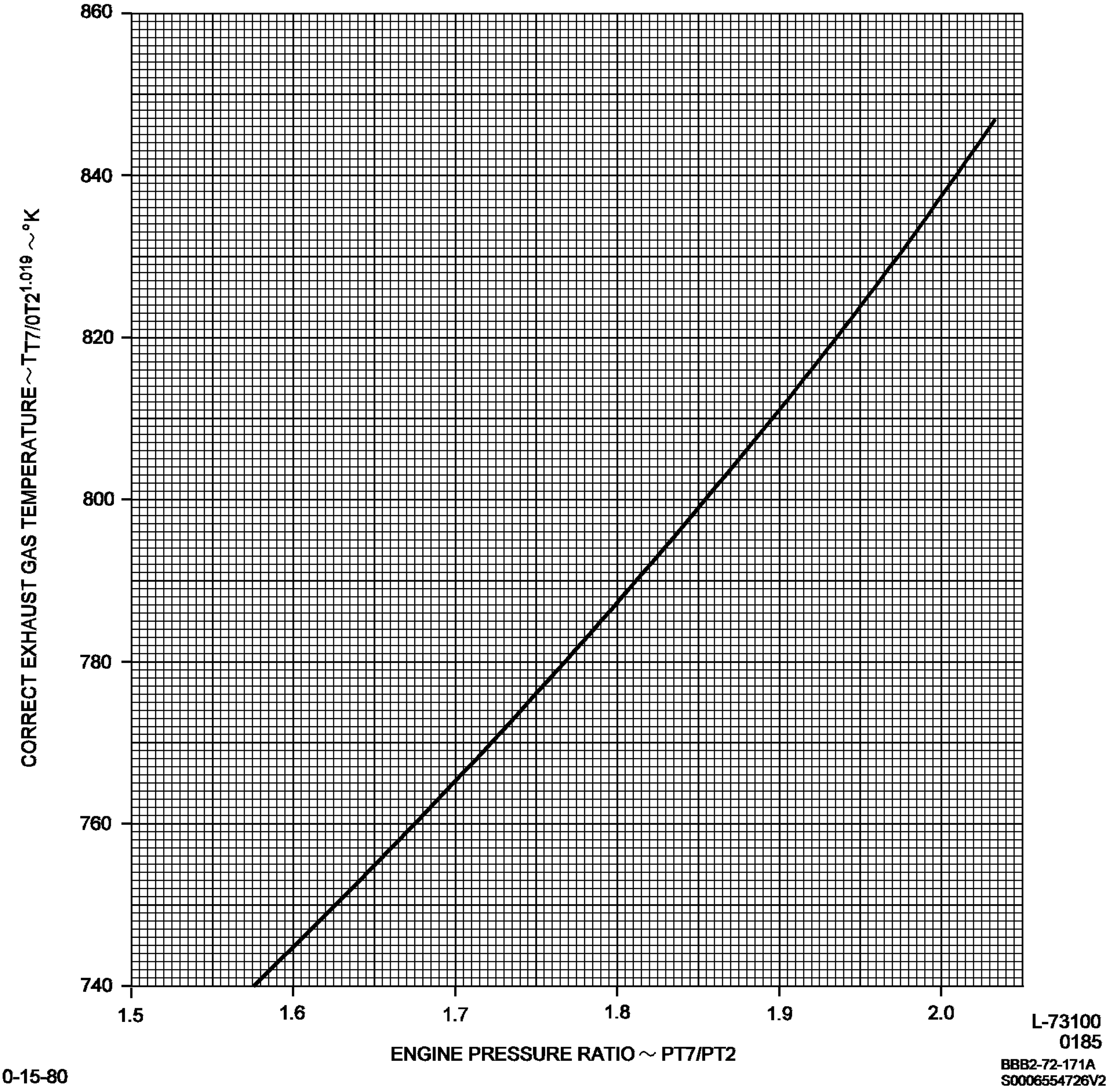
EGT Margin Check Curve
Figure 515/72-00-00-990-873 (Sheet 1 of 3)

JT8D-217, -217A TURBOFAN
EGT MARGIN CHECK

NOTE:

1. CORRECTED EGT= $\dfrac{(T_{T7}\ \text{OBSERVED}\ ^{\circ}C + 273)}{\left(\dfrac{T_{T2}\,^{\circ}C + 273}{288}\right)^{1.019}}$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7/0T2}{}^{1.019}$ AND THE LINE AT CONSTANT EPR.
3. A COMPLETE HIGH QUALITY REFURBISHMENT OF BOTH HOT AND COLD SECTION MODULES SHOULD RESULT IN EGT MARGIN OF 15 - 20 °C.



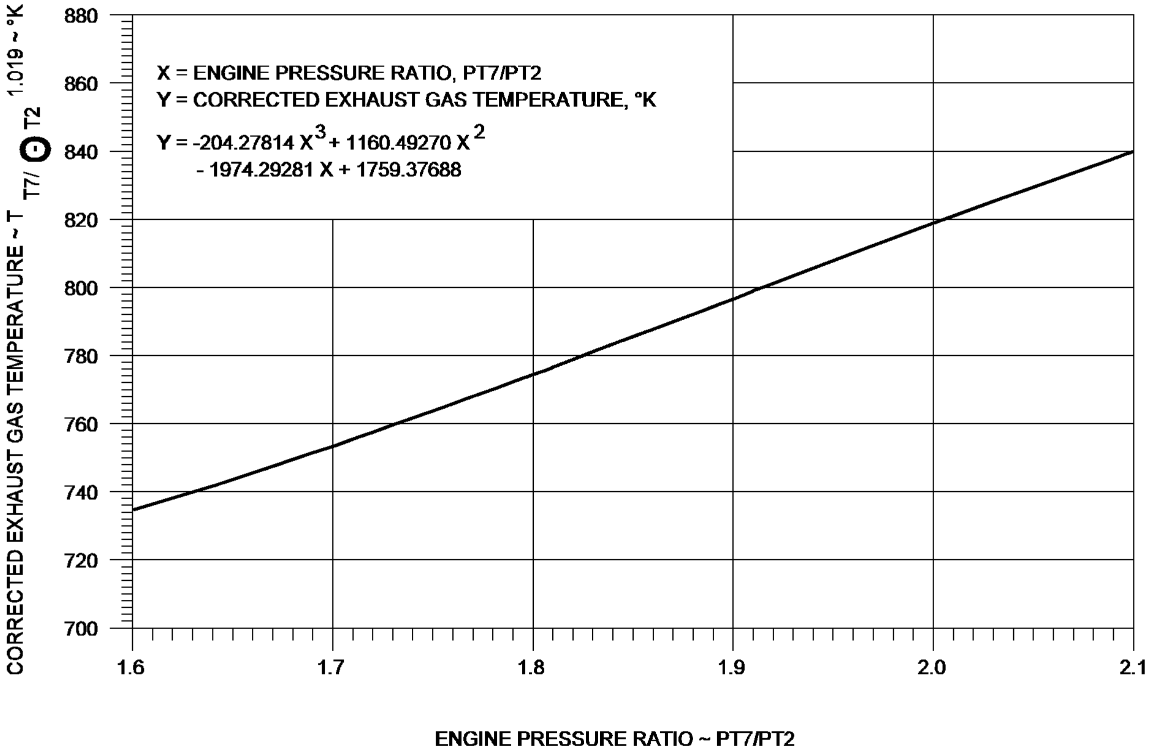
DJ 10-15-80

EGT Margin Check Curve
Figure 515/72-00-00-990-873 (Sheet 2 of 3)

JT8D-217C-219 TURBOFAN
EGT MARGIN CHECK

NOTES:

1. $$\text{CORRECTED EGT} = \frac{(T_{T7}\ \text{OBSERVED °C}+273)}{\left(\frac{T_{T2}\ \text{°C}+273}{288}\right)^{1.019}}$$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7}/\Theta_{T2}^{\;1.019}$ AND THE LINE AT CONSTANT EPR
3. THE EGT LIMIT REPRESENTS AN ENGINE WITH ZERO MARGIN TO THE NORMAL TAKE-OFF LIMIT (ORANGE LINE) ON A 29 °C AMBIENT DAY.



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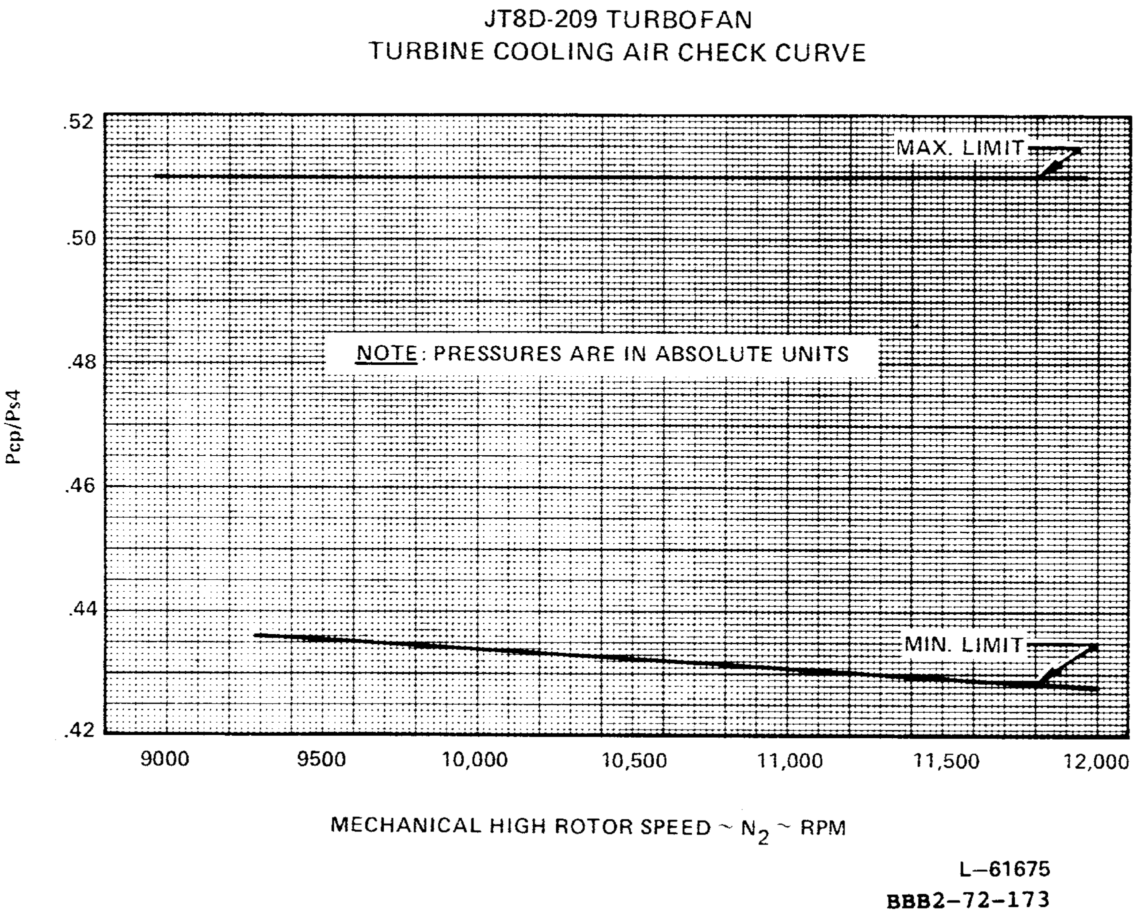
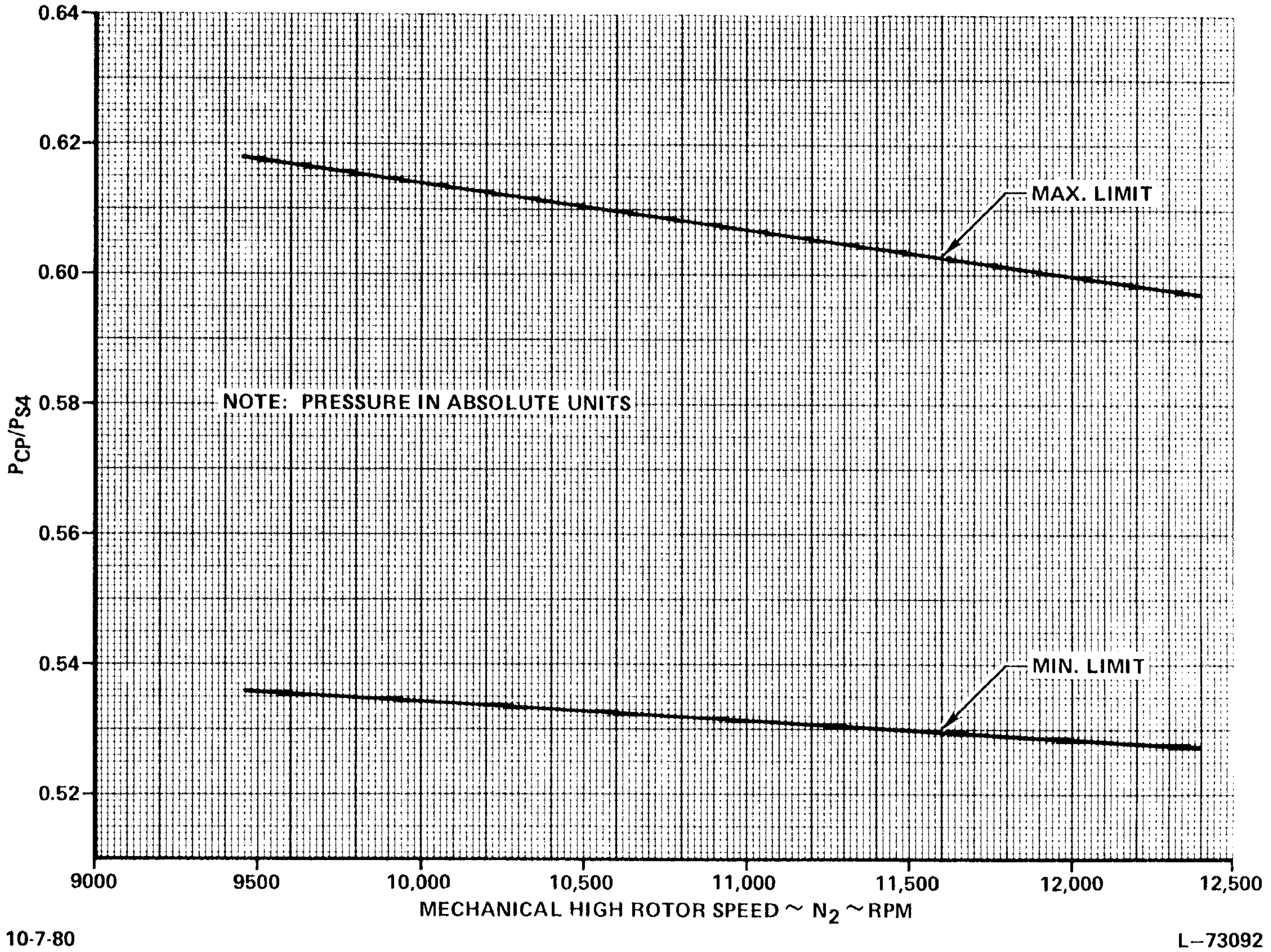
EGT Margin Check Curve
Figure 515/72-00-00-990-873 (Sheet 3 of 3)



Turbine Cooling Air Check Curve
Figure 516/72-00-00-990-874 (Sheet 1 of 5)

JT8D-217, -217A TURBOFAN ENGINE TURBINE COOLING AIR CHECK CURVE



10-7-80

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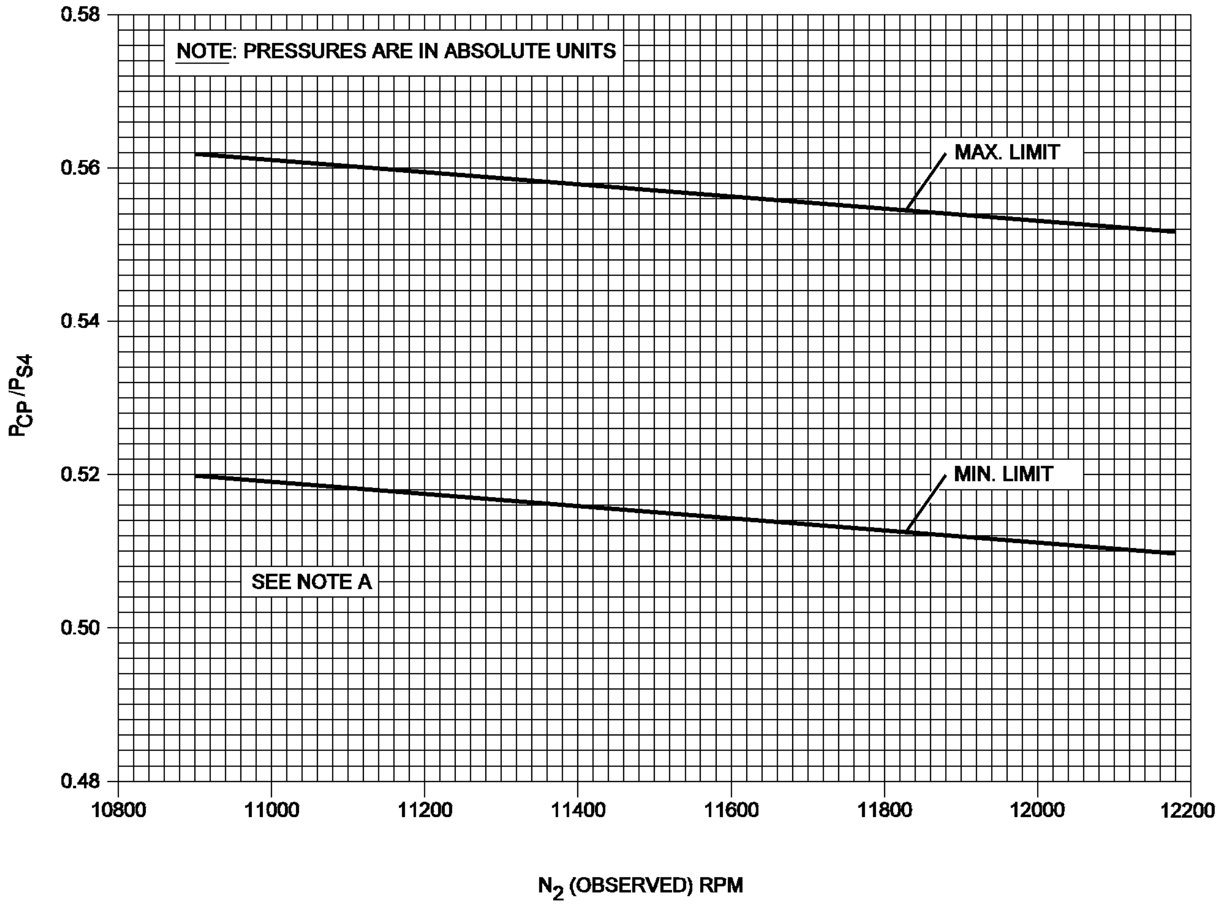
BBB2–72–174

Turbine Cooling Air Check Curve
Figure 516/72-00-00-990-874 (Sheet 2 of 5)

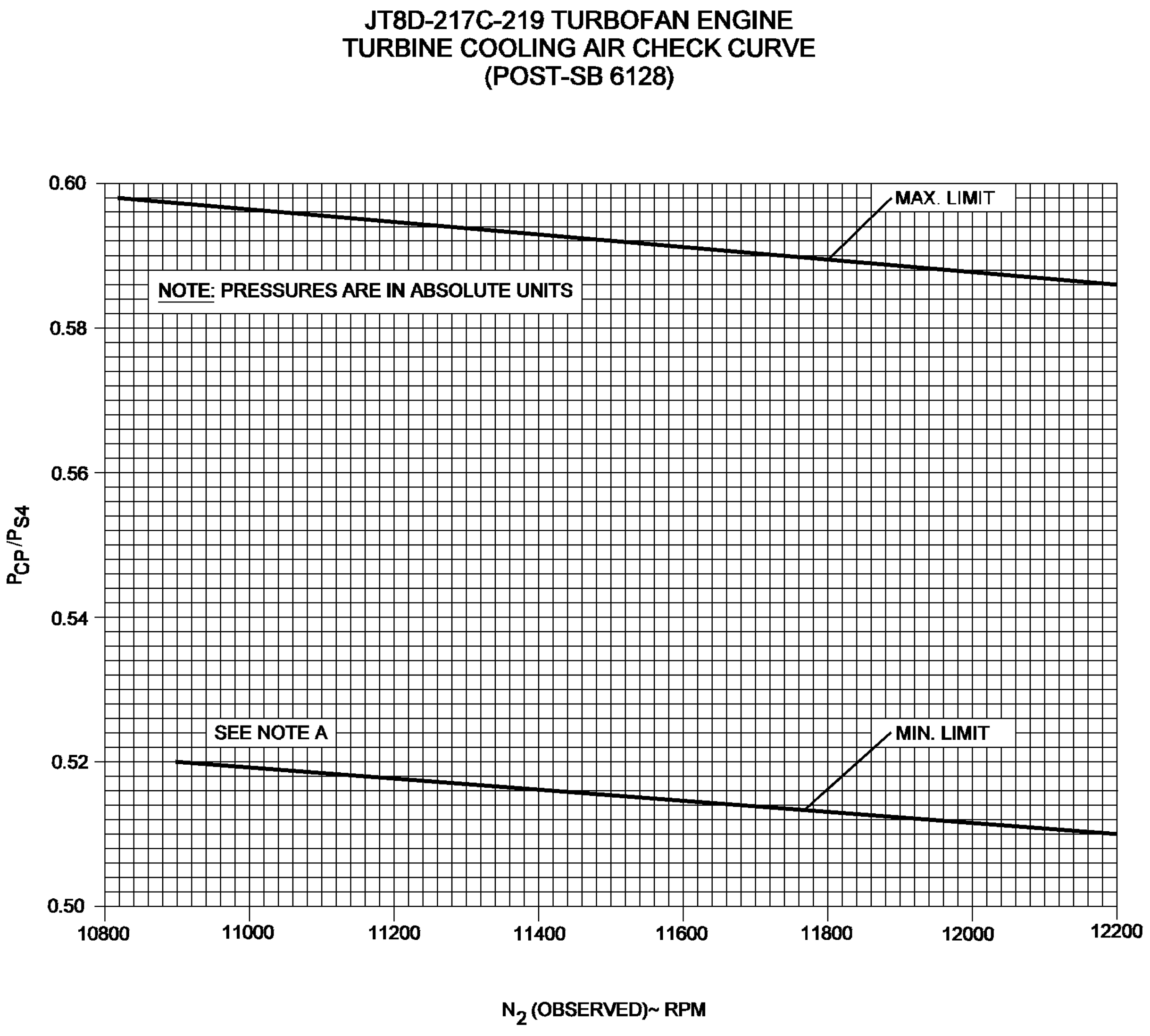
JT8D-217C-219 TURBOFAN ENGINE
TURBINE COOLING AIR CHECK CURVE
(PRE-SB 6128)



L-89276 (0506)

BBB2-72-175B
S0006554730V2

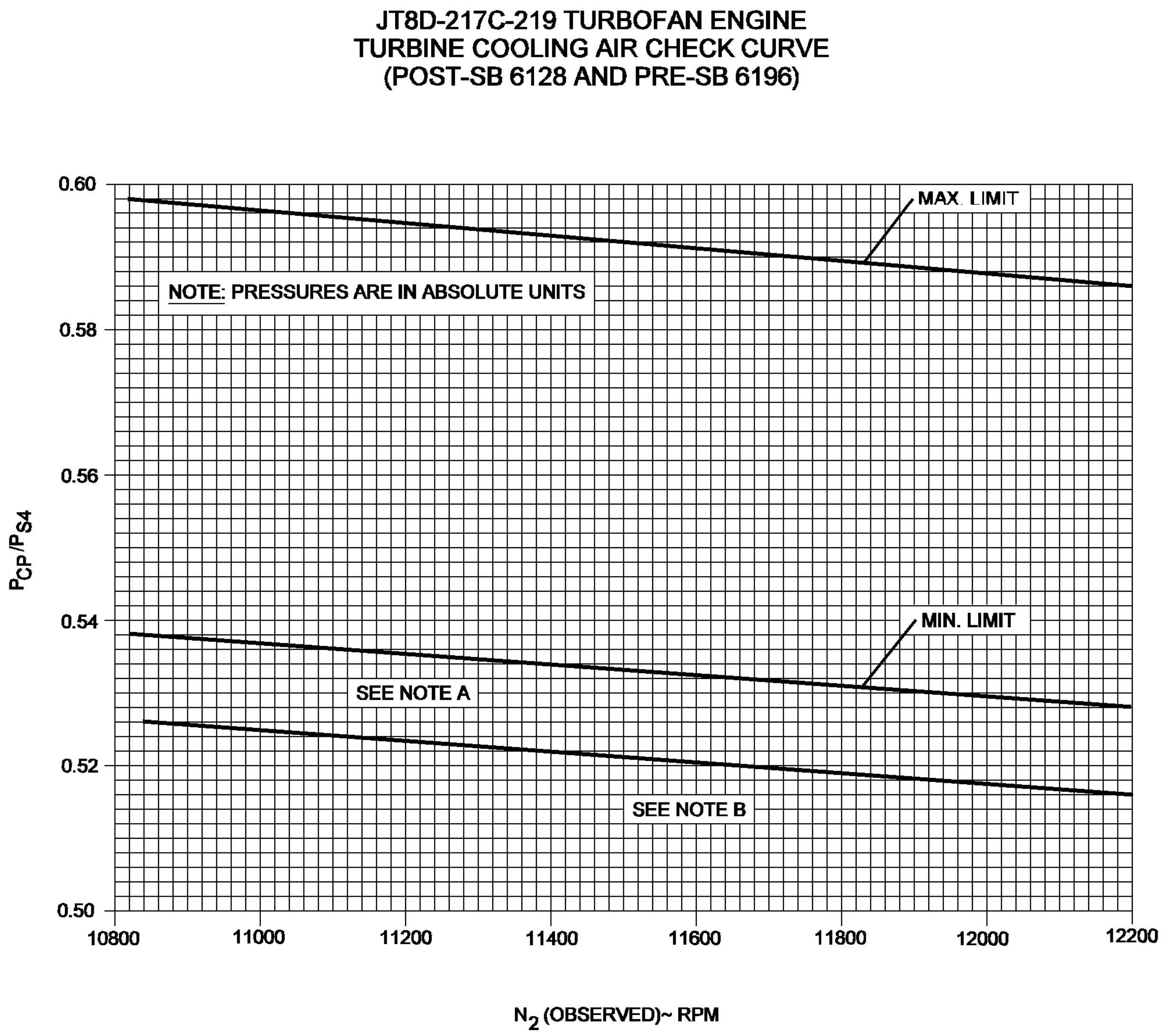
Turbine Cooling Air Check Curve
Figure 516/72-00-00-990-874 (Sheet 3 of 5)



L-H2329 (0506)

BBB2-72-453C
S0006554731V2

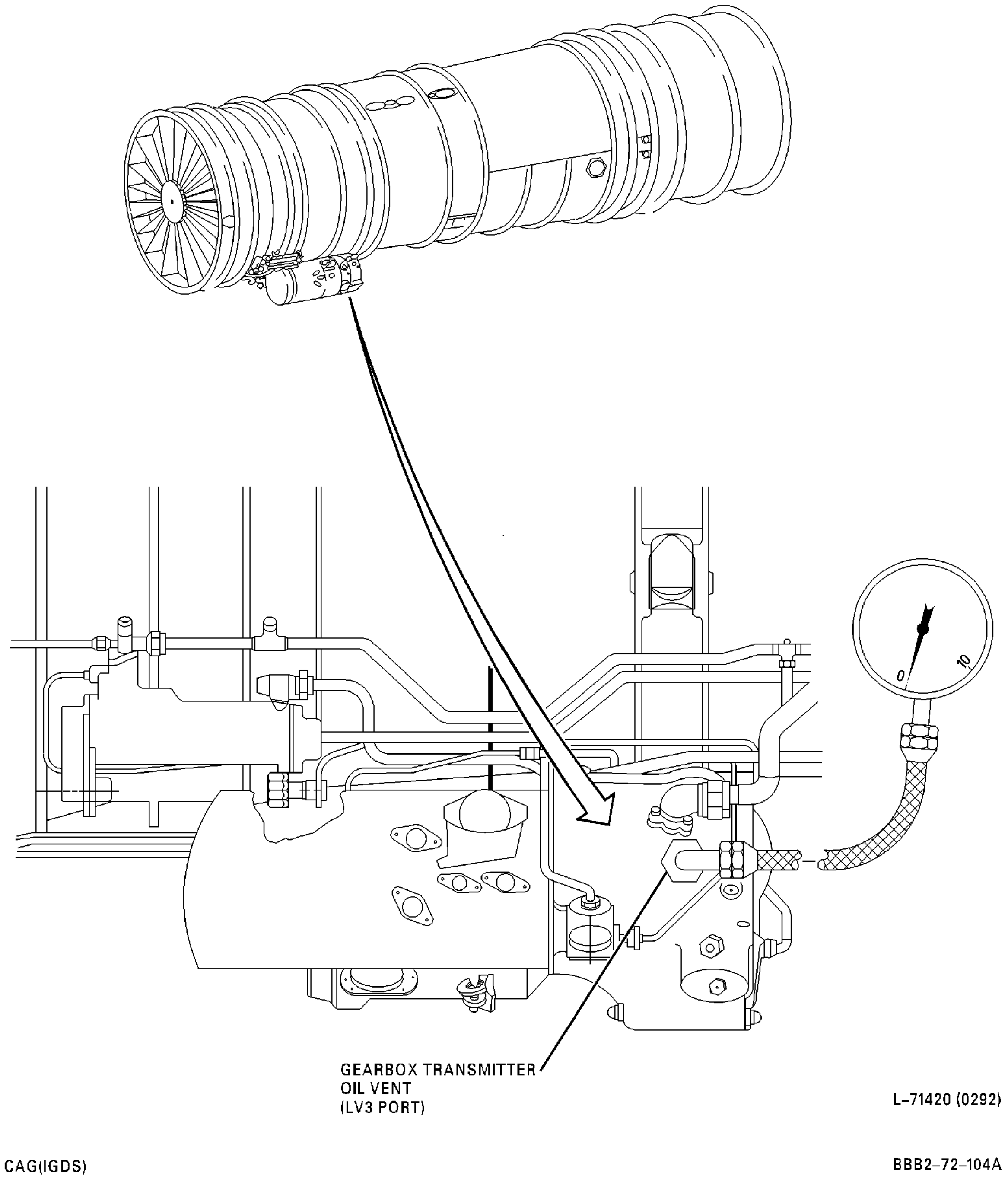
Turbine Cooling Air Check Curve
Figure 516/72-00-00-990-874 (Sheet 4 of 5)



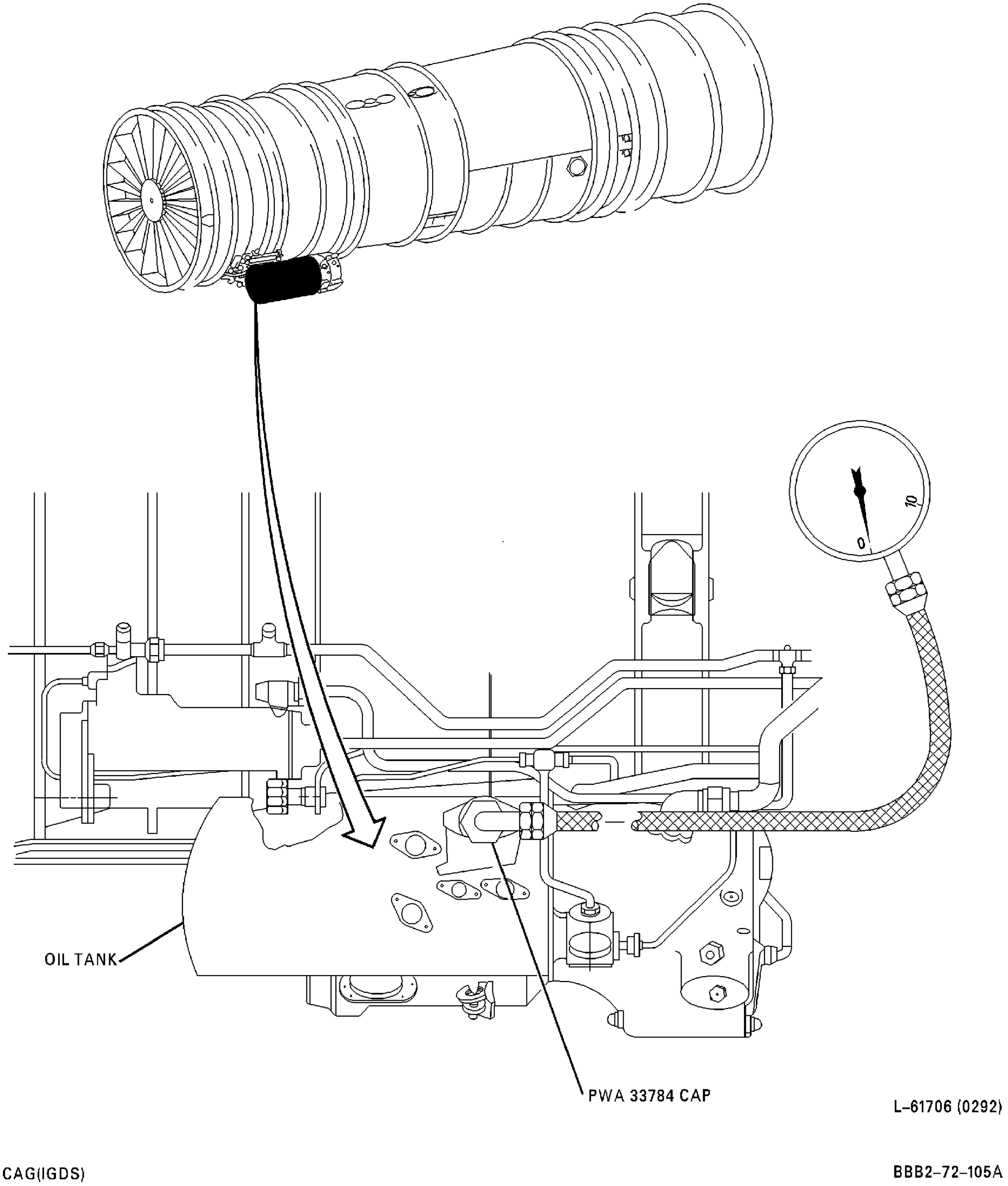
L-H7917 (0506)

BBB2-72-628
S0000306838V1

Turbine Cooling Air Check Curve
Figure 516/72-00-00-990-874 (Sheet 5 of 5)



Gearbox Housing Breather Pressure Instrumentation
Figure 517/72-00-00-990-875



Oil Tank Breather Pressure Instrumentation
Figure 518/72-00-00-990-876

7. Engine Deterioration Ground Check (For Installations Not Equipped With In-Flight Monitoring)

(Figure 519)

A. Procedure

(1) Prior to each removal for hot section inspection perform following ground check to detect engine deterioration.

(2) The following instrumentation is necessary for ground check:

(a) Absolute pressure gage to indicate 13th stage air pressure (Ps4). Special fitting is provided on right-hand side of engine at upper end of bleed valve actuation pressure supply line near high pressure (diffuser) service bleed point. Calibrated accuracy of gage should be ± 0.5 psi (25.4 mm Hg) absolute in range between 150 and 175 psi (7757 - 9050 mm HG) absolute. Maximum instrument requirement is 250 psi (12929 mm Hg) absolute.

NOTE: This measurement will indicate PS4 only when operating above bleed valve actuation point dictated by pressure ratio bleed control.

(b) Laboratory quality mercury thermometer to indicate ambient temperature.

(c) Local facilities (such as airport control tower) for indicating barometric pressure.

(d) Absolute pressure gage to indicate P_{t7}. Calibrated accuracy of gage should be ± 0.2 psi (10.3 mm Hg) absolute in range between 0 and 50 psi (2586 mm Hg) absolute.

(e) Instrumentation to check P_{t7} and EGT and provide comparison with cockpit instrumentation of EPR (P_{t7}/P_{t2}) and EGT. If cockpit EGT instrumentation and accurate null-balance test instrumentation cannot be read simultaneously, EGT may be measured at stabilized condition with test instrument and then with cockpit instrument circuit under same stabilized conditions. Respective readings should then be compared. As alternate method, cockpit instrument system may be calibrated with standard test equipment designed for this purpose.

(3) Use following test procedure:

(a) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(b) With all nonessential aircraft airbleed and electrical systems shut off, set engine power to EPR (P_{t7}/P_{t2}) of 1.65.

(c) Warm up engine for five minutes and reset power to EPR of 1.65 as required.

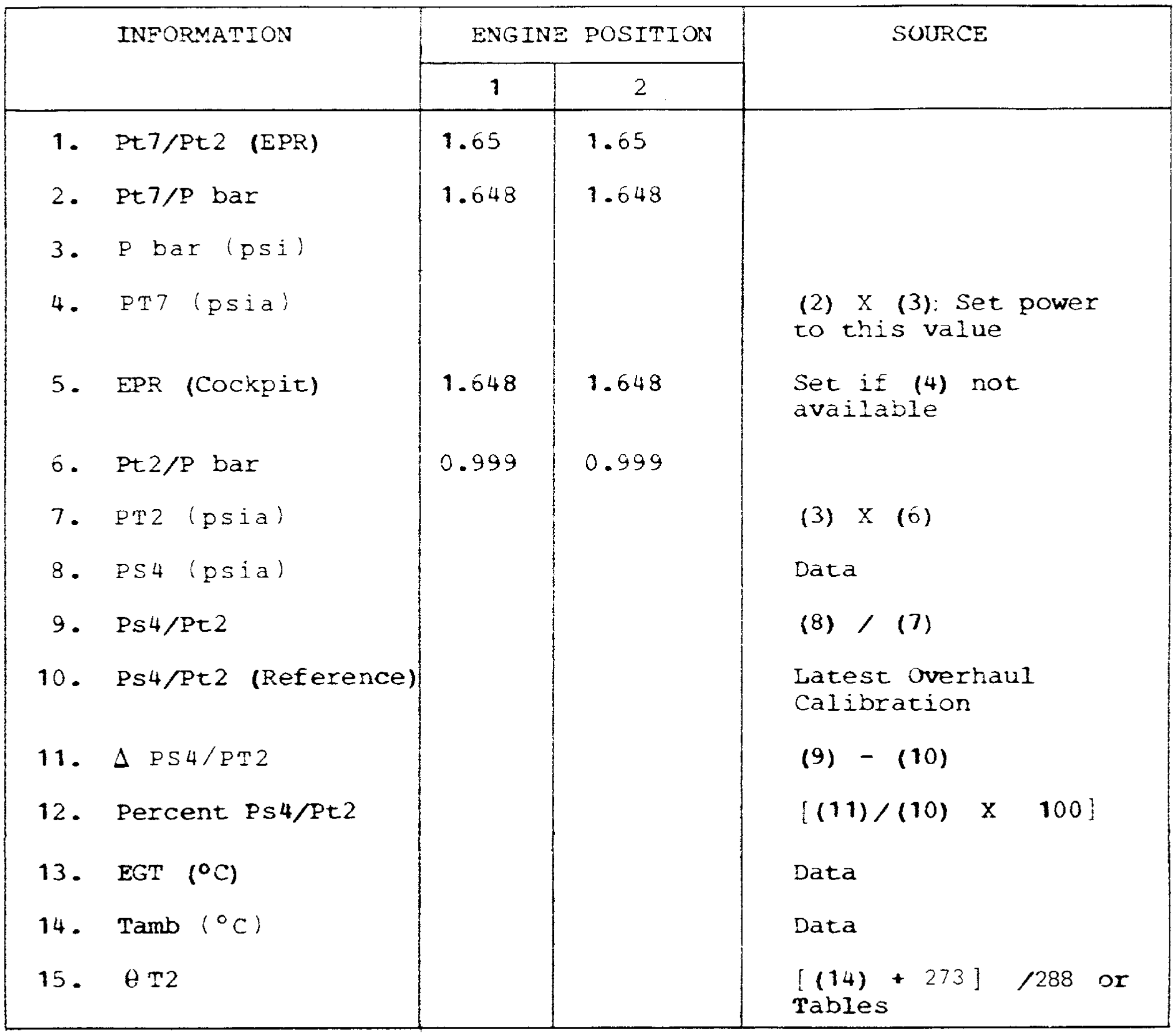
(d) Read and record following:

1) P_{t7}
2) EPR (aircraft instrument)
3) Ps4
4) EGT (accurate null-balance instrument)
5) EGT (aircraft instrument)
6) Percent N_1 (aircraft instrument)
7) Percent N_2 (aircraft instrument)
8) Ambient temperature
9) Barometric pressure
10) Fuel Flow

(e) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(f) Use Figure 519, Figure 520 and Figure 521 to process data. Repair consisting of, replacement of 1st stage turbine vanes, combustion chambers, transition ducts, turbine outer air seals, fuel nozzles, etc. may be necessary if test reveals any of following:

1) Reduction of 3.5 percent Ps4/P_{t2} relative to new engine acceptance test, last complete overhaul, or last repair in which 1st stage turbine vane area was rebuilt within engine manual limits.
2) Corrected maximum T_{t7} more than shown in Figure 515.
3) Minus 100 RPM (minus 0.82 percent tachometer) N_2 theta T2 relative to data plate N_2 RPM.



INFORMATION	ENGINE POSITION		SOURCE
	1	2	
1. Pt7/Pt2 (EPR)	1.65	1.65	
2. Pt7/P bar	1.648	1.648	
3. P bar (psi)			
4. PT7 (psia)			(2) X (3): Set power to this value
5. EPR (Cockpit)	1.648	1.648	Set if (4) not available
6. Pt2/P bar	0.999	0.999	
7. PT2 (psia)			(3) X (6)
8. PS4 (psia)			Data
9. Ps4/Pt2			(8) / (7)
10. Ps4/Pt2 (Reference)			Latest Overhaul Calibration
11. Δ PS4/PT2			(9) - (10)
12. Percent Ps4/Pt2			[(11)/(10) X 100]
13. EGT (°C)			Data
14. Tamb (°C)			Data
15. θ T2			[(14) + 273] /288 or Tables

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 519/72-00-00-990-877 (Sheet 1 of 2)

INFORMATION	ENGINE POSITION		SOURCE
	1	2	
15A. $\theta\ T2^{1.019}$			(15) to exponent 1.019 or Figure 505
16. $\sqrt{\theta\ T2}$			$\sqrt{(15)}$ or Fugure 505
17. EGT (°K)			(13) + 273
18. EGT/ $\theta\ T2^{1.019}$ (°K)			(17)/(15A)
19. EGT/ $\theta\ T2^{1.019}$ (°C)			(18) – 273
20. % N2 (Tach.)			Data
21. % N2/ $\sqrt{\theta\ T2}$			(20)/(16)
22. D.P. N2 %			Data Plate
23. % N2/ $\sqrt{\theta\ T2}$ – D.P. N2			(21) – (22)
24. % N1 (Tach.)			Data
25. % N1/ $\sqrt{\theta\ T2}$			(24)/(26)
26. Ref. N1	80.5	80.5	*or latest overhaul calibration
27. % N1/ $\sqrt{\theta\ T2}$ – Ref. N1			(25) – (26)
28. δ T2			(7)/14.70 or Figure 516
29. Fuel Flow Wf pph			Data
29A. Kc			Figure 517
30. Wf/Kc X δ T2			(29)/[Kc X (28)]
31. Ref. Wf	6980	6980	*or latest overhaul calibration
32. Δ Wf/Kc δ T2			(30) – (31)
33. % Wf/Kc δ T2			(32)/(31) X 100

*Reference Values given are from O.I. 309 and are good for all new engines. Overhauled engines should use last calibration.

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CAG(IDGS)

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 519/72-00-00-990-877 (Sheet 2 of 2)

8. Oil Pressure Adjustment

(Figure 522)

NOTE: At ground/descent Idle, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages and does not require adjustment.

A. Engine Preparation

(1) Ensure that engine has been properly serviced and is ready for operation.

(2) Install 0 - 50 PSIG (0.0 - 344.7 kPa) direct reading gage to LP2 tap on main oil pressure manifold and vent to LV3 tap on main accessory gearbox housing.

(3) Start engine and run at IDLE for two to five minutes, to stabilize power level and allow oil temperature to reach 100°F (38°C) minimum.

B. Pressure Relief Valve Adjustment

CAUTION: WHEN REMOVING OUTER PLUG, DO NOT ALLOW INNER PLUG OR VALVE HOUSING TO TURN. LOSS OF OIL AND LOSS OF VALVE SECURITY CAN RESULT FROM LOOSENING OF THESE PARTS.

(1) Hold pressure relief valve inner plug hex firmly with wrench and remove outer plug.

NOTE: Cut lockwire from outer plug only; lockwire from inner plug to valve housing and from valve housing to gearbox should be left intact.

(2) Hold adjusting screw stationary with screwdriver and loosen locknut. If desired, fabricate valve adjusting tool from 7/16 inch deep socket with angled handle welded to side to allow screwdriver to pass through center. Such a tool will allow turning locknut while holding adjusting screw stationary.

(3) Using screwdriver, adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa) with engine at IDLE. Clockwise rotation will increase pressure; counterclockwise rotation will decrease pressure.

NOTE: One full turn of adjusting screw will change pressure approximately two psi (13.8 kPa).

Key To Figure 522	
1.	Pressure Relief Valve
2.	Locknut
3.	Adjusting Screw
4.	Outer Plug
5.	Packing
6.	Inner Plug
7.	Check This Screw Height After Adjustment (See Text).

CAUTION: AFTER OIL PRESSURE ADJUSTMENT IS COMPLETED, CHECK INDEX 7 DIMENSION IN FIGURE. MEASURED VALUE OF 0.280 INCH (7.112 MM) OR LESS IF NOT CONSIDERED NORMAL AND MAY INDICATE REQUIREMENT FOR OIL SYSTEM TROUBLESHOOTING.

(4) Hold adjusting screw steady and torque locknut. See tool description in Paragraph 8.B.(2).

(5) Install outer plug, with new packing, and torque to 150 - 160 in-lb. (16.948 - 18.078 N·m). Lockwire outer plug to inner plug.

RELATIVE PRESSURE

$\text{DELTA } (\delta) = \frac{P}{PO} = \frac{P}{29.92}$ INCHES HGA = PSIA (2.036)

P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ
40.0	1.337						
39.9	1.334	32.9	1.100	25.9	0.8656	18.9	0.6317
39.8	1.330	32.8	1.096	25.8	0.8623	18.8	0.6283
39.7	1.327	32.7	1.093	25.7	0.8586	18.7	0.6250
39.6	1.324	32.6	1.090	25.6	0.8556	18.6	0.6216
39.5	1.320	32.5	1.086	25.5	0.8523	18.5	0.6183
39.4	1.317	32.4	1.083	25.4	0.8489	18.4	0.6150
39.3	1.313	32.3	1.080	25.3	0.8456	18.3	0.6116
39.2	1.310	32.2	1.076	25.2	0.8422	18.2	0.6083
39.1	1.307	32.1	1.073	25.1	0.8389	18.1	0.6050
39.0	1.303	32.0	1.070	25.0	0.8356	18.0	0.6016
38.9	1.300	31.9	1.066	24.9	0.8322	17.9	0.5983
38.8	1.297	31.8	1.063	24.8	0.8289	17.8	0.5949
38.7	1.293	31.7	1.059	24.7	0.8255	17.7	0.5916
38.6	1.290	31.6	1.056	24.6	0.8222	17.6	0.5882
38.5	1.287	31.5	1.053	24.5	0.8188	17.5	0.5849
38.4	1.283	31.4	1.049	24.4	0.8155	17.4	0.5815
38.3	1.280	31.3	1.046	24.3	0.8122	17.3	0.5782
38.2	1.277	31.2	1.043	24.2	0.8088	17.2	0.5749
38.1	1.273	31.1	1.039	24.1	0.8055	17.1	0.5715
38.0	1.270	31.0	1.036	24.0	0.8021	17.0	0.5682
37.9	1.267	30.9	1.033	23.9	0.7988	16.9	0.5648
37.8	1.263	30.8	1.029	23.8	0.7954	16.8	0.5615
37.7	1.260	30.7	1.026	23.7	0.7921	16.7	0.5581
37.6	1.257	30.6	1.023	23.6	0.7888	16.6	0.5548
37.5	1.253	30.5	1.019	23.5	0.7854	16.5	0.5515
37.4	1.250	30.4	1.016	23.4	0.7821	16.4	0.5481
37.3	1.247	30.3	1.013	23.3	0.7787	16.3	0.5448
37.2	1.243	30.2	1.009	23.2	0.7754	16.2	0.5414
37.1	1.240	30.1	1.006	23.1	0.7720	16.1	0.5381
37.0	1.237	30.0	1.003	23.0	0.7687	16.0	0.5348
36.9	1.233	29.9	0.9993	22.9	0.7654	15.9	0.5314
36.8	1.230	29.8	0.9960	22.8	0.7620	15.8	0.5281
36.7	1.227	29.7	0.9926	22.7	0.7587	15.7	0.5247
36.6	1.223	29.6	0.9893	22.6	0.7553	15.6	0.5214
36.5	1.220	29.5	0.9859	22.5	0.7520	15.5	0.5180
36.4	1.217	29.4	0.9826	22.4	0.7487	15.4	0.5147
36.3	1.213	29.3	0.9793	22.3	0.7453	15.3	0.5224
36.2	1.210	29.2	0.9759	22.2	0.7420	15.2	0.5080
36.1	1.207	29.1	0.9726	22.1	0.7386	15.1	0.5047
36.0	1.203	29.0	0.9692	22.0	0.7353	15.0	0.5013
35.9	1.200	28.9	0.9659	21.9	0.7319	14.9	0.4980
35.8	1.196	28.8	0.9626	21.8	0.7286	14.8	0.4946
35.7	1.193	28.7	0.9592	21.7	0.7253	14.7	0.4913
35.6	1.190	28.6	0.9559	21.6	0.7219	14.6	0.4880
35.5	1.186	28.5	0.9525	21.5	0.7186	14.5	0.4846
35.4	1.183	28.4	0.9492	21.4	0.7152	14.4	0.4813
35.3	1.180	28.3	0.9458	21.3	0.7119	14.3	0.4779
35.2	1.176	28.2	0.9425	21.2	0.7085	14.2	0.4746
35.1	1.173	28.1	0.9392	21.1	0.7052	14.1	0.4713
35.0	1.170	28.0	0.9358	21.0	0.7019	14.0	0.4679
34.9	1.166	27.9	0.9325	20.9	0.6985	13.9	0.4646
34.8	1.163	27.8	0.9291	20.8	0.6952	13.8	0.4612
34.7	1.160	27.7	0.9258	20.7	0.6918	13.7	0.4579
34.6	1.156	27.6	0.9224	20.6	0.6885	13.6	0.4545
34.5	1.153	27.5	0.9191	20.5	0.6852	13.5	0.4512
34.4	1.150	27.4	0.9158	20.4	0.6818	13.4	0.4479
34.3	1.146	27.3	0.9124	20.3	0.6785	13.3	0.4445
34.2	1.143	27.2	0.9091	20.2	0.6751	13.2	0.4412
34.1	1.140	27.1	0.9057	20.1	0.6718	13.1	0.4378
34.0	1.136	27.0	0.9024	20.0	0.6684	13.0	0.4345
33.9	1.133	26.9	0.8990	19.9	0.6651	12.9	0.4311
33.8	1.130	26.8	0.8957	19.8	0.6618	12.8	0.4278
33.7	1.126	26.7	0.8924	19.7	0.6584	12.7	0.4245
33.6	1.123	26.6	0.8890	19.6	0.6551	12.6	0.4211
33.5	1.120	26.5	0.8857	19.5	0.6517	12.5	0.4178
33.4	1.116	26.4	0.8823	19.4	0.6484	12.4	0.4144
33.3	1.113	26.3	0.8790	19.3	0.6450	12.3	0.4111
33.2	1.110	26.2	0.8757	19.2	0.6417	12.2	0.4077
33.1	1.106	26.1	0.8723	19.1	0.6384	12.1	0.4044
33.0	1.103	26.0	0.8690	19.0	0.6350	12.0	0.4011

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Relative Pressure
Figure 520/72-00-00-990-878

TEMPERATURE CORRECTION FOR FUEL FLOW

Tt2			Tt2			Tt2		
°C	°F	Kc	°C	°F	Kc	°C	°F	Kc
-40	-40.0	0.8798	-6	21.2	0.9542	28	82.4	1.0286
-39	-38.2	0.8820	-5	23.0	0.9564	29	84.2	1.0308
-38	-36.4	0.8842	-4	24.8	0.9585	30	86.0	1.0329
-37	-34.6	0.8863	-3	26.6	0.9607	31	87.8	1.0351
-36	-32.8	0.8885	-2	28.4	0.9629	32	89.6	1.0373
-35	-31.0	0.8907	-1	30.2	0.9651	33	91.4	1.0395
-34	-29.2	0.8929	0	32.0	0.9673	34	93.2	1.0417
-33	-27.4	0.8951	1	33.8	0.9695	35	95.0	1.0439
-32	-25.6	0.8973	2	35.6	0.9717	36	96.8	1.0461
-31	-23.8	0.8995	3	37.4	0.9739	37	98.6	1.0483
-30	-22.0	0.9017	4	39.2	0.9761	38	100.4	1.0504
-29	-20.2	0.9038	5	41.0	0.9782	39	102.2	1.0526
-28	-18.4	0.9060	6	42.8	0.9804	40	104.0	1.0548
-27	-16.6	0.9082	7	44.6	0.9826	41	105.8	1.0570
-26	-14.8	0.9104	8	46.4	0.9848	42	107.6	1.0592
-25	-13.0	0.9126	9	48.2	0.9870	43	109.4	1.0614
-24	-11.2	0.9148	10	50.0	0.9892	44	111.2	1.0636
-23	- 9.4	0.9170	11	51.8	0.9914	45	113.0	1.0658
-22	- 7.6	0.9192	12	53.6	0.9936	46	114.8	1.0679
-21	- 5.8	0.9214	13	55.4	0.9957	47	116.6	1.0701
-20	- 4.0	0.9235	14	57.2	0.9979	48	118.4	1.0723
-19	- 2.2	0.9257	15	59.0	1.0001	49	120.2	1.0745
-18	- 0.4	0.9279	16	60.8	1.0023	50	122.0	1.0767
-17	1.4	0.9301	17	62.6	1.0045	51	123.8	1.0789
-16	3.2	0.9323	18	64.4	1.0067	52	125.6	1.0811
-15	5.0	0.9345	19	66.2	1.0089	53	127.4	1.0833
-14	6.8	0.9367	20	68.0	1.0111	54	129.2	1.0855
-13	8.6	0.9389	21	69.8	1.0132	55	131.0	1.0876
-12	10.4	0.9410	22	71.6	1.0154	56	132.8	1.0898
-11	12.2	0.9432	23	73.4	1.0176	57	134.6	1.0920
-10	14.0	0.9454	24	75.2	1.0198	58	136.4	1.0942
-9	15.8	0.9476	25	77.0	1.0220	59	138.2	1.0964
-8	17.6	0.9498	26	78.8	1.0242	60	140.0	1.0986
-7	19.4	0.9520	27	80.6	1.0264			

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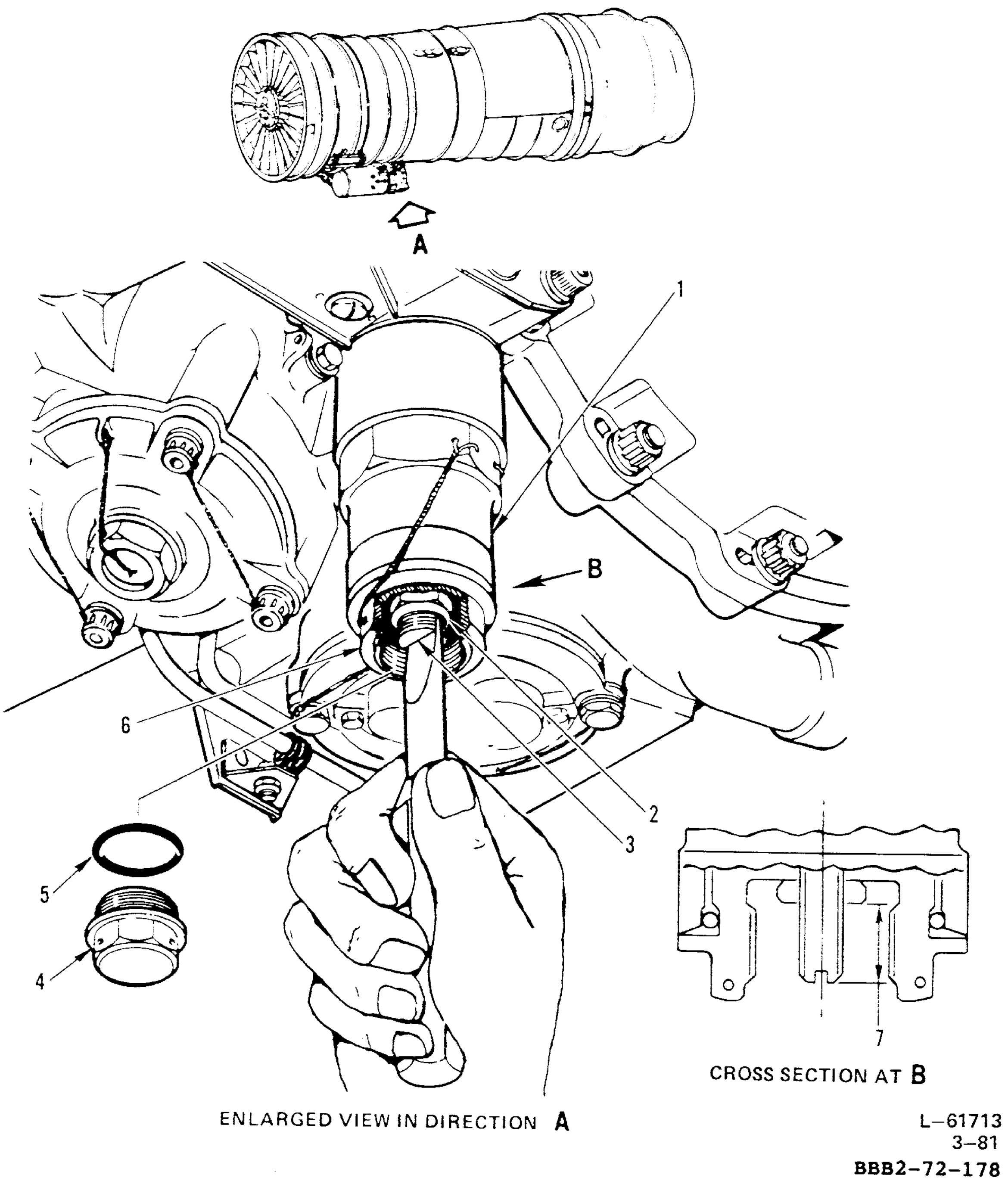
Temperature Correction For Fuel Flow
Figure 521/72-00-00-990-879



Oil Pressure Adjustment
Figure 522/72-00-00-990-880

9. Trim Balance Of Engine Installed In Aircraft

A. On-Wing Trim Balancing - General

CAUTION: APPLICATION OF TRIM BALANCING MUST MEET FOLLOWING PREREQUISITES: TRIM BALANCE IS TO BE USED ONLY ON NEW AND OVERHAULED ENGINES AND ON THOSE REPAIR ENGINES (HEAVY MAINTENANCE) WHICH HAVE HAD LOW COMPRESSOR AND LOW TURBINE ROTORS DISASSEMBLED, INSPECTED, AND REASSEMBLED ACROSS BALANCE MACHINE, EXCEPT AS NOTED BELOW. THOSE ENGINES WITH EXCESSIVE HIGH ROTOR VIBRATION OR LOW ROTOR VIBRATION WHICH EXCEED LIMITS AS SPECIFIED IN PROCEDURE MAY NOT BE TRIM BALANCED.

(1) Engine whose rotating parts are balanced will normally have some residual unbalance which will result in detectable vibration at engine operating condition. This vibration may be minimized by trim balancing, which entails addition of weight positioned to offset residual unbalance in compressor front balance plane and turbine rear balance plane.

NOTE: (Heavy Maintenance) repair engines which do not exceed normal acceptable vibration limits may be trim balanced to lower amplitude, if desired.

B. Equipment For Trim Balance

(1) Vibration Pickups: Phased velocity type, CEC 4-123A or equivalent.

(2) Speed Signal: An exact one-pulse-per revolution is required as the reference signal. Special tachometer and adapter with ratio of 24 to 47 must be mounted in place of any other tachometer or adapter on N_1 tachometer pad. Index rotor by aligning single tooth of tachometer with tip of impulse pickup. Small hole in fact of tachometer is provided for this purpose. In order to reindex rotor after running without having to make above observation, make mark with layout dye on blade and engine case.

Tach. Adapter: Model B1692-2, Ratio 24/47 (Exact)

Vendor: The Electric Tachometer Corporation 68th & Upland Streets Philadelphia, PA 19142, U.S.A.

Pulse Generator: Model HB 163212, one triangular tooth, 0.062 inch (1.588 mm) flat

Vendor: H And B Tool And Engineering Co., 481 Sullivan Ave., South Windsor, CT 06074, U.S.A.

(3) Trim Balance Analyzer: Spectral Dynamics Model SD-119-B, or equivalent.

(a) With vibration data signal (from a velocity, acceleration or non-contacting displacement pickup) and one-pulse-per-revolution reference signal, analyzer provides the following information needed for balancing an engine:

1) Amplitude of vibration

2) Phase angle between reference point and point of maximum unbalance, i.e., location of unbalance.

3) Speed in RPM of engine (N_1).

(b) To provide these operating parameters, balance analyzer accepts signal from vibration pickup and passes it through integrator for conversion to displacement signal. For signal from a displacement pickup or accelerometer, integrator is bypassed.

(c) Displacement signal is then passed through dynamic tracking filter, which is tuned by one-per-revolution signal from tachometer mounted on engine. Pulse-to-sinewave converter uses tachometer signal to provide necessary sinewave for track filter. Converter is phase-locked to tachometer signal for absolute tuning of tracking filter and absolute phase (i.e., balance location) reference. Because it is frequency tuned by speed signal, tracking filter eliminates all frequency signals other than rotor fundamental. Output of tracking filter is displayed as displacement.

(d) Difference in angular degrees between vibration signal (at one-per-revolution tuning frequency) and one-per-revolution reference frequency derived from tachometer through converter is measured by phase meter. Output of phase meter is displayed as phase. Output of pulse-to-sinewave converter is multiplied by 60 factor and displayed as speed in RPM.

C. Setup Of Equipment

(Figure 523)

(1) Install vibration pickups. (Figure 512)

(2) Check vibration pickups to ensure that they are in phase (positive outward displacement gives positive voltage output).

(3) Install special tachometer adapter and reference signal generator in place of engine adapter (if any) and N_1 tachometer.

(4) With generator in "firing position", reference front compressor (low) rotor to engine case using layout dye.

NOTE: Turn rotor in direction of engine rotation to take up backlash of tachometer drive, that is, clockwise (counterclockwise facing engine fan inlet case).

(5) Set up and operate balance analyzer per manufacturer's instructions.

D. Trim Balance Procedures

(Figure 524), (Figure 525), (Figure 526), (Figure 527)

(1) The following procedure establishes a uniform method of approaching trim balance. Phase angle lag and sensitivity data must be determined as a result of trim balance experience. No data is currently available.

(a) Definition of Terms

1) 1EL - The low speed rotor fundamental vibration amplitude.

2) 1EH - The high speed rotor fundamental vibration amplitude.

3) Cw - Calibration weight (serially numbered Cw1, Cw2, etc.) of stainless steel wire used to balance engine. Replaced by equivalent PN balance weight after trim balance.

4) Class - Category into which engine is placed based on prebalance vibration survey. (No data is currently available.)

5) Phase Angle - Phase meter reading. Phase angle by which integrated vibration signal lags reference signal.

6) Phase Angle Lag - Calculated angle indicating lag between passing of unbalance weight and response signal.

7) Assumed Phase Angle Lag - Weighted average of phase angle lags determined from previous balance attempts. Also, correction angle used in "one-shot" method.

8) VD - Vector difference from Point A to Point C.

(b) Trim Balance Sequence

1) Conduct prebalance vibration survey to determine suitability of engine for trim balance and to provide basis for classification.
2) Run "As Is" speed points as prescribed for class engine being balanced.
3) Run "As Is" data, plot A vector on polar paper, angle being laid out counter to engine rotation from 12 o'clock location. Draw R vector equal and opposite A vector. (Figure 524)
4) Apply assumed phase angle lag given for class to which engine has been assigned. Assumed phase angle lag is laid off from R in direction of rotation and indicates angular location of Cw1.
5) Apply assumed sensitivity given in respective trim balance procedures assigned engine class. Multiply amplitude of vector A and sensitivity value to give oz-in required for Cw1.
6) Install Cw1 which may be either stainless steel wire or permanent weight as described previously. See Figure 523 or Figure 526 for computation of wire necessary to correct imbalance. Wire weight is installed on nearest blade to location to that designated by steps outlined in Paragraph 9.D.(1)(b)4) above.
7) Rerun engine as in Paragraph 9.D.(1)(b)2) above repeating each speed point within ± 0.2 rev/sec on counter at time base of 10 sec. Record all data.
8) In conjunction with Paragraph 9. above observe O/A (overall) mils vibration throughout engine speed range to determine if all vibration is within acceptance limits.
9) If engine is acceptable, replace wire trial weight with equivalent weight in 1st stage compressor hub, when applicable. No changes are required if no wire weight was used.
10) If engine is unacceptable, calculate and apply Cw2 as described in specific counterweight installation procedure. All weight runs (Cw1, Cw2 ... Cwn) are calculated with respect to "As Is" data.
11) Continue to trim balance engine as required.
12) Complete trim balance report, shown in Figure 527, and file report with engine records.

(2) Hypothetical Example of Vector Balance Method

(a) Assume:

Vibration survey has shown need to trim balance (± 2.0 mils) (0.05 mm) at 6000 N_1. Engine is classified as "Class X." (Acceptance limits ± 1 mil) (0.03 mm). Procedure calls for a compressor trim at 6000 N_1 RPM, assumed phase angle lag of 130 degrees and sensitivity of 1.0 oz-in/mil (720 g.mm/0.03 mm).

(b) Record inlet pickup phase angle and amplitude at 6000 N_1 RPM. In this example let ± 2.0 mil (0.05 mm) at 300 degrees be the recorded data for run No. 1.

(c) Plot vector A (± 2.0 mil) (0.05 mm) at 300 degrees on polar paper. Lay out angle counter to engine rotation from 12 o'clock location. Draw vector R equal and opposite vector A. (See plot on Figure 524).

(d) Apply assumed phase angle lag (130 degrees) laying it off from R in direction of rotation. This indicates that Cw1 should be applied at 350 degrees as measured from 12 o'clock reference location counter to engine rotation.

(e) Apply assumed sensitivity. Multiple amplitude of A vector (± 2.0 mil) (0.05 mm) by assumed sensitivity (1.0 oz-in/mil) (720 g.mm/0.03 mm). Magnitude of Cw1 should be 2 oz-in (1440 g.mm).

(f) Install Cw1. Wire weight may be installed on nearest blade to 350 degrees. In this example let blade No. 2, shown on plot, be chosen (349 degrees).

(g) Rerun balance point and record phase angle and amplitude resulting from addition of Cw1. Run No. 2.

(h) In conjunction with previous Paragraph 9.D.(2)(g), observe O/A mils throughout engine speed range to determine if all vibration is within acceptance limits.

(i) Let data from Run No. 2 be ± 1.3 mils (0.03 mm) at 20 degrees. Plot data as vector C on polar paper. Lay out angle counter to engine rotation from 12 o'clock location.

(j) Plot Vector Difference (VD) by subtracting vector A from vector C. Draw VD from A to C, arrow pointing to C. Translate VD vector to origin of diagram. In this example VD is ± 2.2 mils (0.06 mm) at 84 degrees. VD represents effect of Cw1 alone, both in magnitude and direction. To eliminate unbalance (A vector), VD must bed rotated and adjusted in length to coincide with R vector.

(k) Calculate location and size of required balance weight, Cw2.

  1) Size of correction weight = size of trial

$$\text{weight} \quad \times \quad \frac{\text{A mils}}{\text{VD mils}}$$

$$\text{Cw2} = 2 \quad \times \quad \frac{2}{2.2} = 1.82\ \text{oz-in.}$$

  2) Location of correction weight: In this example, angular amount between VD (84 degrees) and R (120 degrees) is 36 degrees counter to engine rotation. Remove Cw1, move from its location 36 degrees counter to engine rotation to 25 degrees. Apply Cw2 (1.82 oz-in.) (1310 g.mm) at 25 degree (blade No. 32). This should cause VD to coincide with R.

(l) Above procedure can be repeated using second correction weight as new calibration weight. Data from new weight and "As-Is" data can be used to calculate third correction weight and thereby refine balance.

(m) Determine phase angle lag and vibration sensitivity. (Although not required for any specific engine balance, average values calculated from several engine balances are considered valuable guide for follow-on balance jobs).

  1) Phase Angle Lag: Unbalance vectors are measured in terms of amplitude and phase angle (phase meter reading) and are plotted referenced to 12 o'clock location in direction counter to rotation to indicate "lag". Normal plotting procedure locates reference point at top of engine vertical centerline designated as 12 o'clock. this point is shown on the plot as 0 degrees.

  Balance weights are located on rotor after rotor has been turned (indexed) to locate pulse generator tooth directly under pulse pickup. Angular location of the weight is then measured in direction counter to rotation referenced to 12 o'clock.

  To determine phase angle lag, unbalance vectors and weight locations must be given common frame of reference. Angular location corresponding to 12 o'clock is taken as common reference point. Phase angle lag is angle by which response (VD) lags calibration weight. Graphically, it is angle from calibration weight to VD measured counter to engine rotation. In this example, phase lag is 96 degrees.

2) Sensitivity: Sensitivity can be calculated at any given speed point by dividing weight amplitude (Cw1 = 2.0 oz-in.) (1440 g.mm) by measured response (VD - ± 2.2 mils) (0.06 mm). In this example calculated sensitivity is 0.91 oz-in. per mil (655 g.mm per 0.03 mm).

(n) The purpose of calculating phase angle lag and sensitivity is to provide information to assist in future balances. Weighted average of these data for number of balances provide assumed phase angle lag and assumed sensitivity which, when applied to "As Is" data, established "one shot" balance method. In this example let assumed phase angle lag equal 95 degrees. After plotting information described in Paragraph 9.D.(2)(a) the 95 degree angle is now laid out from R vector in direction of engine rotation and establishes Cw1 location. Amount of weight required is established by multiplying A vector amplitude (+ mils) (+ mm) by sensitivity (oz-in./mil) (g.mm/mm) which, for this example, gives 1.82 oz-in. (1310 g.mm) required. It can now be seen that engine would be balanced by this Cw1 and no further runs are necessary.

E. Trim Balance Limits And Procedures

(1) Trim Balance Limits

(a) Engines that experience vibration at N_1 rotational frequency at inlet case and/or exhaust duct up to and including 0.002 inch single amplitude may be trim balanced to bring them within acceptable limits.

(b) Maximum correction (all trim weights) for trim balance of the front compressor at the front plane must be a vector sum of no more than 7.0 oz-in. (5040. g.mm). The total number of trim weights used on the inner balance rib of the front hub must not be more than five.

(c) Maximum correction (all trim weights) for trim balancing front compressor drive turbine at rear plane shall not exceed total vector sum of 10.5 oz-in. when combined with weights previously installed while balancing turbine rotor. Previously installed weights may be moved or replaced, but total number of weights used on turbine rotor assembly shall not exceed five and total vector sum shall not exceed 10.5 oz-in. (7560 g.mm).

(d) After completing installation of final trim balance weights, conduct vibration survey to ensure that vibration levels are within acceptance limits.

(2) Trim Balance Weight Installation

(a) Front Plane

1) Remove front accessory drive group. (PAGEBLOCK 72-21-00/401)

2) Remove retaining ring holding front accessory drive gearshaft in front hub. Engage PWA 45009 Puller behind gearshaft gearteeth and remove gearshaft carefully with knocker action.

3) Find the applicable counterweight (0 - 5) as shown in Figure 528.

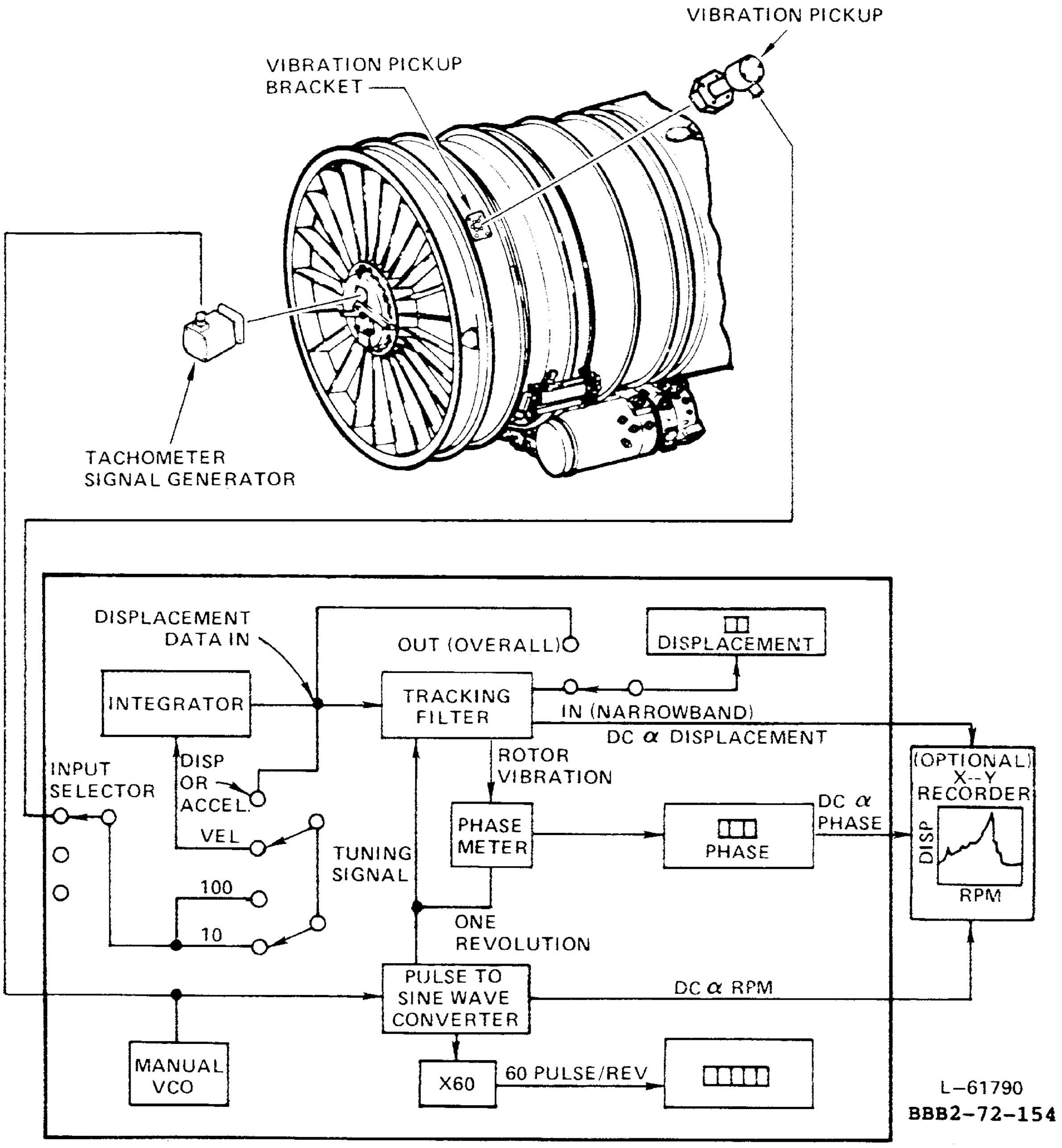
4) Install counterweight inside front hub on balancing rib as close to required angular location as possible. Compress counterweight shank against spring pressure and release shank when weight straddles balancing rib and hook section of shank is in line with hole in rib. Figure 528

5) Install a packing, lubricated with PWA 36500 Assembly Fluid, on the front accessory drive gearshaft and install the shaft on the front hub. Hold the gearshaft in position with a retaining ring.

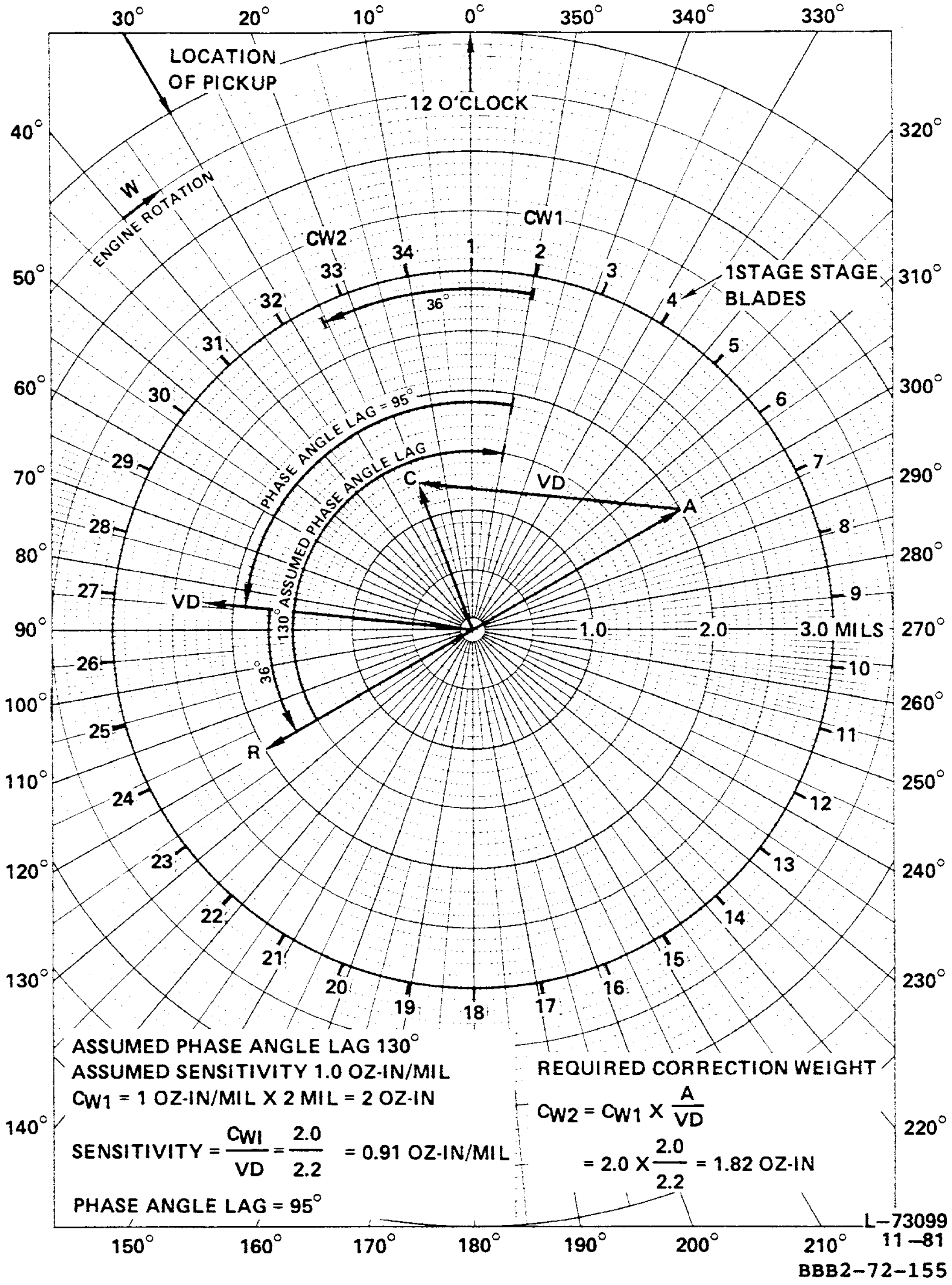
6) Install front accessory group. (PAGEBLOCK 72-21-00/401)

(b) Rear Plane

1) Remove the fan and turbine exhaust duct (mixer) for access to the rear of the turbine.
2) Add counterweights (or remove and replace counterweights found on the rear of the 4th stage turbine disk). Refer to the limits in Paragraph 9.E.(2)(b)1). (Figure 529)
3) Attach counterweights with rivets (rivet heads pointed to the disk surface). Flare the rivet ends to 0.125 inch (3.175 mm) diameter minimum (PWA 46320 Riveter is available to do this).
4) Install the fan and turbine exhaust duct (mixer).



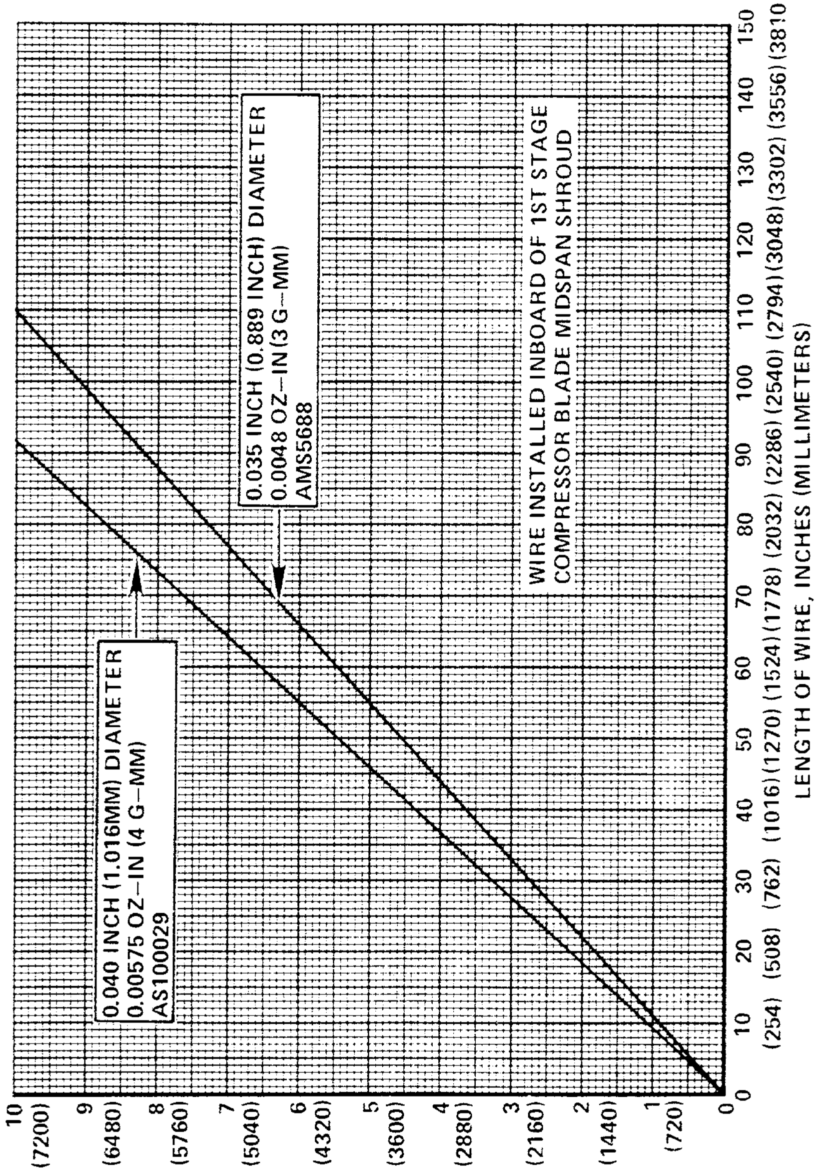
Instrumentation Block
Figure 523/72-00-00-990-881



Trim Balance Calculation Diagram
Figure 524/72-00-00-990-882

FIRST STAGE COMPRESSOR

OUNCE–INCH MOMENT VS LENGTH OF WIRE



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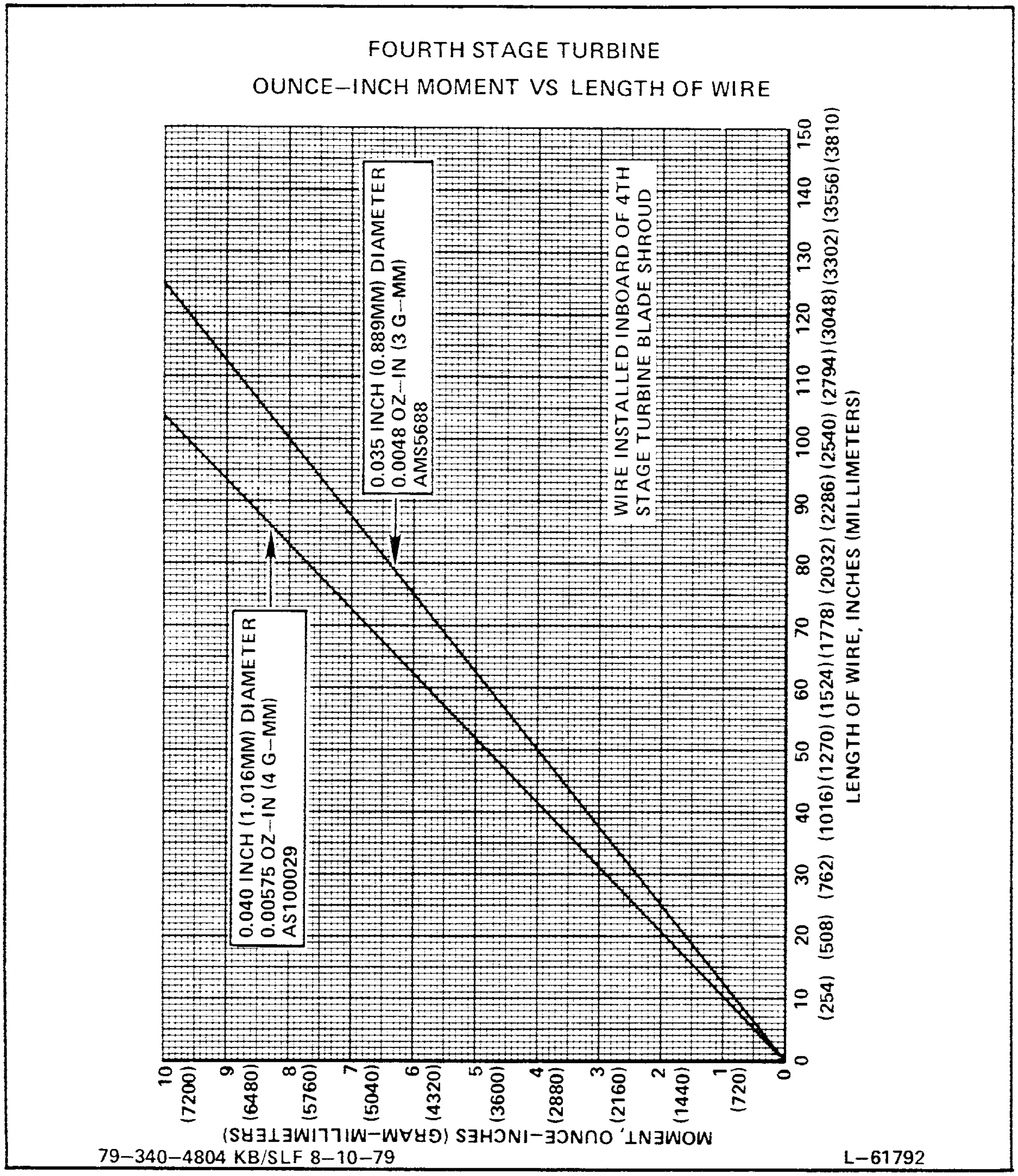
Ounce-Inch Moment Vs. Length Of Wire (First Stage Compressor)
Figure 525/72-00-00-990-883



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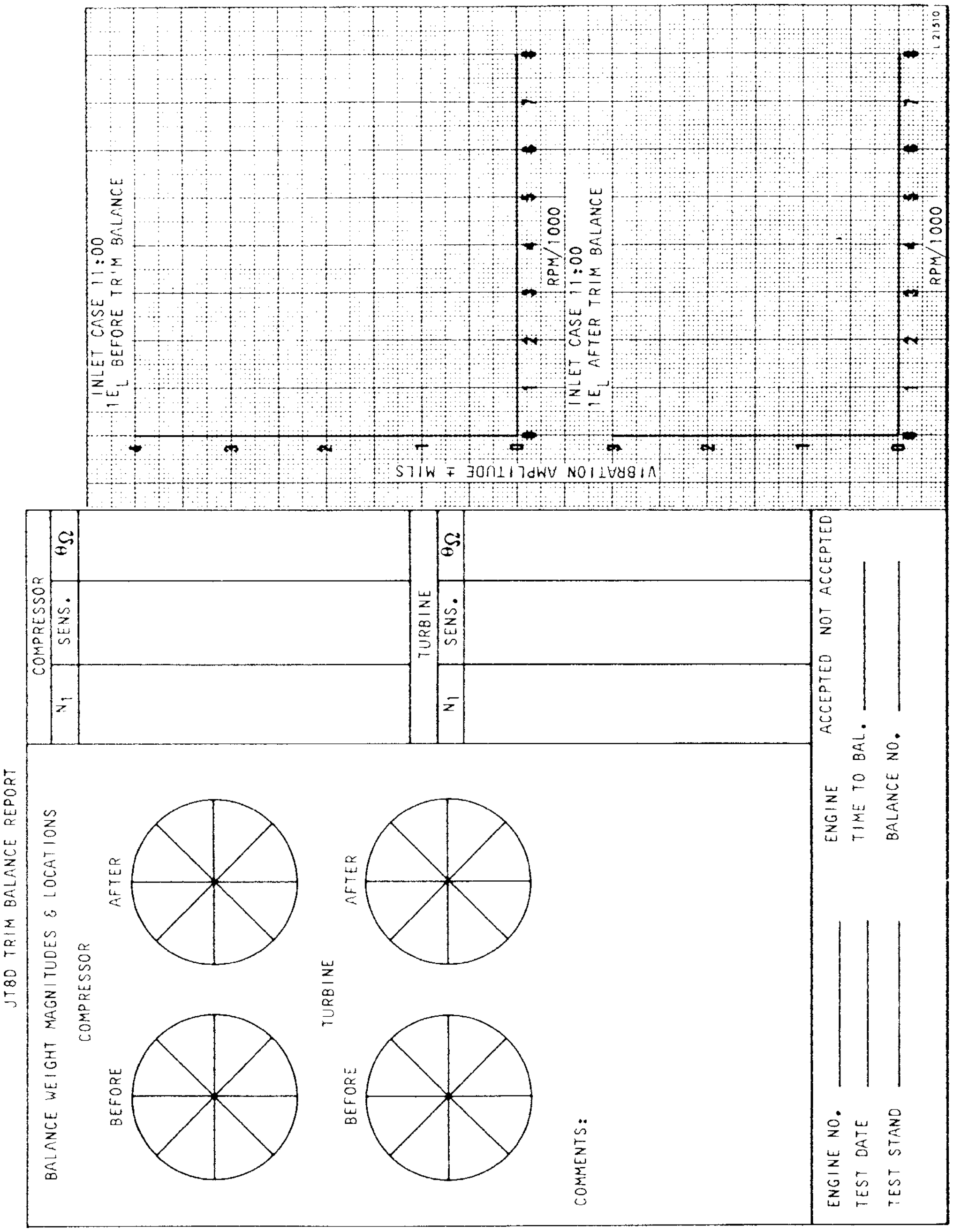
Ounce-Inch Moment Vs. Length of Wire (Fourth Stage Turbine)
Figure 526/72-00-00-990-884



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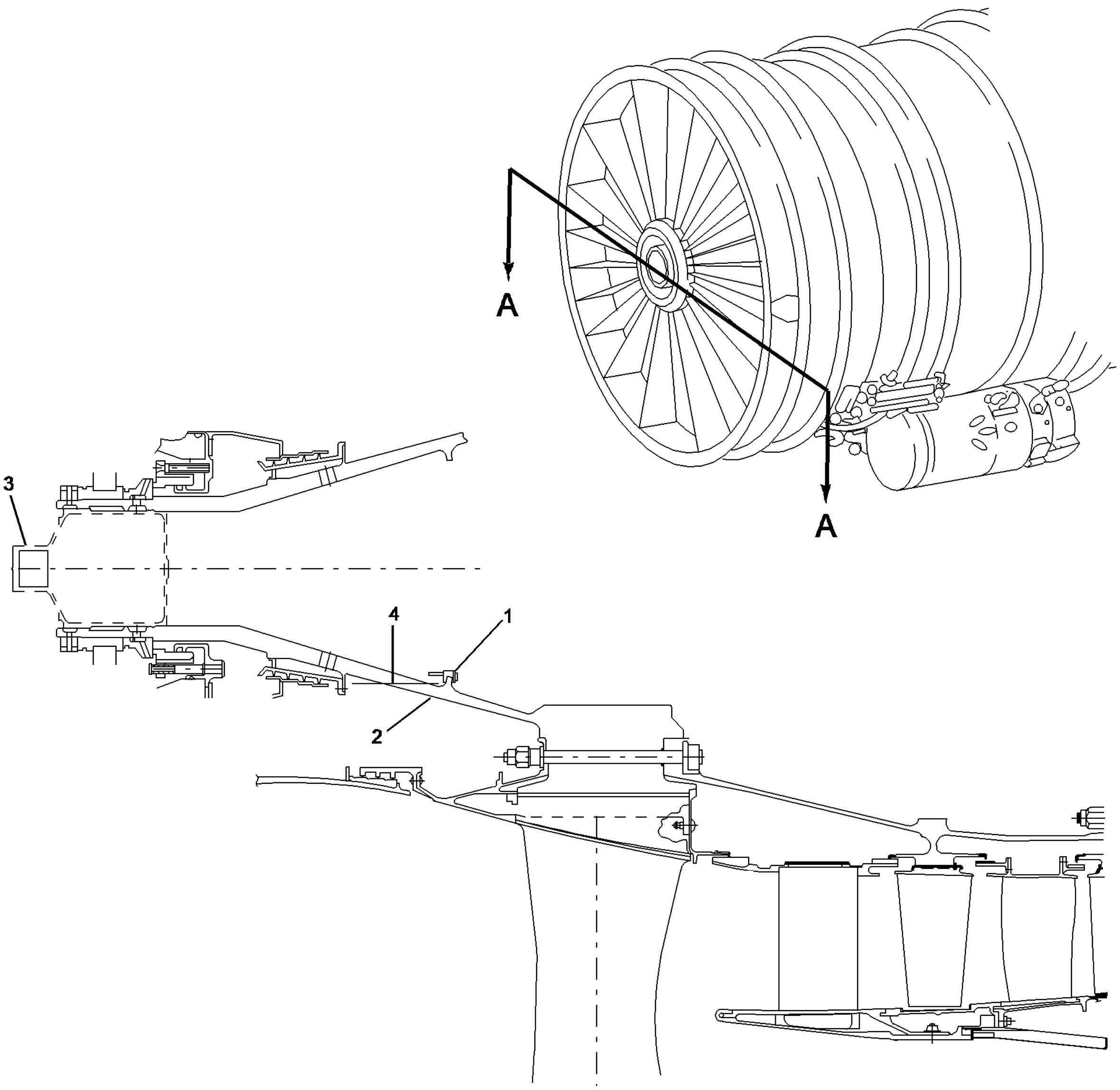
Trim Balance Report
Figure 527/72-00-00-990-885



SECTION A-A

LEGEND:

1. COUNTERWEIGHT PN 658339, 658341 (CLASS 1 OR 2) OR 761787, 0 - 5 AS REQUIRED
2. FRONT COMPRESSOR FRONT HUB
3. GEARSHAFT (REMOVED FOR ACCESS)
4. 4.000 in. (101.600 mm) BALANCING RADIUS (REFERENCE)

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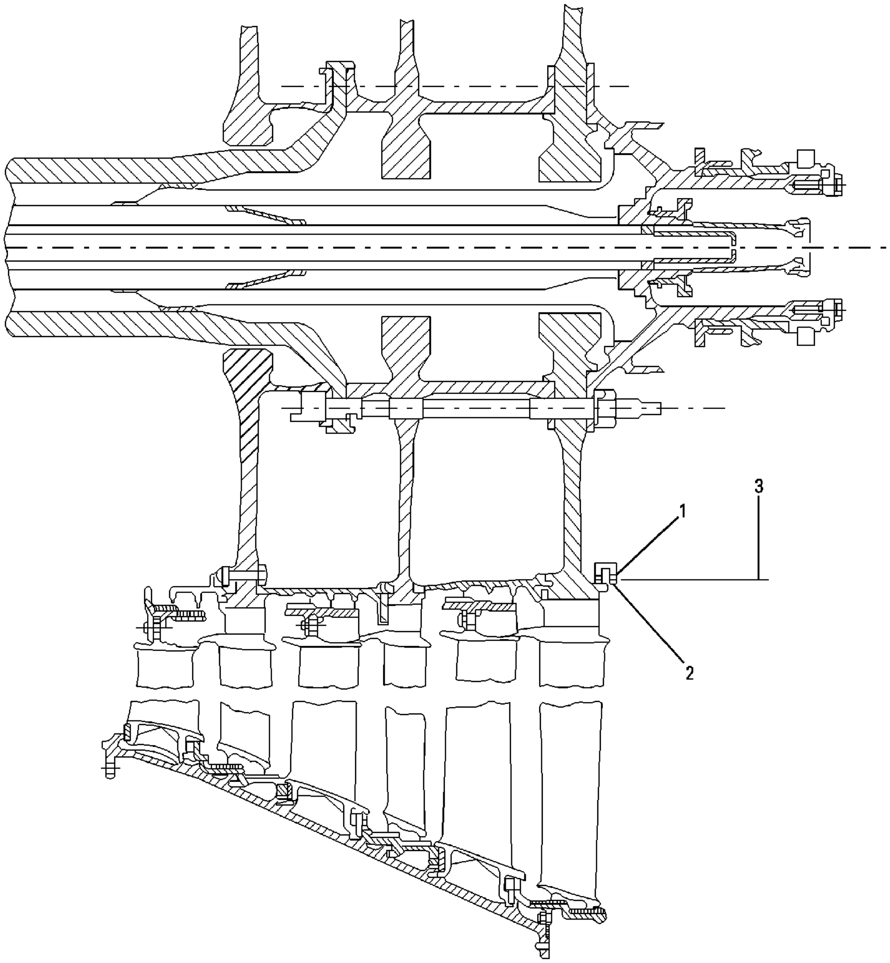
Front Compressor Trim Balancing
Figure 528/72-00-00-990-886



1. PN 534492, 584943, OR 584994 COUNTERWEIGHTS. SELECT CLASS AS NECESSARY AND INSTALL, REMOVE, OR REPLACE BY THE LIMITS IN THE TEXT. IT IS PERMITTED TO INSTALL PN 534492 EITHER SIDE OF THE DISK FLANGE.
2. RIVET (PN 4028248) (USE WITH PN 584943 OR 584944).
3. 7.715 INCHES (195.961 MM) BALANCE RADIUS (REFERENCE)

L-84125

CAG(IGDS)

BBB2-72-518

Rear Turbine Trim Balance
Figure 529/72-00-00-990-887

10. Fuel Control Starting Schedule Adjustment

A. General

(1) Fuel control removals have occurred on engines that had what could become "hot starts" and also on engines which had slow acceleration. Experience shows that fuel control linkages can have wear or part movement which can cause changes in the starting flow schedule, in either the rich or the lean direction. A rich change in fuel flow can cause hot starts. A lean change in fuel flow can cause slow acceleration. Adjustments to the fuel control to put the start schedule back in its initial calibration limits, as specified in the CMM, can decrease the number of fuel control removals which are the result of possible hot start or slow acceleration.

(2) It is possible to do this adjustment on a fuel control only two times, in the upward or downward direction. If a fuel control continues to be part of a hot start or slow acceleration problem, remove the control for approved component repair or calibration.

(3) This procedure is approved for all dash numbers of Hamilton Standard (HSD) PN 769606 fuel controls.

(4) Before fuel control adjustment, do all other applicable procedures in PAGEBLOCK 72-00-04/101 to make sure that there are no other possible causes of the hot start or slow acceleration problem.

(5) Adjustments to the fuel control other than what is specified in the procedures in this section are not permitted.

B. Procedure

(Figure 530), (Figure 531), (Figure 532), (Figure 533)

CAUTION: DO NOT USE AN ABSOLUTE PRESSURE GAGE TO MEASURE PRIMARY FUEL PRESSURES. THIS TYPE OF GAGE WILL NOT GIVE CORRECT READINGS FOR THIS PROCEDURE.

(1) Attach a gage, STD-14581 to the pressurizing and dump valve FP4 port as shown in (Figure 530).

(2) Wet motor the engine for ten (10) seconds minimum after the N_2 speed becomes stable.

(3) Measure the fuel pressure at the FP4 port.

(4) Record the engine speed and the ambient atmospheric pressure (in inches Hg).

(5) Use Figure 531 to convert the primary fuel pressure at the FP4 port to fuel flow (primary fuel pressure versus primary nozzle pressure).

(6) Find the nominal fuel flow (Wf) for the N_2 speed from the applicable starting schedule. (Figure 532, Sheets 1 thru 10)

(7) Add and subtract 30 PPH to get a plus or minus 30 PPH acceptance band.

(8) If the fuel flow (Wf) in Paragraph 10.B.(5) is in the band of fuel flow (Wf) set in Paragraph 10.B.(6), do not adjust the fuel control.

(9) If the fuel flow (Wf) in Paragraph 10.B.(5) is more than the higher fuel flow (Wf) set in Paragraph 10.B.(7), turn the throttle valve position adjustment counterclockwise to decrease the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(10) If the fuel flow (Wf) in Paragraph 10.B.(5) is less than the lower fuel flow (WF) set in Paragraph 10.B.(7), turn the throttle valve position adjustment clockwise to increase the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(11) Adjust the throttle valve position adjustment as follows: (Figure 509)

  (a) Remove the screw and plate from the fuel control as shown in Figure 533.

(b) Use a 3/32 inch hex wrench to turn the adjustment in the necessary direction.

NOTE: The adjustment has a limit of 230 PPH for a fuel control between bench calibrations (this will be approximately 0.3 turn). This adjustment will make a change of 800 PPH per turn. Make the last adjustment in a clockwise direction. To get a decrease in fuel flow, turn the adjustment counterclockwise one eighth (1/8) turn past the necessary position, then turn it clockwise to the necessary position.

(c) Install the plate and attach it with the screw and washer after the adjustment is completed.

(12) After all adjustments, do this procedure to make sure that the schedule mechanism is stable:

(a) Get the engine to a stable motoring speed.

(b) Set the condition lever to ON for ten (10) seconds and record the primary nozzle pressure at the P&D valve FP4 port.

(c) Set the condition lever to OFF for ten (10) seconds.

(d) Do Paragraph 10.B.(12)(b) and Paragraph 10.B.(12)(c) again.

(e) Do Paragraph 10.B.(12)(b) again.

(f) If the pressure recorded in Paragraph 10.B.(12)(e) is not plus or minus 2 psi of the pressure recorded in Paragraph 10.B.(12)(d), stop the motoring procedure and do Paragraph 10.B.(12)(a) thru Paragraph 10.B.(12)(e) again.

(g) Use Figure 531 to convert primary nozzle pressures recorded in Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) to fuel flow (Wf).

(h) The average of the fuel flow (Wf) readings from Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) will usually be plus or minus 25 PPH from the nominal fuel flow (Wf) in Paragraph 10.B.(6). If the average fuel flow (Wf) is more than this limit, adjust the starting fuel flow (Wf) and do all of Paragraph 10.B.(12) again.

NOTE: It is possible to do an engine run to Idle as an alternate to Paragraph 10.B.(12)(b) thru Paragraph 10.B.(12)(e), with only one pressure measured during a motoring procedure.

(13) Make sure that an increase or decrease in starting fuel flow (Wf) shows on the flight deck indicator as well as during the primary pressure flow check at the P&D valve. If the two indications are not the same, this can be a result of contamination in the primary fuel nozzles, or a problem with the flight deck instrumentation.

(14) After the adjustment, make sure that the necessary fuel control trim parameters are in limits. These parameters will include Idle and Part Power trim limits, and Takeoff, acceleration, and deceleration checks. Refer to the airframe manufacturer's trim information.

(15) Sample Calculation

(a) Sample A

1) Conditions:

a) 22 percent N_2 motoring speed

b) Fuel: Jet A

c) Pamb: 29.92 inches Hg

d) Primary fuel nozzle pressure measured at 100 PSIG

(b) Sample B

1) From Figure 532 (for -7 and -08 fuel controls) the nominal fuel flow (Wf) for 22 percent N_2 at 29.92 inches hg ambient pressure will be 730 PPH.

2) Add and subtract 30 PPH as shown in Paragraph 10.B.(7):

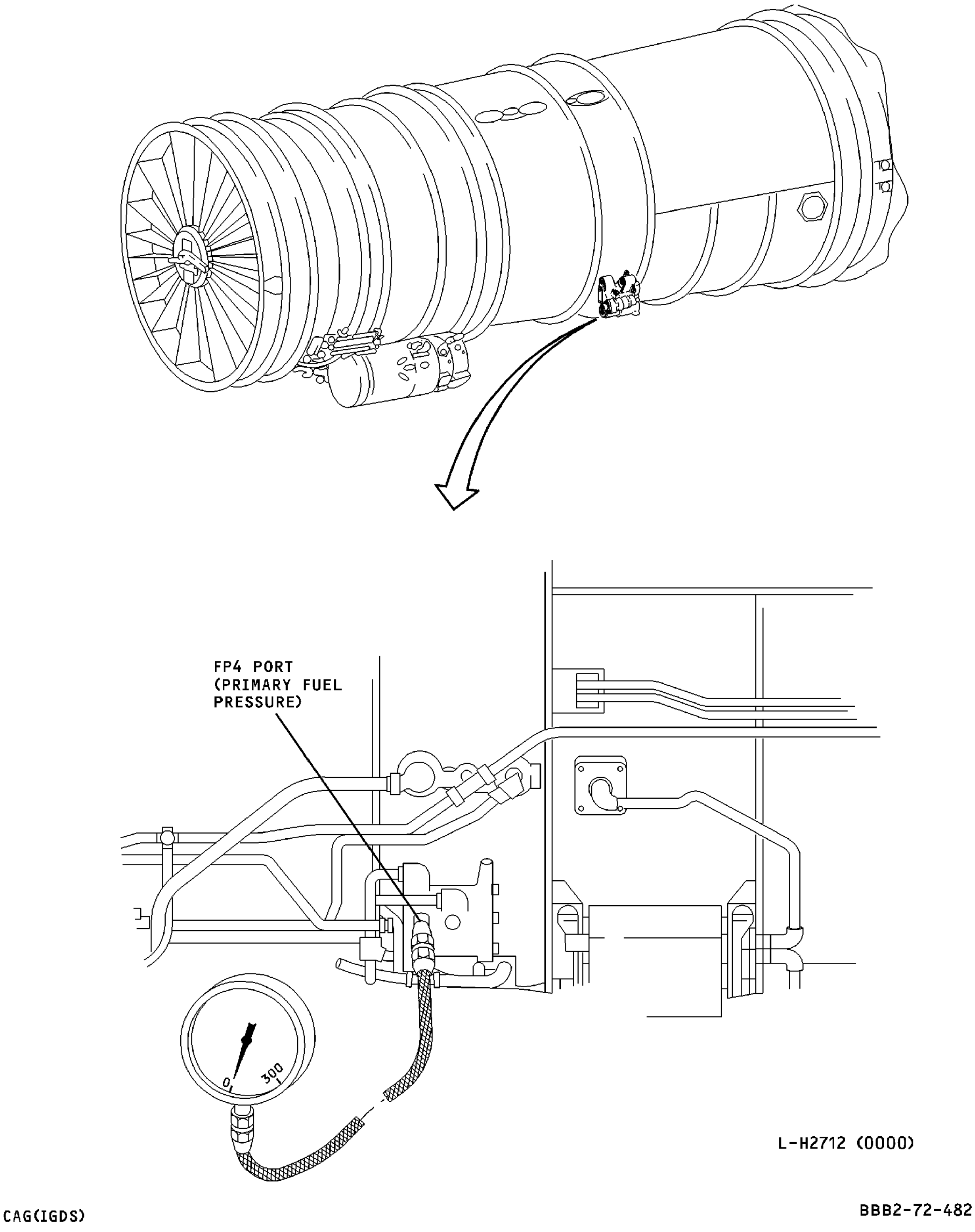
730 + 30 = 760 pph

730 - 30 = 700 pph

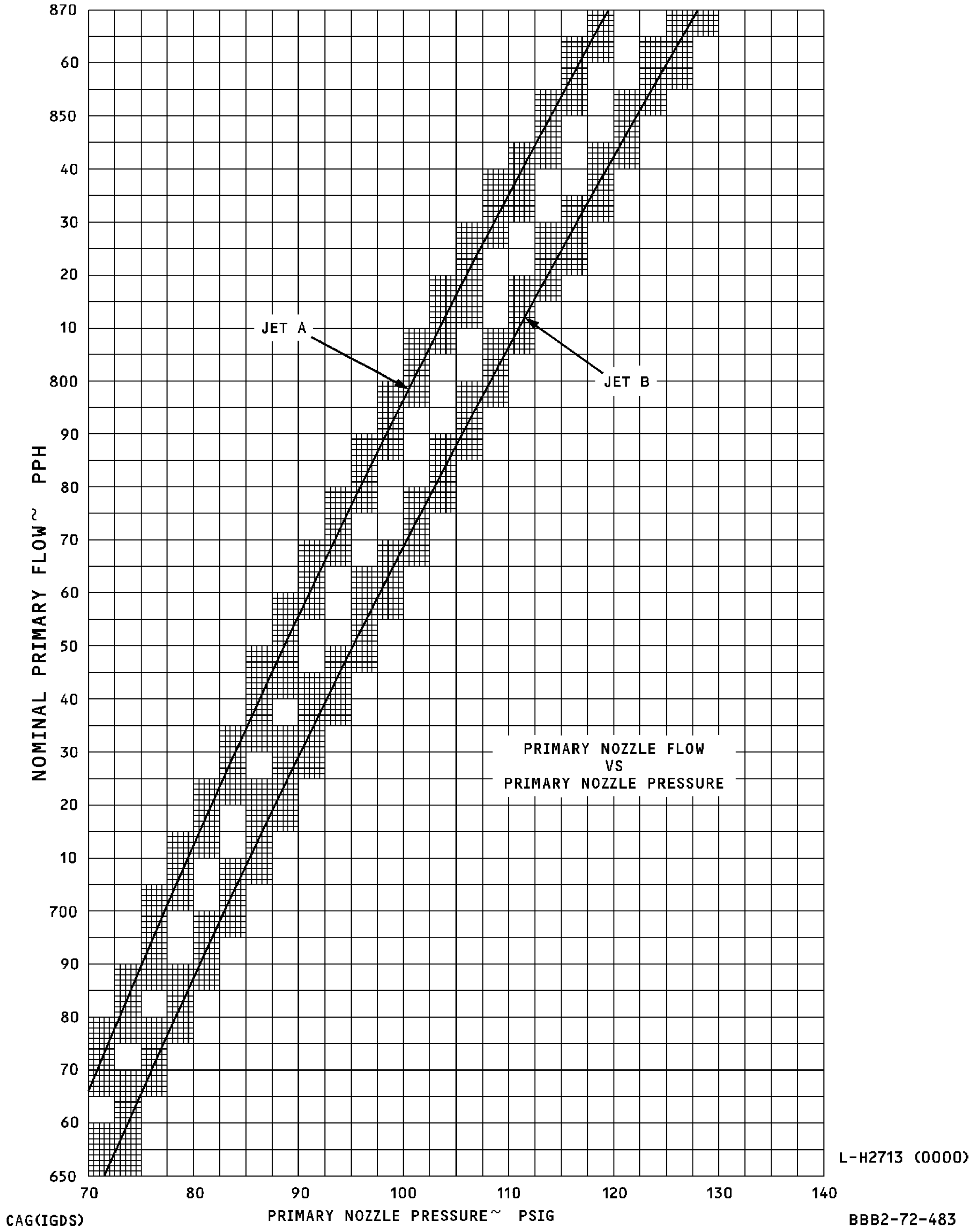
3) In this example the fuel flow (Wf) from Paragraph 10.B.(15)(a) is more than the higher fuel flow (Wf) in Paragraph 10.B.(15)(b). Therefore, it will be necessary to decrease the flow to 730 ±25 PPH. Turn the throttle valve position adjustment counterclockwise to get a primary nozzle pressure of 84 PSIG. Make the last adjustment in a clockwise direction as shown in Paragraph 10.B.(9). Refer to Table 509 for typical adjustment limits.

Table 509 Fuel Control Fuel Flow Adjustment

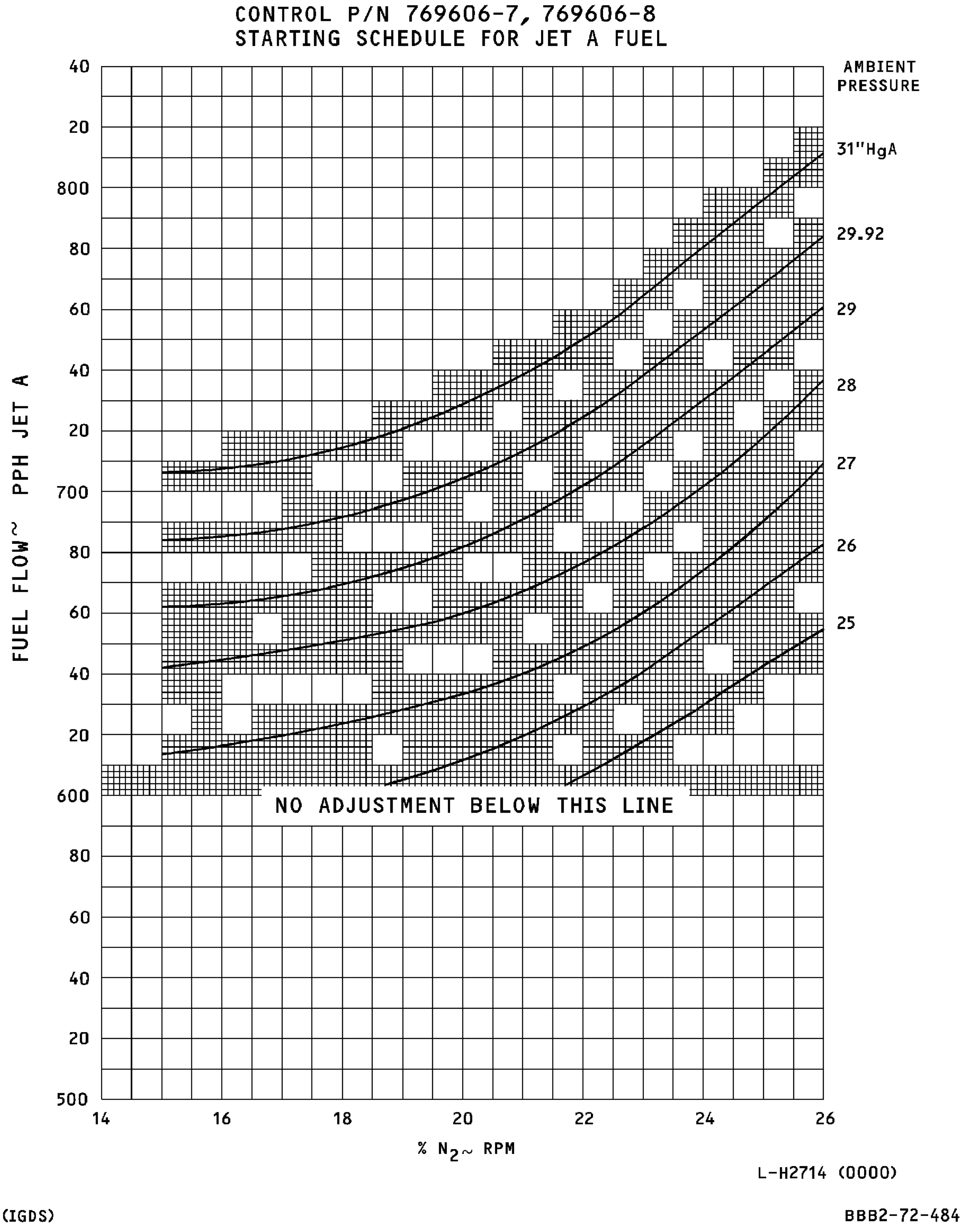
Fuel Control Throttle Valve Position Adjustment Turns	Fuel Flow (Wf) Difference (PPH)
Clockwise:	
1/16	50
1/8	100
3/16	150
1/4	200
5/16	250
3/8	300
Counterclockwise:	
1/16	-50
1/8	-100
3/16	-150
1/4	-200
5/16	-250
3/8	-300



Pressurizing and Dump Valve
Figure 530/72-00-00-990-888

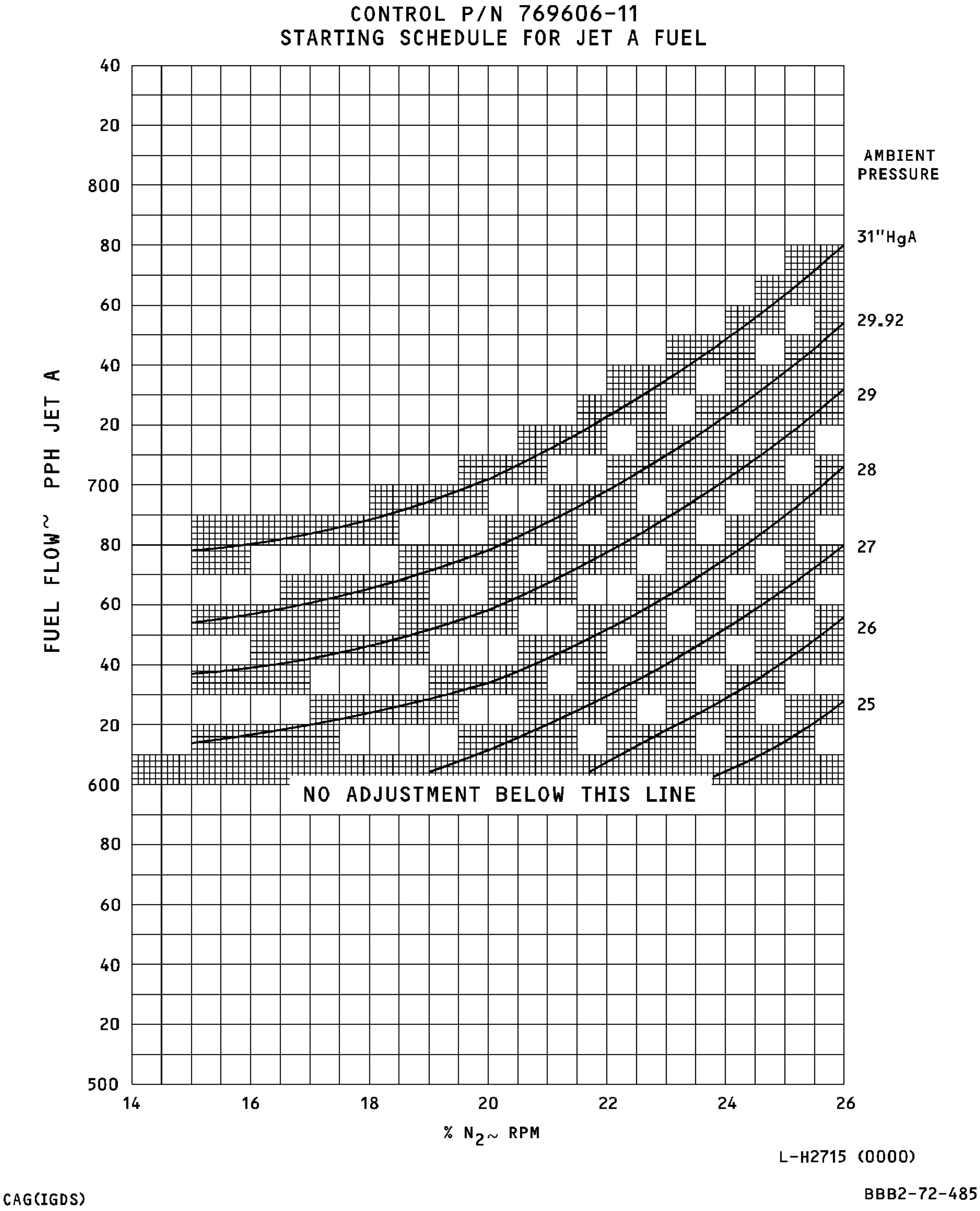


Fuel Pressure to Flow Conversion
Figure 531/72-00-00-990-889

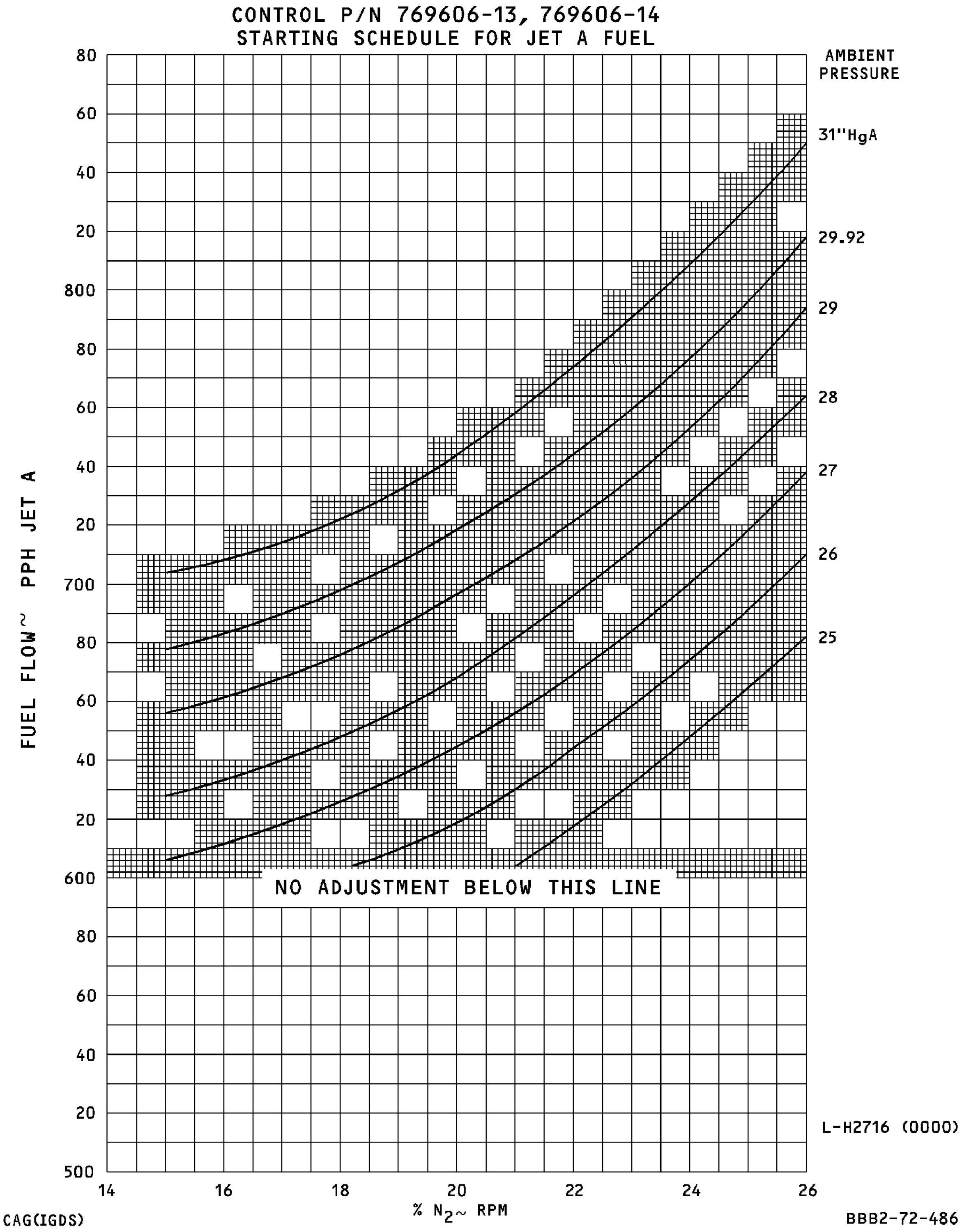


Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 1 of 10)

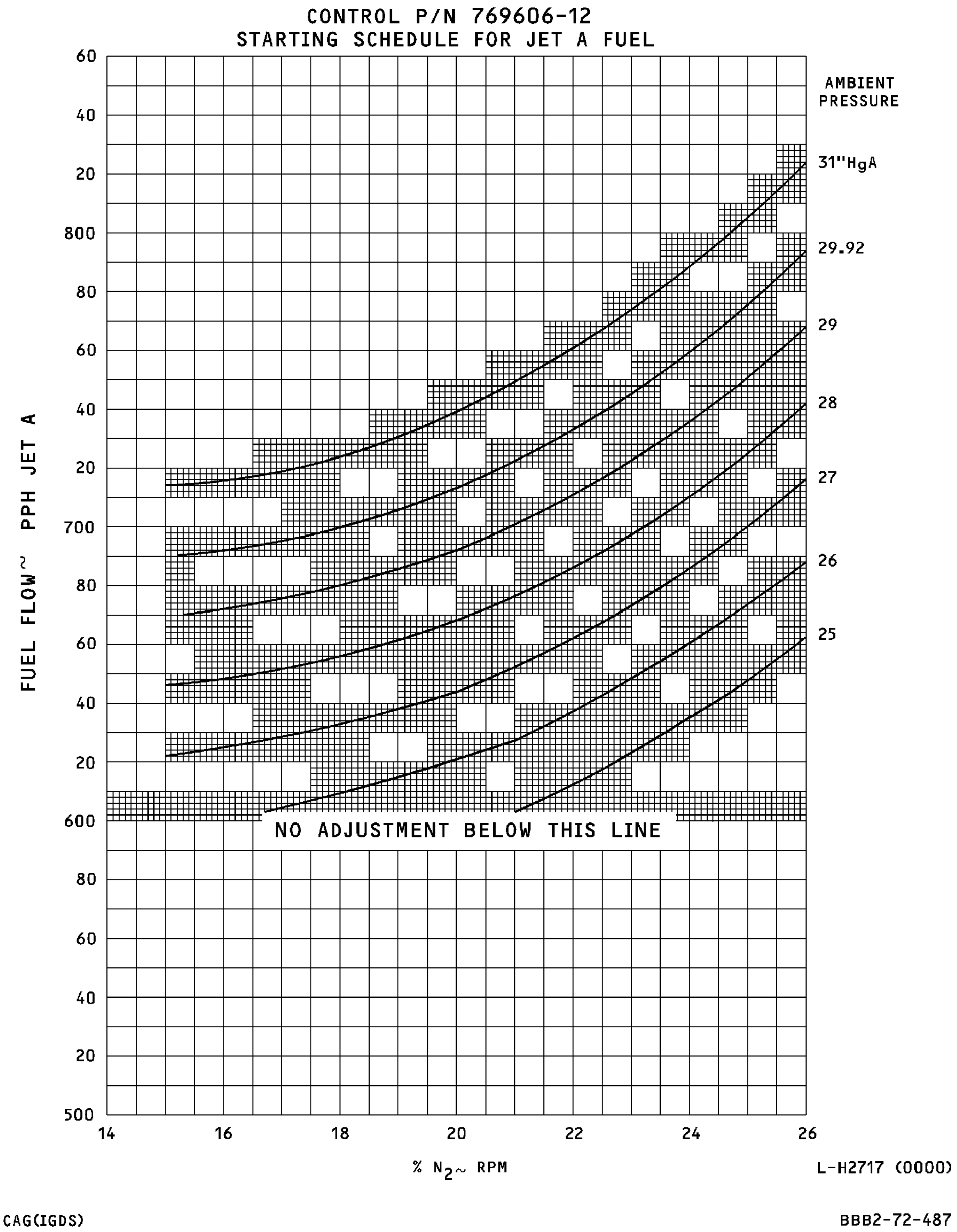
EFFECTIVITY
WJE 401-404, 412, 414-427, 429, 861-866, 868, 869, 871, 872, 891



Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 2 of 10)

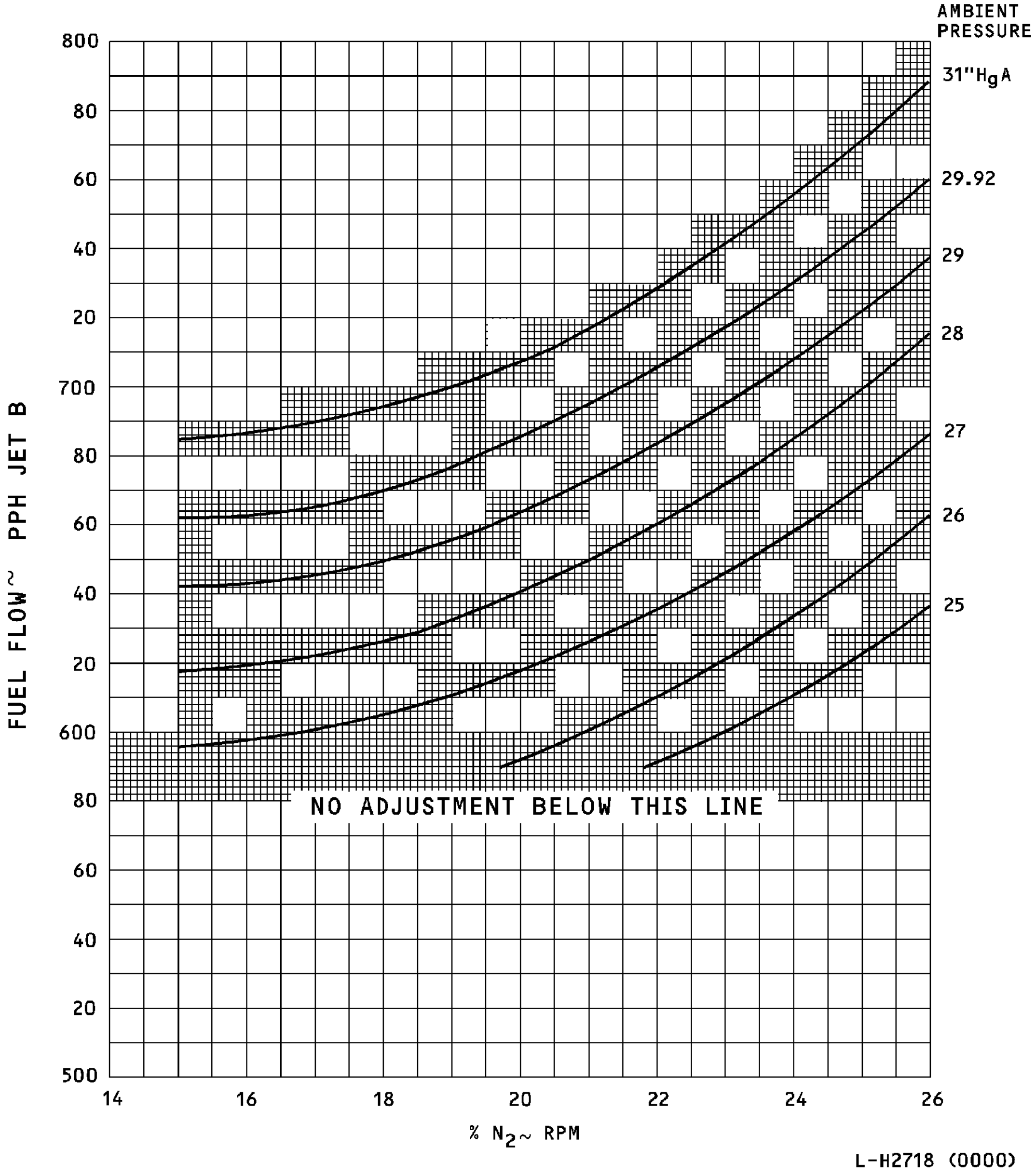


Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 3 of 10)



Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 4 of 10)

CONTROL P/N 769606-7, 769606-8
STARTING SCHEDULE FOR JET B FUEL



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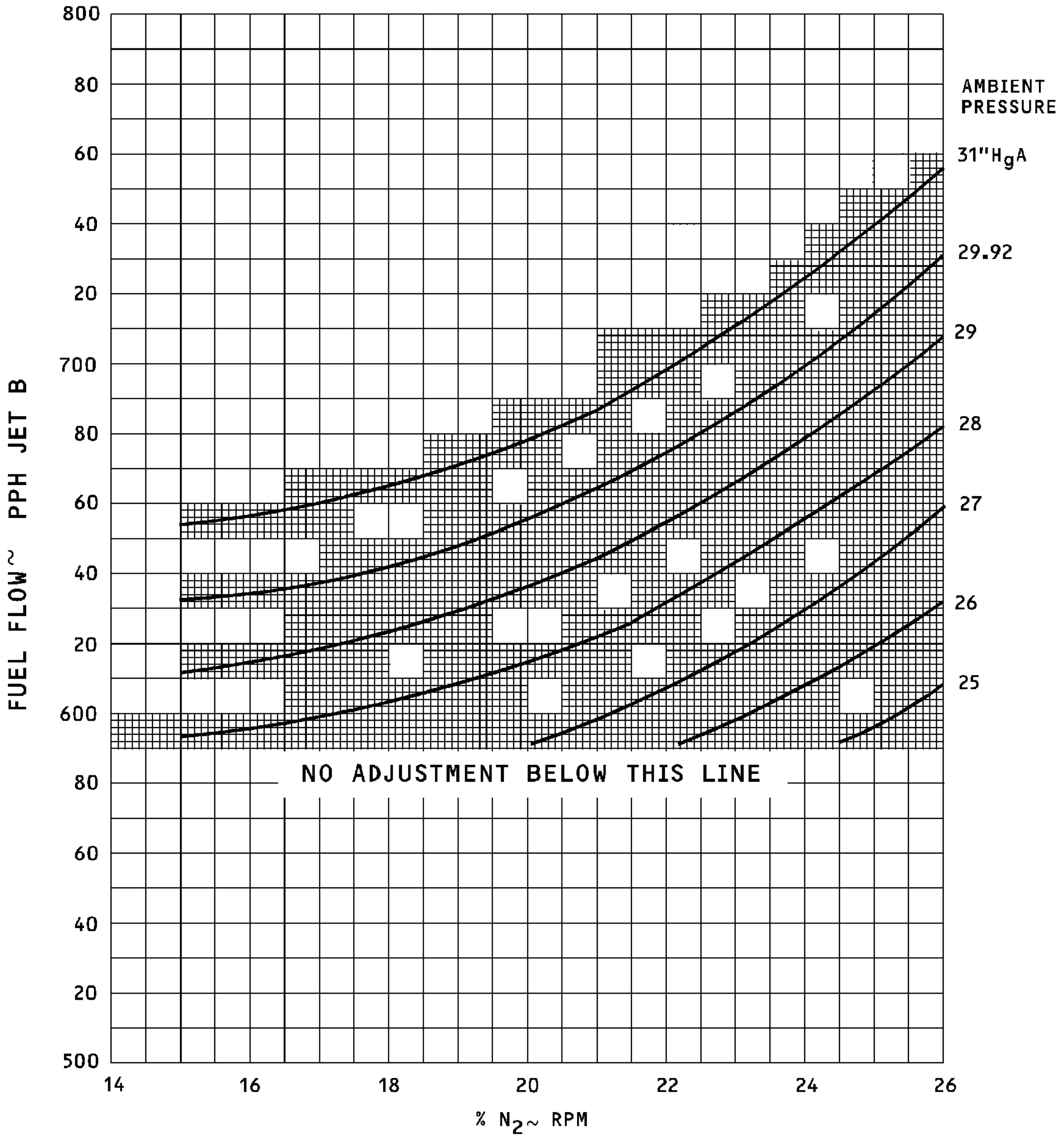
Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 5 of 10)

CONTROL P/N 769606-11
STARTING SCHEDULE FOR JET B FUEL



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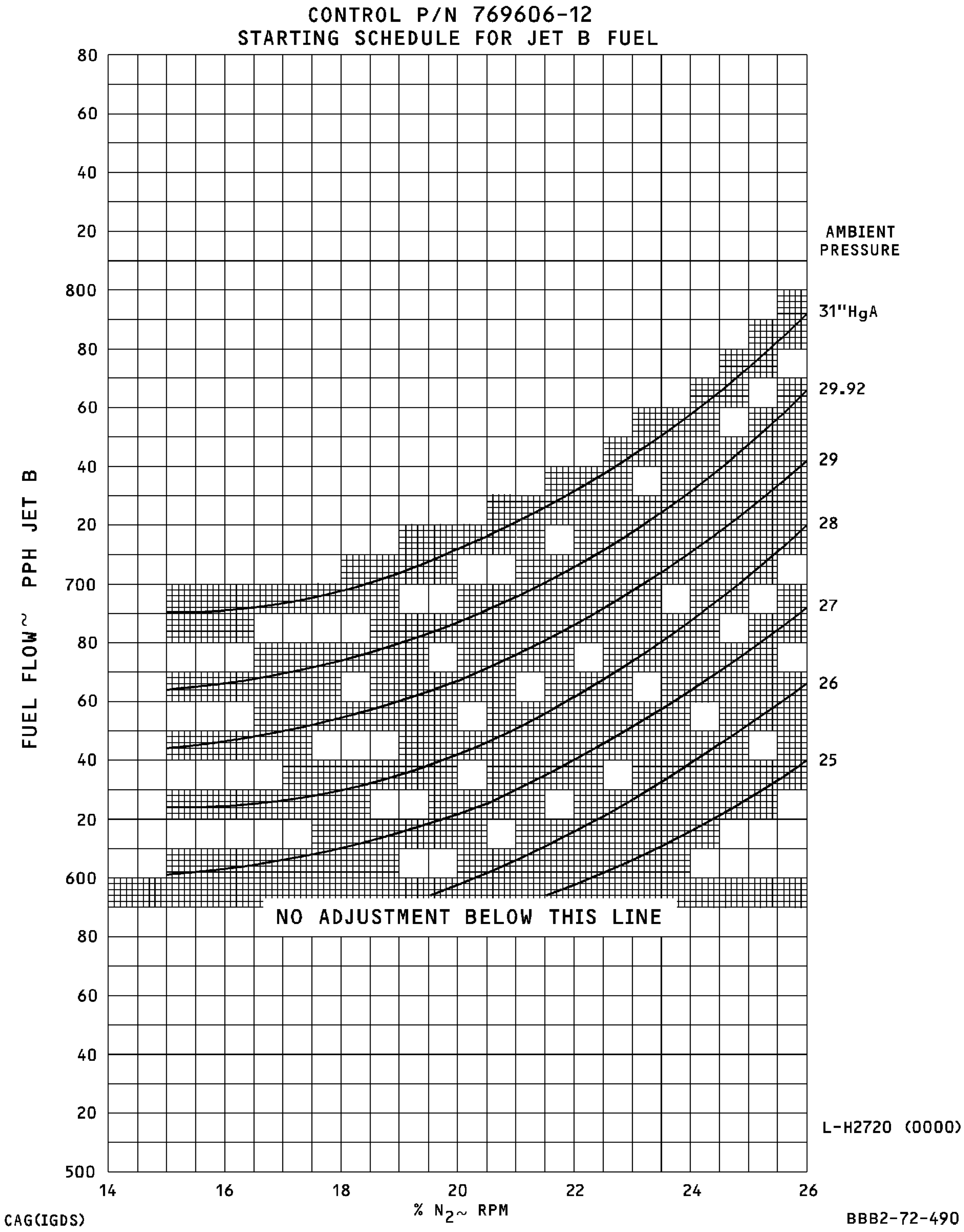
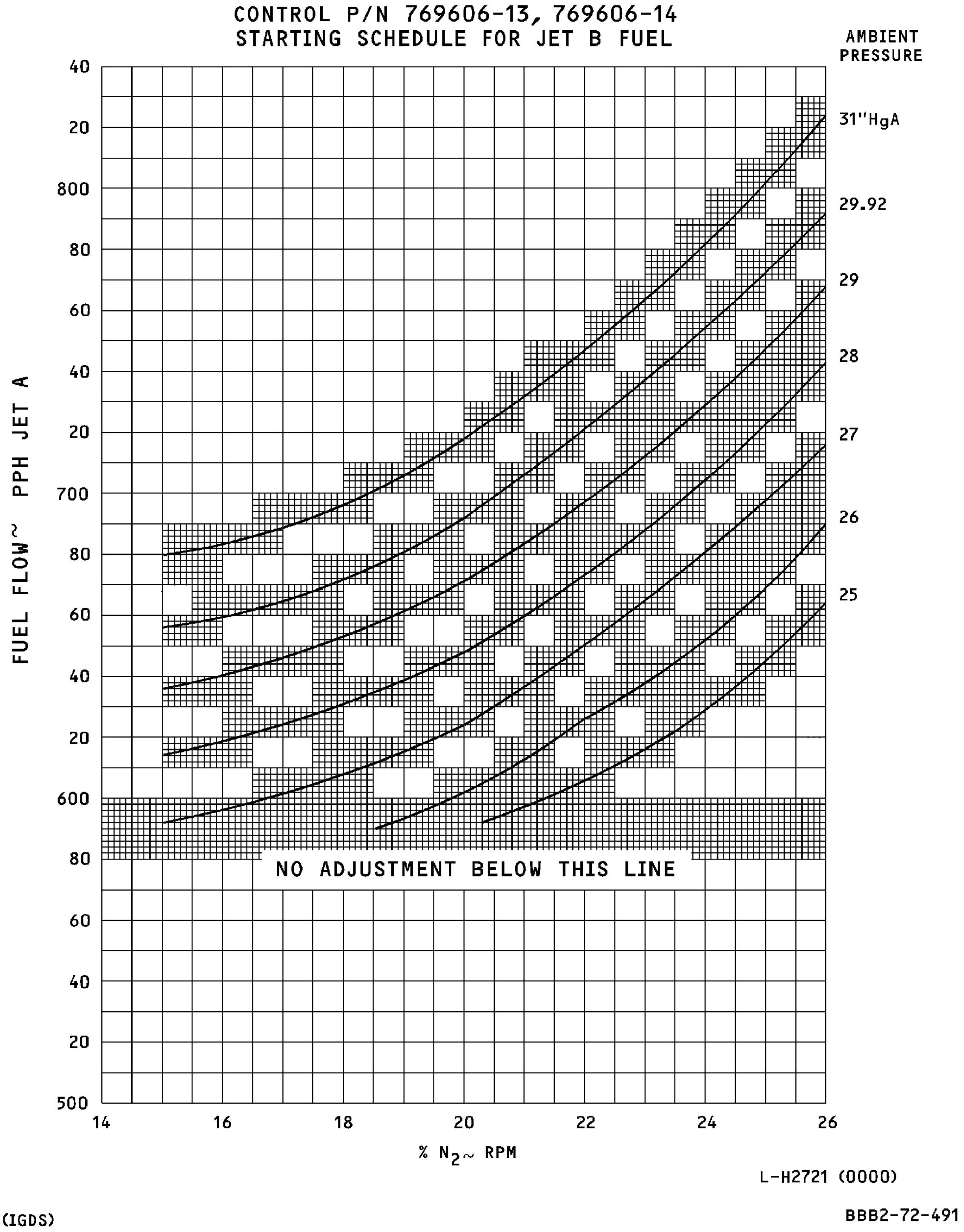
Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 6 of 10)

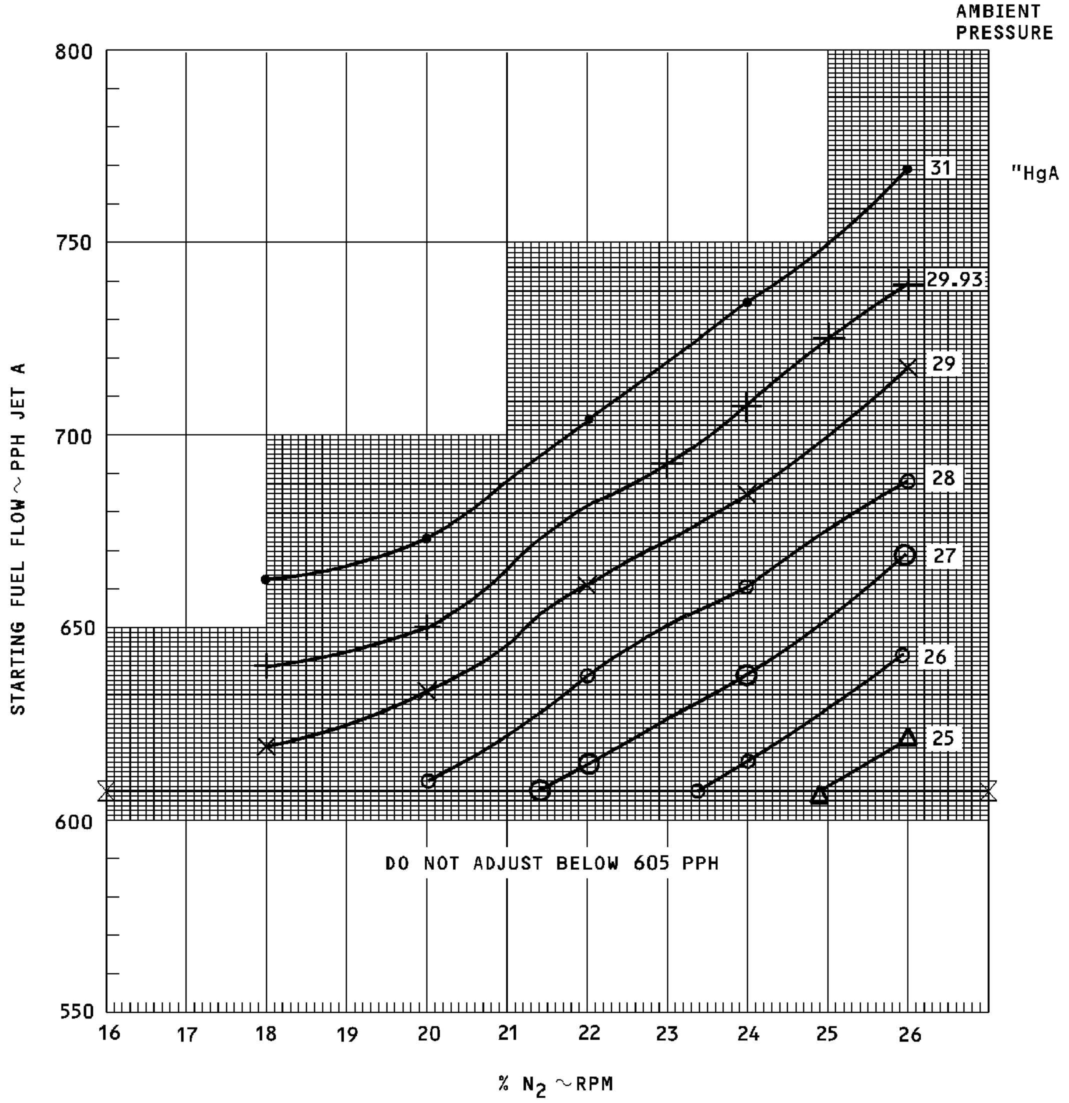


Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 7 of 10)



Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 8 of 10)

CONTROL P/N 769606-15, 769606-16
STARTING SCHEDULE FOR JET A FUEL



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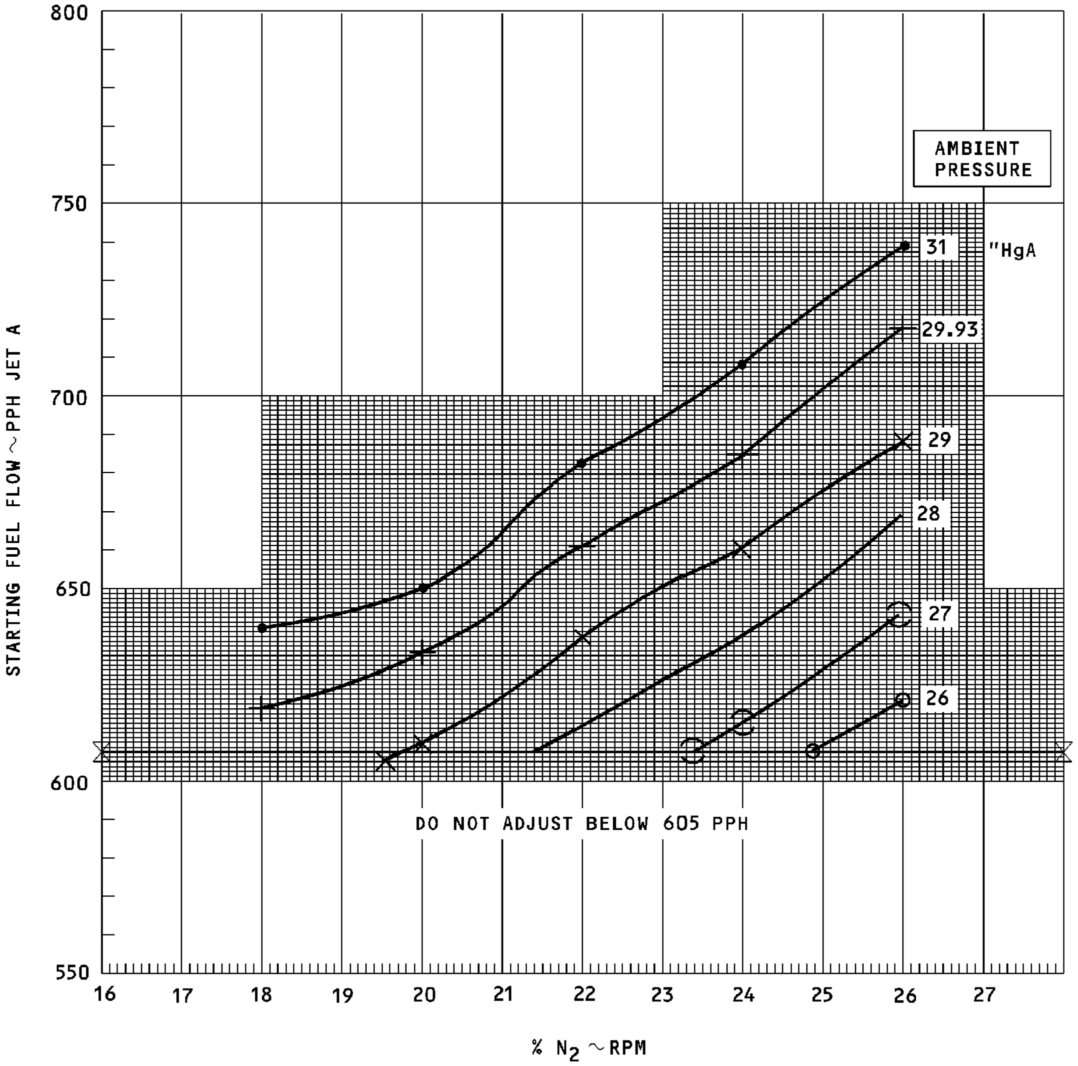
Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 9 of 10)

CONTROL P/N 769606-15, 769606-16
STARTING SCHEDULE FOR JET B FUEL



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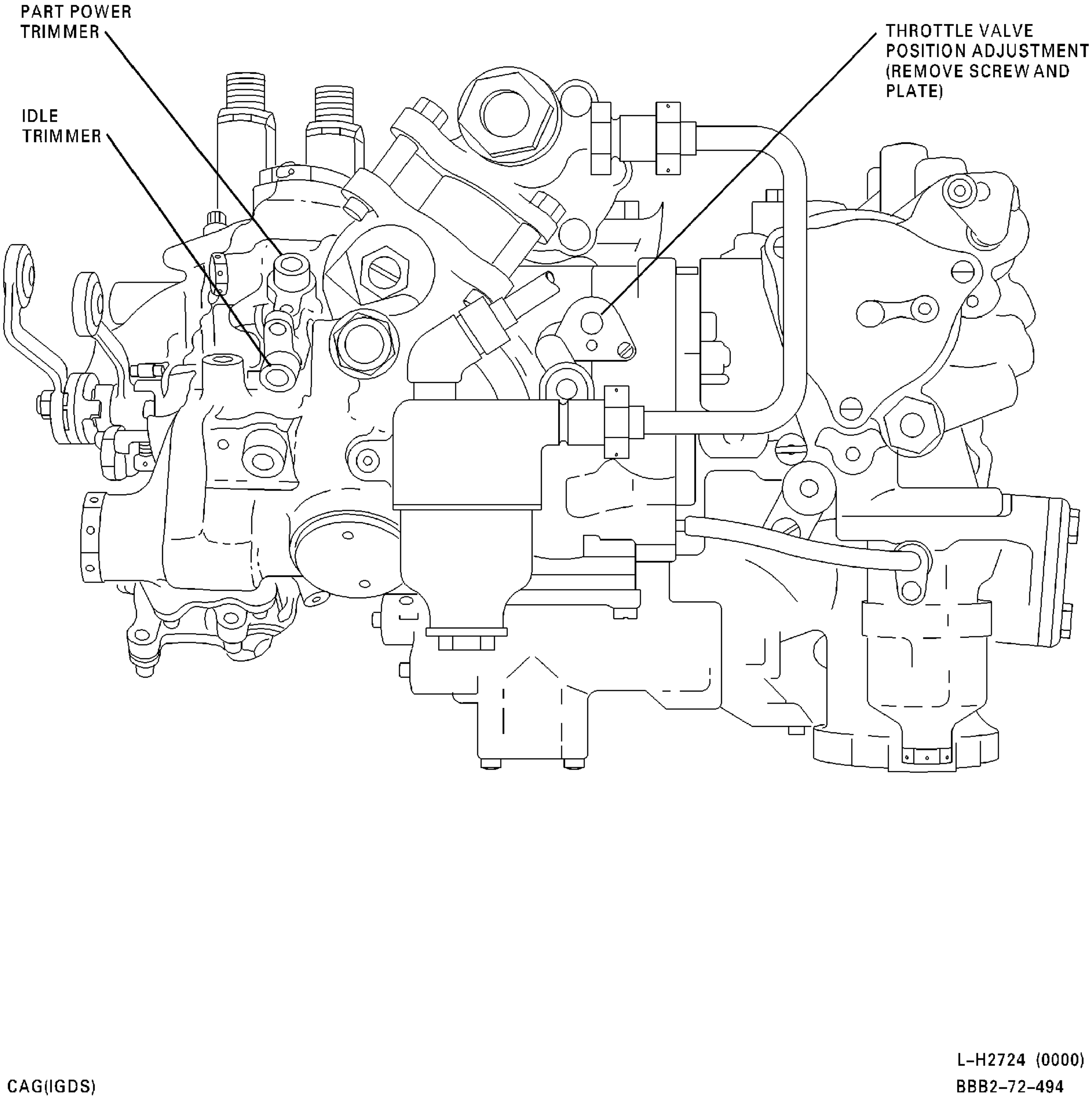
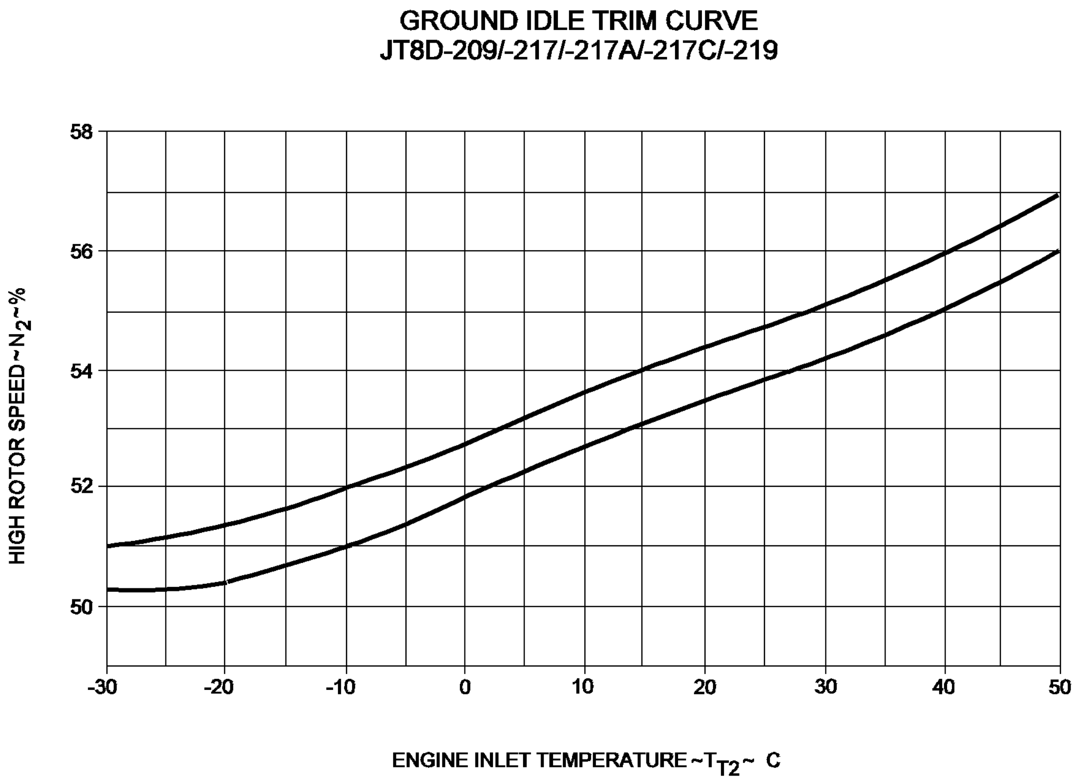
Starting Schedule Limits
Figure 532/72-00-00-990-890 (Sheet 10 of 10)



Fuel Control Adjustment
Figure 533/72-00-00-990-891



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Engine Idle Trim Curve
Figure 534/72-00-00-990-C48

ENGINE GENERAL - ADJUSTMENT/TEST

1. Engine Ground Safety Precautions

A. General

(1) The operating characteristics of jet engine powered aircraft have changed the ground safety picture. To prevent injury to persons and damage to property, handling and working procedures must be modified to meet new exposures. On piston engine aircraft the propeller was carefully avoided. In the case of the jet engine powered aircraft, one must avoid not only the engine intake ducts, but also the exhaust nozzle where hot, high velocity exhaust gases are discharged. Listed below are some of the general safety items which shall be supplemented according to the needs of the job, to prevent accidents.

B. The Air Intake (Figure 501)

WARNING: ALL PERSONNEL MUST AVOID HAZARD AREAS AROUND THE POWER PLANT AND REMAIN OUTSIDE OF ENGINE SAFETY BARRIER, IF USED, DURING GROUND RUNNING OPERATIONS. THE ENGINE IS CAPABLE OF DEVELOPING ENOUGH SUCTION AT THE INLET TO PULL A PERSON UP TO OR PARTIALLY INTO THE INLET WITH POSSIBLE FATAL RESULTS. THEREFORE, WHEN APPROACHING ANY TYPE OF JET ENGINE, PRECAUTIONS MUST BE TAKEN TO KEEP CLEAR OF THE INLET AIR STREAM. THE SUCTION NEAR THE INLET CAN ALSO PULL IN HATS, GLASSES, LOOSE CLOTHING AND WIPE-RAGS FROM POCKETS. ANY LOOSE ARTICLES MUST BE MADE SECURE OR REMOVED BEFORE WORKING AROUND THE ENGINE.

C. Exhaust Characteristics (Figure 501)

(1) Velocity. At high engine speeds the exhaust may pick up and blow loose dirt, sizeable stones, sand and debris a distance of several hundred feet. Therefore, due caution must be used in parking the aircraft for run-up to avoid injury to persons or damage to property or other aircraft. A blast fence is suggested if the engines are going to be run-up for trim and power adjustment in an area where there is not sufficient space available for dissipation of the exhaust blast.

(2) Temperature. High temperature will be found up to several hundred feet from exhaust nozzle depending on wind conditions. Closer to engine, exhaust temperature is high enough to deteriorate bituminous pavement, therefore, concrete aprons are suggested for run-up areas. Occasionally when a jet engine is started, excess fuel that has accumulated in the tailpipe ignites and long flames are blown out of exhaust nozzle. Possibility of this hazard must be watched and all flammable materials kept in the clear.

(3) Toxicity. Tests have indicated that carbon monoxide content is low but other gases are present which have disagreeable odor and are irritating in effect. Exposure will usually cause watering or burning sensation of the eyes. Less noticeable but important is respiratory irritation which may be caused. For both these reasons exposure must be avoided, particularly in confined spaces or pockets where concentration may build up.

D. Engine Cool Down

WARNING: USE APPROPRIATE HAND PROTECTION WHEN WORKING AROUND ENGINE AREAS WHICH ARE LIKELY TO BE HOT.

(1) After engine operation no work or inspection shall be done on tailpipe for at least one-half hour, preferably longer. All other parts may usually be worked upon without danger.

(2) Certain parts of the engine which contain or are exposed to high compressor air, like fuel deicing air tubing and anti-icing air tubing, may be hot immediately after engine shutdown. The use of insulated gloves is recommended whenever work must be performed on the engine in the vicinity of such parts soon after engine shutdown.

E. Engine Noise

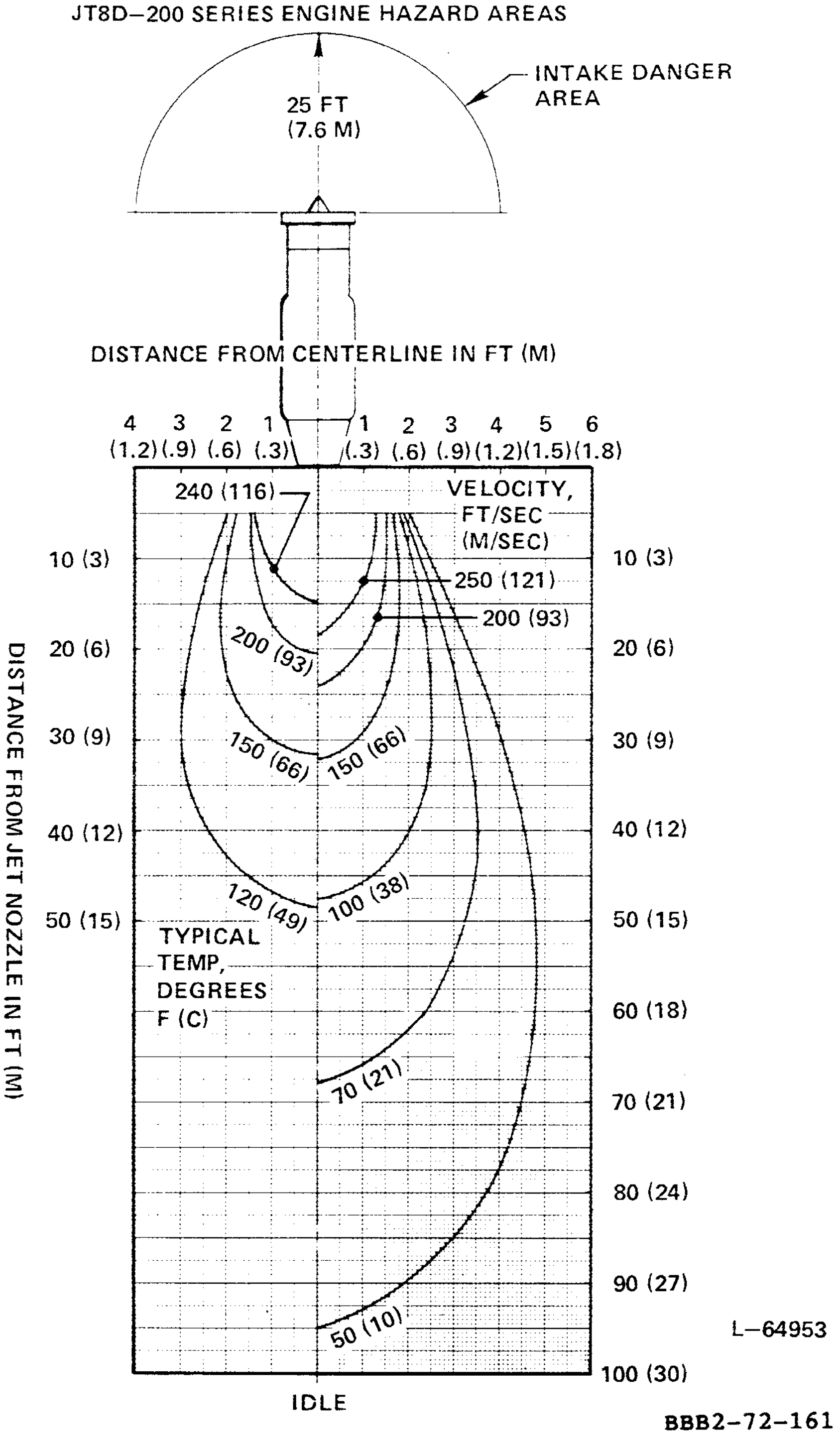
(1) Jet engines typically produce noise capable of causing temporary, as well as permanent, loss of hearing. Even short exposures to extreme noise may result in damage to ears and all personnel must use some means of protection. Noise can effect ear mechanism in such a way as to cause unsteadiness or inability to walk or stand without reeling. Therefore, use of cup type ear protection is recommended. If engines are to be serviced from aero-stands or platforms these shall be equipped with protective railings to prevent falls.

WARNING: THE JT8D ENGINE IGNITION SYSTEM IS CHARACTERISTICALLY HIGH IN ENERGY. THE NATURE OF THE SYSTEM IS SUCH AS TO RENDER IT A HAZARDOUS, POSSIBLY FATAL, SOURCE OF ELECTRICAL SHOCK UNLESS NECESSARY PRECAUTIONS ARE EXERCISED. DO NOT TOUCH IGNITER PLUGS WHEN IGNITION IS ON. DO NOT TEST IGNITION SYSTEM WHEN PERSONNEL MAY BE IN CONTACT WITH IGNITER PLUGS OR WHEN FLAMMABLE MATERIALS ARE NEARBY.

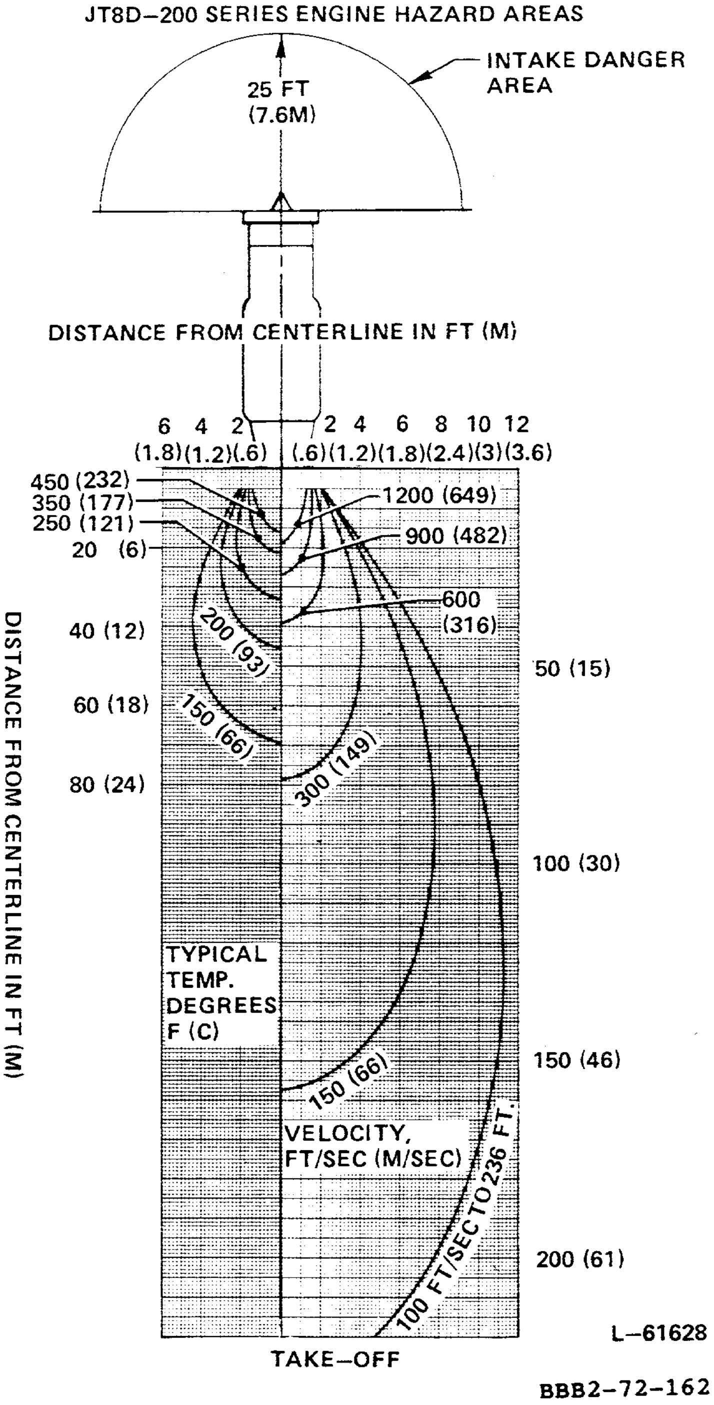
F. Engine Ignition

G. Fuel And Lubricating Oils

(1) All fuels and lubricating oils tend to dry the skin. Precautions shall be taken to avoid contact as much as possible.



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-892 (Sheet 1 of 2)



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-892 (Sheet 2 of 2)

2. Testing Information

A. General

(1) Pratt & Whitney strongly recommends that the measurement and setting of engine thrust be accomplished by use of turbine discharge pressure and compressor inlet pressure as the primary parameters, while using engine speed, tailpipe temperature, and fuel flow as secondary parameters to monitor engine condition, and as limits. Engine speed (low and high compressor RPM) is not a sufficiently accurate indicator of thrust, to provide adequate control of engine thrust and internal conditions under normal service operation. Therefore, the engine fuel control is adjusted in order to obtain desired turbine discharge pressure (P_{t7}) or engine pressure ratio (P_{t7}/P_{t2}) shown on applicable engine trim curves. Turbine discharge pressure or pressure ratio overshoot, or higher than normal reading, may be noted when power lever is first advanced to PART THRUST stop on a cold engine. For accurate indication of engine thrust during engine test or trimming, engine must be allowed to stabilize.

NOTE: It is suggested that a remote fuel control trimmer such as is available from Lear Siegler Inc. be employed when trimming engine.

(2) Whenever trimming engines installed in aircraft, aircraft manufacturer's trim curves, corrected for specific inlet duct loss, must be used.

NOTE: The procedures contained in Chapter 72 are the engine manufacturer's originated data. However, for engine operational and trimming data, refer to SUBJECT 71-00-00.

(3) Symbols have been designated for the various stations within the engine, and the external working pressures and temperatures. These variables are listed in Table 501 below:

Table 501 Engine Station Symbols

TAMB	Compressor Ambient Temperature
PAMB	Compressor Inlet Ambient Pressure
N_1	Low Pressure Compressor RPM
N_2	High Pressure Compressor RPM
Ps3	Intercompressor Static Pressure
Ps4	Bleed Annulus Static Pressure
P_{t2}	Compressor Inlet Total Pressure
T_{t7}	Turbine Discharge Total Temperature
P_{t7}	Turbine Discharge Total Pressure
P_{t7}/PAMB	Engine Pressure Ratio
PBAR	True Barometric Pressure

(4) The extent of repair and replacement will vary with each engine; therefore, the degree of test necessary to demonstrate satisfactory repair will vary also. To minimize ground running and to conserve fuel, this section provides five ground test procedures which are related to the extent of repair or replacement. Before attempting to test an engine after repair, the applicable sections of the Table Table 507 must be consulted to determine the test required for any given engine repair.

(5) The Engine Check Chart provides the general operating condition limits and references to the necessary test curves for testing an installed engine. The ratings listed in the Engine Check Chart are described as follows and are obtained by positioning the power lever to a predetermined turbine discharge pressure (P_{t7}):

(a) Maximum Takeoff - This is the maximum thrust certified for takeoff. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. In the event of an engine out situation this rating is provided by the Reserve Takeoff Thrust mechanism when operating at the Normal Takeoff rating. This rating is time-limited to a total of five (5) minutes including the time spent at the Normal Takeoff Rating.

(b) Normal Takeoff - The Normal Takeoff Rating is the maximum thrust normally set for takeoff operation. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. The rating is time limited to five (5) minutes.

(c) Maximum Continuous - The Maximum Continuous Rating is the maximum thrust certified for continuous use. For the purpose of P&W service policy coverage and prolonging engine life, this rating should be used, at the pilot's discretion, only when required to ensure safe flight. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(d) Maximum Climb - Maximum Climb thrust is the maximum thrust approved for normal climb. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(e) Maximum Cruise - This is the maximum thrust approved for cruising. The Maximum Cruise is obtained in the same manner as Maximum Climb or Maximum Continuous thrust.

(f) Idle - This is not an engine rating but, rather, a power lever position suitable for minimum thrust operation on the ground or in flight. It is obtained by positioning the power lever in the IDLE detent or the IDLE stop position.

(g) Reverse - Reverse thrust will be obtained at power lever positions below IDLE.

B. Operating Limits and Performance Data

(1) JT8D-209: See Table 502.

Table 502 Engine Check Chart For JT8D-209

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			Operating Limits	
Thrust Setting	Time Limit (Minutes)	Max. Observed Exhaust Gas Temp. °F/(°C)	Oil Pressure (PSIG) Normal (7) (8)	Maximum Oil Temperature °F(°C) (10)
Maximum Takeoff	5 (3)	1058°F (570°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Continuous	Continuous	986°F (530°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Climb	Continuous	959°F (515°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Cruise	Continuous	941°F (505°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

Table 502 Engine Check Chart For JT8D-209 (Continued)

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			Operating Limits	
Thrust Setting	Time Limit (Minutes)	Max. Observed Exhaust Gas Temp. °F/(°C)	Oil Pressure (PSIG) Normal (7) (8)	Maximum Oil Temperature °F(°C) (10)
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting				
Ground		932°F (500°C) (6)	(9)	
Flight		1058°F (570°C) (6)		
Acceleration T.O. (4)		1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.K. for procedures related to oil temperature.

C. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-209

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 7,850 RPM (95.5 percent) for N_1 and 12,150 RPM (99.2 percent) for N_2.

2) Engines run at speeds between 7,850 - 8,150 RPM (95.5 - 99.2 percent) N_1 or 12,150 - 12,370 RPM (99.2 - 101.0 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) function and determine cause and correct problem prior to reactivating ART (RTT) function.

3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,370 RPM (101.0 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.C.(1)(a)1) or Paragraph 2.C.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If visual inspection reveals physical damage, or if N_1 speed exceeds 8,450 RPM (102.8 percent), or if N_2 speed exceeds 12,550 RPM (102.5 percent) proceed as follows:

1) Remove high and low compressors and perform complete overhaul inspection.

2) Inspect all turbine disks for growth and hardness.

3) Inspect all turbine blades for stretch.

4) Inspect all disks and blades by fluorescent penetrant.

D. Overtemperature

(Figure 502), (Figure 503), (Figure 504)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition. (Figure 502), (Figure 503), (Figure 504)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C (see Figure 505 or Figure 506), it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time at peak temperature.

(5) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

E. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near or above maximum values listed above shall be investigated promptly.

F. Oil Inlet Overtemperature Limits and Procedures

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

G. Operating Limits and Performance Data

(1) JT8D-217, JT8D-217A, JT8D-217C, JT8D-219: See Table 503.

Table 503 Engine Check Chart For JT8D-217, -217A, -217C, -219

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Maximum Takeoff	5 (3)	1157°F (625°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1094°F (590°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting				
Ground		932°F (500°C)	(9)	
Flight		1157°F (625°C) (6)		
Acceleration (Maximum Takeoff) (4)	2	1166°F (630°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Acceleration (Normal Takeoff)	2	1103°F (595°C)		

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.K. for procedures related to oil temperature.

H. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-217

   (a) Normal Takeoff power level engine speed limits.

      1) Maximum permissible operating speeds are 7,770 RPM (94.5 percent) for N_1 and 12,285 RPM (100.3 percent) for N_2.

      2) Engines run at speeds between 7,770 - 8,150 RPM (94.5 -99.2 percent) N_1 or 12,285 - 12,550 RPM (100.3 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond permissible limits in Paragraph 2.H.(1)(a)1) or Paragraph 2.H.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,584 RPM (102.8 - 104.4 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is continued-in-service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(1)(e) below if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(1)(e) below if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(1)(e) below if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and (ENGINE GENERAL, SUBJECT 72-00-00, Page 601).

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

   a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

   b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is returned to service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,584 RPM (104.4 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(2) JT8D-217A, -217C

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,080 RPM (98.3 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,080 - 8,350 RPM (98.3 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,459 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12.675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.H.(2)(a) or Paragraph 2.H.(2)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

   NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(2)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(2)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(2)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and (ENGINE GENERAL, SUBJECT 72-00-00, Page 601).

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

   a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

   b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

   b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is continued-in-service.

10) Visually examine the 4th stage turbine blades to make sure that no blade shrouds are missing. Repair any 4th stage turbine with missing shrouds before the engine is continued-in-service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(3) JT8D-219

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,120 RPM (98.8 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,120 - 8,350 RPM (98.8 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.H.(3)(a) or Paragraph 2.H.(3)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(3)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(3)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(3)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and (ENGINE GENERAL, SUBJECT 72-00-00, Page 601).

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

I. Overtemperature

(Figure 502)

(Figure 505)

(Figure 506)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition.

(Figure 502)

(Figure 505)

(Figure 506)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C (see Figure 505 or Figure 506), it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time peak temperature.

(5) If two engines had overtemperature events, it is not permitted to install them on the same aircraft (if an engine was disassembled and given overhaul inspection and was found to be in good condition, this is not applicable).

(6) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below Idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

J. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near, or above maximum values listed above shall be investigated promptly.

Table 504

KEY TO Figure 505

CHART ZONE	ACTION
A	Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B. An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B. NOTE: A 25 flight hour fly back interval is permitted before doing Zone B corrective action. Another excursion into Zone A during the fly back interval requires the completion of Zone B corrective action before the next flight. Subsequent excursions into Zone A get Zone B corrective action.
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Disassemble the engine hot section and do full overhaul inspection. NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades. or Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the procedures specified for Zone D.
D	Disassemble the engine hot section and do full overhaul inspection. NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.
F	Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated.

Table 504 (Continued)

KEY TO Figure 505	
CHART ZONE	**ACTION**
	If an engine goes into Zone F four times since the last time the engine hot section got full disassembly and inspection, and an external cause for the overtemperature is not found, a borescope inspection (refer to Inspection/Check-01) can often find the problem (an internal condition can be the cause of the overtemperature).
G	No action necessary
NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades. NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades. NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.	

Table 505

KEY TO Figure 506	
CHART ZONE	**ACTION**
A	De-energize the ART system and find the cause of the overtemperature. Correct the cause before the ART system is energized. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B. An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized.

Table 505 (Continued)

<table>
<tr><th colspan="2">KEY TO Figure 506</th></tr>
<tr><th>CHART ZONE</th><th>ACTION</th></tr>
<tr><td></td><td>Disassemble the engine hot section and do full overhaul inspection.
or
Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1)
An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D.
Total time in this zone must not be more than 30 seconds per event. An engine above these limits must get the procedures specified for Zone D.</td></tr>
<tr><td>D</td><td>Disassemble the engine hot section and do full overhaul inspection.</td></tr>
<tr><td colspan="2">NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.</td></tr>
<tr><td>G</td><td>No action necessary</td></tr>
<tr><td colspan="2">NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades.
NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades.
NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.</td></tr>
</table>

K. Oil Inlet Overtemperature Limits and Procedures.

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

(2) After complying with the above and providing no engine damage is indicated, engine may be continued in service.

(3) If oil-in temperature exceeds 329°F (165°C) for any interval, remove engine to overhaul and inspect all main and accessory drive bearings for hardness and condition. All main shaft seals shall be inspected for condition.

L. Engine Windmilling or Oil Pressure Interruption/Low Oil Pressure

NOTE: You must record operating conditions before and after any oil pressure interruption, low oil pressure indication, engine shutdown and windmilling to find classification of windmilling.

NOTE: The classification of windmilling is based on time and oil pressure. Although the engine must show continuous oil pressure after shutdown, the oil pressure after in-flight shutdown (IFSD) (after the engine becomes stable) is what is used for the classification of the windmilling. Because oil pressure is a function of ram air, this pressure will usually decrease to less than 10 psi (68.9 kPa) during the descent and approach phases. Also the oil pressure can show zero when the ram air can no longer cause sufficient oil pump rotation (during landing, rollout, and taxi). These conditions are acceptable and do not change the classification of windmilling.

(1) Engine Windmilling

(a) Inspect all engines that have windmilled as a result of shutdown in flight.

NOTE: Operator must also do all corrective actions necessary to find cause of in flight engine shutdown.

(b) If an engine windmilled for 30 minutes or less, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can continue in service after satisfactory inspection of main oil filter and chip detectors (if installed), servicing of engine and ground run-up.

NOTE: Ground run-up is a normal start, followed by five minutes at idle then a normal shutdown.

Chip detectors are optional equipment. If installed, they are part of windmilling inspection procedure.

(c) If an engine windmills for more than 30 minutes but less than 60 minutes, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can be continued in service after satisfactory examination of main oil filter and chip detectors (if installed), servicing of engine and ground run-up. In addition, use a Spectrometric Oil Analysis Program (SOAP) requesting concentrations of Iron (Fe), Vanadium (V) and Molybdenum (Mo) as indicators of main shaft bearing distress. Refer to JT8D Oil Monitoring Guide (P&W Part Number 821432), Section "G" for more information on SOAP. Do main oil filter, chip detectors (if installed) and SOAP inspection after first flight, at 15 hours, at 50 hours and at 100 hours. Do any corrective action required.

NOTE: JT8D Oil Monitoring Guide - Part No. 821432

This guide describes the inspections and tests that can be done to the engine oil to find if there is something that should be done before it leads to an untimely removal of the engine. This guide will show various inspections and tests, in its own section that will identify and describe each, as well as provide information as to the results that will be found and how to understand them to best maintain the engine. For this purpose, the guide also includes tables and illustrations that give guidelines or samples of “limits” used in the field for various analysis techniques.

(d) If an engine windmilled for more than 60 minutes with more than 10 psi (68.9 kPa) of continuous oil pressure after engine shutdown or engines that windmilled for any length of time with 10 psi (68.9 kPa) or less oil pressure after shutdown, operator must disassemble it for an Oil System Components Inspection.

NOTE: Oil System Components Inspection includes a visual and dimensional inspection of all Bearings (Main and Accessory), seals and gears in both Engine and Main Accessory Gearbox. Do a careful inspection of No. 2, 3, 4 and 5 bearings. Bearing cages must not show excessive wear. No ball or roller skidding, loss of hardness or shape because of overheating is permitted. Acceptable parts may be continued in service.

(2) Oil Pressure Interruption/Low Oil Pressure

CAUTION: ANY POWER OPERATION AT OR ABOVE IDLE WITH OIL PRESSURE OF 34 PSI (234.4 KPA) OR LESS REQUIRES ENGINE TO BE DISASSEMBLED FOR AN OIL SYSTEM COMPONENTS INSPECTION.

(a) Be careful to operate engine with sufficient oil pressure.

M. Breather Pressure

(1) General

(a) Breather pressure is differential between gearbox internal pressure and pressure at gearbox breather discharge port.

(b) Prior to checking breather pressure, it is important to remove all hardware for gearbox breather port, including short breather outlet duct. Experience has shown that this duct affects reading obtained, and correction factors have been unreliable.

(2) Limits

(a) During acceptance test, breather pressure as determined by the differential between engine accessory gearbox pressure and the pressure measured in the disposal system immediately adjacent to the accessory gearbox discharge port shall not exceed 1.8 psi (12.4 kPa). Allow engine to remain at Normal Takeoff two minutes minimum. Record the breather pressure (see NOTE below). Bring the engine power back to idle. Shut the engine down.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

NOTE: Engines with breather pressure tests conducted using continuous permanent recording equipment may be continued in service if the steady state limit of 1.8 psi (12.4 kPa) is exceeded for not more than 30 seconds and the pressure level does not exceed 3.0 psi (20.7 kPa). An engine accepted to this additional limit must be put on watch and a repeat test conducted every 50 cycles thereafter.

N. Fuel and Oil Leakage Limits

(1) Fuel or oil leakage from overboard drains, accessory drive seal drains, or No. 6 bearing sump is acceptable provided leakage is within the following limits:

Table 506

Location	Fluid	Allowable Leakage
Gearbox Starter Drive Overboard Drain	Oil	10 cc/hr

Table 506 (Continued)

Location	Fluid	Allowable Leakage
Gearbox Hydraulic Pump Drive Overboard Drain	Oil	10 cc/hr
No. 1, 2 And 3 Bearing Fluid Seal Drain	Oil	0.5 cc/min (10 drops per min) from each drain.
No. 4 Bearing Air Check Valve	Oil	Oil leakage from check valve at Idle power is normal.
Fuel Pump Drive Overboard Drain	Oil	10 cc/hr
Fuel Pump Drain	Fuel	60 cc/hr with engine running or shut down
Fuel Control Drain	Fuel	None
P&D Valve	Fuel	None
Exhaust Case - No. 6 Bearing Sump	Oil	Oil wetness not resulting in oil puddling within 20 minutes after engine shutdown.
Combustion Chamber Drain	Fuel	1. No leakage with engine running. 2. 90 cc maximum one time upon engine shutdown. 3. 60 cc/hr maximum after engine shutdown.
Combustion Chamber Drain and/or Wet 1st Stage Turbine Vanes/Blades	Oil	1. For engines without SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed: a. Be sure the condition seen is oil leakage and not fuel leakage. b. Operate the engine at idle for five minutes, then approximately cruise power or 1.8 EPR for five minutes, then at idle again for five minutes. Then shut down. c. After engine shutdown look for oil leakage from the combustion chamber drain (when it occurs, leakage usually starts ten minutes or less after shutdown). d. Engine removal for repair is necessary if oil leakage from the combustion chamber drain is more than 40 drops (or 2.0 cc), per minute. If oil leakage from the drain is less than 40 drops (or 2.0 cc), the engine can return to service with these limits: 1) Do a breather pressure test (must be in limits). 2) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection). 3) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 2. For engines with SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed:

NOTE: Oil leakage from the combustion chamber drain and/or wet 1st stage turbine vanes/ blades is not permitted if the engine is post SB A6196 - Improved No 5. bearing oil return and compartment sealing.

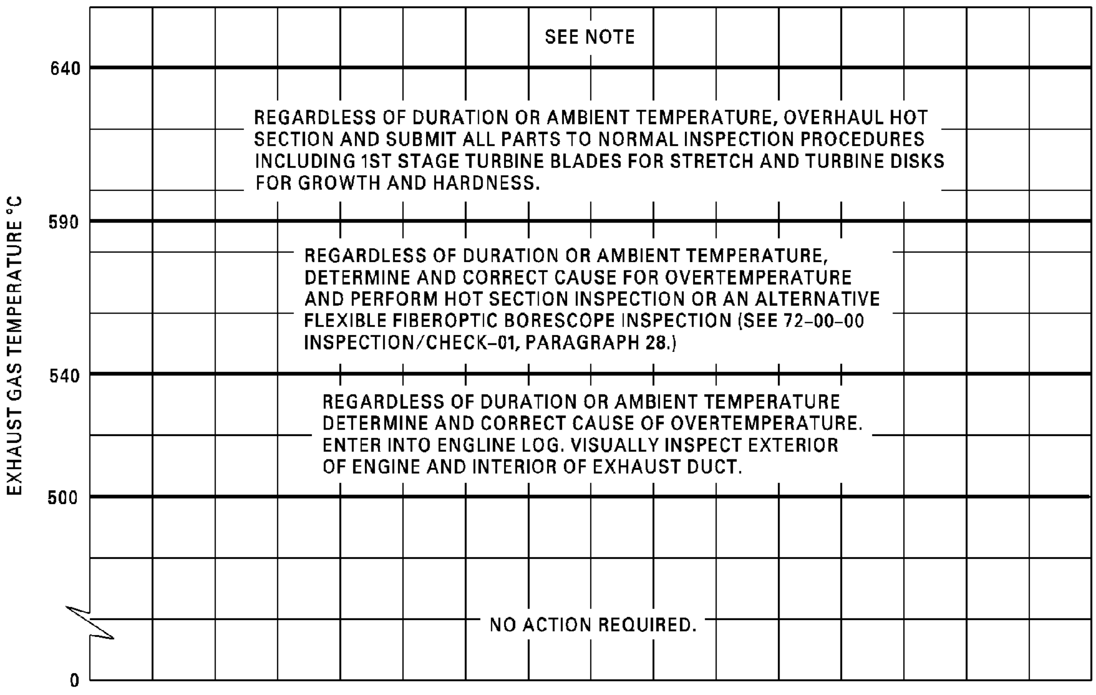
Table 506 (Continued)

Location	Fluid	Allowable Leakage
		a. Be sure the condition observed is oil leakage and not fuel leakage. b. Do a visual inspection of the No. 4 - 5 scavenge oil temperature indicators as specified in SB A5944/SB 6101. c. If indicator color has changed, do corrective action as specified in SB A5944/SB 6101. d. If indicator color did not change, return engine to service with these limits: 1) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection). 2) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 3) Monitor the SB A5944/SB 6101 indicators at the intervals given in SB A5944/SB 6101.

(2) If leakage is found outside of the above limits the problem shall be repaired and the engine further tested using the following as a guide.

- (a) For overboard drain leakage, run engine for five minutes at Max. Continuous and five minutes at Normal Takeoff.
- (b) For accessory drive seal leakage and parting surface leakage, run engine for ten minutes at Max. Continuous and five minutes at Normal Takeoff.

JT8D-209, -217,-217A -217C, -219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, OVERHAUL HOT SECTION AND SUBMIT ALL PARTS TO NORMAL INSPECTION PROCEDURES INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND TURBINE DISKS FOR GROWTH AND HARDNESS.

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, DETERMINE AND CORRECT CAUSE FOR OVERTEMPERATURE AND PERFORM HOT SECTION INSPECTION OR AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE 72-00-00 INSPECTION/CHECK-01, PARAGRAPH 28.)

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE. ENTER INTO ENGLINE LOG. VISUALLY INSPECT EXTERIOR OF ENGINE AND INTERIOR OF EXHAUST DUCT.

NO ACTION REQUIRED.

NOTE:

FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

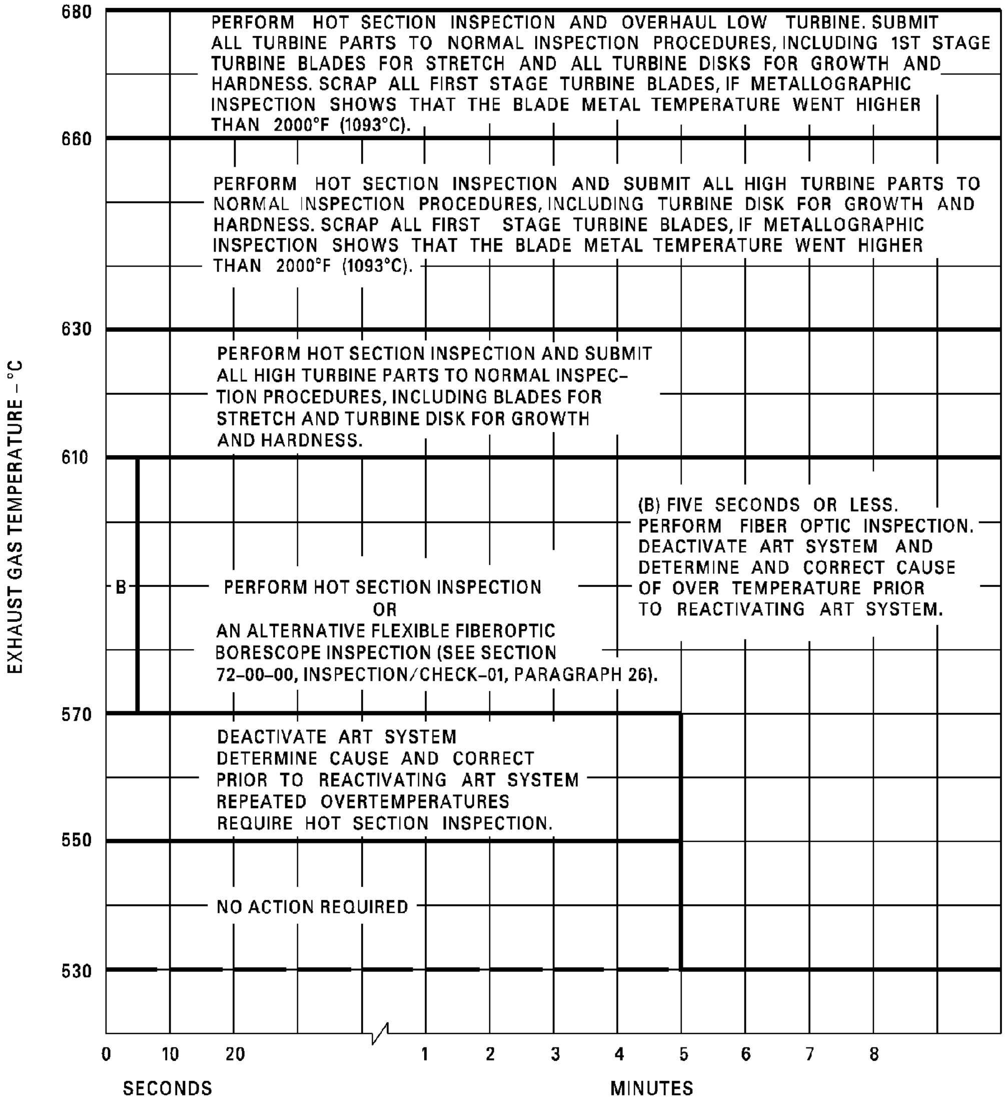
L-89085 (0299)

CAG(IGDS)

BBB2-72-40F

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 502/72-00-00-990-893

JT8D–209
NORMAL TAKEOFF
OVERTEMPERATURE LIMITS AND INSPECTION



PERFORM HOT SECTION INSPECTION AND OVERHAUL LOW TURBINE. SUBMIT ALL TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND ALL TURBINE DISKS FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING TURBINE DISK FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING BLADES FOR STRETCH AND TURBINE DISK FOR GROWTH AND HARDNESS.

(B) FIVE SECONDS OR LESS. PERFORM FIBER OPTIC INSPECTION. DEACTIVATE ART SYSTEM AND DETERMINE AND CORRECT CAUSE OF OVER TEMPERATURE PRIOR TO REACTIVATING ART SYSTEM.

PERFORM HOT SECTION INSPECTION
OR
AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE SECTION 72–00–00, INSPECTION/CHECK–01, PARAGRAPH 26).

DEACTIVATE ART SYSTEM
DETERMINE CAUSE AND CORRECT
PRIOR TO REACTIVATING ART SYSTEM
REPEATED OVERTEMPERATURES
REQUIRE HOT SECTION INSPECTION.

NO ACTION REQUIRED

NOTE:

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR–COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

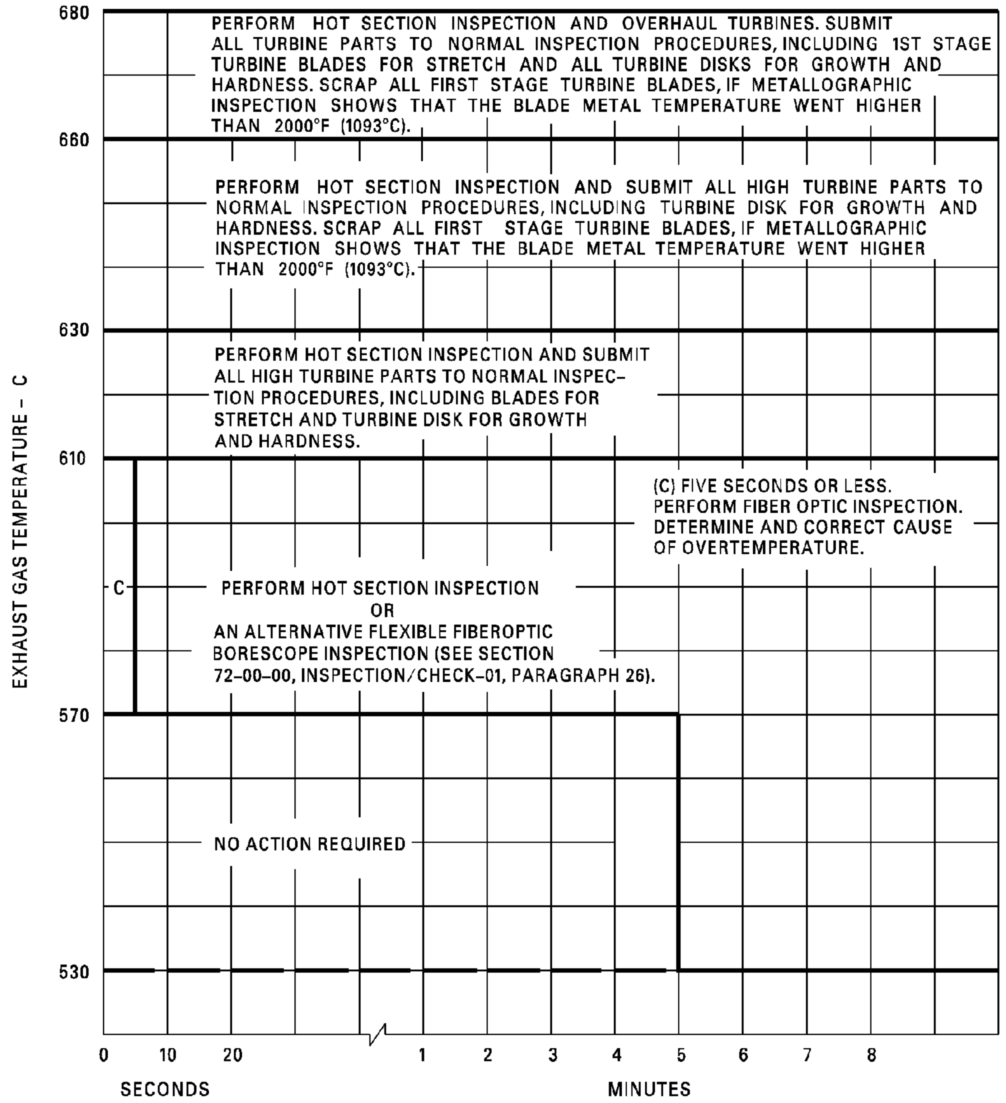
L–89086 (0299)

CAG(IGDS)

BBB2–72–163C

Normal Takeoff Overtemperature Limits and Inspection Procedures
Figure 503/72-00-00-990-894

JT8D–209
MAXIMUM TAKEOFF AND AIR STARTING
OVERTEMPERATURE LIMITS AND INSPECTION



PERFORM HOT SECTION INSPECTION AND OVERHAUL TURBINES. SUBMIT ALL TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND ALL TURBINE DISKS FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING TURBINE DISK FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING BLADES FOR STRETCH AND TURBINE DISK FOR GROWTH AND HARDNESS.

(C) FIVE SECONDS OR LESS. PERFORM FIBER OPTIC INSPECTION. DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE.

PERFORM HOT SECTION INSPECTION
OR
AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE SECTION 72–00–00, INSPECTION/CHECK–01, PARAGRAPH 26).

NO ACTION REQUIRED

NOTE:

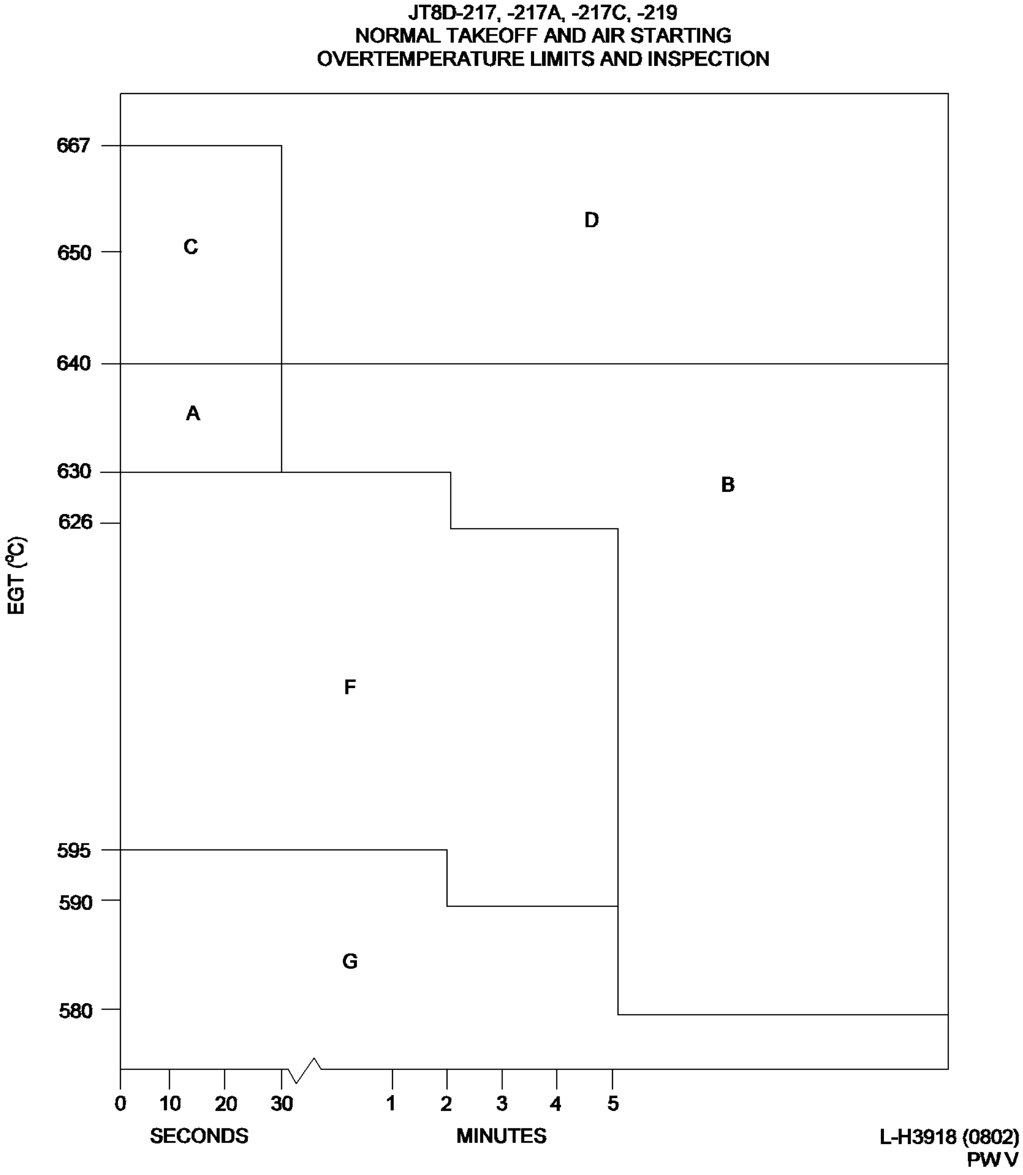
REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR–COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

L–89087 (0299)

CAG(IGDS)

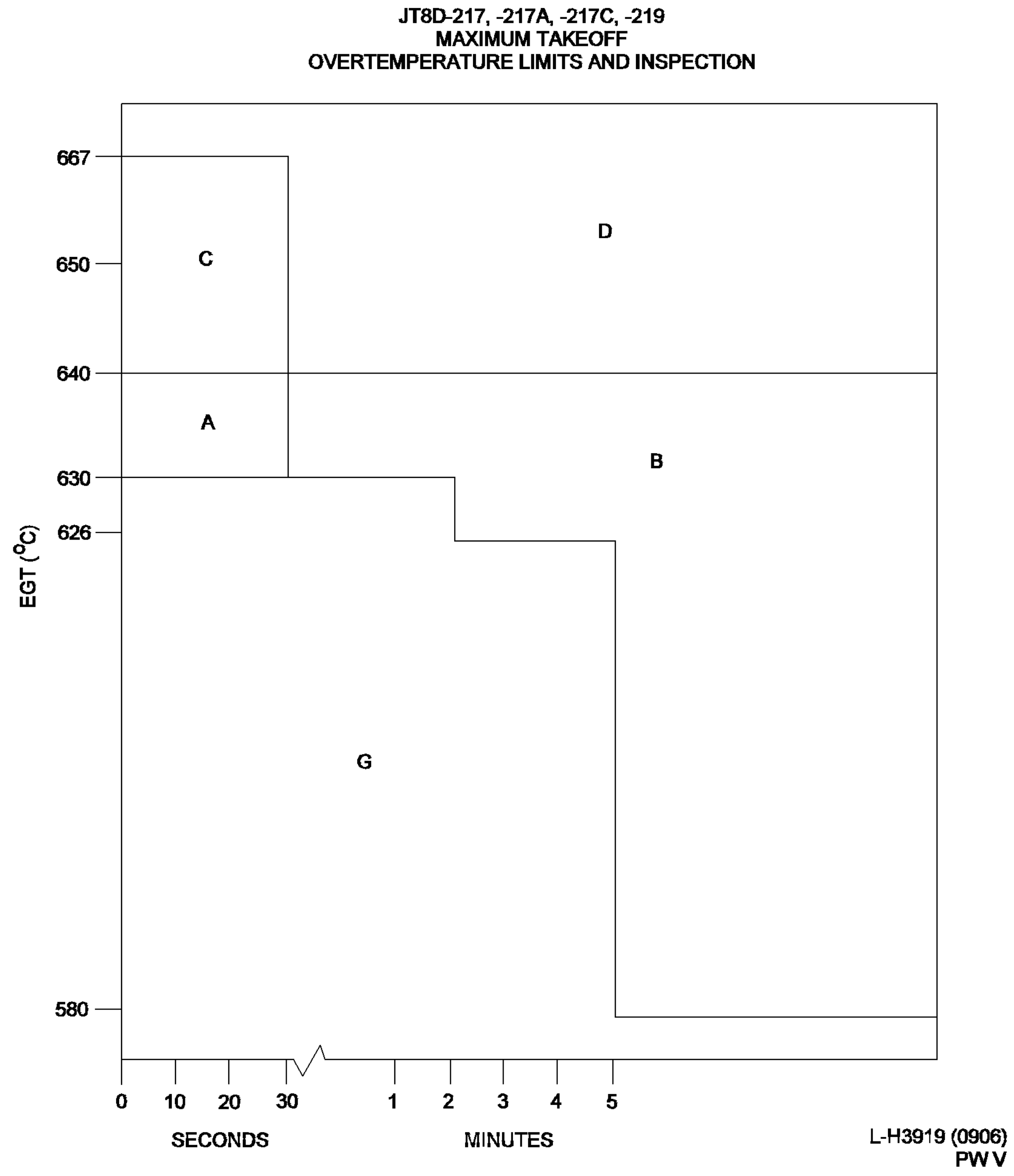
BBB2–72–164C

Maximum Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 504/72-00-00-990-895



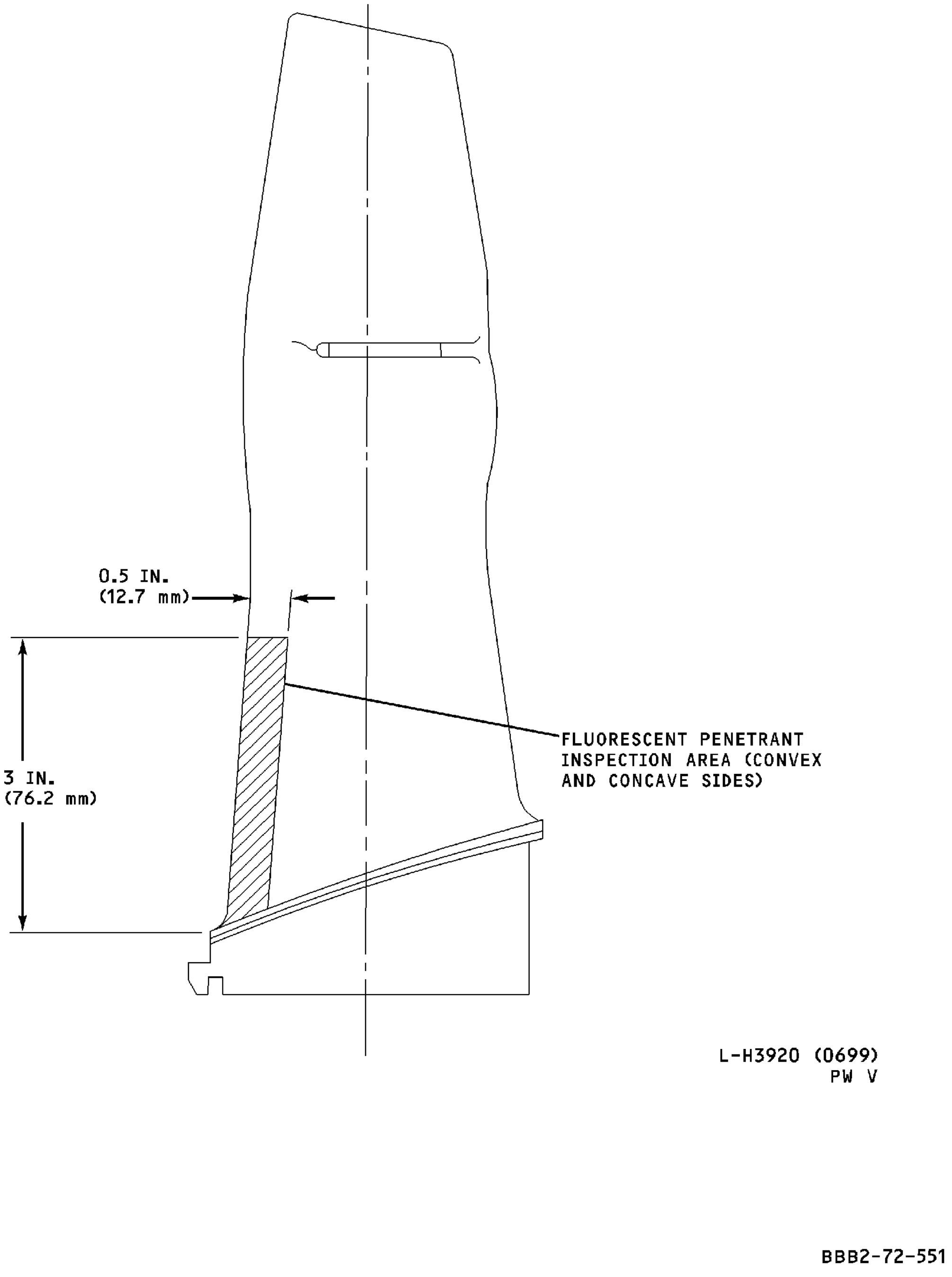
BBB2-72-549A
S0006554693V2

Normal Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 505/72-00-00-990-896



BBB2-72-550A
S0006554697V2

Maximum Takeoff Overtemperature Limits and Inspection Procedures
Figure 506/72-00-00-990-897



First Stage Compressor Blade Inspection Zone
Figure 507/72-00-00-990-898

3. Inspection Prior To Test

A. Fuel System Inspection

(1) Fuel System

(a) Visually check all fuel system tubes and components for security and leakage.

(b) Remove, clean if necessary and install the fuel pump filters.

(c) Remove, clean if necessary and install the fuel control filters.

(d) Check the fuel system for the presence of water.

(e) Service the fuel system with an approved fuel conforming to SB 2016.

NOTE: The engine should be ground tested and trimmed using the same grade fuel as used for flight operations. Slight variations for any given lever position will result if alternate fuels are used.

B. Oil System Inspection

(1) Oil System

(a) Remove, disassemble, clean, and reinstall the main oil strainer. Replace filter if cartridge type.

(b) Visually check all of the oil system tubes and components for security and leakage.

(c) Fill the oil tank with an approved oil conforming to Specification 521 Synthetic Oil.

NOTE: Approved oils are listed in Turbojet Engine Service Bulletin No. 238.

CAUTION: UP TO TWO GALLONS OF OIL MAY BE IN THE SCAVENGE SECTIONS; THEREFORE, OIL MUST NOT BE ADDED TO THE TANK UNTIL THE SCAVENGE SECTIONS ARE CLEANED. IF THE ABOVE PROCEDURE IS NOT FOLLOWED, EXCESSIVE OIL MAY BE ADDED WHICH WILL RESULT IN A BUILDUP OF SUFFICIENT INTERNAL PRESSURE TO RUPTURE THE TANK DURING ENGINE OPERATION.

(d) If oil is required after starting the engine, the engine shall be operated for approximately one minute at IDLE speed. This is required to make certain that any oil which may be in the scavenge section of the engine is returned to the tank, thereby assuring an accurate oil level check.

C. Electrical System Inspection

(1) Electrical System

(a) Check the ignition system components for security.

WARNING: BECAUSE THE VOLTAGE TO THE SPARK IGNITERS IS DANGEROUSLY HIGH, THE IGNITION SWITCH MUST BE IN THE "OFF" POSITION BEFORE REMOVAL OF ANY OF THE IGNITION SYSTEM COMPONENTS. APPROXIMATELY THREE MINUTES OF TIME MUST ELAPSE BETWEEN THE OPERATION OF THE IGNITION SYSTEM AND THE REMOVAL OF COMPONENTS WHEN A SPARK IGNITER LEAD IS DETACHED FROM A SPARK IGNITER, TOUCH THE END OF THE LEAD TO THE SHELL OF THE IGNITER TO DISSIPATE THE RESIDUAL ENERGY.

(b) Remove both spark igniters; check and reinstall.

D. Instrumentation System Inspection

(1) Instrumentation System

(a) Check engine instrumentation for security and general condition.

(b) Inspect the pressure sensing probes for security.

(c) Visually check all indicating thermocouples for security.

(d) Check the thermocouple harness and all lead insulations and shields for chafing and security.

E. Engine Controls Inspection

(1) Engine Controls

(a) Check the power lever for full travel, ease of movement and security.

NOTE: To prevent dilution of the bearing lubrication medium, protect the prepacked bearings used in the power cross shaft assembly during any washing process. The same precautions must be taken when fuel lines near this assembly are disconnected and fuel is, or may be, in these lines.

(b) Inspect the compressor bleed valve, override control, pressure ratio bleed control, and the air tubes for security.

F. Run-Up Area and Engine Inlet Duct Inspection

(1) Run-Up Area and Engine Inlet Duct

(a) Prior to starting the engine, the inlet must be thoroughly inspected and cleaned of possible loose nuts, bolts, tools and other objects which could cause engine damage and possible subsequent failure.

(b) Examine the inlet and exhaust areas to ensure against the presence of foreign objects which could, under some circumstances, enter the engine.

4. Engine Test Procedure

A. Starting Procedure for Pneumatic and Combustion Starters. (GENERAL, SUBJECT 71-00-00, Page 501)

B. Satisfactory Start. (GENERAL, SUBJECT 71-00-00, Page 501)

C. Unsatisfactory Start. (GENERAL, SUBJECT 71-00-00, Page 501)

D. Unsatisfactory Start Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

E. Clear Engine Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

F. Determination of Corrected N_2 Speed. (Figure 508 and Figure 509)

(1) Corrected N_2 speed is determined as shown in Figure 508.

(2) JT8D engine experience indicates a recommended high rotor data plate speed deterioration limit of plus 1.8 percent minus 0.8 percent corrected RPM be established.

G. Max. Observed Exhaust Gas Temperature & Spread Check.

(1) A check of the exhaust gas measurement system shall be made following a stabilization at Normal Takeoff power. Remove four screws and cover from thermocouple cable junction box located at 7 o'clock on rear rail of turbine exhaust outer duct. Remove nine nuts, chromel bus bar and two leads. Position PWA 45563 Adapter on the studs and secure with nuts previously removed. Torque nuts to 15 - 18 in-lb. (1.695 - 2.034 N·m), then connect instrumentation. Maximum allowable T_{t7} for any single probe reading is the maximum limit with averaging harness plus 110°F (61°C). Readings from each T_{t7} probe shall be recorded and maximum acceptable spread shall not exceed 230°F (127.8°C). Remove PWA 45563 Adapter, reinstall two leads, chromel bus bar and nine nuts. Torque nuts to 15 -18 in-lb. (1.695 - 2.034 N·m), then install and secure junction box cover.

(2) The JT8D Part Power Trim temperature spread check shall not exceed 230°F (127.8°C).

H. Shutdown Procedure. (GENERAL, SUBJECT 71-00-00, Page 501).

I. Anti-Surge Bleed Operation Limits Refer to Paragraph 6.F..

N2 CORRECTION

(1) Corrected N2 (%) $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}}$

Where: $\sqrt{\theta} = \sqrt{\dfrac{\text{Compressor Inlet Temperature}\ ^{\circ}\text{K}}{288}}$

(2) From the Inlet Temperature Correction Factor Chart determine N2 correction factor ($\sqrt{\theta}$) for compressor inlet temperature -

(3) Divide observed N2 speed by $\sqrt{\theta}$ -

Example: Inlet temperature = 30°C (86°F)

$\sqrt{\theta}$ (From the Inlet Temperature Correction Factor Chart) = 1.026

Observed N2 = 87.5%

Corrected N2 $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}} = \dfrac{87.5\%}{1.026} = 85.3\%$

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Rotor Speed Correction
Figure 508/72-00-00-990-899

INLET TEMPERATURE CORRECTION FACTOR

Tt2				Tts				Tts			
°C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	°C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	°C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$
48.3	119	1.056	1.118	15.0	59	1.000	1.000	−18.3	−1	0.940	0.882
47.8	118	1.055	1.115	14.4	58	0.999	0.998	−18.9	−2	0.939	0.880
47.2	117	1.054	1.113	13.9	57	0.998	0.996	−19.4	−3	0.938	0.878
46.7	116	1.054	1.113	13.3	56	0.997	0.994	−20.0	−4	0.937	0.876
46.1	115	1.053	1.111	12.8	55	0.996	0.992	−20.6	−5	0.936	0.874
45.6	114	1.052	1.109	12.2	54	0.995	0.990	−21.1	−6	0.935	0.873
45.0	113	1.051	1.106	11.7	53	0.994	0.988	−21.7	−7	0.934	0.871
44.4	112	1.050	1.104	11.1	52	0.993	0.986	−22.2	−8	0.933	0.869
43.9	111	1.049	1.102	10.6	51	0.992	0.984	−22.8	−9	0.932	0.862
43.3	110	1.048	1.100	10.0	50	0.991	0.982				
42.8	109	1.047	1.098	9.4	49	0.990	0.980	−23.3	−10	0.931	0.865
42.2	108	1.046	1.096	8.9	48	0.989	0.978	−23.9	−11	0.930	0.863
41.7	107	1.045	1.094	8.3	47	0.988	0.976	−24.4	−12	0.929	0.861
41.1	106	1.044	1.092	7.8	46	0.987	0.974	−25.0	−13	0.928	0.859
40.6	105	1.043	1.090	7.2	45	0.986	0.973	−25.6	−14	0.927	0.857
40.0	104	1.042	1.088	6.7	44	0.985	0.971	−26.1	−15	0.926	0.855
39.4	103	1.041	1.086	6.1	43	0.984	0.969	−26.7	−16	0.925	0.853
38.9	102	1.041	1.084	5.6	42	0.984	0.967	−27.2	−17	0.924	0.851
38.3	101	1.040	1.083	5.0	41	0.983	0.965	−27.8	−18	0.923	0.849
37.8	100	1.039	1.081	4.4	40	0.982	0.963	−28.3	−19	0.922	0.842
37.2	99	1.038	1.079	3.9	39	0.981	0.961	−28.9	−20	0.921	0.845
36.7	98	1.037	1.077	3.3	38	0.980	0.959	−29.4	−21	0.920	0.843
36.1	97	1.036	1.075	2.8	37	0.979	0.957	−30.0	−22	0.919	0.841
35.6	96	1.035	1.073	2.2	36	0.978	0.955	−30.6	−23	0.918	0.839
35.0	95	1.034	1.071	1.7	35	0.977	0.953	−31.1	−24	0.917	0.837
34.4	94	1.033	1.069	1.1	34	0.976	0.951	−31.7	−25	0.916	0.835
33.9	93	1.032	1.067	0.6	33	0.975	0.949	−32.2	−26	0.914	0.833
33.3	92	1.031	1.065	0.0	32	0.974	0.947	−32.8	−27	0.913	0.831
32.8	91	1.030	1.063	−0.6	31	0.973	0.945	−33.3	−28	0.912	0.829
32.2	90	1.029	1.061	−1.1	30	0.972	0.943	−33.9	−29	0.911	0.828
31.7	89	1.029	1.059	−1.7	29	0.971	0.941	−34.4	−30	0.910	0.826
31.1	88	1.028	1.057	−2.2	28	0.970	0.939	−35.0	−31	0.909	0.824
30.6	87	1.027	1.055	−2.8	27	0.969	0.937	−35.6	−32	0.908	0.822
30.0	86	1.026	1.053	−3.3	26	0.968	0.935	−36.1	−33	0.907	0.820
29.4	85	1.025	1.051	−3.9	25	0.967	0.933	−36.7	−34	0.906	0.818
28.9	84	1.024	1.049	−4.4	24	0.966	0.931	−37.2	−35	0.905	0.816
28,3	83	1.023	1.047	−5.0	23	0.965	0.929	−37.8	−36	0.904	0.814
27.8	82	1.022	1.045	−5.6	22	0.964	0.927	−38.3	−37	0.903	0.812
27.2	81	1.021	1.043	−6.1	21	0.963	0.925	−38.9	−38	0.902	0.810
26.7	80	1.020	1.041	−6.7	20	0.962	0.923	−39.4	−39	0.901	0.808
26.1	79	1.019	1.039	−7.2	19	0.961	0.922	−40.0	−40	0.900	0.806
25.6	78	1.018	1.037	−7.8	18	0.960	0.920	−40.6	−41	0.899	0.804
25.0	77	1.017	1.035	−8.3	17	0.959	0.918	−41.1	−42	0.897	0.802
24.4	76	1.016	1.033	−8.9	16	0.958	0.916	−41.7	−43	0.896	0.800
23.9	75	1.015	1.031	−9.4	15	0.957	0.914	−42.2	−44	0.895	0.798
23.3	74	1.014	1.029	−10.0	14	0.956	0.912	−42.8	−45	0.894	0.796
22.8	73	1.013	1.027	−10.6	13	0.955	0.910	−43.3	−46	0.893	0.794
22.2	72	1.012	1.026	−11.1	12	0.954	0.908	−43.9	−47	0.892	0.792
21.7	71	1.012	1.024	−11.7	11	0.953	0.906	−44.4	−48	0.891	0.790
21.1	70	1.011	1.022	−12.2	10	0.952	0.904	−45.0	−49	0.890	0.788
20.6	69	1.010	1.020	−12.8	9	0.951	0.902	−45.6	−50	0.889	0.786
20.0	68	1.009	1.018	−13.3	8	0.950	0.900	−46.1	−51	0.888	0.784
19.4	67	1.008	1.016	−13.9	7	0.949	0.898	−46.7	−52	0.887	0.783
18.9	66	1.007	1.014	−14.4	6	0.948	0.896	−47.2	−53	0.886	0.781
18.3	65	1.006	1.012	−15.0	5	0.947	0.894	−47.8	−54	0.885	0.779
17.8	64	1.005	1.010	−15.6	4	0.946	0.892	−48.3	−55	0.883	0.777
17.2	63	1.004	1.008	−16.1	3	0.945	0.890	−48.9	−56	0.882	0.775
16.7	62	1.003	1.006	−16.7	2	0.944	0.888	−49.4	−57	0.881	0.773
16.1	61	1.002	1.004	−17.2	1	0.943	0.886	−50.0	−58	0.880	0.771
15.6	60	1.001	1.002	−17.8	0	0.942	0.884	−50.6	−59	0.879	0.769

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Inlet Temperature Correction Factor Chart
Figure 509/72-00-00-990-900

5. Repair/Test Reference

(Table 507)

A. General

(1) Repair/test reference table lists various repairs, replacements and reinstallations and corresponding test to be performed following these actions. When more than one maintenance action has been done, combine different features of two or more tests, eliminate duplication, and perform resultant test during one period of operation. Where multiple tests each require single power setting, higher power setting shall be used.

(2) In order to achieve high degree of accuracy, it is recommended that all tests be conducted in P&W approved indoor test facility previous to installing engine in aircraft. However, in cases where such test facility was not available or if operator prefers to test engine on aircraft, test requirements are indicated in Table 507.

(3) It should be understood that quality of test data from an on-the-wing engine test may not be as accurate as data generated from indoor engine test facility. While quality of on-the-wing test data should be sufficient to determine if engine is acceptable, operator should be willing to sacrifice certain degree of troubleshooting or trend monitoring capability when relying on installed engine data.

Table 507 Repair/Test Reference

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Accessory Drive Seals	A
Anti-icing Air Shutoff Actuator And Valve	*[2]
Average Pressure Probe P_{t7} (8 Required)	B
Combustion Area Inspection	B
Combustion Chambers	B
Combustion Chamber Duct	F
Combustion Chamber Inner Case	F
Combustion Chamber And Turbine Fan Ducts	C
Compressor Inlet Duct	A
Compressor Inlet Group	A
Compressor Inlet and Front Compressor Section	B, I
Compressor Intermediate Group	F
Constant Speed Drive/Alternator Drive Oil Seal	A
Differential Fluid Pressure Switch	C
Diffuser Group	F
Diffuser Outer Fan Duct Group	C
Eighth Stage Bleed Valve	E
Engine Exhaust Case Section	G
Engine Oil Tank	A
Engine Oil Tank Drain Valve	None

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Fan Exhaust (Mixer) Rear Outer Duct	None
Fan Exhaust Outer Rear (Transition) Duct	None
Fan And Turbine Exhaust Duct (Mixer)	None
Fan Exit Stator Segments	None
First Stage Compressor (Fan) Blades	I(4)
First Stage Compressor Disk And Blade Assembly (Fan)	G(5), I(4)
First Stage Turbine Vanes (Through Hot Section With Turbines Installed)	B, H
First Stage Turbine Vanes (Turbines Removed)	F
Front Accessory Drive Group	A
Front Compressor Drive Turbine Group	F
Front Compressor Drive Turbine Group And Engine Exhaust Case Section Group	F
Front Compressor Drive Turbine Rotor And Stator Assembly	F
Front Compressor Rotor And Stator Assembly	G, I
Front Fan Case	A
Fuel Control (Replacement Fuel Control)	D, H
Fuel Control Condensation Trap	None
Fuel Control Main Filter	C
Fuel Deicing Air Shutoff Actuator And Valve	*[2]
Fuel Deicing Heater Assembly	C
Fuel Nozzle And Support Assemblies	B, H
Fuel Manifold Assembly	B, H
Fuel/Oil Cooler And Seals	C (6)
Fuel/Oil Cooler Bypass Valve And Seals	C (6)
Fuel/Oil Cooler Inlet Tube And Seals	C (6)
Fuel/Oil Cooler Outlet Sensing Tube And Seals	C (6)
Fuel Pressurizing And Dump Valve	C(3)
Fuel Pressurizing And Dump Valve Strainer	C
Fuel Pump (Same Fuel Control)	B(2), H
Fuel Pump Drive Oil Seal	A
Fuel Pump Filter	C
Fuel Pump And Fuel Control Package (Different Fuel Control)	D(2), H
Gearbox Coupling (Constant Speed Drive)	A
Gearbox Deairator Oil Seal	A
Hydraulic Pump Drive Oil Seal	A

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Igniter Plug (2 Required)	*[1]
Ignition Cable (2 Required)	*[1]
Ignition Exciter	*[1]
Main Accessory Gearbox Assembly (Same Fuel Control)	B
Main Accessory Gearbox Group (Same Fuel Control) (And Fuel Control Connecting Linkage)	B
Main Gearbox Drive Bevel Gearshaft And Bearings	B
Main Oil Filter (Strainer) And Seals	C (6)
Main Oil Pump And Seals	C (6)
N_1 Tachometer Drive Oil Seal	A
N_2 Tachometer Drive Gearshaft Oil Seal	A
No. 1 Bearing	G, I
No. 1 Bearing Air Sealing Ring And Seal Assembly	G, I
No. 1 Bearing Oil Scavenge Pump	A
No. 2 Bearing	F
No. 2 Bearing Seal Assembly	G, I
No. 3 Bearing And Seal	F
No. 4 Bearing	F
No. 4 Bearing Seal Assembly	F
No. 4 Bearing Sealing Ring	F
No. 4 And 5 Bearing Oil Pressure/Scavenge Tube (External) And Seals	A
No. 4 And 5 Bearing Oil Breather Tube (External) And Seals	B
No. 4 And 5 Bearing Oil Scavenge Pump	F
No. 4 1/2 Bearing, Seals And Seal Spacers	F
No. 5 Bearing And Seal Assembly	F
No. 6 Bearing And Seals	G, I
No. 6 Bearing Oil Scavenge Pump	A
Oil Filter Pressure Relief Valve And Seals	C (6)
Oil Pressure Relief Valve Assembly	C(1) (6)
Power Lever Cross Shafts	B
Pressure Ratio Bleed Control	E
Rear Compressor And Diffuser Section	F
Rear Compressor Drive Turbine Rotor And Shaft Assembly	F
Rear Compressor Drive Turbine Group	F

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Rear Compressor Exit Stator Assembly	F
Rear Compressor Through The Rear Compressor Drive Turbine Section	F
Rear Compressor Rotor And Stator Assembly	F
Rear Fan Case	G
Starter Drive Gearshaft Coupling	A
Starter Drive Oil Seal	A
Thermocouple - T_{t7} (8 Required)	None
Thermocouple Box And Cable Assembly - T_{t7}	None
Total Pressure Probe - P_{t2}	E
Turbine Exhaust Cone And Duct	None
Turbine Nozzle Group	F
Turbine Shaft Inner Heat shield Assembly	F
Turbine Shaft Outer Heat shield Assembly	F
13th Stage Bleed Valve	E
13th Stage Compressor Sealing Ring	F

(1) When engine oil pressure adjustment is required, install 0 - 50 PSIG (0.0 - 344.7 kPa) direct-reading gage to LP2 tap on main oil pressure manifold, vented to LV3 tap on main accessory gearbox housing. Adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa at Idle. 100°F (38°C) oil temperature is recommended during oil pressure adjustment. See Paragraph 8..

(2) After replacing fuel pump and performing engine test run, torque fuel pump quick-disconnect nut per PAGEBLOCK 73-00-00/601.

(3) During and after this test, carefully inspect for fuel leakage at fuel manifold inlet tube to P&D valve tube end fittings. No Leakage is permitted.

(4) See the locations that follow for a 24 hour flyback time limit permitted before the vibration check is necessary:

  (a) Section (ENGINE GENERAL, SUBJECT 72-00-00, Page 601) - Inspect First Stage Compressor Blades.

  (b) Section PAGEBLOCK 72-33-21/401 - Replace First Stage Compressor Blades.

  (c) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.

(5) See the location that follows for a 24 hour flyback time limit permitted before the breather pressure check is necessary:

  (a) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.

(6) Test A (Ground Check at Idle) is an option to Test C for leak check of these replaced parts, but Test A will not give the increased oil pressure that is typical during engine accelerations. If an oil leak problem is possible, use Test C (with the thrust level modification specified for leak check) to see if there are oil leaks.

*[1] Aural Check Igniter Firing With Engine Not Running.

*[2] Observe Valve Position While Actuating Valve With Engine Not Running.

6. Test For Repaired Engines

A. When cleaning engines prior to test, following precautions must be taken.

CAUTION: IF FUEL LINES ARE TO BE DISCONNECTED, PRE-PACKED BEARINGS IN THE AREA MUST BE PROTECTED FROM ANY LOST FUEL.

(1) Protect all prepacked bearings, such as cross-shaft or control rod linkage bearings.

(2) Protect pressure ratio bleed control.

(3) Protect silicone rubber shock mounts on oil tank and oil tank strap. Wash down area as soon as possible after washing with cleaning solution.

B. Test A - Ground Check at Idle

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Allow engine to run at IDLE for minimum of three minutes for oil system repair/replacement as required for oil temperature to reach 100°F (38°C).

(4) Shut down. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

C. Test B - Ground Check at Normal Takeoff

(1) Inspect and clean engine test area.

(2) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Operate engine at IDLE until readings have stabilized and oil temperature reaches minimum of 100°F (38°C).

(4) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(5) Stabilize for three minutes at Normal Takeoff.

(6) Check that oil pressure, oil temperature and EGT are within limits of Table 502

(7) Retard power lever to IDLE and operate engine for five minutes.

(8) Shut down engine (GENERAL, SUBJECT 71-00-00, Page 501) and perform normal engine inspection procedures. (GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 72-00-00/201)

NOTE: It is not necessary to inspect the oil filter if the oil system was not disturbed and no oil wetted components were replaced during the maintenance action.

D. Test C - Ground Check at 3000 lb/hr (1360 kg) Fuel Flow

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start engine(GENERAL, SUBJECT 71-00-00, Page 501) and allow to stabilize at idle for minimum of three minutes.

(3) Advance power lever as necessary until minimum of 3000 lb/hr of fuel flow is observed. Maintain for minimum of two minutes.

(4) After completion of check, return power lever to IDLE.

(5) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

E. Test D - Part Power Trim Check. (GENERAL, SUBJECT 71-00-00, Page 501).

F. Test E - Ground Check for Bleed System Operation. (Figure 510)

NOTE: This check is only applicable to the engine surge bleed system. With engines which have a 6th stage bleed system, refer to PAGEBLOCK 72-00-03/101 for a functional check. It is not possible to do a ground check of the 6th stage bleed system because the bleed closure and opening does not give a satisfactory engine parameter change.

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Run engine at IDLE until oil temperature reaches 100°F (38°C) minimum.

(4) Slowly accelerate engine and record N_1 speed at which anti-surge bleed valves close. Bleed closing is indicated by sudden increase in EPR.

(5) Slowly decelerate engine from stabilized point just above bleed valve closing and record N_1 speed at which anti-surge bleed valves open. Bleed valve opening is indicated by sudden decrease in EPR.

(6) Check bleed valve opening and closing per Figure 510.

(7) Retard power lever to Idle and shut down engine.

(8) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

(9) If anti-surge bleed valves do not open and close within limits of Figure 510, refer to PAGEBLOCK 72-00-03/101.

G. Test F - Acceptance and Performance

(1) Instrumentation Required

(a) N_1 - cockpit

(b) N_2 - cockpit

(c) EGT - cockpit

(d) EPR - cockpit

(e) Fuel Flow - cockpit

(f) Oil pressure - cockpit

(g) Oil temperature - cockpit

(h) PCP - external instrumentation - 0 - 200 psi (0.0 - 1379.0 kPa) range, measured at PCP fitting located on left side of engine diffuser case high pressure service bleed port near PS3 filter.

(i) PS4 - external instrumentation - 0 - 300 psi (0.0 - 2068.4 kPa) range, measured at PS4 fitting located on right side of engine diffuser case high pressure service bleed port at upper end of bleed valve actuation pressure supply line.

(j) P_{t7} - external instrumentation - 0 - 50 psi (0.0 - 344.7 kPa) range measured at P_{t7} line test fitting.

(k) Breather pressure - external instrumentation - 09 - 30 psi (0.0 - 206.8 kPa) range. Refer to Paragraph 6.H. for installation.

(l) Ambient temperature - Laboratory Quality Mercury Thermometer

(m) Ambient pressure - Local facilities

(n) Install vibration pickups at locations indicated in Figure 512. Connect to vibration monitoring instrumentation, including low frequency (40 cps) filter.

(2) To ensure accuracy of P_{t7} system, pressure check system as follows:

(a) Connect PWA 46415 (formerly 45513) Adapter to P_{t7} manifold outlet and attach source of dry, filtered compressed air, with PWA 21875 Regulator.

(b) Apply 35 - 45 PSIG (241.3 - 310.3 kPa) air pressure to P_{t7} system.

(c) Use soap and water solution, check each connection in manifold and at probes for leakage. No leakage is permitted.

(d) Disconnect and remove test equipment and reconnect manifold outlet.

(3) Verify proper exhaust nozzle area as specified by airframe manufacturer.

NOTE: Engine bleed and electrical loads must be minimized during test. Fuel heater, generator, air conditioning packs, anti-icing and low pressure airbleed must be off. However, generator cooling airbleed and hydraulic pumps shall be set as "low" or "no load".

(4) Inspect and clean engine test area.

(5) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Operate engine at idle for two minutes until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(7) Shut down engine and conduct Part Power Trim check per GENERAL, SUBJECT 71-00-00, Page 501.

(8) Service engine oil system and record oil level.

(9) Restart engine.(GENERAL, SUBJECT 71-00-00, Page 501) Inspect engine for evidence of fuel or oil leak.

(10) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(a) During acceleration, check that operation of anti-surge bleed valves is within limits of Figure 510, or applicable limits in airframe manufacturer's maintenance manual. If bleed valve operation is not within limits of Figure 510, refer to PAGEBLOCK 72-00-03/101.

(b) During acceleration, mark point on power lever pedestal where EPR is 0.03 EPR ratios above bleed closing point and preserve this mark for deceleration bleed control system check.

(c) Monitor engine vibration during acceleration to Normal Takeoff.

(d) Stabilize for three minutes at Normal Takeoff. Record a full set of the readings in Paragraph 6.G.(1) and make a mark to record the power lever position. Calculate 95 percent of Normal Takeoff N_2 and keep this result for the acceleration check.

(e) Check operation of fuel deicing system during this Normal Takeoff running. Open deicing air valve and observe change in fuel temperature using cockpit instrumentation. Fuel temperature must increase minimum of 104°F (58°C) in less than one minute after valve is opened. Do not adjust power lever for resultant loss of EPR. Do not allow fuel temperature to exceed 176°F (80°C). Close fuel deicing air valve.

(f) During Takeoff running, actuate engine anti-icing system. EPR should decrease by 0.08 - 0.11 ratio, when engine anti-icing air is turned on. Do not adjust power lever for resultant loss of EPR. Close engine anti-icing valves.

(11) Retard power lever to Descent/Ground Idle and deenergize idle select solenoid. Stabilize for seven minutes. Adjust idle speed to limits specified by airframe manufacturer.

(12) Operate the engine at Approach Idle for five minutes. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, calculate Normal Takeoff EPR and do the procedure again from Paragraph 6.G.(13).

(13) Advance power lever slowly (in 30 seconds minimum) to Normal Takeoff EPR determined in Paragraph 6.G.(10) and stabilize for no more and no less than 60 seconds.

(14) Retard the power lever to Approach Idle, and in not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the mark made on the quadrant in Paragraph 6.G.(10)(d), in not more than one second.

(15) Record with a stop watch the time from when the power lever starts to move to when the engine gets to the 95 percent N_2 limit as calculated in Paragraph 6.G.(10)(d).

(16) Go back to Approach Idle and do Paragraph 6.G.(12) thru Paragraph 6.G.(14) two times again.

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(17) Calculate the average of all three acceleration times and compare this average to the limit curve calculated by the airframe manufacturer for this procedure.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in this maintenance procedure (in which a stop watch is used) are to make sure that the acceleration time is accurately calculated, with the same result each time. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Takeoff N_2) as calculated from test cell procedures.

(18) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

(19) Retard power lever to EPR = 1.75. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(20) Retard power lever to EPR = 1.65. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(21) Advance power lever to EPR = 1.8. Stabilize for 30 seconds then snap power lever in one second or less to point on pedestal marked in Paragraph 6.G.(10)(b) just above bleed closing point. Deceleration bleed system is operating normally if bleed valve supply pressure (PS4) drops to near ambient pressure and then increases to normal PS4 pressure.

(22) Retard power lever to Idle. During deceleration, monitor engine vibration. Also check that anti-surge bleed valves open within limits of Figure 510.

(23) Conduct functional check of reverse thrust system per airframe manufacturer's maintenance manual instructions.

(24) Perform functional check of Reserve Takeoff Thrust system as specified by airframe manufacturer's instructions.

(25) Shut down engine and perform normal engine inspection procedures as specified by airframe manufacturer, including oil filter inspection. (GENERAL, SUBJECT 71-00-00, Page 501)

(26) Service engine oil tank as necessary. Record amount of oil added.

(27) Compute oil consumption for acceptance test. Oil consumption shall not exceed 0.1 gal/hr.

(28) Corrected N_1 vs EPR should be checked per Figure 513. This curve is designed to verify accuracy of the EPR system. During Takeoff and part power, record N_1 speed, EPR and T_{t2} at both part power and Takeoff after engine has stabilized. Check corrected N_1 according to Figure 513.

   (a) Engines which plot in band of Figure 513 are acceptable if all other operating limits are met.

(b) Engine plotting above band should be investigated for cause of high N_1. Troubleshooting must include leak check of P_{t7} indicating system. If no leaks are found, following items may also be investigated for cause of high N_1:

1) Inspect fan for FOD, blended blades.
2) Check N_1 indication system.
3) Waterwash engine per airframe manufacturer's instructions.

(c) If none of above items reduce high N_1 condition but all other operating limits are met, engine is acceptable. However, high N_1 condition may result in N_1 redline limiting situation on hot days.

(d) Engines which plot below band should be checked for N_1 indicating system problems and proper size exhaust nozzle. If N_1 indicating system is not cause of low N_1 speed, but all other engine operating limits are met, engine is acceptable.

(29) EGT shall be within recommended guidelines as specified in Figure 514. Available EGT margin at Normal Takeoff rating may be determined by calculating corrected EGT from data point observed EGT and TAMB as shown in notes on Figure 514 and computing difference relative to curve in Figure 514 at constant EPR.

(30) Oil pressure and oil temperature shall not exceed limits as specified in Table 502.

(31) Measure and record the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) and compare it to the limits in Figure 515.

FIGURE 72-00-00-990-906	NOTE
Sheet 3	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 4	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 5	A. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is in the range shown (between the Minimum limit and the lower limit), do the sub-idle leak check specified in the test.
	B. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is less than the lower limit, it will be necessary to remove the engine for disassembly and corrective action.

(a) If a JT8D-217C/219 engine (which is post-SB 6128 and pre-SB 6196) has a Pcp/Ps4 ratio less than the Minimum limit in Figure 515 (Sheet 5), do a sub-idle leak test as follows:

1) Attach containers to the No. 4 bearing scupper drain and the No. 5 bearing area (combution section) drain.

NOTE: For all engines a Pcp transducer (with an accuracy of ±0.1 psig) will be necessary to measure the low Pcp values at idle and lower accurately. You must not do an engine shutdown during the test procedure.

2) Do the usual acceptance test as specified in this section (but do not do an engine shutdown when the test is completed). Adjust the idle trim N2 to 46 percent (+0, -0.2 percent) and the maximum oil pressure to 50.0 psig (344.7 kPa) (-0, +0.5 psi (3.4 kPa)). Operate the engine at Idle for 20 minutes. Increase the Idle N2 to the Figure 533 limits, then do an engine shutdown.

a) Record the Pcp on all data points at idle or lower with the transducer specified above. If it is difficult to trim to low idle, or if the idle speed does not stay stable, tell Pratt & Whitney Engineering immediately.

3) After the test, look for streaks in the tailpipe and remove the drain bottles (record what is found in them). Attach new bottles, then (after an hour) remove these bottles and record what is in them.

4) Do a borescope inspection of the 1st stage turbine vane area (through the igniter plug ports) and look for wet surfaces or puddles of oil. Record the inspection results.

5) If no oil leaks are found, the engine is satisfactory. If oil leaks are found, remove the engine for disassembly to correct the leaks.

(32) Breather pressure shall not exceed limit given in Paragraph 2.M.(2).

(33) Vibration shall not exceed limits given in Table 508.

NOTE: If the engine vibration is above the limits, the operator can trim balance the engine on the aircraft to decrease vibration levels. However, trim balance only those engines on which the fan is replaced. See Paragraph 7..

Table 508 Acceptance Limits Vibration Amplitudes

Pickup Location	Single Amplitude	Double Amplitude
INLET SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
REAR SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
NOTE: The limits in this table are valid only when vibration pickups are mounted at locations specified and only when the low frequency filter (40 CPS) is selected in the vibration monitoring circuit.		

H. Test G - Breather Pressure Check (Figure 516 and Figure 517)

(1) Disconnect airframe breather duct from engine gearbox and leave gearbox port open.

(2) On engines with oil pressure transmitter vented to gearbox, disconnect airframe vent tube from gearbox LV3 fitting and remove fitting from gearbox port. On engines with oil pressure transmitter vented to ambient, remove fitting from gearbox LV3 port.

(3) Connect 0 - 10 PSIG (0.0 - 68.9 kPa) gage to LV3 port with the gage held above the LV3 port at all times (loops in the gage line can collect oil and cause false readings). Gage should be maximum-indication type with dial marker. Wire equipment securely to protect it from vibration. (Figure 516)

NOTE: If desired, PWA 33784 Cap may be used to obtain breather pressure measurement. Make sure the gage is held above the oil tank cap at all times to keep loops out of the gage line. See Figure 517. Breather pressure measured at this location will approximate breather pressure at gearbox LV3 port. If pressure reading obtained in the following procedure is close to or higher than limits given, procedure should be repeated with pressure gage connected to gearbox LV3 port.

WARNING: OBSERVE PROPER SAFETY PRECAUTIONS AROUND RUNNING ENGINE. WEAR EAR PROTECTORS AND STAY CLEAR OF ENGINE HAZARD AREAS. SEE "ENGINE GROUND SAFETY PRECAUTIONS" FOR ENGINE HAZARD DESCRIPTION.

(4) Start engine and operate at Idle for five minutes. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Slowly accelerate (60 seconds) to Normal Takeoff power (accelerate slowly to avoid possible overshoot on 0 - 10 psi (0.0 - 68.9 kPa) gage).

WARNING: OBSERVE PROPER SAFETY PRECAUTIONS AROUND RUNNING ENGINE. WEAR EAR PROTECTORS AND STAY CLEAR OF ENGINE HAZARD AREAS. SEE "ENGINE GROUND SAFETY PRECAUTIONS" FOR ENGINE HAZARD DESCRIPTION.

(6) After engine has stabilized at Normal Takeoff (two minutes minimum), retard engine power to Idle and record breather pressure.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

(7) Compare recorded breather pressure with maximum limit given in Paragraph 2.M.(2).

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

CAUTION: DO NOT RETURN ENGINE TO SERVICE IF IT HAS HIGH BREATHER PRESSURE. HIGH BREATHER PRESSURE IS AN INDICATION THAT HIGH TEMPERATURE, HIGH PRESSURE AIR MAY BE LEAKING INTO A BEARING COMPARTMENT, CREATING A POTENTIALLY DANGEROUS SITUATION.

(9) If observed breather pressure is not within limits, investigate and correct as necessary. Remove engine for inspection if necessary.

NOTE: If pressure reading from oil tank mounted gage fitting is close to limits, repeat engine test with gage mounted at gearbox. See Note after Paragraph 6.H.(3).

(10) Remove test equipment and reinstall engine fittings.

I. Test H - Acceleration Check

(1) Make sure the engine test area is clean.

(2) Start the engine (use the approved aircraft maintenance procedures).

(3) Set the flight deck switches in the correct positions to make sure that there is no engine air bleed or power extraction.

NOTE: Make sure that test instruments are kept sufficiently cool during the test procedure.

(4) Operate the engine at Idle until indications are stable and the oil temperature is at 100°F (38°C) minimum.

(5) Set the Approach Idle switch to On. Engine N_2 must increase to Approach Idle level.

(6) Operate the engine at Approach Idle for five minutes, until the N_2 is stable.

(7) Calculate the Normal Takeoff EPR limit from barometric pressure and temperature (refer to the airframe manufacturer's data).

(8) Advance the power lever slowly (in 30 seconds minimum) to the Normal Takeoff EPR limit calculated in Paragraph 6.I.(7). Keep the engine at this power level for no more and no less than 60 seconds.

(9) With the engine at Normal Takeoff EPR, make a mark to record the power lever position. Record EPR, N_1, EGT, and N_2. Calculate and record 95 percent of N_2 (as seen on the flight deck instrument).

(10) Retard the power lever to Approach Idle. In not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the Normal Takeoff mark made on the quadrant in Paragraph 6.I.(9) in not more than one second. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, then do the procedure again from Paragraph 6.I.(7).

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(11) Record with a stop watch the time from when the power lever started to move to when the engine gets to the 95 percent N_2 limit calculated in Paragraph 6.I.(9).

(12) Go back to Approach Idle and do Paragraph 6.I.(6) thru Paragraph 6.I.(11) two times again.

(13) After three accelerations are completed, retard the power lever to Idle and do the approved airframe powerplant shutdown procedure.

(14) Calculate the average of all three acceleration times. Compare this average to the limit curve given by the airframe manufacturer.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in the maintenance procedure in this manual (in which a stop watch is used and an average is calculated) are to keep variations to a minimum in this less accurate procedure. This average time value will give results that are as much the same each time as the more accurate test cell procedure. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Normal Takeoff N_2) as calculated from test cell procedures.

(15) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

J. Test I - Vibration Check

(1) Install vibration pickups at locations indicated in Figure 512. Connect pickups to vibration monitoring instrumentation, including low frequency filter (40 CPS).

(2) Inspect and clean test area.

(3) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(4) Operate engine at Idle until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(5) Make a slow (two to three minute) acceleration from Idle to Normal Takeoff EPR as specified by airframe manufacturer for ambient conditions. Monitor inlet and rear case vibration during acceleration. Record peak observed inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

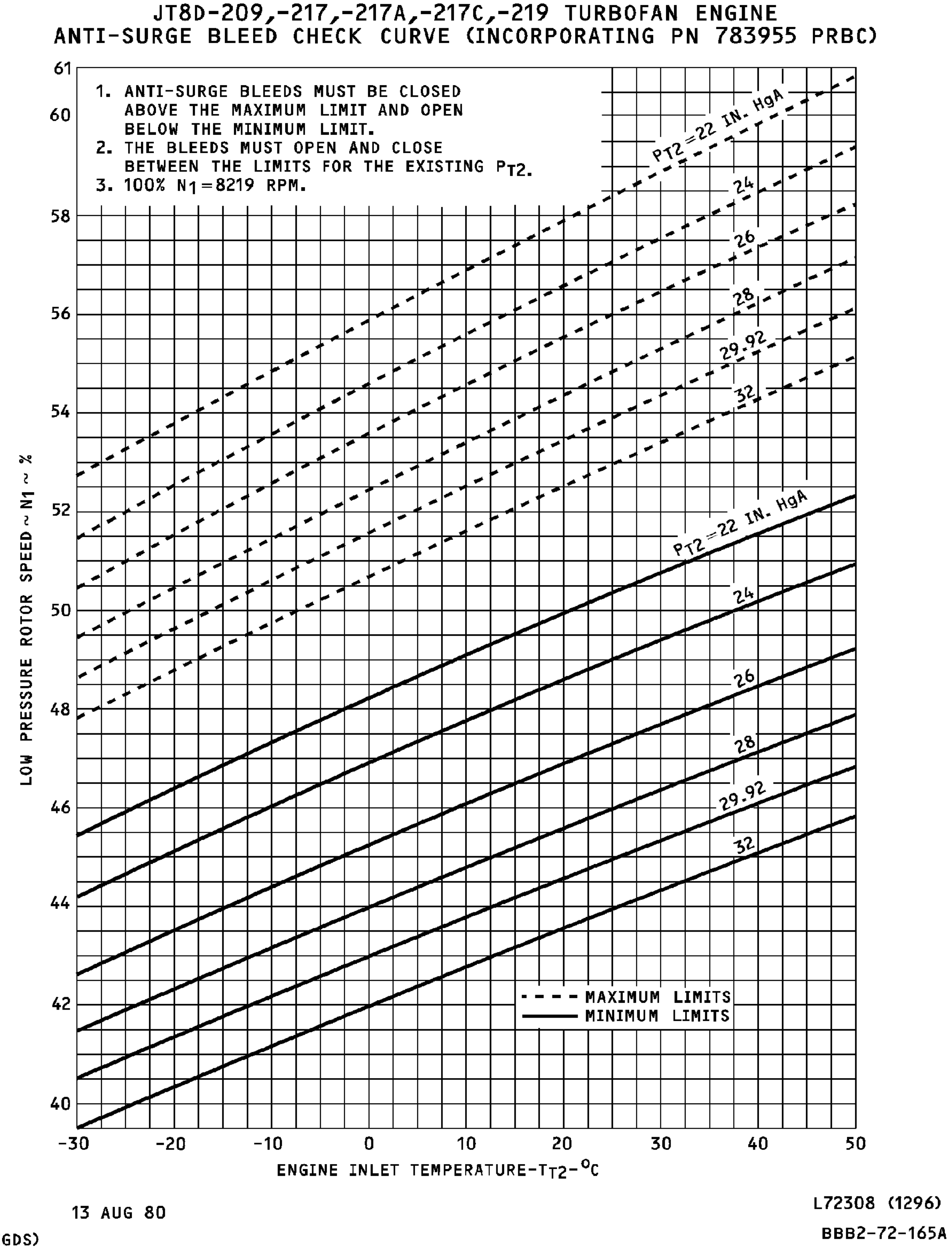
(6) Stabilize 30 seconds at Normal Takeoff EPR.

(7) Retard power lever slowly (two to three minutes) to Idle. Monitor inlet and rear case vibration during deceleration. Record Peak inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

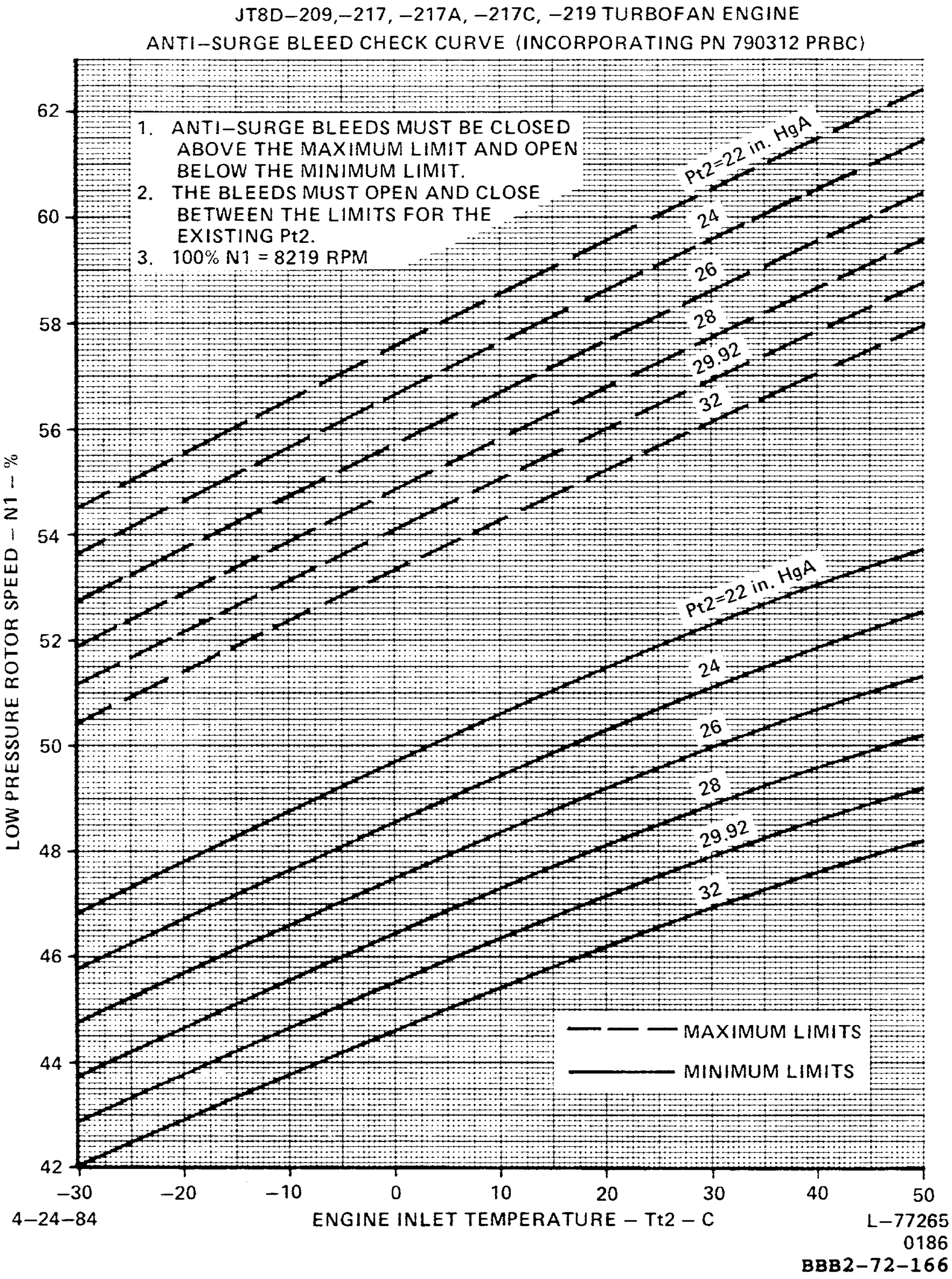
(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(9) Peak vibration shall not exceed limits in Table 508.

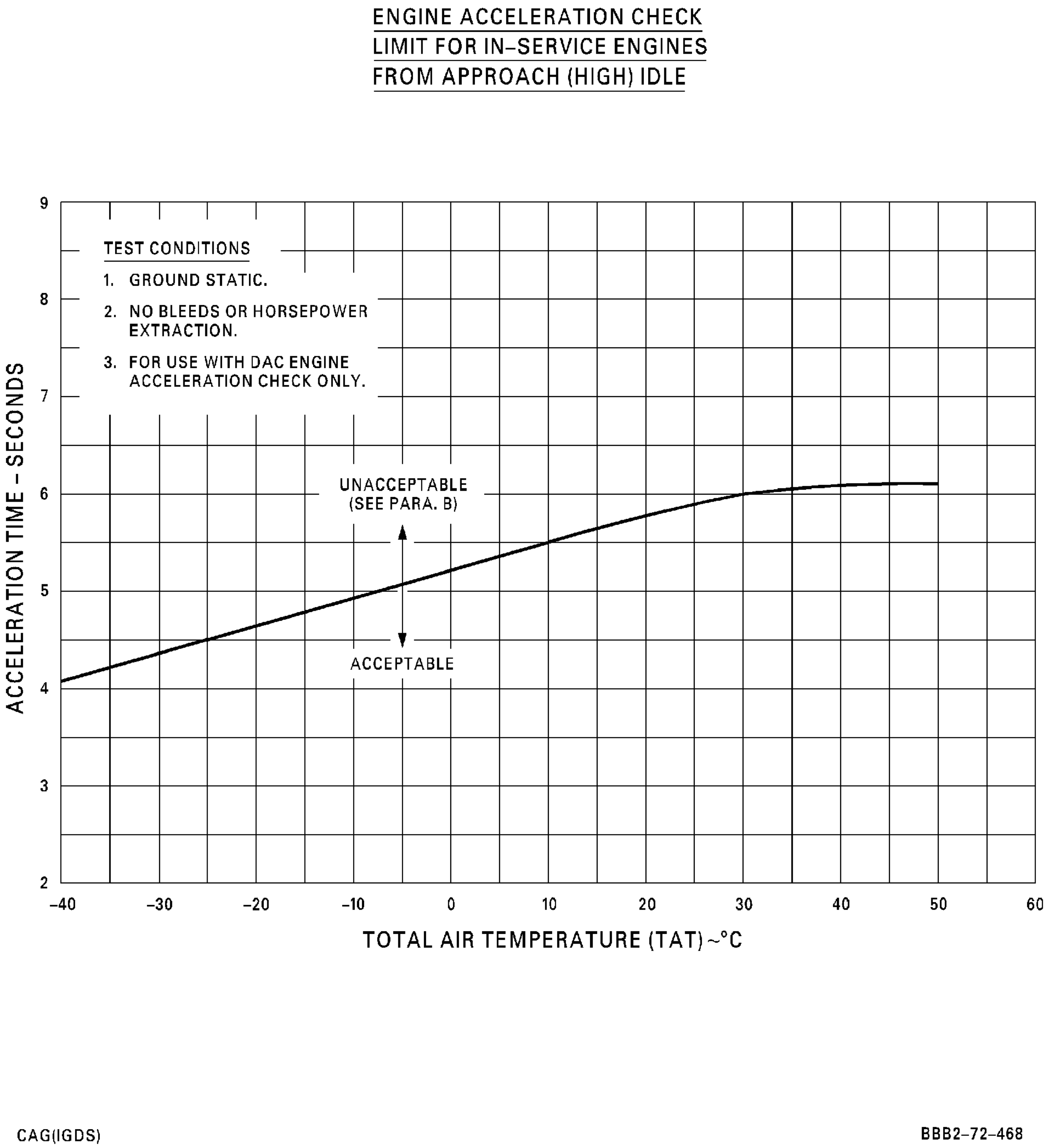
NOTE: The operator can trim balance repaired engines on the aircraft to decreased vibration levels. See Paragraph 9..



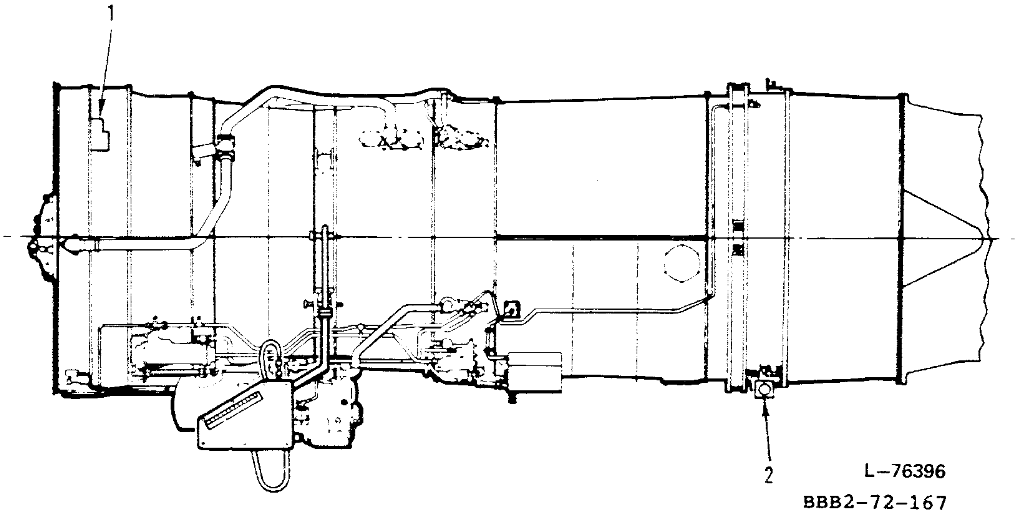
Anti-Surge Bleed Chart
Figure 510/72-00-00-990-901 (Sheet 1 of 2)



Anti-Surge Bleed Chart
Figure 510/72-00-00-990-901 (Sheet 2 of 2)



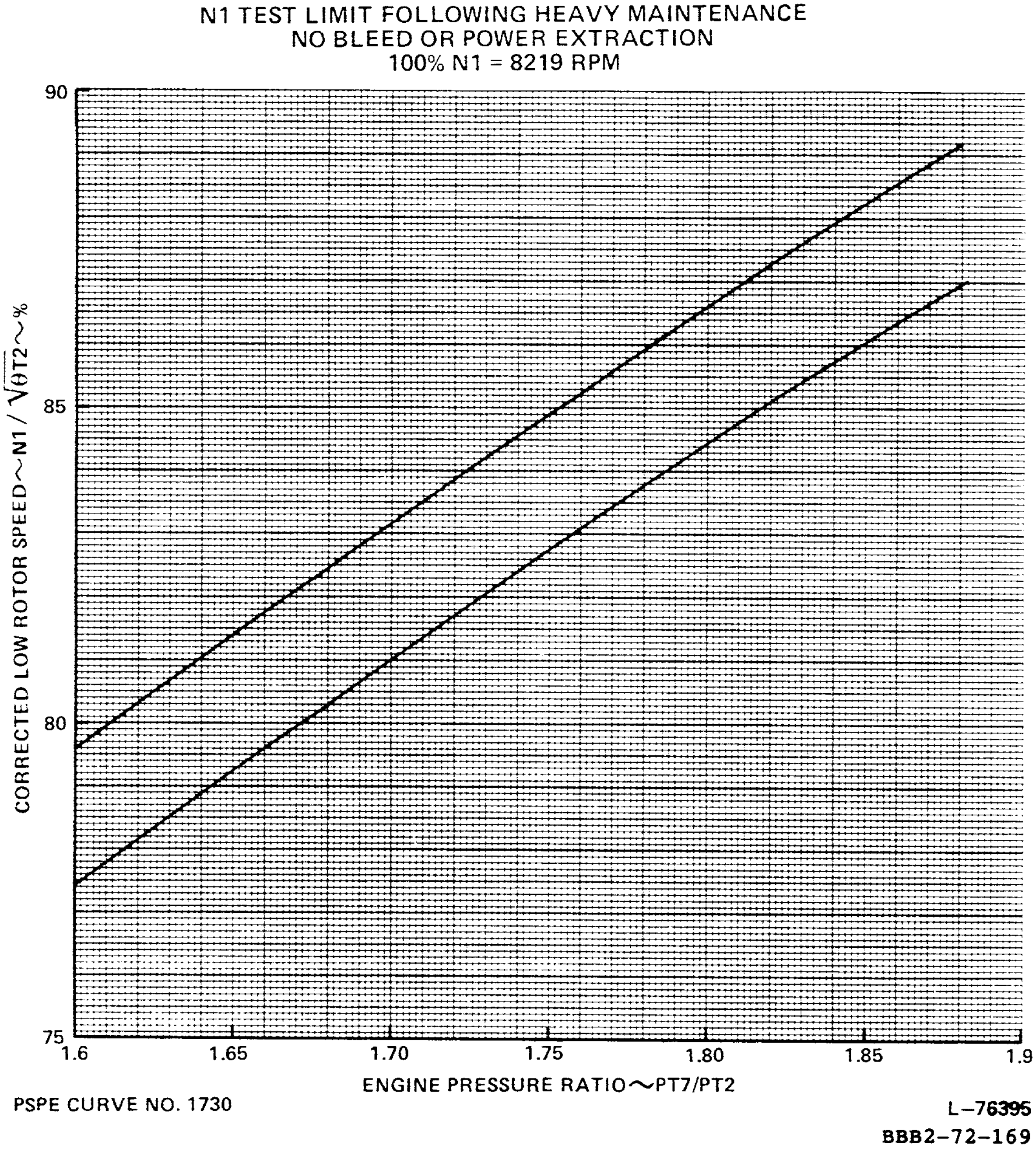
Acceleration Time Limit From Approach Idle
Figure 511/72-00-00-990-904



LEFT SIDE VIEW

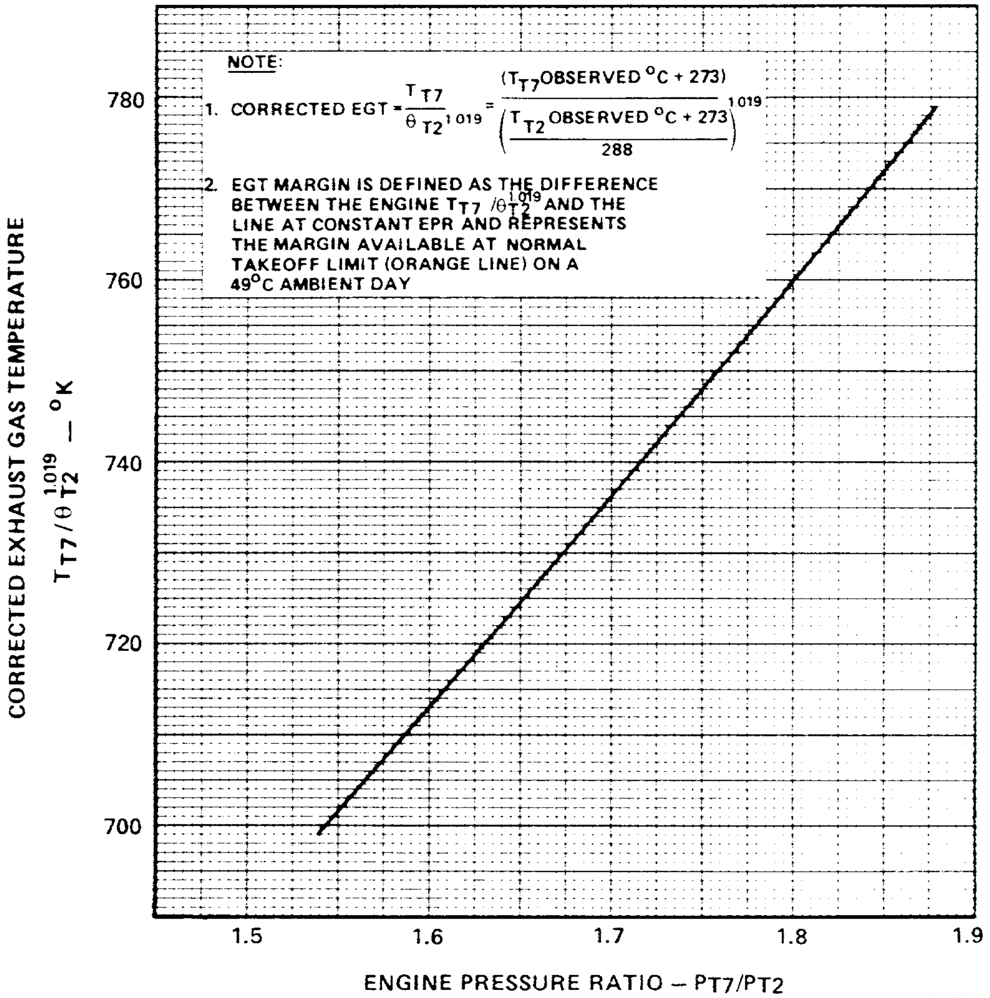
1. Front Vibration Pickup
2. Rear Vibration Pickup

Location Of Vibration Pickups
Figure 512/72-00-00-990-902



Low Rotor Speed Limit Curve
Figure 513/72-00-00-990-903

JT8D–209 TURBOFAN
EGT MARGIN CHECK CURVE



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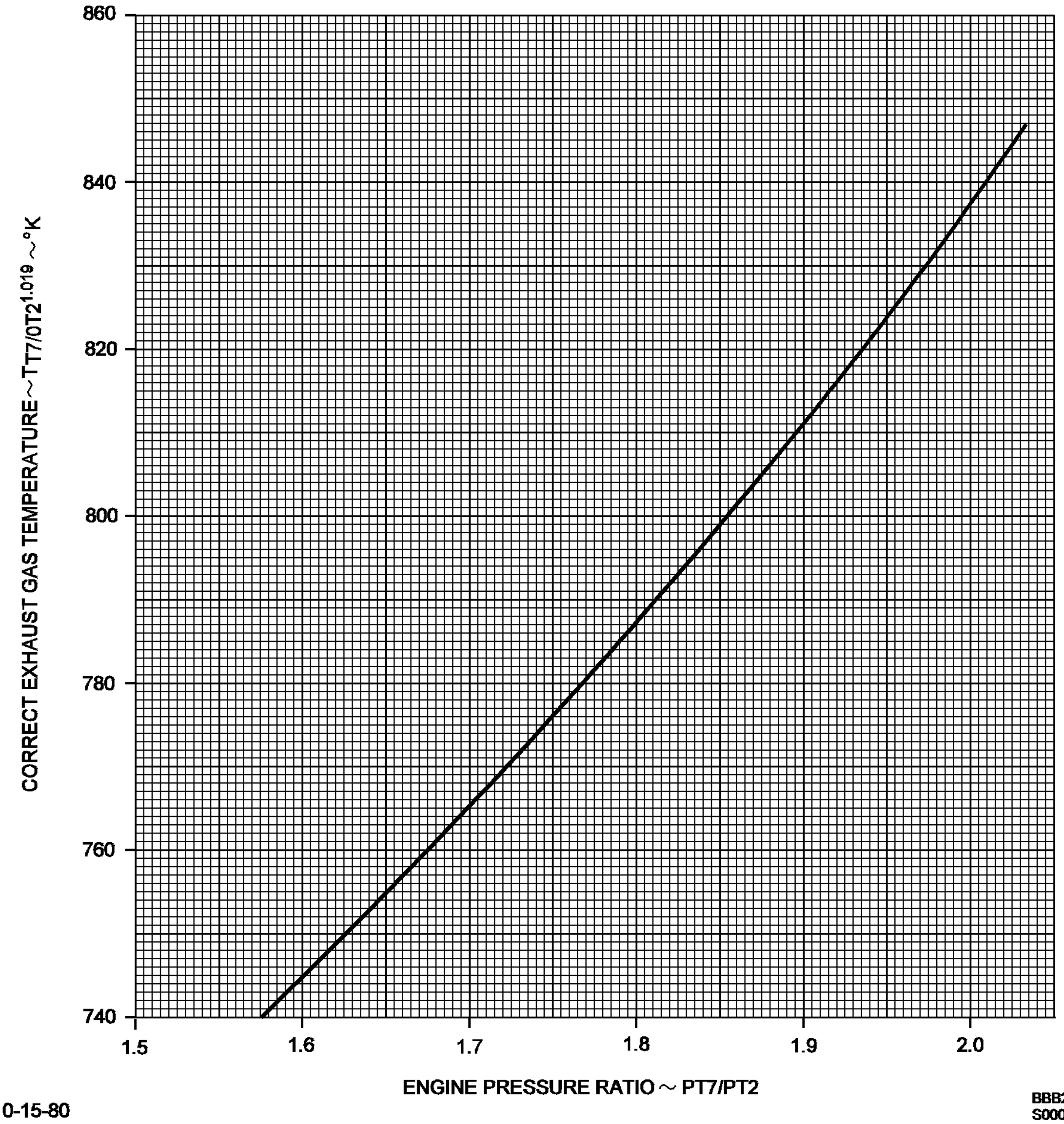
EGT Margin Check Curve
Figure 514/72-00-00-990-905 (Sheet 1 of 3)

JT8D-217, -217A TURBOFAN
EGT MARGIN CHECK

NOTE:

1. CORRECTED EGT= $\dfrac{(T_{T7}\ \text{OBSERVED}\ ^{\circ}\text{C} + 273)}{\left(\dfrac{T_{T2}\ ^{\circ}\text{C} + 273}{288}\right)^{1.019}}$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7/0T2}{}^{1.019}$ AND THE LINE AT CONSTANT EPR.
3. A COMPLETE HIGH QUALITY REFURBISHMENT OF BOTH HOT AND COLD SECTION MODULES SHOULD RESULT IN EGT MARGIN OF 15 - 20 °C.



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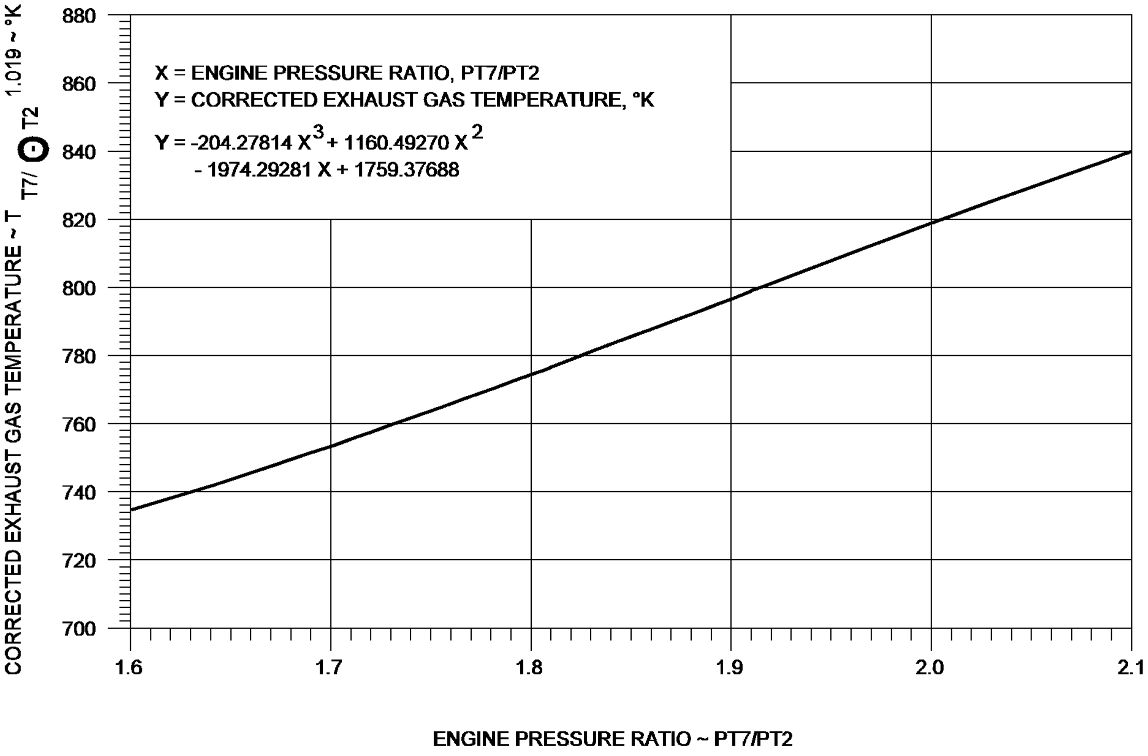
EGT Margin Check Curve
Figure 514/72-00-00-990-905 (Sheet 2 of 3)

JT8D-217C-219 TURBOFAN
EGT MARGIN CHECK

NOTES:

1. CORRECTED EGT = $\dfrac{(T_{T7}\text{ OBSERVED }°C+273)}{\left(\dfrac{T_{T2}\,°C+273}{288}\right)^{1.019}}$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7}/\Theta_{T2}^{\ 1.019}$ AND THE LINE AT CONSTANT EPR
3. THE EGT LIMIT REPRESENTS AN ENGINE WITH ZERO MARGIN TO THE NORMAL TAKE-OFF LIMIT (ORANGE LINE) ON A 29 °C AMBIENT DAY.



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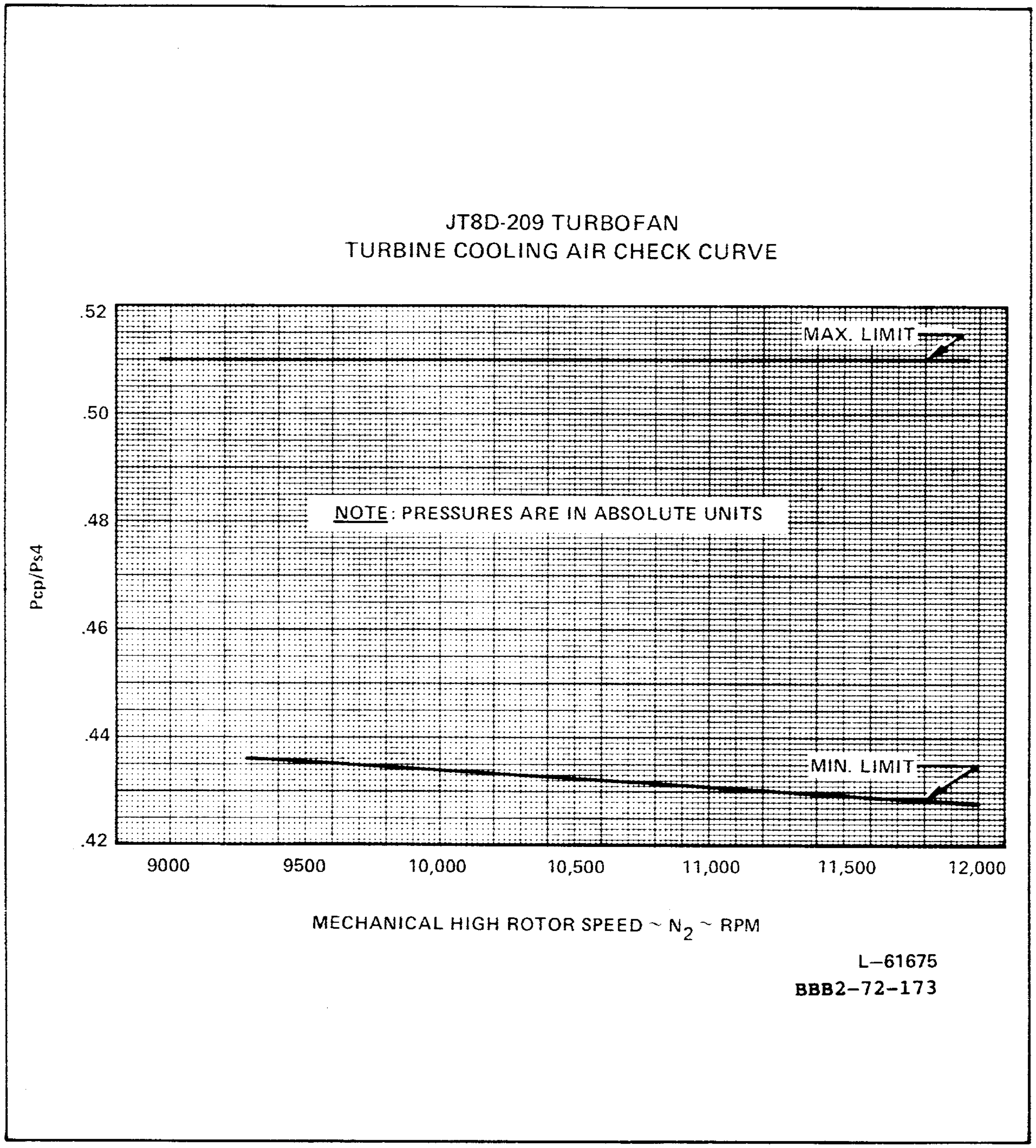
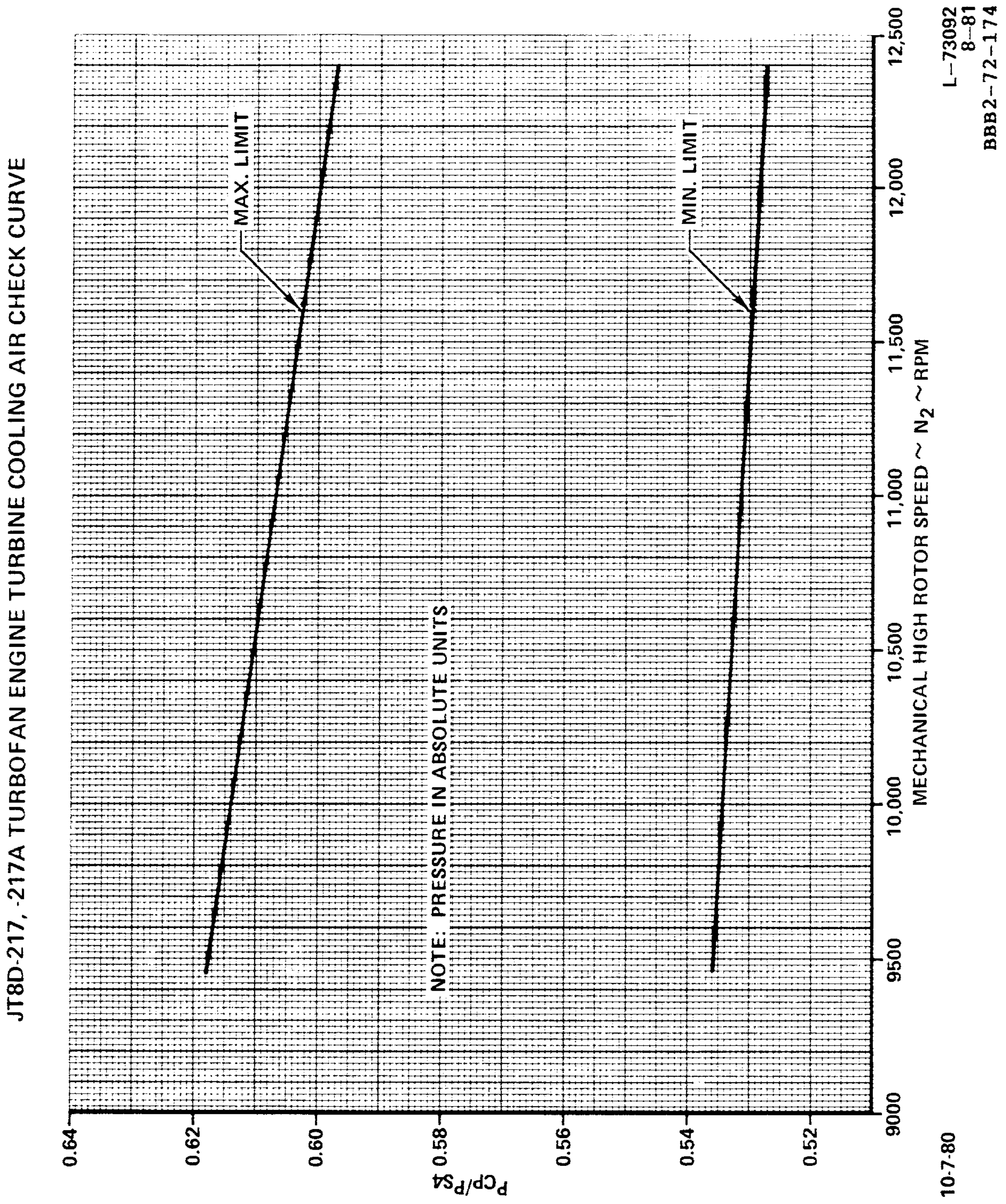
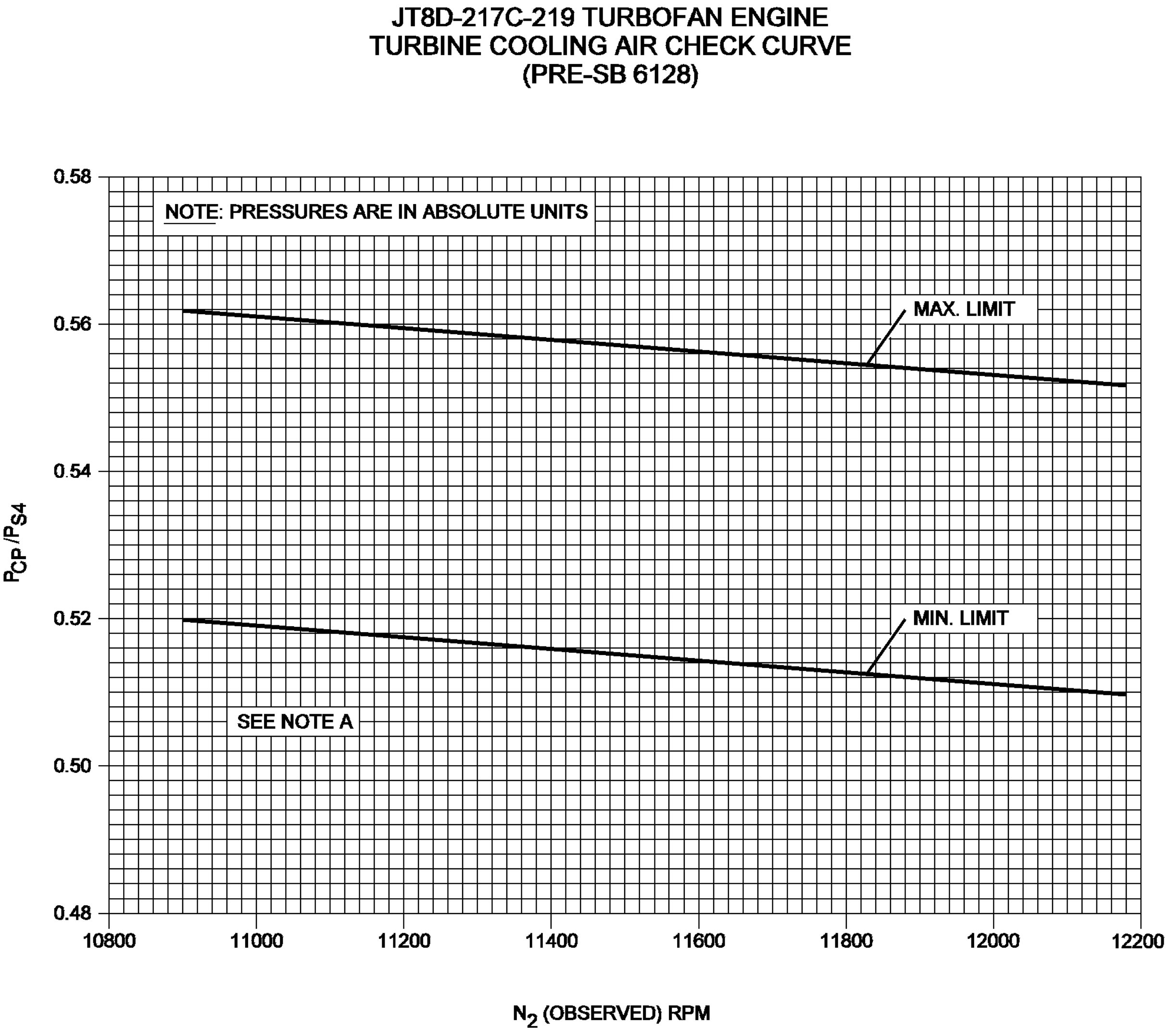
EGT Margin Check Curve
Figure 514/72-00-00-990-905 (Sheet 3 of 3)



Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-906 (Sheet 1 of 5)



Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-906 (Sheet 2 of 5)



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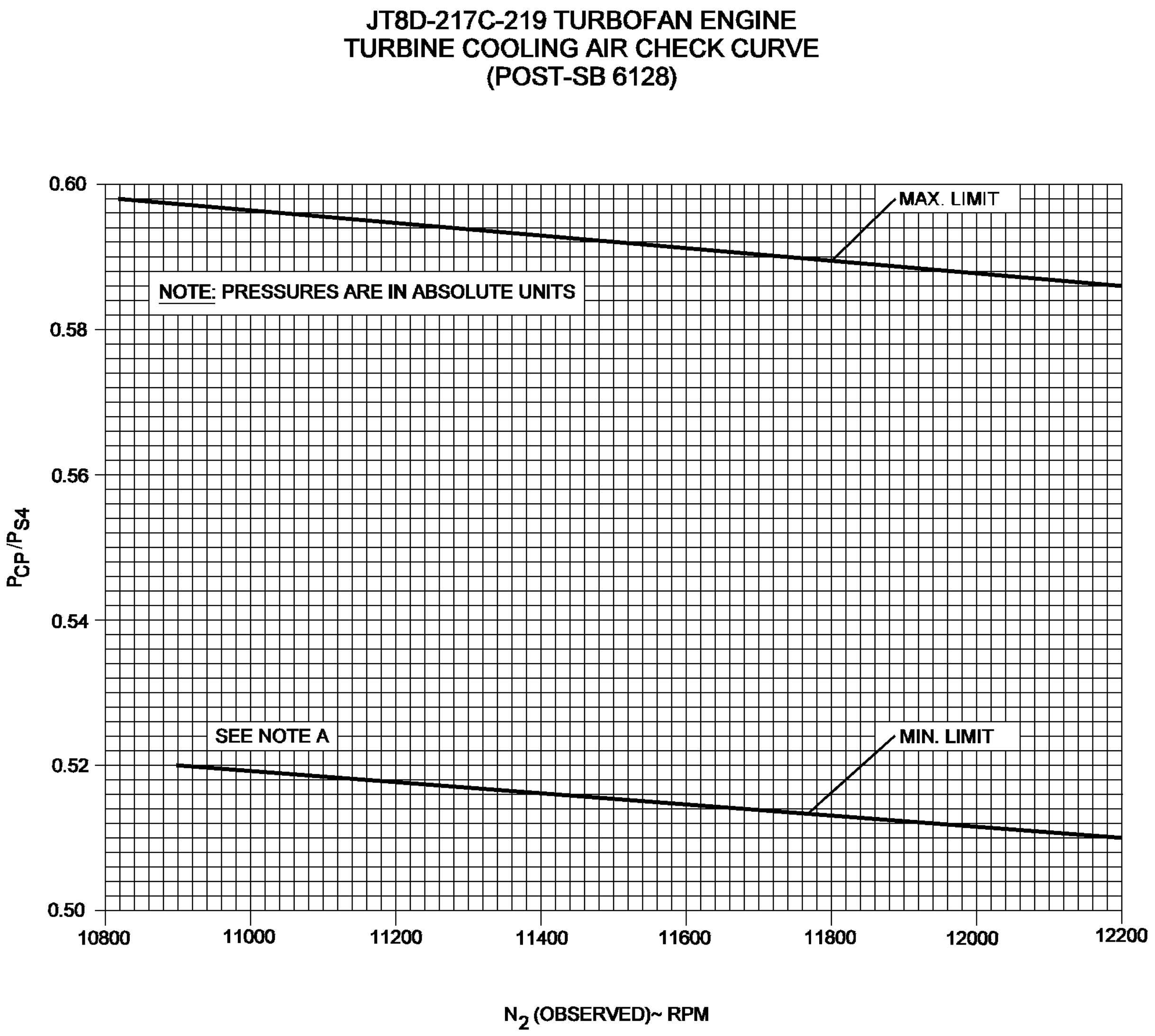
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-906 (Sheet 3 of 5)



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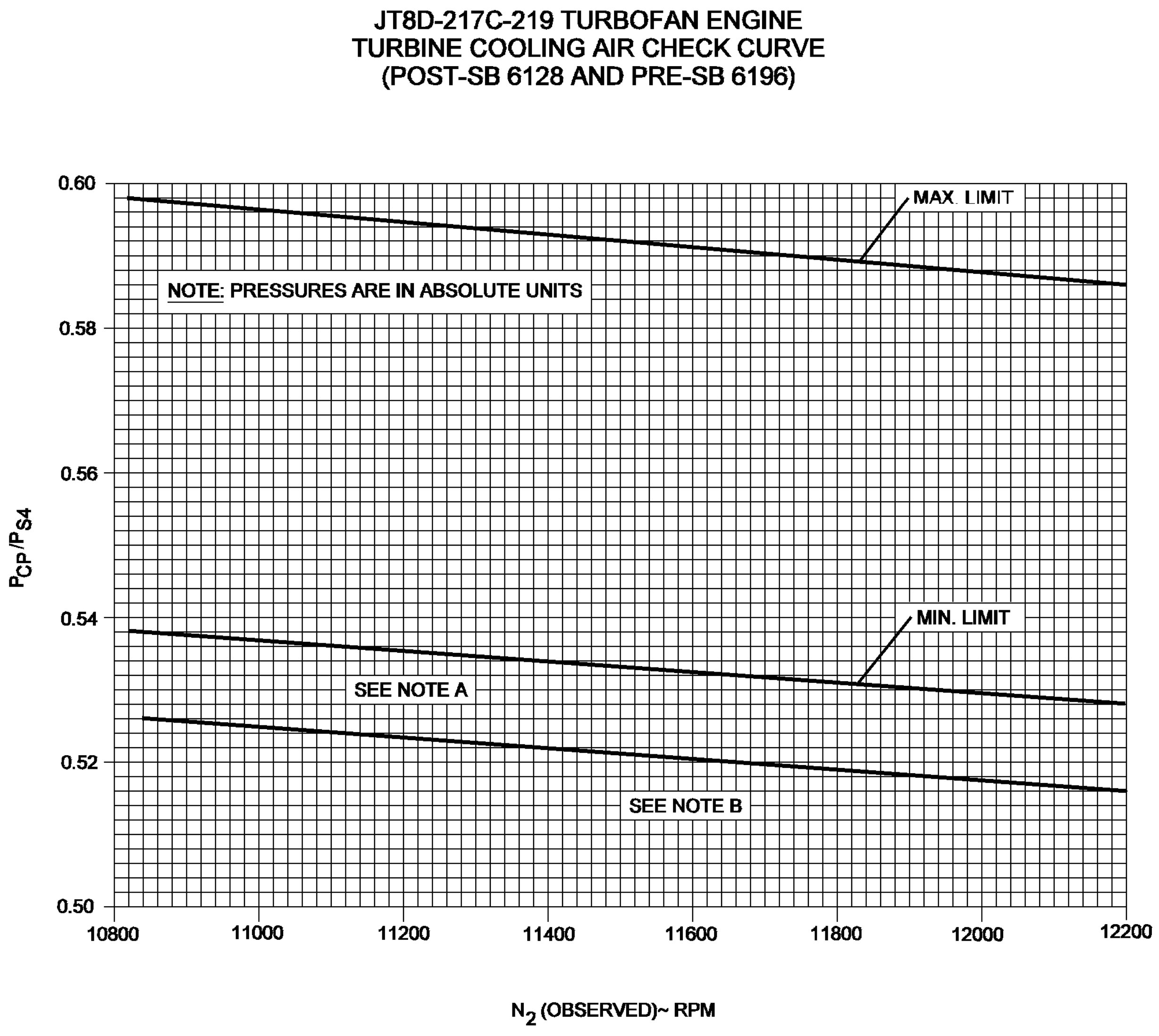
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-906 (Sheet 4 of 5)



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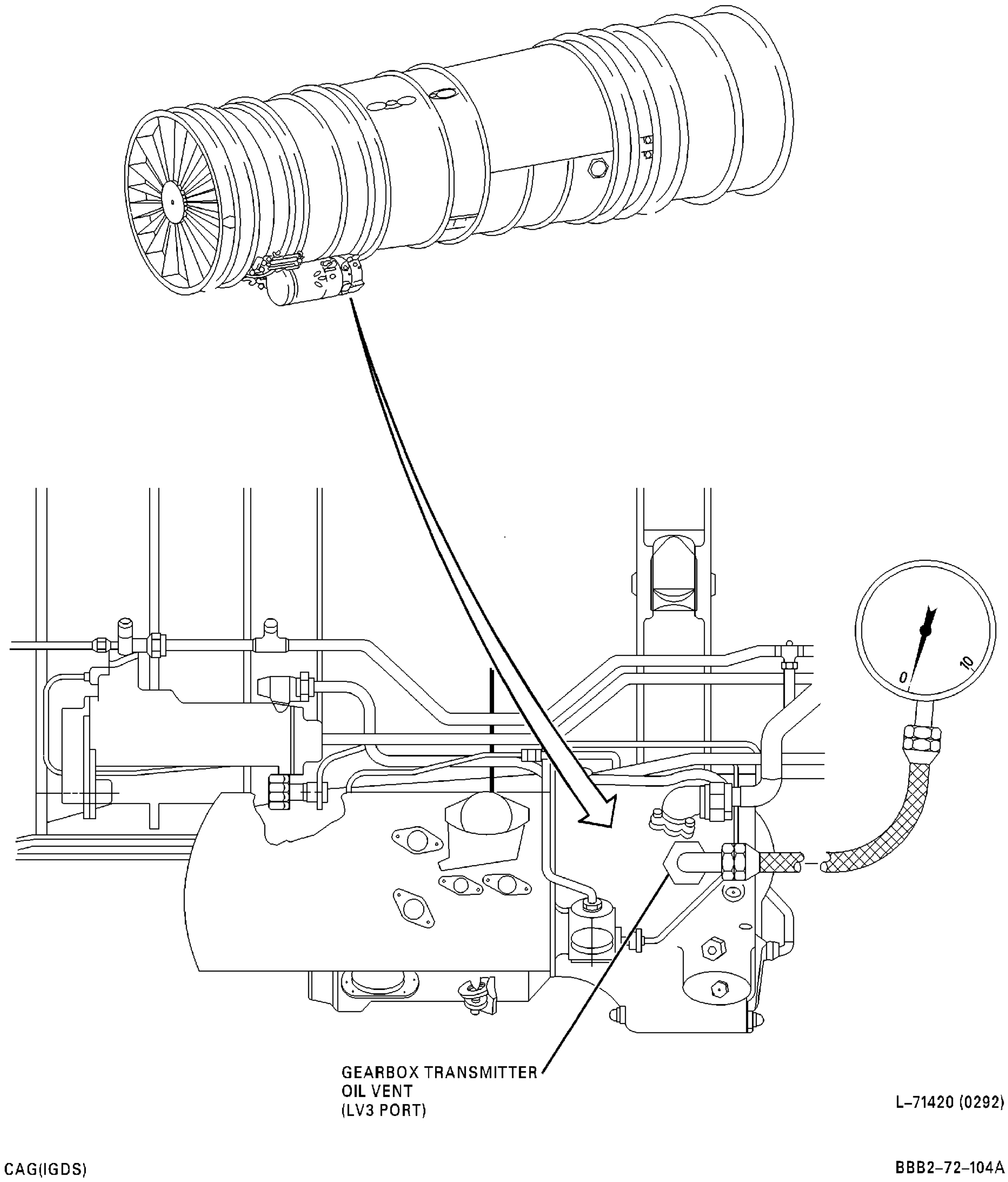
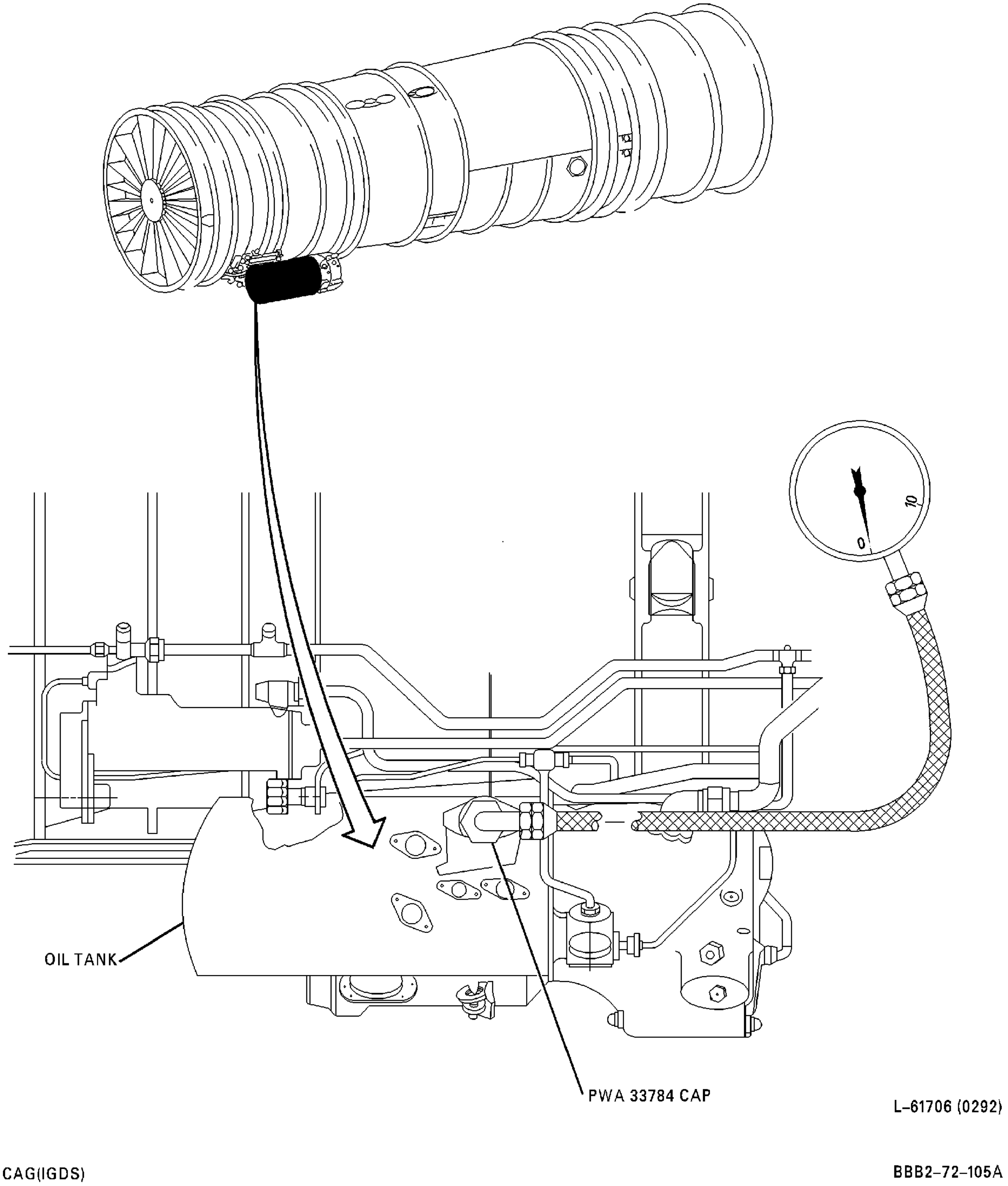
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-906 (Sheet 5 of 5)



Gearbox Housing Breather Pressure Instrumentation
Figure 516/72-00-00-990-907



Oil Tank Breather Pressure Instrumentation
Figure 517/72-00-00-990-908

7. Engine Deterioration Ground Check (For Installations Not Equipped With In-Flight Monitoring)

(Figure 518)

A. Procedure

(1) Prior to each removal for hot section inspection perform following ground check to detect engine deterioration.

(2) The following instrumentation is necessary for ground check:

(a) Absolute pressure gage to indicate 13th stage air pressure (Ps4). Special fitting is provided on right-hand side of engine at upper end of bleed valve actuation pressure supply line near high pressure (diffuser) service bleed point. Calibrated accuracy of gage should be ± 0.5 psi (25.4 mm Hg) absolute in range between 150 and 175 psi (7757 - 9050 mm HG) absolute. Maximum instrument requirement is 250 psi (12929 mm Hg) absolute.

NOTE: This measurement will indicate PS4 only when operating above bleed valve actuation point dictated by pressure ratio bleed control.

(b) Laboratory quality mercury thermometer to indicate ambient temperature.

(c) Local facilities (such as airport control tower) for indicating barometric pressure.

(d) Absolute pressure gage to indicate P_{t7}. Calibrated accuracy of gage should be ± 0.2 psi (10.3 mm Hg) absolute in range between 0 and 50 psi (2586 mm Hg) absolute.

(e) Instrumentation to check P_{t7} and EGT and provide comparison with cockpit instrumentation of EPR (P_{t7}/P_{t2}) and EGT. If cockpit EGT instrumentation and accurate null-balance test instrumentation cannot be read simultaneously, EGT may be measured at stabilized condition with test instrument and then with cockpit instrument circuit under same stabilized conditions. Respective readings should then be compared. As alternate method, cockpit instrument system may be calibrated with standard test equipment designed for this purpose.

(3) Use following test procedure:

(a) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(b) With all nonessential aircraft airbleed and electrical systems shut off, set engine power to EPR (P_{t7}/P_{t2}) of 1.65.

(c) Warm up engine for five minutes and reset power to EPR of 1.65 as required.

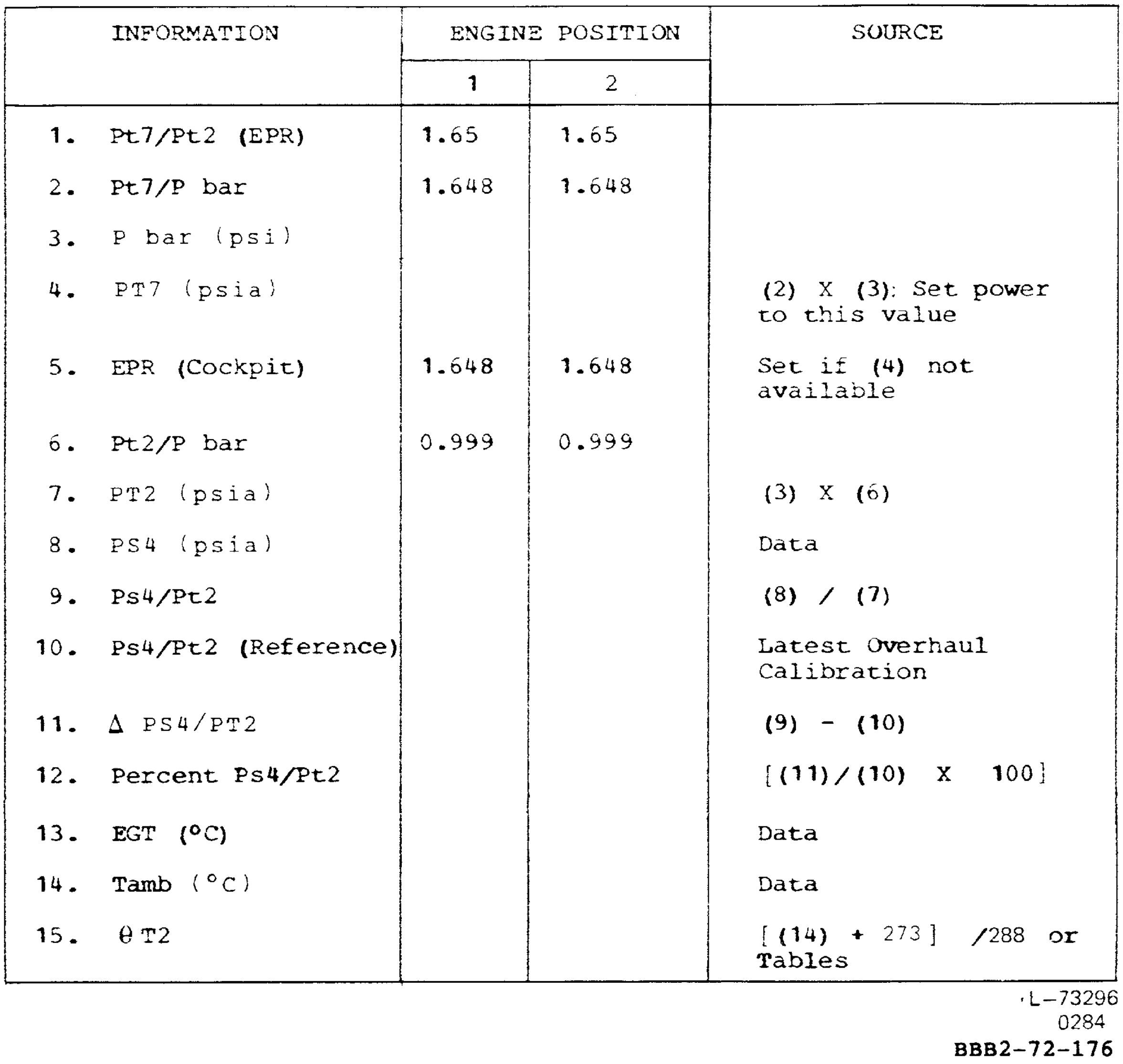
(d) Read and record following:

1) P_{t7}
2) EPR (aircraft instrument)
3) Ps4
4) EGT (accurate null-balance instrument)
5) EGT (aircraft instrument)
6) Percent N_1 (aircraft instrument)
7) Percent N_2 (aircraft instrument)
8) Ambient temperature
9) Barometric pressure
10) Fuel Flow

(e) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(f) Use Figure 518, Figure 519 and Figure 520 to process data. Repair consisting of, replacement of 1st stage turbine vanes, combustion chambers, transition ducts, turbine outer air seals, fuel nozzles, etc. may be necessary if test reveals any of following:

1) Reduction of 3.5 percent Ps4/P_{t2} relative to new engine acceptance test, last complete overhaul, or last repair in which 1st stage turbine vane area was rebuilt within engine manual limits.
2) Corrected maximum T_{t7} more than shown in Figure 514.
3) Minus 100 RPM (minus 0.82 percent tachometer) N_2 theta T2 relative to data plate N_2 RPM.



INFORMATION	ENGINE POSITION		SOURCE
	1	2	
1. Pt7/Pt2 (EPR)	1.65	1.65	
2. Pt7/P bar	1.648	1.648	
3. P bar (psi)			
4. PT7 (psia)			(2) X (3): Set power to this value
5. EPR (Cockpit)	1.648	1.648	Set if (4) not available
6. Pt2/P bar	0.999	0.999	
7. PT2 (psia)			(3) X (6)
8. PS4 (psia)			Data
9. Ps4/Pt2			(8) / (7)
10. Ps4/Pt2 (Reference)			Latest Overhaul Calibration
11. Δ PS4/PT2			(9) - (10)
12. Percent Ps4/Pt2			[(11)/(10) X 100]
13. EGT (°C)			Data
14. Tamb (°C)			Data
15. θ T2			[(14) + 273] /288 or Tables

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 518/72-00-00-990-909 (Sheet 1 of 2)

INFORMATION	ENGINE POSITION		SOURCE
	1	2	
15A. $\theta\ T2^{1.019}$			(15) to exponent 1.019 or Figure 505
16. $\sqrt{\theta\ T2}$			$\sqrt{(15)}$ or Fugure 505
17. EGT (°K)			(13) + 273
18. EGT/ $\theta\ T2^{1.019}$ (°K)			(17)/(15A)
19. EGT/ $\theta\ T2^{1.019}$ (°C)			(18) – 273
20. % N2 (Tach.)			Data
21. % N2/ $\sqrt{\theta\ T2}$			(20)/(16)
22. D.P. N2 %			Data Plate
23. % N2/ $\sqrt{\theta\ T2}$ – D.P. N2			(21) – (22)
24. % N1 (Tach.)			Data
25. % N1/ $\sqrt{\theta\ T2}$			(24)/(26)
26. Ref. N1	80.5	80.5	*or latest overhaul calibration
27. % N1/ $\sqrt{\theta\ T2}$ – Ref. N1			(25) – (26)
28. δ T2			(7)/14.70 or Figure 516
29. Fuel Flow Wf pph			Data
29A. Kc			Figure 517
30. Wf/Kc X δ T2			(29)/[Kc X (28)]
31. Ref. Wf	6980	6980	*or latest overhaul calibration
32. Δ Wf/Kc δ T2			(30) – (31)
33. % Wf/Kc δ T2			(32)/(31) X 100

*Reference Values given are from O.I. 309 and are good for all new engines. Overhauled engines should use last calibration.

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 518/72-00-00-990-909 (Sheet 2 of 2)

8. Oil Pressure Adjustment

(Figure 521)

NOTE: At ground/descent Idle, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages and does not require adjustment.

A. Engine Preparation

(1) Ensure that engine has been properly serviced and is ready for operation.

(2) Install 0 - 50 PSIG (0.0 - 344.7 kPa) direct reading gage to LP2 tap on main oil pressure manifold and vent to LV3 tap on main accessory gearbox housing.

(3) Start engine and run at IDLE for two to five minutes, to stabilize power level and allow oil temperature to reach 100°F (38°C) minimum.

B. Pressure Relief Valve Adjustment

CAUTION: WHEN REMOVING OUTER PLUG, DO NOT ALLOW INNER PLUG OR VALVE HOUSING TO TURN. LOSS OF OIL AND LOSS OF VALVE SECURITY CAN RESULT FROM LOOSENING OF THESE PARTS.

(1) Hold pressure relief valve inner plug hex firmly with wrench and remove outer plug.

NOTE: Cut lockwire from outer plug only; lockwire from inner plug to valve housing and from valve housing to gearbox should be left intact.

(2) Hold adjusting screw stationary with screwdriver and loosen locknut. If desired, fabricate valve adjusting tool from 7/16 inch deep socket with angled handle welded to side to allow screwdriver to pass through center. Such a tool will allow turning locknut while holding adjusting screw stationary.

(3) Using screwdriver, adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa) with engine at IDLE. Clockwise rotation will increase pressure; counterclockwise rotation will decrease pressure.

NOTE: One full turn of adjusting screw will change pressure approximately two psi (13.8 kPa).

Key To Figure 521	
1.	Pressure Relief Valve
2.	Locknut
3.	Adjusting Screw
4.	Outer Plug
5.	Packing
6.	Inner Plug
7.	Check This Screw Height After Adjustment (See Text).

CAUTION: AFTER OIL PRESSURE ADJUSTMENT IS COMPLETED, CHECK INDEX 7 DIMENSION IN FIGURE. MEASURED VALUE OF 0.280 INCH (7.112 MM) OR LESS IF NOT CONSIDERED NORMAL AND MAY INDICATE REQUIREMENT FOR OIL SYSTEM TROUBLESHOOTING.

(4) Hold adjusting screw steady and torque locknut. See tool description in Paragraph 8.B.(2).

(5) Install outer plug, with new packing, and torque to 150 - 160 in-lb. (16.948 - 18.078 N·m). Lockwire outer plug to inner plug.

RELATIVE PRESSURE

DELTA (δ) $= \frac{P}{PO} = \frac{P}{29.92}$ INCHES HGA = PSIA (2.036)

P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ
40.0	1.337						
39.9	1.334	32.9	1.100	25.9	0.8656	18.9	0.6317
39.8	1.330	32.8	1.096	25.8	0.8623	18.8	0.6283
39.7	1.327	32.7	1.093	25.7	0.8586	18.7	0.6250
39.6	1.324	32.6	1.090	25.6	0.8556	18.6	0.6216
39.5	1.320	32.5	1.086	25.5	0.8523	18.5	0.6183
39.4	1.317	32.4	1.083	25.4	0.8489	18.4	0.6150
39.3	1.313	32.3	1.080	25.3	0.8456	18.3	0.6116
39.2	1.310	32.2	1.076	25.2	0.8422	18.2	0.6083
39.1	1.307	32.1	1.073	25.1	0.8389	18.1	0.6050
39.0	1.303	32.0	1.070	25.0	0.8356	18.0	0.6016
38.9	1.300	31.9	1.066	24.9	0.8322	17.9	0.5983
38.8	1.297	31.8	1.063	24.8	0.8289	17.8	0.5949
38.7	1.293	31.7	1.059	24.7	0.8255	17.7	0.5916
38.6	1.290	31.6	1.056	24.6	0.8222	17.6	0.5882
38.5	1.287	31.5	1.053	24.5	0.8188	17.5	0.5849
38.4	1.283	31.4	1.049	24.4	0.8155	17.4	0.5815
38.3	1.280	31.3	1.046	24.3	0.8122	17.3	0.5782
38.2	1.277	31.2	1.043	24.2	0.8088	17.2	0.5749
38.1	1.273	31.1	1.039	24.1	0.8055	17.1	0.5715
38.0	1.270	31.0	1.036	24.0	0.8021	17.0	0.5682
37.9	1.267	30.9	1.033	23.9	0.7988	16.9	0.5648
37.8	1.263	30.8	1.029	23.8	0.7954	16.8	0.5615
37.7	1.260	30.7	1.026	23.7	0.7921	16.7	0.5581
37.6	1.257	30.6	1.023	23.6	0.7888	16.6	0.5548
37.5	1.253	30.5	1.019	23.5	0.7854	16.5	0.5515
37.4	1.250	30.4	1.016	23.4	0.7821	16.4	0.5481
37.3	1.247	30.3	1.013	23.3	0.7787	16.3	0.5448
37.2	1.243	30.2	1.009	23.2	0.7754	16.2	0.5414
37.1	1.240	30.1	1.006	23.1	0.7720	16.1	0.5381
37.0	1.237	30.0	1.003	23.0	0.7687	16.0	0.5348
36.9	1.233	29.9	0.9993	22.9	0.7654	15.9	0.5314
36.8	1.230	29.8	0.9960	22.8	0.7620	15.8	0.5281
36.7	1.227	29.7	0.9926	22.7	0.7587	15.7	0.5247
36.6	1.223	29.6	0.9893	22.6	0.7553	15.6	0.5214
36.5	1.220	29.5	0.9859	22.5	0.7520	15.5	0.5180
36.4	1.217	29.4	0.9826	22.4	0.7487	15.4	0.5147
36.3	1.213	29.3	0.9793	22.3	0.7453	15.3	0.5224
36.2	1.210	29.2	0.9759	22.2	0.7420	15.2	0.5080
36.1	1.207	29.1	0.9726	22.1	0.7386	15.1	0.5047
36.0	1.203	29.0	0.9692	22.0	0.7353	15.0	0.5013
35.9	1.200	28.9	0.9659	21.9	0.7319	14.9	0.4980
35.8	1.196	28.8	0.9626	21.8	0.7286	14.8	0.4946
35.7	1.193	28.7	0.9592	21.7	0.7253	14.7	0.4913
35.6	1.190	28.6	0.9559	21.6	0.7219	14.6	0.4880
35.5	1.186	28.5	0.9525	21.5	0.7186	14.5	0.4846
35.4	1.183	28.4	0.9492	21.4	0.7152	14.4	0.4813
35.3	1.180	28.3	0.9458	21.3	0.7119	14.3	0.4779
35.2	1.176	28.2	0.9425	21.2	0.7085	14.2	0.4746
35.1	1.173	28.1	0.9392	21.1	0.7052	14.1	0.4713
35.0	1.170	28.0	0.9358	21.0	0.7019	14.0	0.4679
34.9	1.166	27.9	0.9325	20.9	0.6985	13.9	0.4646
34.8	1.163	27.8	0.9291	20.8	0.6952	13.8	0.4612
34.7	1.160	27.7	0.9258	20.7	0.6918	13.7	0.4579
34.6	1.156	27.6	0.9224	20.6	0.6885	13.6	0.4545
34.5	1.153	27.5	0.9191	20.5	0.6852	13.5	0.4512
34.4	1.150	27.4	0.9158	20.4	0.6818	13.4	0.4479
34.3	1.146	27.3	0.9124	20.3	0.6785	13.3	0.4445
34.2	1.143	27.2	0.9091	20.2	0.6751	13.2	0.4412
34.1	1.140	27.1	0.9057	20.1	0.6718	13.1	0.4378
34.0	1.136	27.0	0.9024	20.0	0.6684	13.0	0.4345
33.9	1.133	26.9	0.8990	19.9	0.6651	12.9	0.4311
33.8	1.130	26.8	0.8957	19.8	0.6618	12.8	0.4278
33.7	1.126	26.7	0.8924	19.7	0.6584	12.7	0.4245
33.6	1.123	26.6	0.8890	19.6	0.6551	12.6	0.4211
33.5	1.120	26.5	0.8857	19.5	0.6517	12.5	0.4178
33.4	1.116	26.4	0.8823	19.4	0.6484	12.4	0.4144
33.3	1.113	26.3	0.8790	19.3	0.6450	12.3	0.4111
33.2	1.110	26.2	0.8757	19.2	0.6417	12.2	0.4077
33.1	1.106	26.1	0.8723	19.1	0.6384	12.1	0.4044
33.0	1.103	26.0	0.8690	19.0	0.6350	12.0	0.4011

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Relative Pressure
Figure 519/72-00-00-990-910

TEMPERATURE CORRECTION FOR FUEL FLOW

Tt2			Tt2			Tt2		
°C	°F	Kc	°C	°F	Kc	°C	°F	Kc
–40	–40.0	0.8798	–6	21.2	0.9542	28	82.4	1.0286
–39	–38.2	0.8820	–5	23.0	0.9564	29	84.2	1.0308
–38	–36.4	0.8842	–4	24.8	0.9585	30	86.0	1.0329
–37	–34.6	0.8863	–3	26.6	0.9607	31	87.8	1.0351
–36	–32.8	0.8885	–2	28.4	0.9629	32	89.6	1.0373
–35	–31.0	0.8907	–1	30.2	0.9651	33	91.4	1.0395
–34	–29.2	0.8929	0	32.0	0.9673	34	93.2	1.0417
–33	–27.4	0.8951	1	33.8	0.9695	35	95.0	1.0439
–32	–25.6	0.8973	2	35.6	0.9717	36	96.8	1.0461
–31	–23.8	0.8995	3	37.4	0.9739	37	98.6	1.0483
–30	–22.0	0.9017	4	39.2	0.9761	38	100.4	1.0504
–29	–20.2	0.9038	5	41.0	0.9782	39	102.2	1.0526
–28	–18.4	0.9060	6	42.8	0.9804	40	104.0	1.0548
–27	–16.6	0.9082	7	44.6	0.9826	41	105.8	1.0570
–26	–14.8	0.9104	8	46.4	0.9848	42	107.6	1.0592
–25	–13.0	0.9126	9	48.2	0.9870	43	109.4	1.0614
–24	–11.2	0.9148	10	50.0	0.9892	44	111.2	1.0636
–23	– 9.4	0.9170	11	51.8	0.9914	45	113.0	1.0658
–22	– 7.6	0.9192	12	53.6	0.9936	46	114.8	1.0679
–21	– 5.8	0.9214	13	55.4	0.9957	47	116.6	1.0701
–20	– 4.0	0.9235	14	57.2	0.9979	48	118.4	1.0723
–19	– 2.2	0.9257	15	59.0	1.0001	49	120.2	1.0745
–18	– 0.4	0.9279	16	60.8	1.0023	50	122.0	1.0767
–17	1.4	0.9301	17	62.6	1.0045	51	123.8	1.0789
–16	3.2	0.9323	18	64.4	1.0067	52	125.6	1.0811
–15	5.0	0.9345	19	66.2	1.0089	53	127.4	1.0833
–14	6.8	0.9367	20	68.0	1.0111	54	129.2	1.0855
–13	8.6	0.9389	21	69.8	1.0132	55	131.0	1.0876
–12	10.4	0.9410	22	71.6	1.0154	56	132.8	1.0898
–11	12.2	0.9432	23	73.4	1.0176	57	134.6	1.0920
–10	14.0	0.9454	24	75.2	1.0198	58	136.4	1.0942
–9	15.8	0.9476	25	77.0	1.0220	59	138.2	1.0964
–8	17.6	0.9498	26	78.8	1.0242	60	140.0	1.0986
–7	19.4	0.9520	27	80.6	1.0264			

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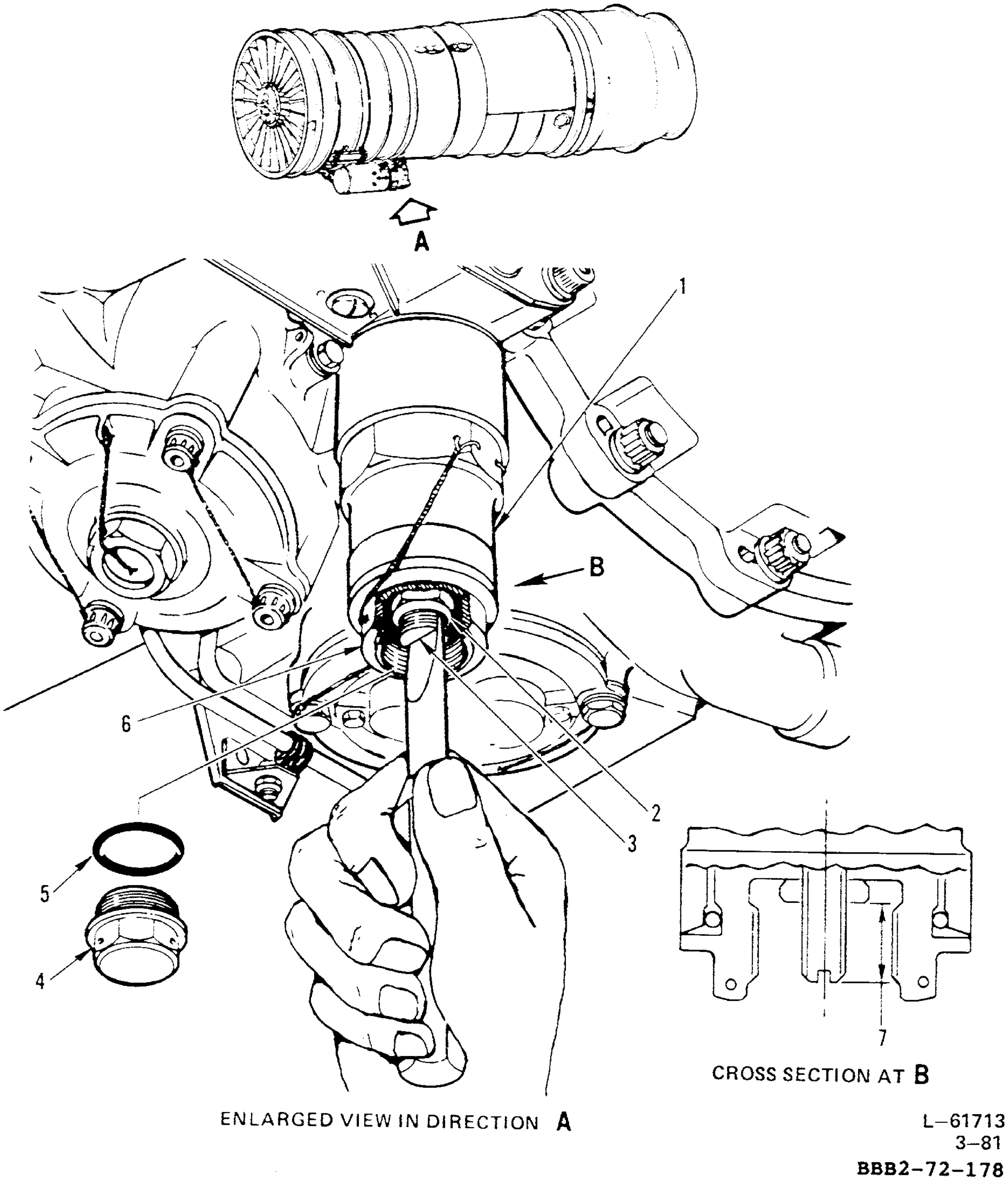
Temperature Correction For Fuel Flow
Figure 520/72-00-00-990-911



Oil Pressure Adjustment
Figure 521/72-00-00-990-912

9. Trim Balance Of Engine Installed In Aircraft

A. On-Wing Trim Balancing - General

CAUTION: APPLICATION OF TRIM BALANCING MUST MEET FOLLOWING PREREQUISITES: TRIM BALANCE IS TO BE USED ONLY ON NEW AND OVERHAULED ENGINES AND ON THOSE REPAIR ENGINES (HEAVY MAINTENANCE) WHICH HAVE HAD LOW COMPRESSOR AND LOW TURBINE ROTORS DISASSEMBLED, INSPECTED, AND REASSEMBLED ACROSS BALANCE MACHINE, EXCEPT AS NOTED BELOW. THOSE ENGINES WITH EXCESSIVE HIGH ROTOR VIBRATION OR LOW ROTOR VIBRATION WHICH EXCEED LIMITS AS SPECIFIED IN PROCEDURE MAY NOT BE TRIM BALANCED.

(1) Engine whose rotating parts are balanced will normally have some residual unbalance which will result in detectable vibration at engine operating condition. This vibration may be minimized by trim balancing, which entails addition of weight positioned to offset residual unbalance in compressor front balance plane and turbine rear balance plane.

NOTE: (Heavy Maintenance) repair engines which do not exceed normal acceptable vibration limits may be trim balanced to lower amplitude, if desired.

B. Equipment For Trim Balance

(1) Vibration Pickups: Phased velocity type, CEC 4-123A or equivalent.

(2) Speed Signal: An exact one-pulse-per revolution is required as the reference signal. Special tachometer and adapter with ratio of 24 to 47 must be mounted in place of any other tachometer or adapter on N_1 tachometer pad. Index rotor by aligning single tooth of tachometer with tip of impulse pickup. Small hole in fact of tachometer is provided for this purpose. In order to reindex rotor after running without having to make above observation, make mark with layout dye on blade and engine case.

Tach. Adapter: Model B1692-2, Ratio 24/47 (Exact)

Vendor: The Electric Tachometer Corporation 68th & Upland Streets Philadelphia, PA 19142, U.S.A.

Pulse Generator: Model HB 163212, one triangular tooth, 0.062 inch (1.588 mm) flat

Vendor: H And B Tool And Engineering Co., 481 Sullivan Ave., South Windsor, CT 06074, U.S.A.

(3) Trim Balance Analyzer: Spectral Dynamics Model SD-119-B, or equivalent.

(a) With vibration data signal (from a velocity, acceleration or non-contacting displacement pickup) and one-pulse-per-revolution reference signal, analyzer provides the following information needed for balancing an engine:

1) Amplitude of vibration

2) Phase angle between reference point and point of maximum unbalance, i.e., location of unbalance.

3) Speed in RPM of engine (N_1).

(b) To provide these operating parameters, balance analyzer accepts signal from vibration pickup and passes it through integrator for conversion to displacement signal. For signal from a displacement pickup or accelerometer, integrator is bypassed.

(c) Displacement signal is then passed through dynamic tracking filter, which is tuned by one-per-revolution signal from tachometer mounted on engine. Pulse-to-sinewave converter uses tachometer signal to provide necessary sinewave for track filter. Converter is phase-locked to tachometer signal for absolute tuning of tracking filter and absolute phase (i.e., balance location) reference. Because it is frequency tuned by speed signal, tracking filter eliminates all frequency signals other than rotor fundamental. Output of tracking filter is displayed as displacement.

(d) Difference in angular degrees between vibration signal (at one-per-revolution tuning frequency) and one-per-revolution reference frequency derived from tachometer through converter is measured by phase meter. Output of phase meter is displayed as phase. Output of pulse-to-sinewave converter is multiplied by 60 factor and displayed as speed in RPM.

C. Setup Of Equipment

(Figure 522)

(1) Install vibration pickups. (Figure 512)

(2) Check vibration pickups to ensure that they are in phase (positive outward displacement gives positive voltage output).

(3) Install special tachometer adapter and reference signal generator in place of engine adapter (if any) and N_1 tachometer.

(4) With generator in "firing position", reference front compressor (low) rotor to engine case using layout dye.

NOTE: Turn rotor in direction of engine rotation to take up backlash of tachometer drive, that is, clockwise (counterclockwise facing engine fan inlet case).

(5) Set up and operate balance analyzer per manufacturer's instructions.

D. Trim Balance Procedures

(Figure 523), (Figure 524), (Figure 525), (Figure 526)

(1) The following procedure establishes a uniform method of approaching trim balance. Phase angle lag and sensitivity data must be determined as a result of trim balance experience. No data is currently available.

(a) Definition of Terms

1) 1EL - The low speed rotor fundamental vibration amplitude.

2) 1EH - The high speed rotor fundamental vibration amplitude.

3) Cw - Calibration weight (serially numbered Cw1, Cw2, etc.) of stainless steel wire used to balance engine. Replaced by equivalent PN balance weight after trim balance.

4) Class - Category into which engine is placed based on prebalance vibration survey. (No data is currently available.)

5) Phase Angle - Phase meter reading. Phase angle by which integrated vibration signal lags reference signal.

6) Phase Angle Lag - Calculated angle indicating lag between passing of unbalance weight and response signal.

7) Assumed Phase Angle Lag - Weighted average of phase angle lags determined from previous balance attempts. Also, correction angle used in "one-shot" method.

8) VD - Vector difference from Point A to Point C.

(b) Trim Balance Sequence

1) Conduct prebalance vibration survey to determine suitability of engine for trim balance and to provide basis for classification.
2) Run "As Is" speed points as prescribed for class engine being balanced.
3) Run "As Is" data, plot A vector on polar paper, angle being laid out counter to engine rotation from 12 o'clock location. Draw R vector equal and opposite A vector. (Figure 523)
4) Apply assumed phase angle lag given for class to which engine has been assigned. Assumed phase angle lag is laid off from R in direction of rotation and indicates angular location of Cw1.
5) Apply assumed sensitivity given in respective trim balance procedures assigned engine class. Multiply amplitude of vector A and sensitivity value to give oz-in required for Cw1.
6) Install Cw1 which may be either stainless steel wire or permanent weight as described previously. See Figure 522 or Figure 525 for computation of wire necessary to correct imbalance. Wire weight is installed on nearest blade to location to that designated by steps outlined in Paragraph 9.D.(1)(b)4) above.
7) Rerun engine as in Paragraph 9.D.(1)(b)2) above repeating each speed point within ± 0.2 rev/sec on counter at time base of 10 sec. Record all data.
8) In conjunction with Paragraph 9. above observe O/A (overall) mils vibration throughout engine speed range to determine if all vibration is within acceptance limits.
9) If engine is acceptable, replace wire trial weight with equivalent weight in 1st stage compressor hub, when applicable. No changes are required if no wire weight was used.
10) If engine is unacceptable, calculate and apply Cw2 as described in specific counterweight installation procedure. All weight runs (Cw1, Cw2 ... Cwn) are calculated with respect to "As Is" data.
11) Continue to trim balance engine as required.
12) Complete trim balance report, shown in Figure 526, and file report with engine records.

(2) Hypothetical Example of Vector Balance Method

(a) Assume:

Vibration survey has shown need to trim balance (± 2.0 mils) (0.05 mm) at 6000 N_1. Engine is classified as "Class X." (Acceptance limits ± 1 mil) (0.03 mm). Procedure calls for a compressor trim at 6000 N_1 RPM, assumed phase angle lag of 130 degrees and sensitivity of 1.0 oz-in/mil (720 g.mm/0.03 mm).

(b) Record inlet pickup phase angle and amplitude at 6000 N_1 RPM. In this example let ± 2.0 mil (0.05 mm) at 300 degrees be the recorded data for run No. 1.

(c) Plot vector A (± 2.0 mil) (0.05 mm) at 300 degrees on polar paper. Lay out angle counter to engine rotation from 12 o'clock location. Draw vector R equal and opposite vector A. (See plot on Figure 523).

(d) Apply assumed phase angle lag (130 degrees) laying it off from R in direction of rotation. This indicates that Cw1 should be applied at 350 degrees as measured from 12 o'clock reference location counter to engine rotation.

(e) Apply assumed sensitivity. Multiple amplitude of A vector (± 2.0 mil) (0.05 mm) by assumed sensitivity (1.0 oz-in/mil) (720 g.mm/0.03 mm). Magnitude of Cw1 should be 2 oz-in (1440 g.mm).

(f) Install Cw1. Wire weight may be installed on nearest blade to 350 degrees. In this example let blade No. 2, shown on plot, be chosen (349 degrees).

(g) Rerun balance point and record phase angle and amplitude resulting from addition of Cw1. Run No. 2.

(h) In conjunction with previous Paragraph 9.D.(2)(g), observe O/A mils throughout engine speed range to determine if all vibration is within acceptance limits.

(i) Let data from Run No. 2 be ± 1.3 mils (0.03 mm) at 20 degrees. Plot data as vector C on polar paper. Lay out angle counter to engine rotation from 12 o'clock location.

(j) Plot Vector Difference (VD) by subtracting vector A from vector C. Draw VD from A to C, arrow pointing to C. Translate VD vector to origin of diagram. In this example VD is ± 2.2 mils (0.06 mm) at 84 degrees. VD represents effect of Cw1 alone, both in magnitude and direction. To eliminate unbalance (A vector), VD must bed rotated and adjusted in length to coincide with R vector.

(k) Calculate location and size of required balance weight, Cw2.

1) Size of correction weight = size of trial

$$\text{weight} \quad \times \quad \frac{\text{A mils}}{\text{VD mils}}$$

$$\text{Cw2} = 2 \quad \times \quad \frac{2}{2.2} = 1.82 \text{ oz-in.}$$

2) Location of correction weight: In this example, angular amount between VD (84 degrees) and R (120 degrees) is 36 degrees counter to engine rotation. Remove Cw1, move from its location 36 degrees counter to engine rotation to 25 degrees. Apply Cw2 (1.82 oz-in.) (1310 g.mm) at 25 degree (blade No. 32). This should cause VD to coincide with R.

(l) Above procedure can be repeated using second correction weight as new calibration weight. Data from new weight and "As-Is" data can be used to calculate third correction weight and thereby refine balance.

(m) Determine phase angle lag and vibration sensitivity. (Although not required for any specific engine balance, average values calculated from several engine balances are considered valuable guide for follow-on balance jobs).

1) Phase Angle Lag: Unbalance vectors are measured in terms of amplitude and phase angle (phase meter reading) and are plotted referenced to 12 o'clock location in direction counter to rotation to indicate "lag". Normal plotting procedure locates reference point at top of engine vertical centerline designated as 12 o'clock. this point is shown on the plot as 0 degrees.

Balance weights are located on rotor after rotor has been turned (indexed) to locate pulse generator tooth directly under pulse pickup. Angular location of the weight is then measured in direction counter to rotation referenced to 12 o'clock.

To determine phase angle lag, unbalance vectors and weight locations must be given common frame of reference. Angular location corresponding to 12 o'clock is taken as common reference point. Phase angle lag is angle by which response (VD) lags calibration weight. Graphically, it is angle from calibration weight to VD measured counter to engine rotation. In this example, phase lag is 96 degrees.

2) Sensitivity: Sensitivity can be calculated at any given speed point by dividing weight amplitude (Cw1 = 2.0 oz-in.) (1440 g.mm) by measured response (VD - ± 2.2 mils) (0.06 mm). In this example calculated sensitivity is 0.91 oz-in. per mil (655 g.mm per 0.03 mm).

(n) The purpose of calculating phase angle lag and sensitivity is to provide information to assist in future balances. Weighted average of these data for number of balances provide assumed phase angle lag and assumed sensitivity which, when applied to "As Is" data, established "one shot" balance method. In this example let assumed phase angle lag equal 95 degrees. After plotting information described in Paragraph 9.D.(2)(a) the 95 degree angle is now laid out from R vector in direction of engine rotation and establishes Cw1 location. Amount of weight required is established by multiplying A vector amplitude (+ mils) (+ mm) by sensitivity (oz-in./mil) (g.mm/mm) which, for this example, gives 1.82 oz-in. (1310 g.mm) required. It can now be seen that engine would be balanced by this Cw1 and no further runs are necessary.

E. Trim Balance Limits And Procedures

(1) Trim Balance Limits

(a) Engines that experience vibration at N_1 rotational frequency at inlet case and/or exhaust duct up to and including 0.002 inch single amplitude may be trim balanced to bring them within acceptable limits.

(b) Maximum correction (all trim weights) for trim balance of the front compressor at the front plane must be a vector sum of no more than 7.0 oz-in (5040. g.mm). The total number of trim weights used on the inner balance rib of the front hub must not be more than five.

(c) Maximum correction (all trim weights) for trim balancing front compressor drive turbine at rear plane shall not exceed total vector sum of 10.5 oz-in. when combined with weights previously installed while balancing turbine rotor. Previously installed weights may be moved or replaced, but total number of weights used on turbine rotor assembly shall not exceed five and total vector sum shall not exceed 10.5 oz-in. (7560 g.mm).

(d) After completing installation of final trim balance weights, conduct vibration survey to ensure that vibration levels are within acceptance limits.

(2) Trim Balance Weight Installation

(a) Front Plane

1) Remove front accessory drive group. (PAGEBLOCK 72-21-00/401)

2) Remove retaining ring holding front accessory drive gearshaft in front hub. Engage PWA 45009 Puller behind gearshaft gearteeth and remove gearshaft carefully with knocker action.

3) Find the applicable counterweight (0 - 5) as shown in Figure 527.

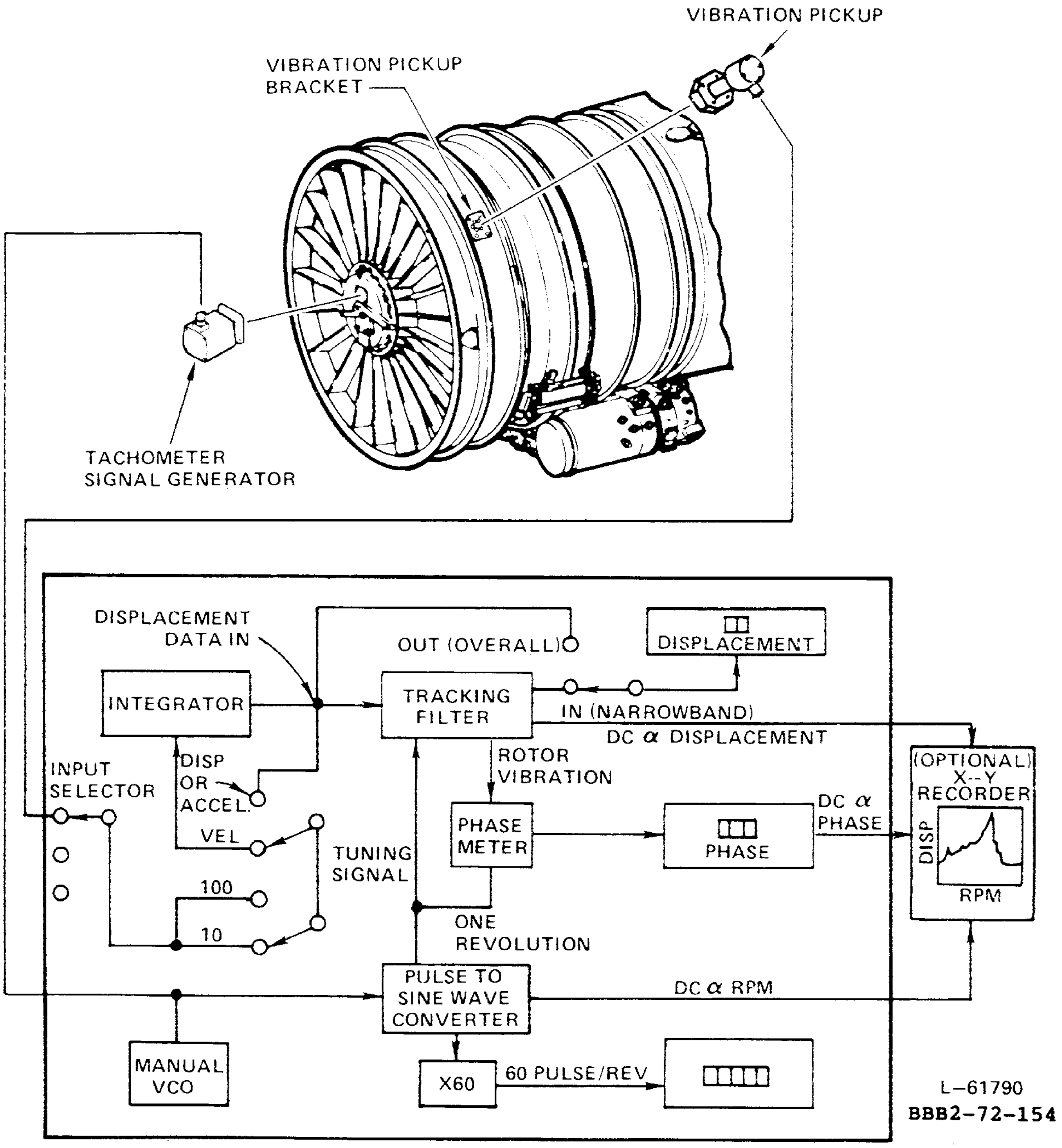
4) Install counterweight inside front hub on balancing rib as close to required angular location as possible. Compress counterweight shank against spring pressure and release shank when weight straddles balancing rib and hook section of shank is in line with hole in rib. Figure 527

5) Install a packing, lubricated with PWA 36500 Assembly Fluid, on the front accessory drive gearshaft and install the shaft on the front hub. Hold the gearshaft in position with a retaining ring.

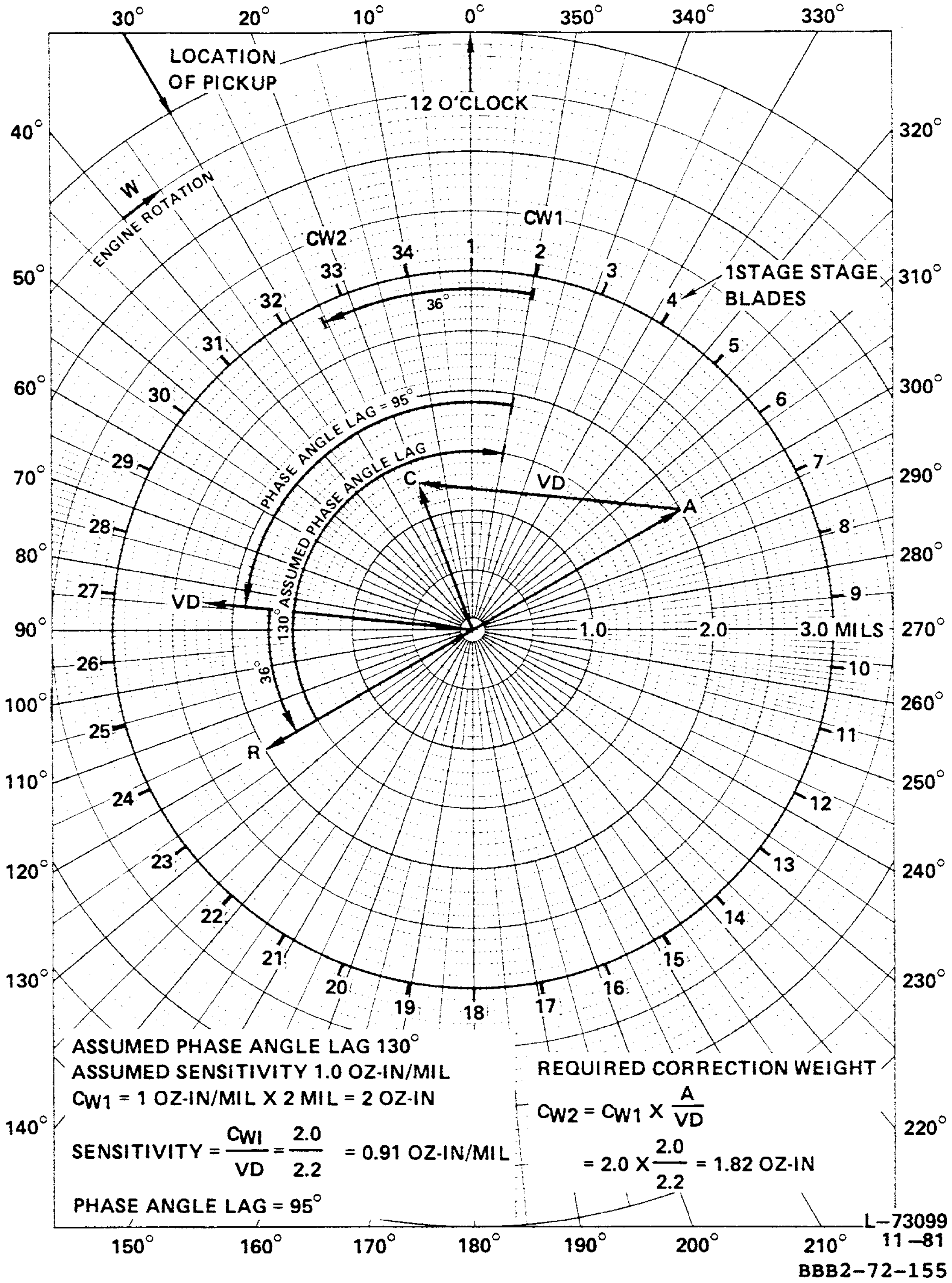
6) Install front accessory group. (PAGEBLOCK 72-21-00/401)

(b) Rear Plane

1) Remove the fan and turbine exhaust duct (mixer) for access to the rear of the turbine.
2) Add counterweights (or remove and replace counterweights found on the rear of the 4th stage turbine disk). Refer to the limits in Paragraph 9.E.(1). (Figure 528)
3) Attach counterweights with rivets (rivet heads pointed to the disk surface). Flare the rivet ends to 0.125 inch (3.175 mm) diameter minimum (PWA 46320 Riveter is available to do this).
4) Install the fan and turbine exhaust duct (mixer).



Instrumentation Block
Figure 522/72-00-00-990-913



ASSUMED PHASE ANGLE LAG 130°

ASSUMED SENSITIVITY 1.0 OZ-IN/MIL

C_{W1} = 1 OZ-IN/MIL X 2 MIL = 2 OZ-IN

SENSITIVITY = $\frac{C_{WI}}{VD} = \frac{2.0}{2.2}$ = 0.91 OZ-IN/MIL

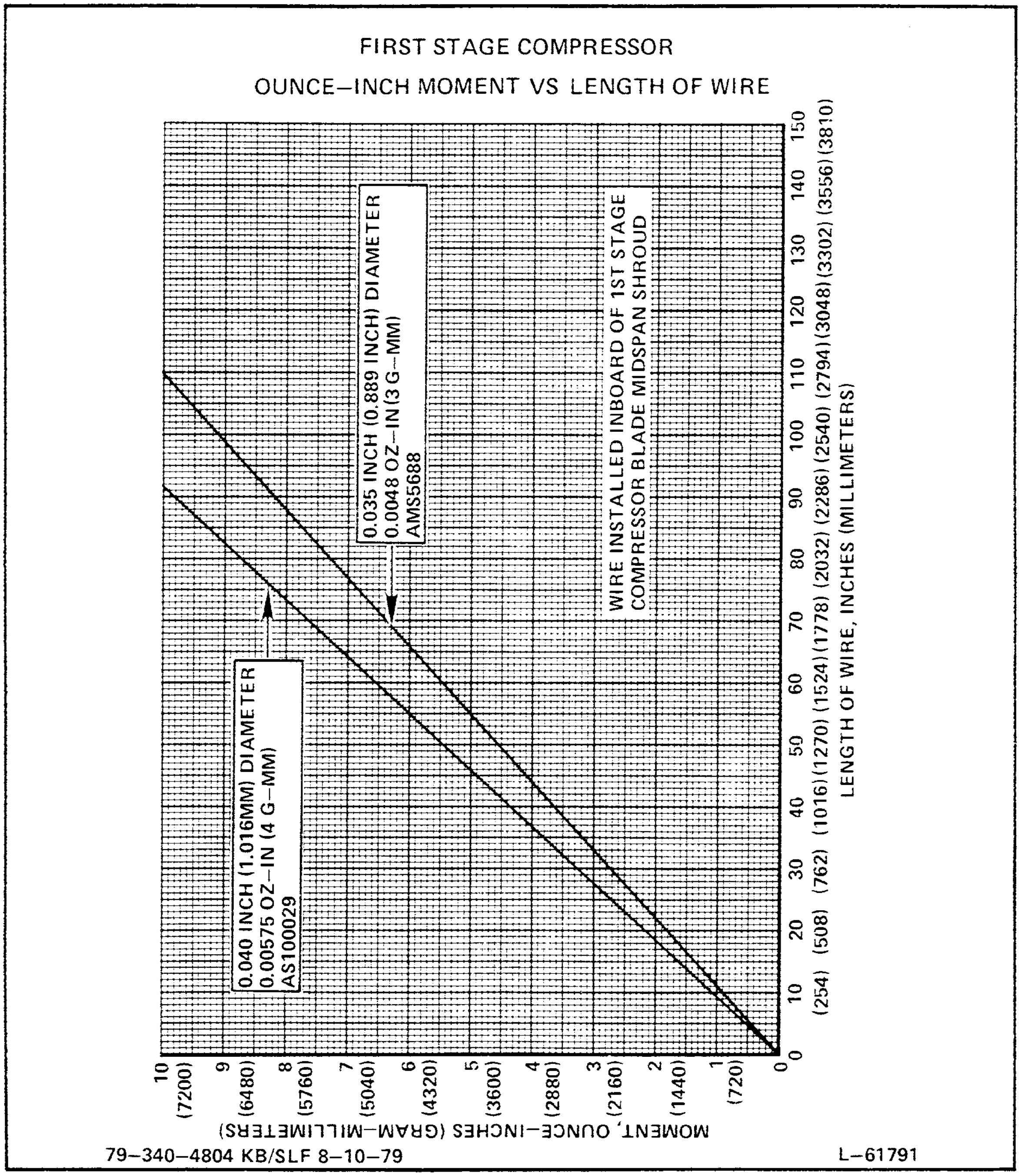
PHASE ANGLE LAG = 95°

REQUIRED CORRECTION WEIGHT

$C_{W2} = C_{W1} \times \frac{A}{VD}$

$= 2.0 \times \frac{2.0}{2.2} = 1.82$ OZ-IN

Trim Balance Calculation Diagram
Figure 523/72-00-00-990-914


FIRST STAGE COMPRESSOR

OUNCE–INCH MOMENT VS LENGTH OF WIRE

79–340–4804 KB/SLF 8–10–79

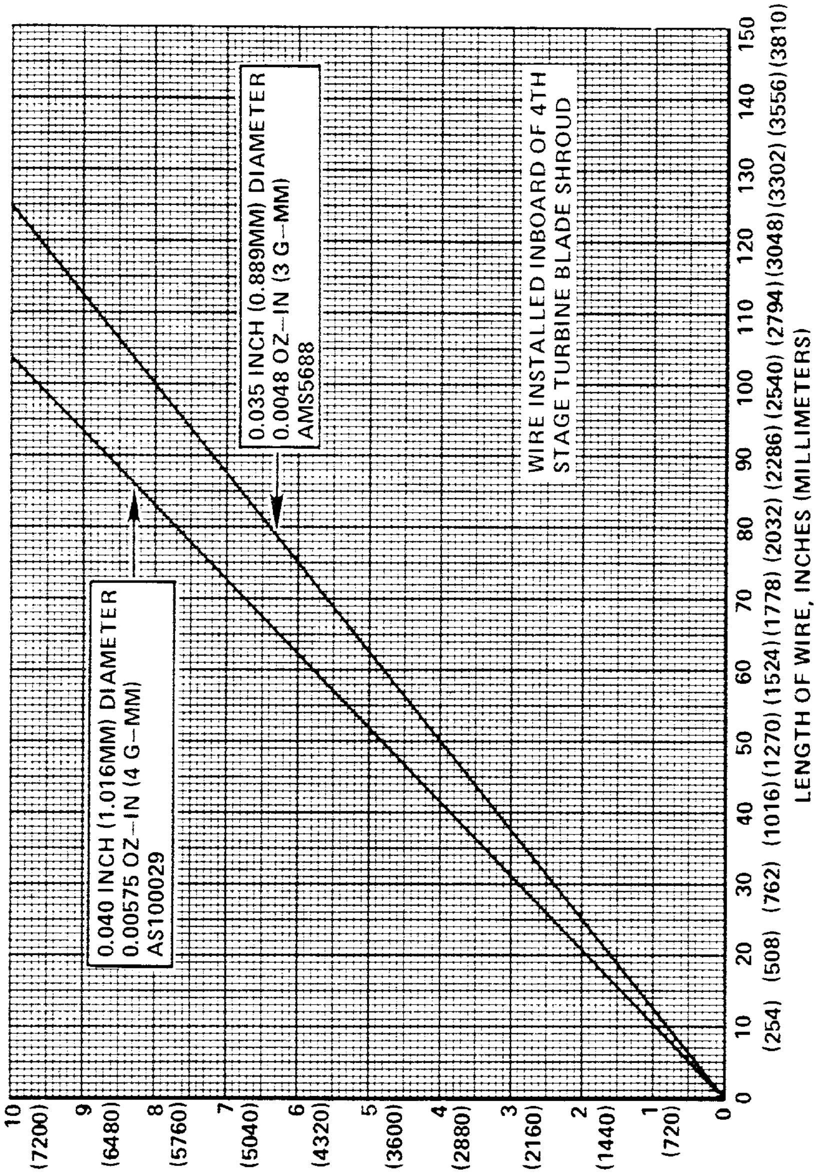
L–61791

BBB2–72–156

Ounce-Inch Moment Vs. Length Of Wire (First Stage Compressor)
Figure 524/72-00-00-990-915

FOURTH STAGE TURBINE

OUNCE–INCH MOMENT VS LENGTH OF WIRE

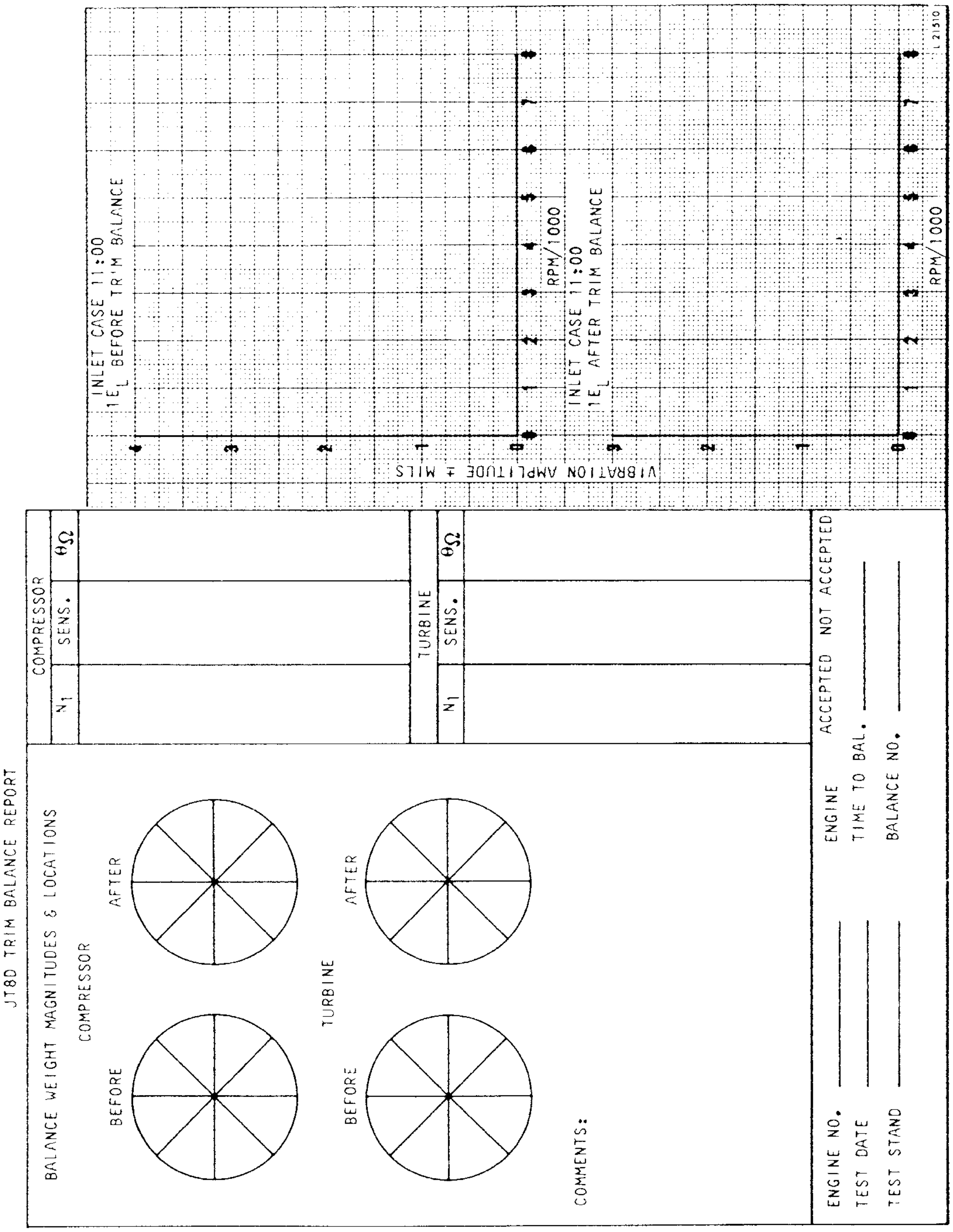


79–340–4804 KB/SLF 8–10–79

L–61792

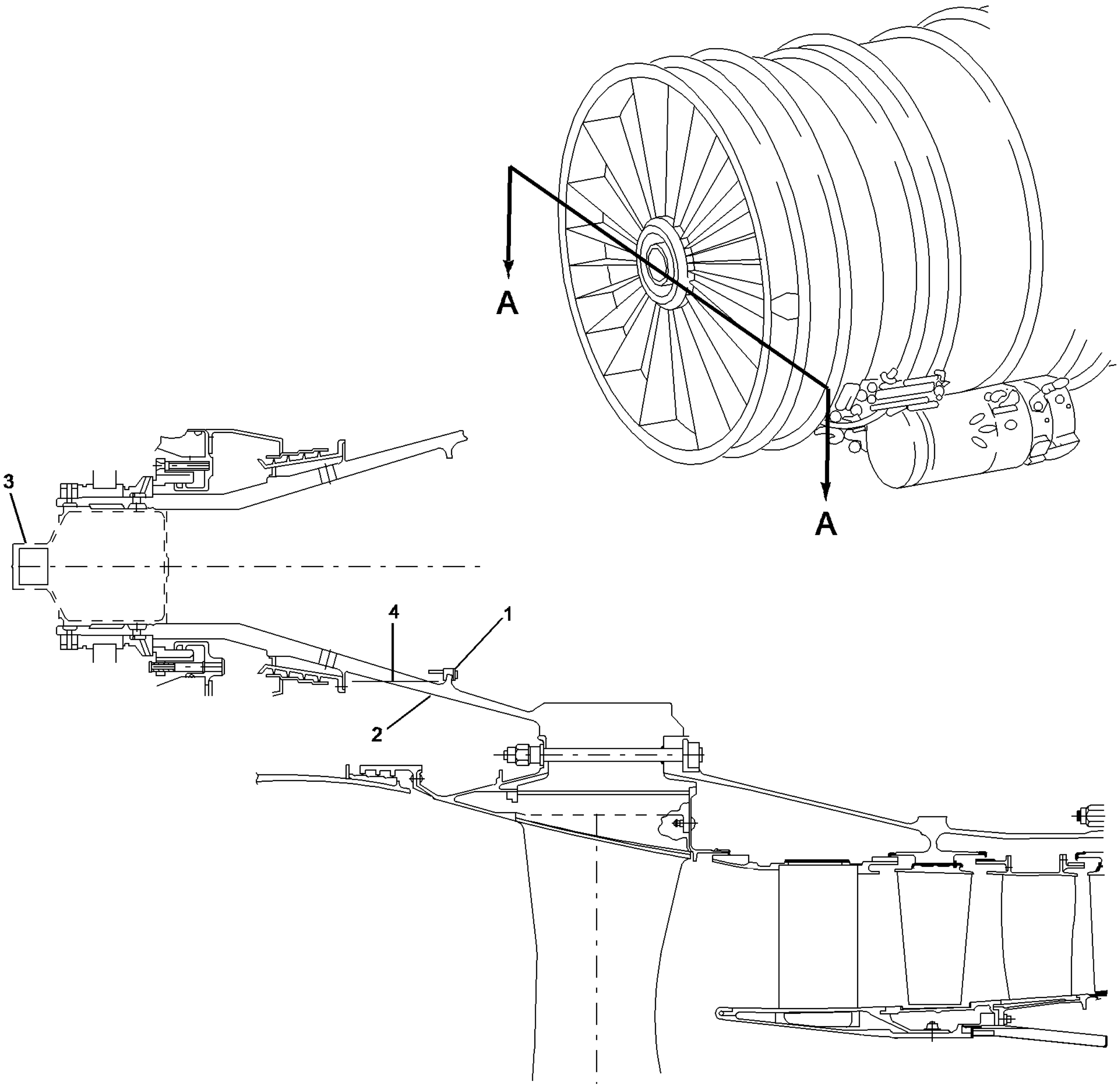
BBB2–72–157

Ounce-Inch Moment Vs. Length of Wire (Fourth Stage Turbine)
Figure 525/72-00-00-990-916



BBB2-72-158

Trim Balance Report
Figure 526/72-00-00-990-917



SECTION A-A

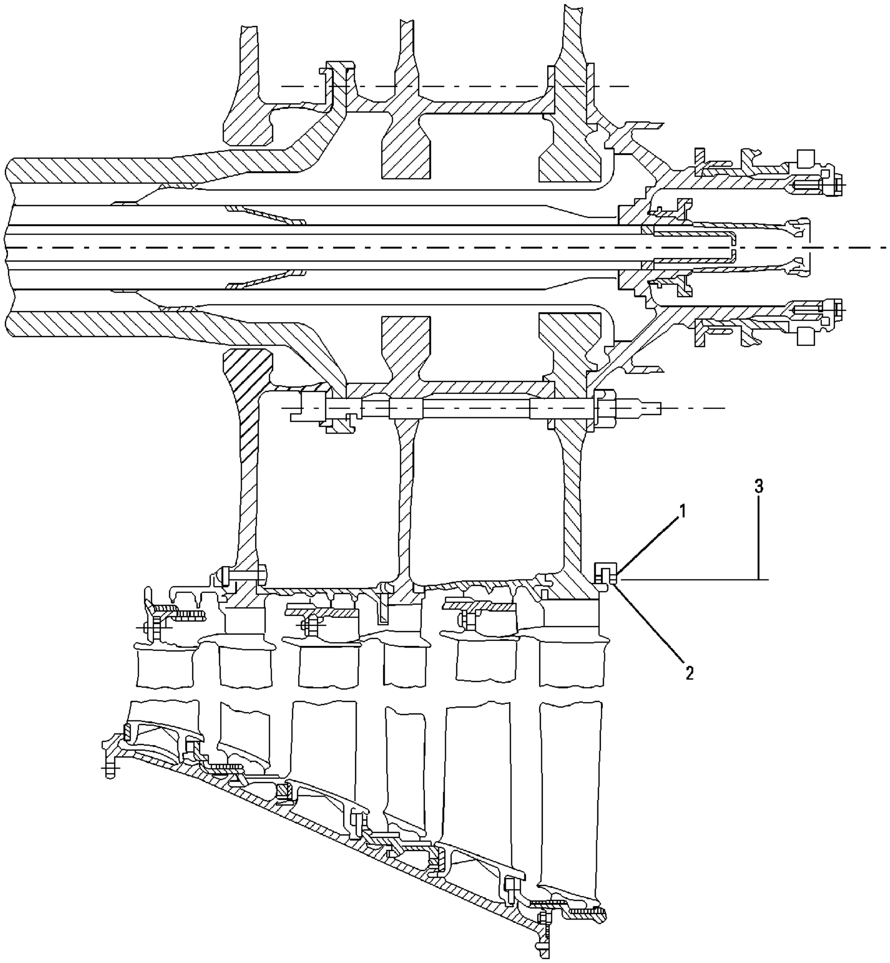
LEGEND:

1. COUNTERWEIGHT PN 658339, 658341 (CLASS 1 OR 2) OR 761787, 0 - 5 AS REQUIRED
2. FRONT COMPRESSOR FRONT HUB
3. GEARSHAFT (REMOVED FOR ACCESS)
4. 4.000 in. (101.600 mm) BALANCING RADIUS (REFERENCE)

L-83887

BBB2-72-159A
S0006554749V2

Front Compressor Trim Balancing
Figure 527/72-00-00-990-918



1. PN 534492, 584943, OR 584994 COUNTERWEIGHTS. SELECT CLASS AS NECESSARY AND INSTALL, REMOVE, OR REPLACE BY THE LIMITS IN THE TEXT. IT IS PERMITTED TO INSTALL PN 534492 EITHER SIDE OF THE DISK FLANGE.
2. RIVET (PN 4028248) (USE WITH PN 584943 OR 584944).
3. 7.715 INCHES (195.961 MM) BALANCE RADIUS (REFERENCE)

L-84125

CAG(IGDS)

BBB2-72-518

Rear Turbine Trim Balance
Figure 528/72-00-00-990-919

10. Fuel Control Starting Schedule Adjustment

A. General

(1) Fuel control removals have occurred on engines that had what could become "hot starts" and also on engines which had slow acceleration. Experience shows that fuel control linkages can have wear or part movement which can cause changes in the starting flow schedule, in either the rich or the lean direction. A rich change in fuel flow can cause hot starts. A lean change in fuel flow can cause slow acceleration. Adjustments to the fuel control to put the start schedule back in its initial calibration limits, as specified in the CMM, can decrease the number of fuel control removals which are the result of possible hot start or slow acceleration.

(2) It is possible to do this adjustment on a fuel control only two times, in the upward or downward direction. If a fuel control continues to be part of a hot start or slow acceleration problem, remove the control for approved component repair or calibration.

(3) This procedure is approved for all dash numbers of Hamilton Standard (HSD) PN 769606 fuel controls.

(4) Before fuel control adjustment, do all other applicable procedures in PAGEBLOCK 72-00-04/101 to make sure that there are no other possible causes of the hot start or slow acceleration problem.

(5) Adjustments to the fuel control other than what is specified in the procedures in this section are not permitted.

B. Procedure

(Figure 529), (Figure 530), (Figure 531), (Figure 532)

CAUTION: DO NOT USE AN ABSOLUTE PRESSURE GAGE TO MEASURE PRIMARY FUEL PRESSURES. THIS TYPE OF GAGE WILL NOT GIVE CORRECT READINGS FOR THIS PROCEDURE.

(1) Attach a gage, STD-14581 to the pressurizing and dump valve FP4 port as shown in (Figure 529).

(2) Wet motor the engine for ten (10) seconds minimum after the N_2 speed becomes stable.

(3) Measure the fuel pressure at the FP4 port.

(4) Record the engine speed and the ambient atmospheric pressure (in inches Hg).

(5) Use Figure 530 to convert the primary fuel pressure at the FP4 port to fuel flow (primary fuel pressure versus primary nozzle pressure).

(6) Find the nominal fuel flow (Wf) for the N_2 speed from the applicable starting schedule. (Figure 531, Sheets 1 thru 10)

(7) Add and subtract 30 PPH to get a plus or minus 30 PPH acceptance band.

(8) If the fuel flow (Wf) in Paragraph 10.B.(5) is in the band of fuel flow (Wf) set in Paragraph 10.B.(6), do not adjust the fuel control.

(9) If the fuel flow (Wf) in Paragraph 10.B.(5) is more than the higher fuel flow (Wf) set in Paragraph 10.B.(7), turn the throttle valve position adjustment counterclockwise to decrease the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(10) If the fuel flow (Wf) in Paragraph 10.B.(5) is less than the lower fuel flow (WF) set in Paragraph 10.B.(7), turn the throttle valve position adjustment clockwise to increase the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(11) Adjust the throttle valve position adjustment as follows: (Figure 527)

  (a) Remove the screw and plate from the fuel control as shown in Figure 532.

(b) Use a 3/32 inch hex wrench to turn the adjustment in the necessary direction.

NOTE: The adjustment has a limit of 230 PPH for a fuel control between bench calibrations (this will be approximately 0.3 turn). This adjustment will make a change of 800 PPH per turn. Make the last adjustment in a clockwise direction. To get a decrease in fuel flow, turn the adjustment counterclockwise one eighth (1/8) turn past the necessary position, then turn it clockwise to the necessary position.

(c) Install the plate and attach it with the screw and washer after the adjustment is completed.

(12) After all adjustments, do this procedure to make sure that the schedule mechanism is stable:

(a) Get the engine to a stable motoring speed.

(b) Set the condition lever to ON for ten (10) seconds and record the primary nozzle pressure at the P&D valve FP4 port.

(c) Set the condition lever to OFF for ten (10) seconds.

(d) Do Paragraph 10.B.(12)(b) and Paragraph 10.B.(12)(c) again.

(e) Do Paragraph 10.B.(12)(b) again.

(f) If the pressure recorded in Paragraph 10.B.(12)(e) is not plus or minus 2 psi of the pressure recorded in Paragraph 10.B.(12)(d), stop the motoring procedure and do Paragraph 10.B.(12)(a) thru Paragraph 10.B.(12)(e) again.

(g) Use Figure 530 to convert primary nozzle pressures recorded in Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) to fuel flow (Wf).

(h) The average of the fuel flow (Wf) readings from Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) will usually be plus or minus 25 PPH from the nominal fuel flow (Wf) in Paragraph 10.B.(6). If the average fuel flow (Wf) is more than this limit, adjust the starting fuel flow (Wf) and do all of Paragraph 10.B.(12) again.

NOTE: It is possible to do an engine run to Idle as an alternate to Paragraph 10.B.(12)(b) thru Paragraph 10.B.(12)(e), with only one pressure measured during a motoring procedure.

(13) Make sure that an increase or decrease in starting fuel flow (Wf) shows on the flight deck indicator as well as during the primary pressure flow check at the P&D valve. If the two indications are not the same, this can be a result of contamination in the primary fuel nozzles, or a problem with the flight deck instrumentation.

(14) After the adjustment, make sure that the necessary fuel control trim parameters are in limits. These parameters will include Idle and Part Power trim limits, and Takeoff, acceleration, and deceleration checks. Refer to the airframe manufacturer's trim information.

(15) Sample Calculation

(a) Sample A

1) Conditions:

a) 22 percent N_2 motoring speed

b) Fuel: Jet A

c) Pamb: 29.92 inches Hg

d) Primary fuel nozzle pressure measured at 100 PSIG

(b) Sample B

1) From Figure 531 (for -7 and -08 fuel controls) the nominal fuel flow (Wf) for 22 percent N_2 at 29.92 inches hg ambient pressure will be 730 PPH.

2) Add and subtract 30 PPH as shown in Paragraph 10.B.(7):

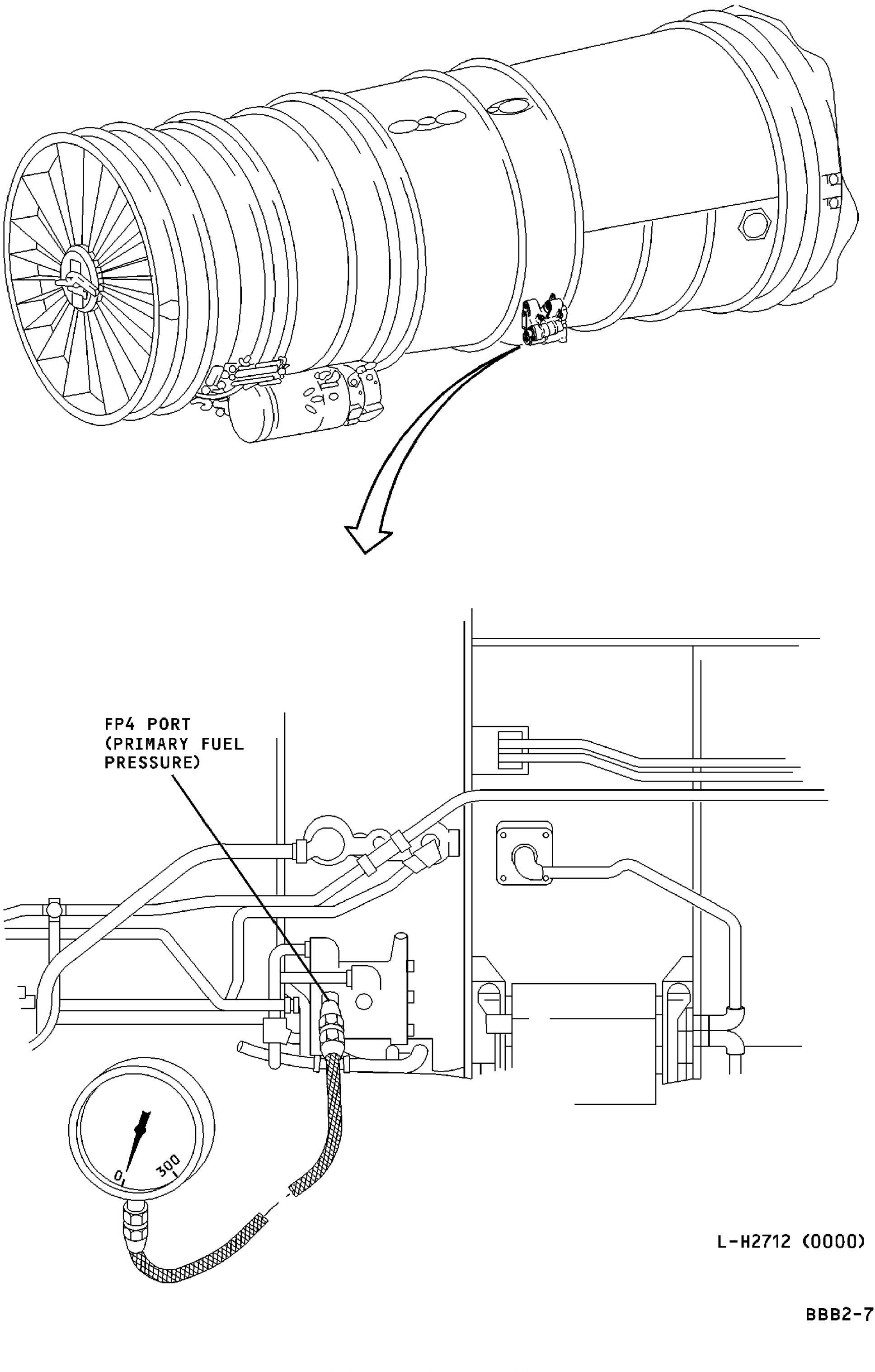
   730 + 30 = 760 pph

   730 - 30 = 700 pph

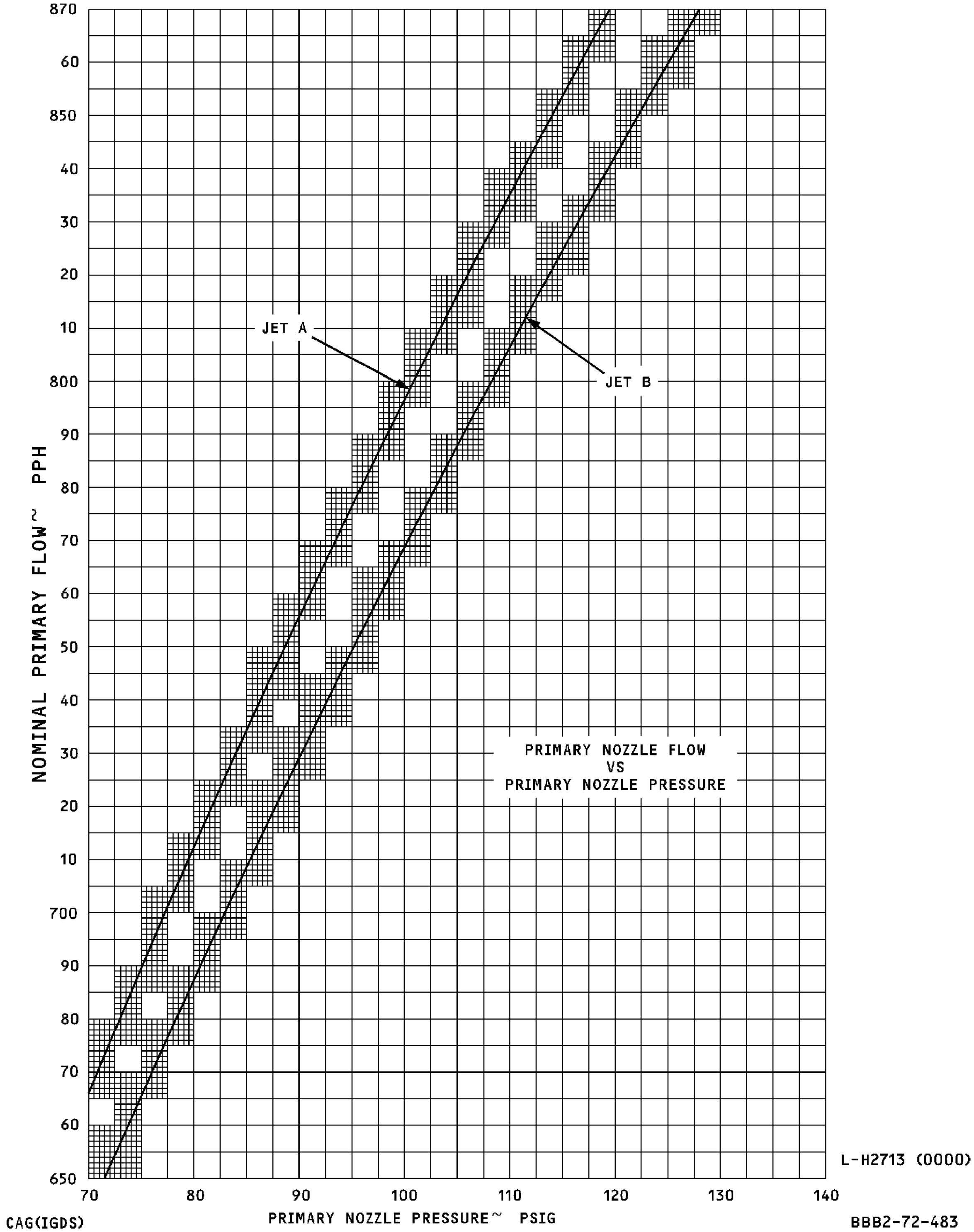
3) In this example the fuel flow (Wf) from Paragraph 10.B.(15)(a) is more than the higher fuel flow (Wf) in Paragraph 10.B.(15)(b). Therefore, it will be necessary to decrease the flow to 730 ±25 PPH. Turn the throttle valve position adjustment counterclockwise to get a primary nozzle pressure of 84 PSIG. Make the last adjustment in a clockwise direction as shown in Paragraph 10.B.(9). Refer to Table 509 for typical adjustment limits.

Table 509 Fuel Control Fuel Flow Adjustment

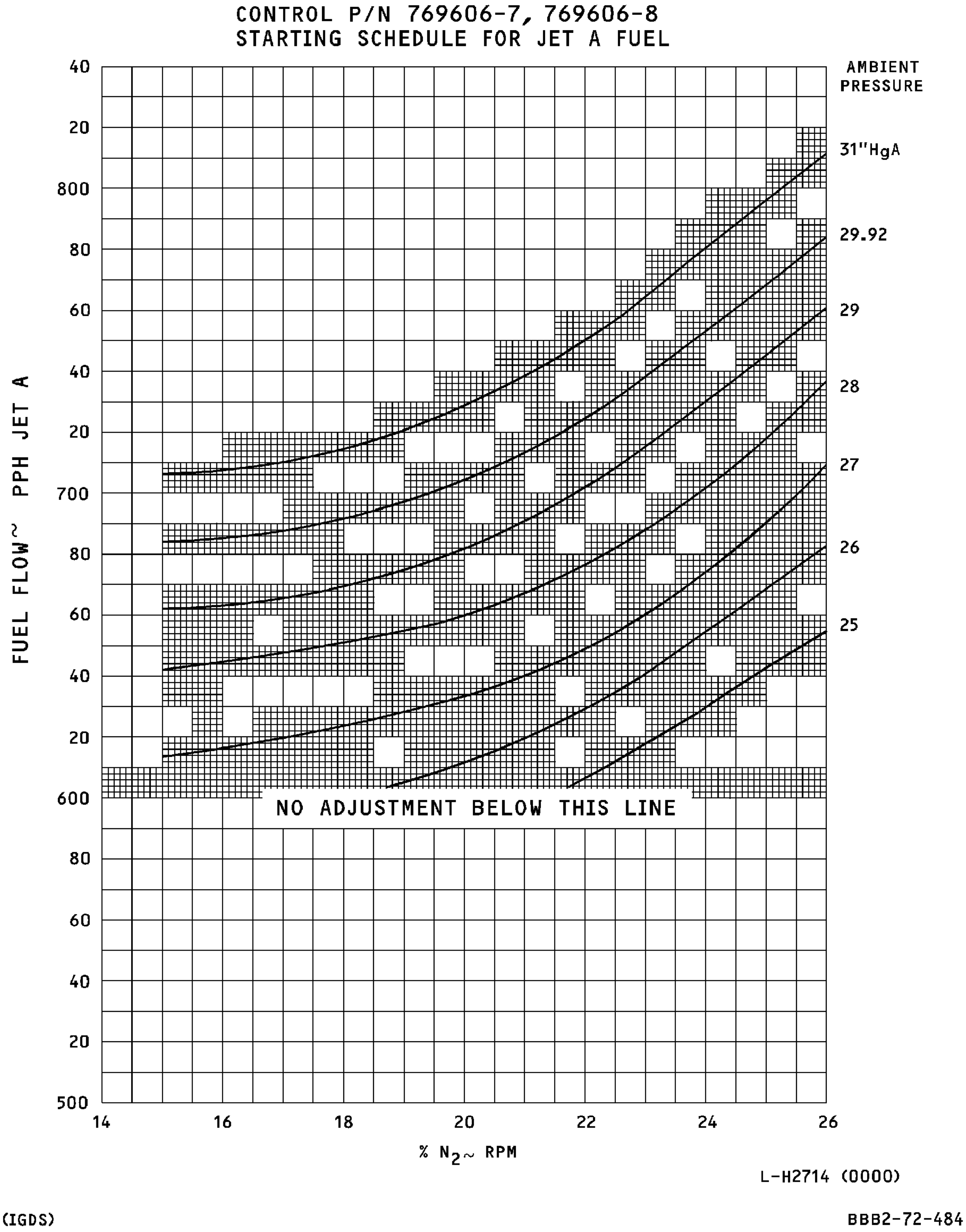
Fuel Control Throttle Valve Position Adjustment Turns	Fuel Flow (Wf) Difference (PPH)
Clockwise:	
1/16	50
1/8	100
3/16	150
1/4	200
5/16	250
3/8	300
Counterclockwise:	
1/16	-50
1/8	-100
3/16	-150
1/4	-200
5/16	-250
3/8	-300



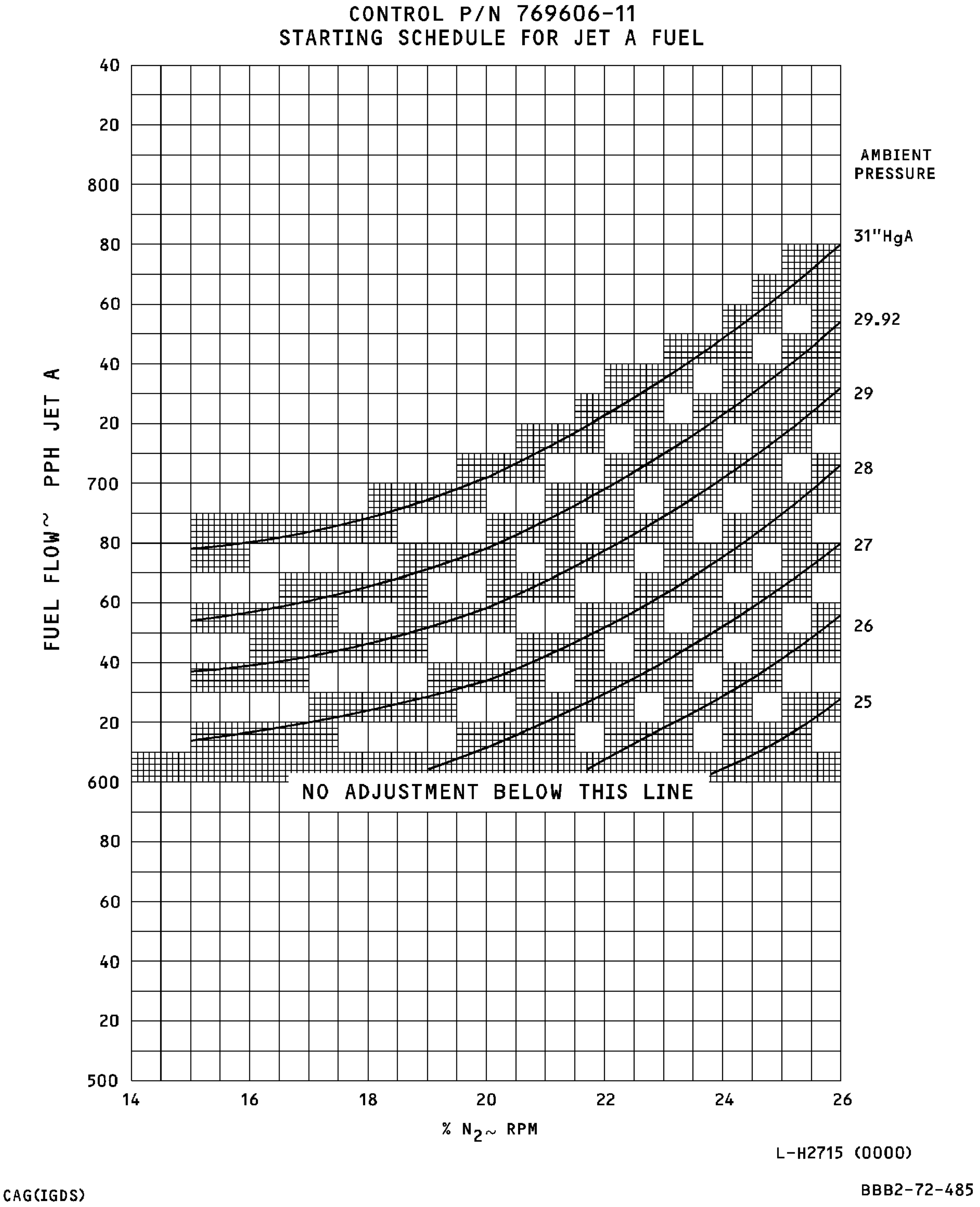
Pressurizing and Dump Valve
Figure 529/72-00-00-990-920



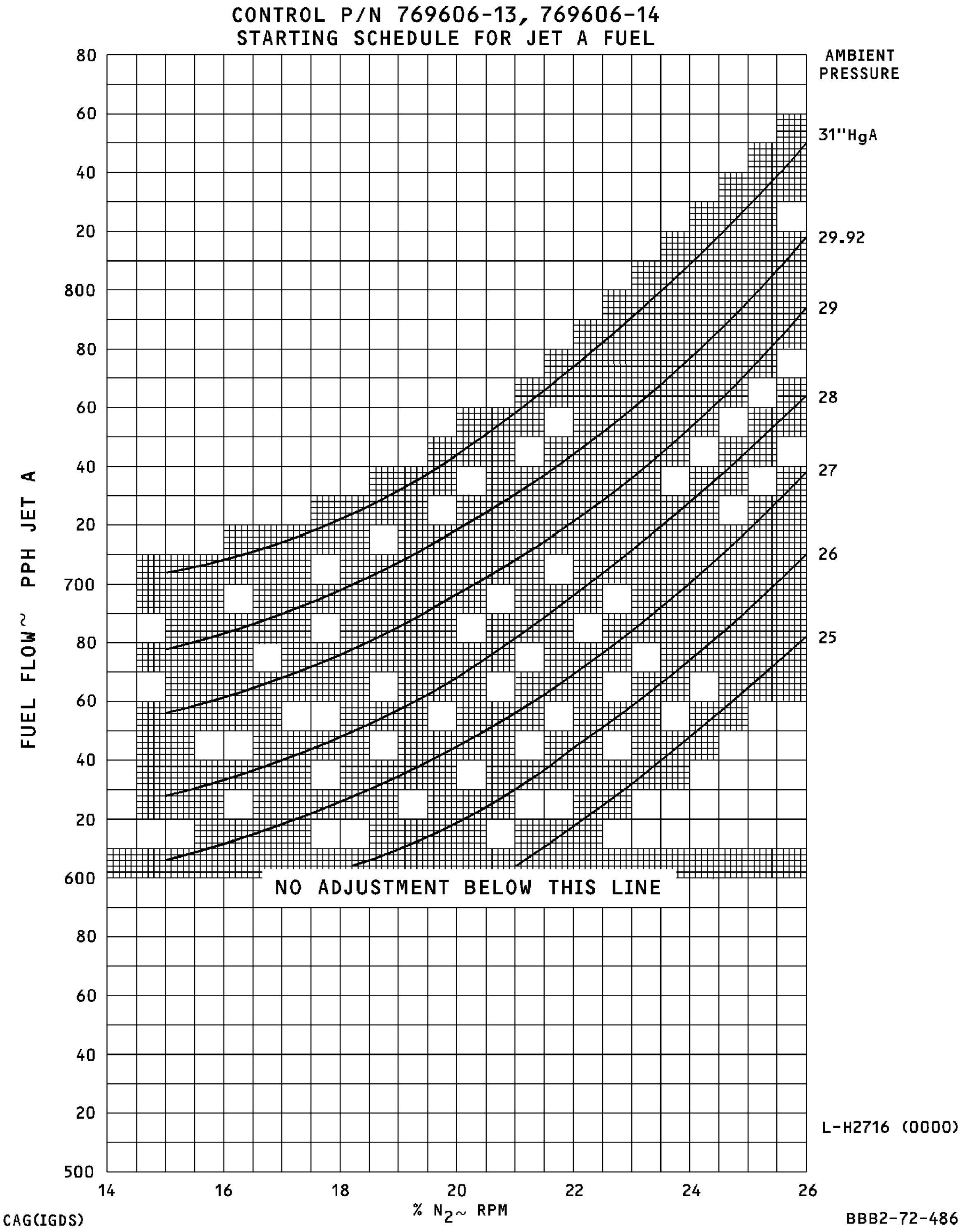
Fuel Pressure to Flow Conversion
Figure 530/72-00-00-990-921



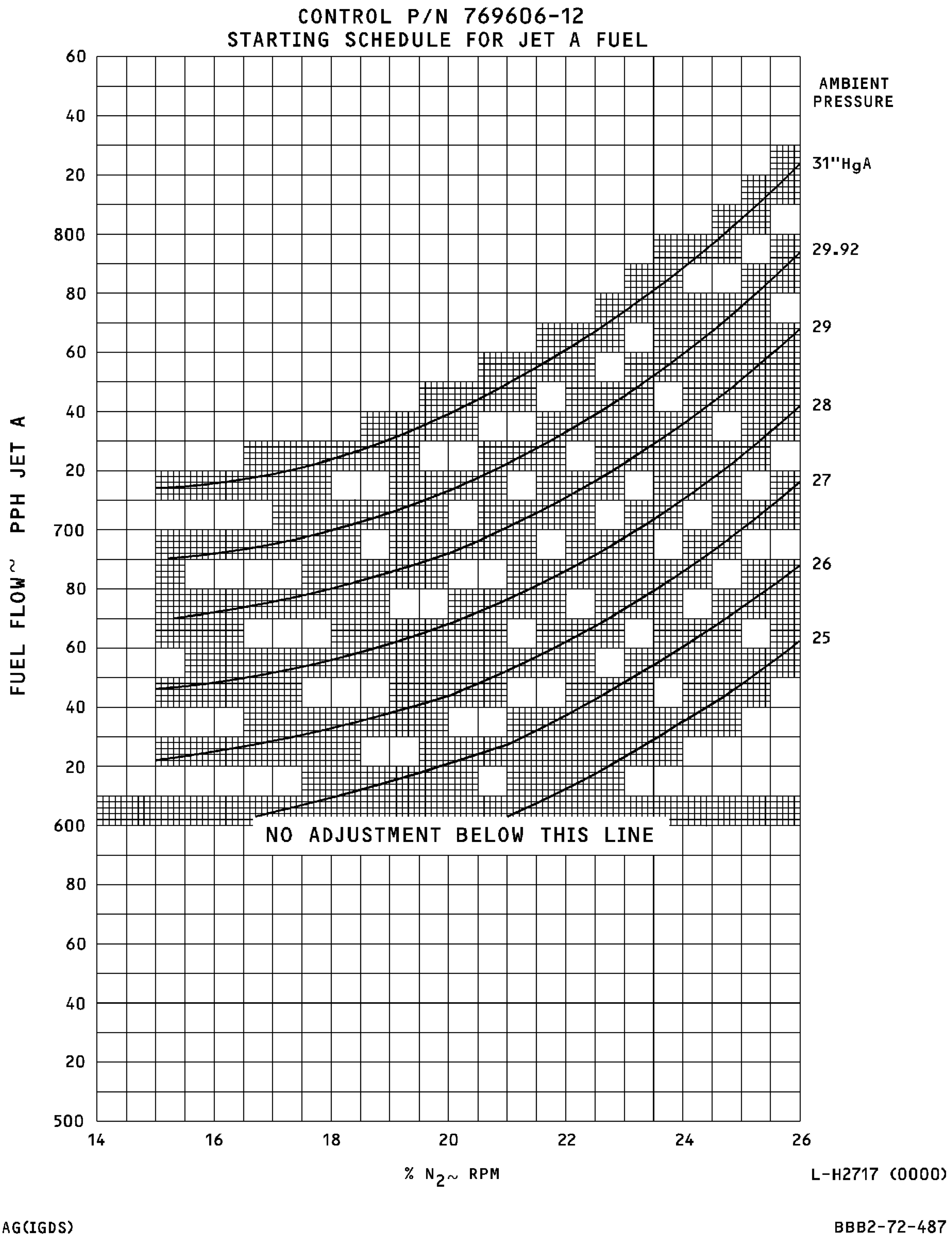
Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 1 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 2 of 10)

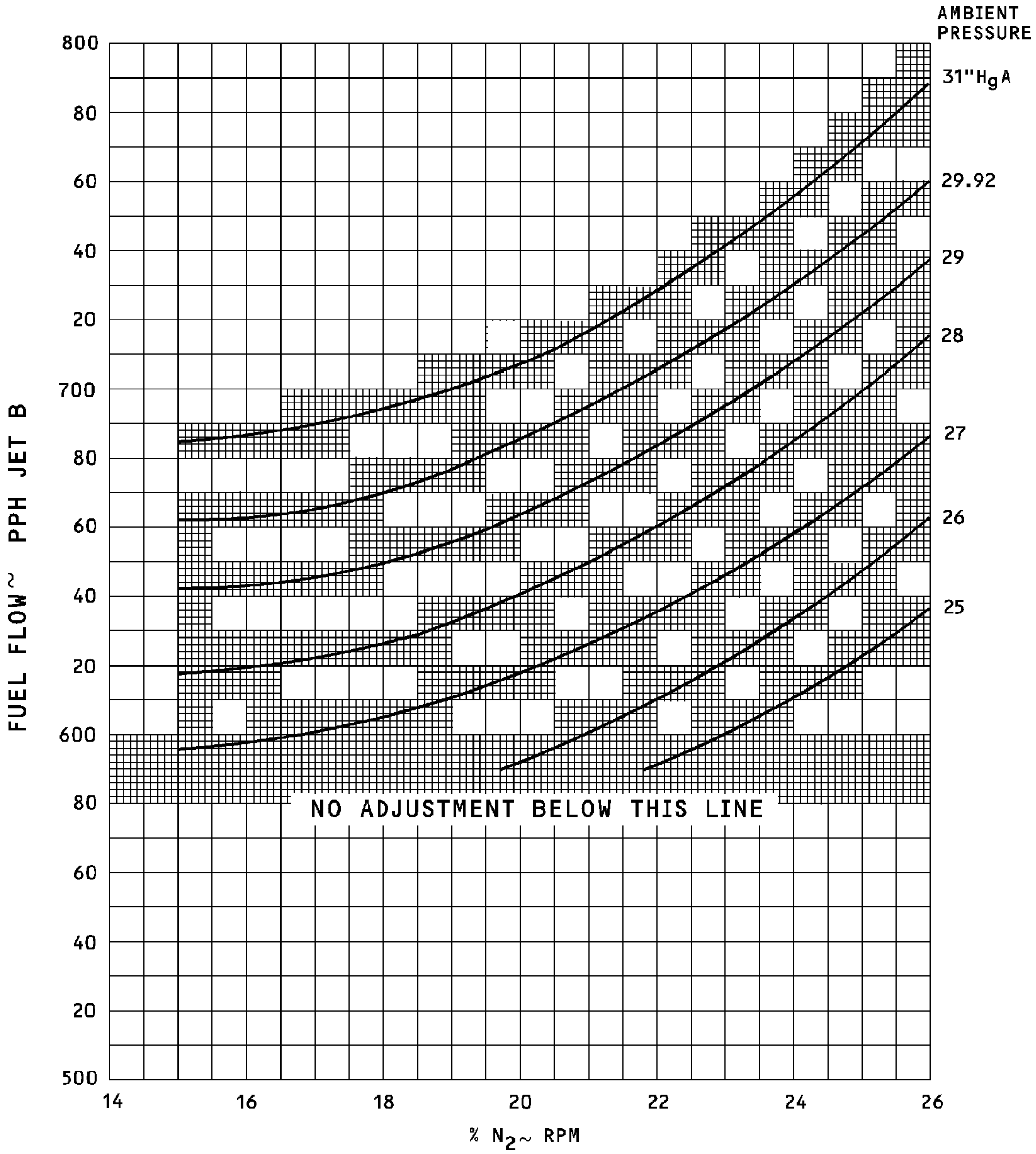


Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 3 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 4 of 10)

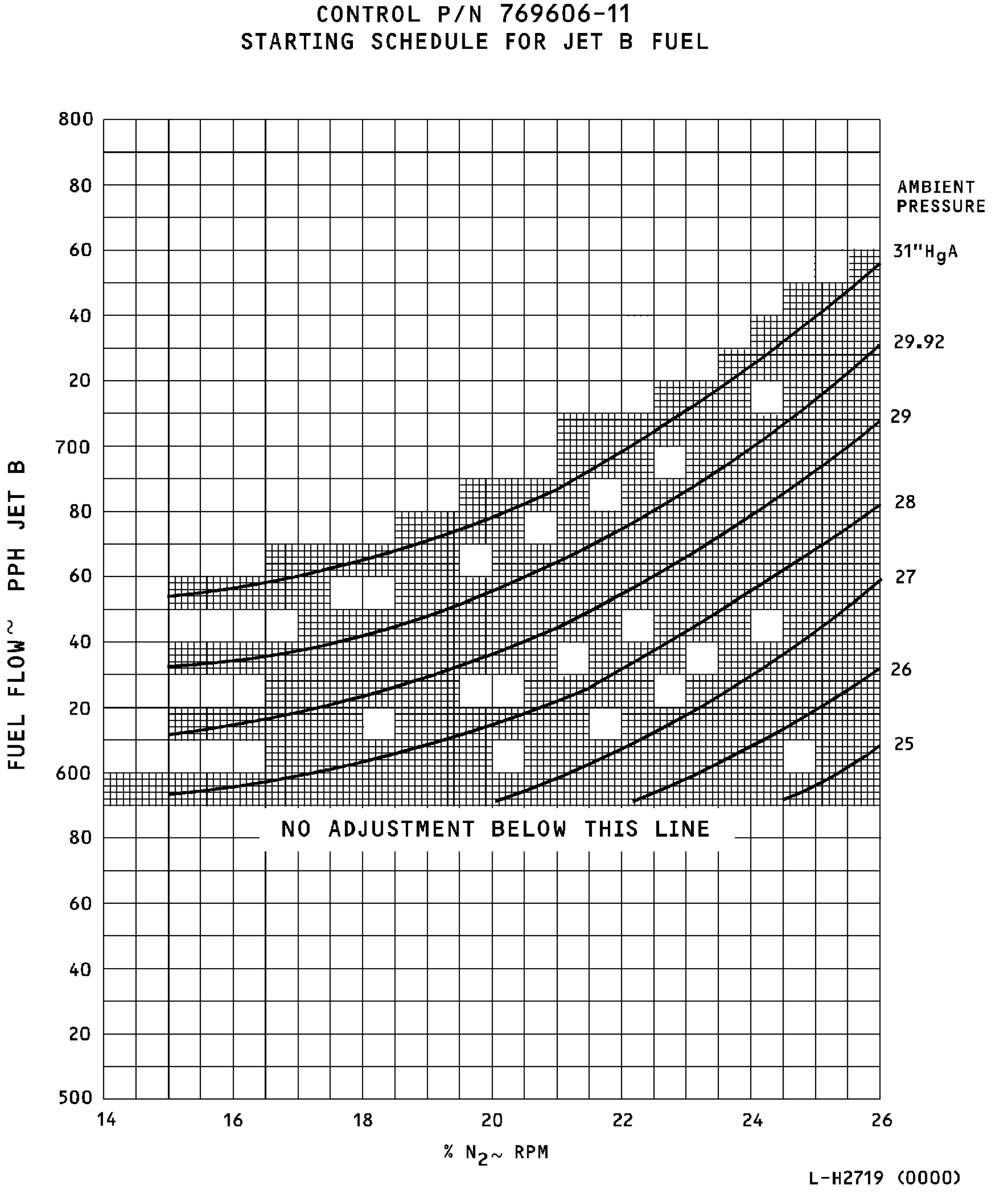
CONTROL P/N 769606-7, 769606-8
STARTING SCHEDULE FOR JET B FUEL



CAG(IGDS)

BBB2-72-488

Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 5 of 10)



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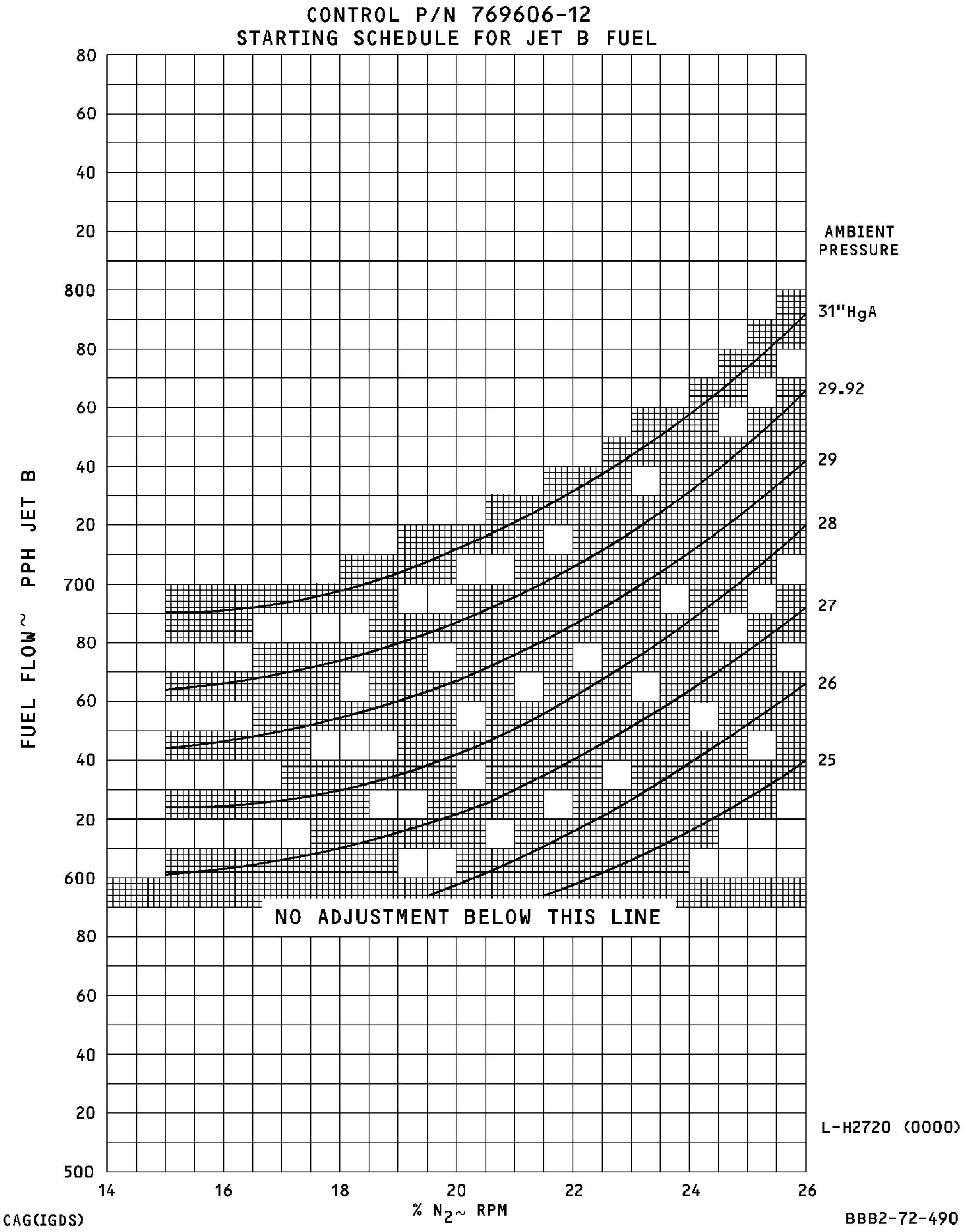
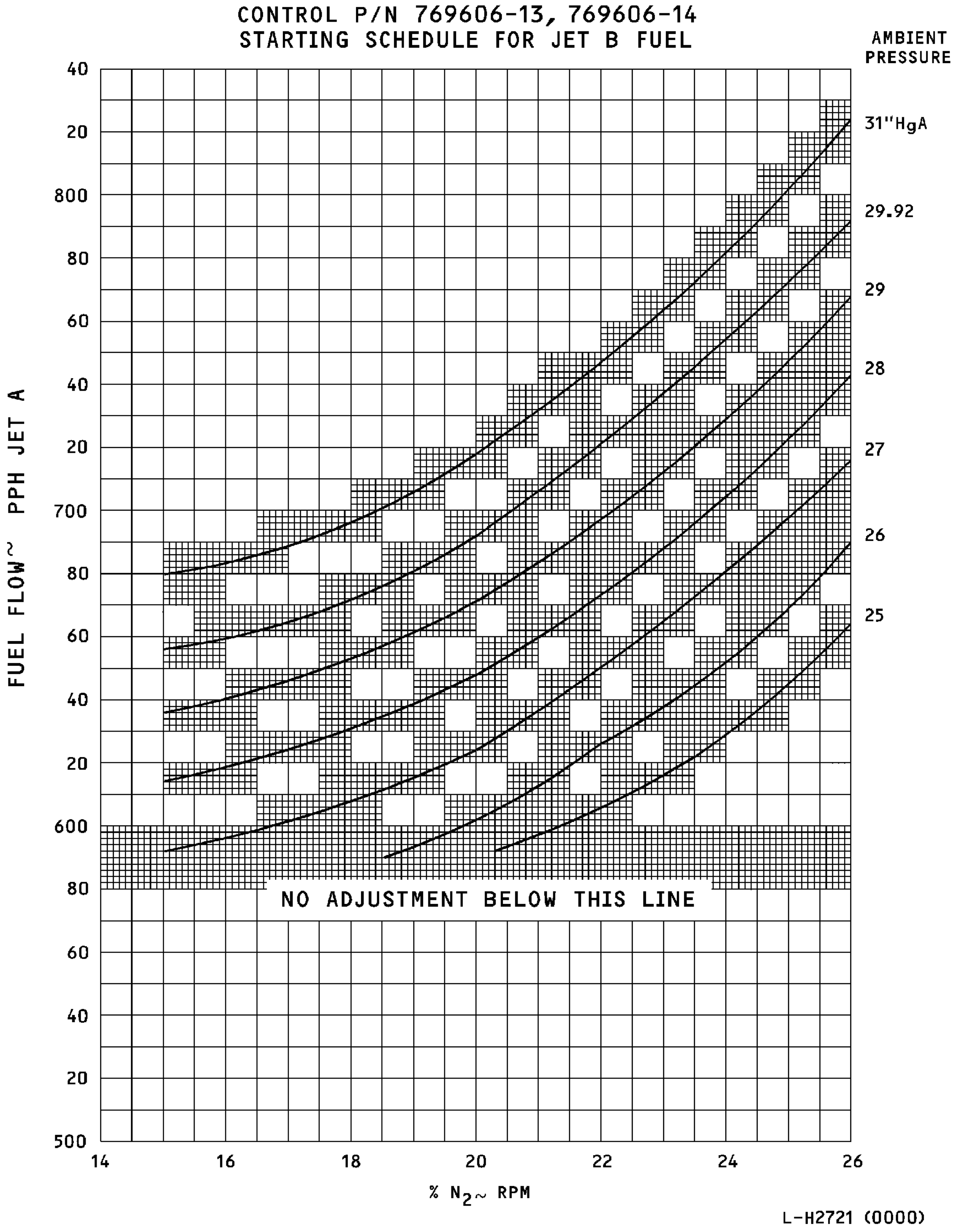
Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 6 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 7 of 10)



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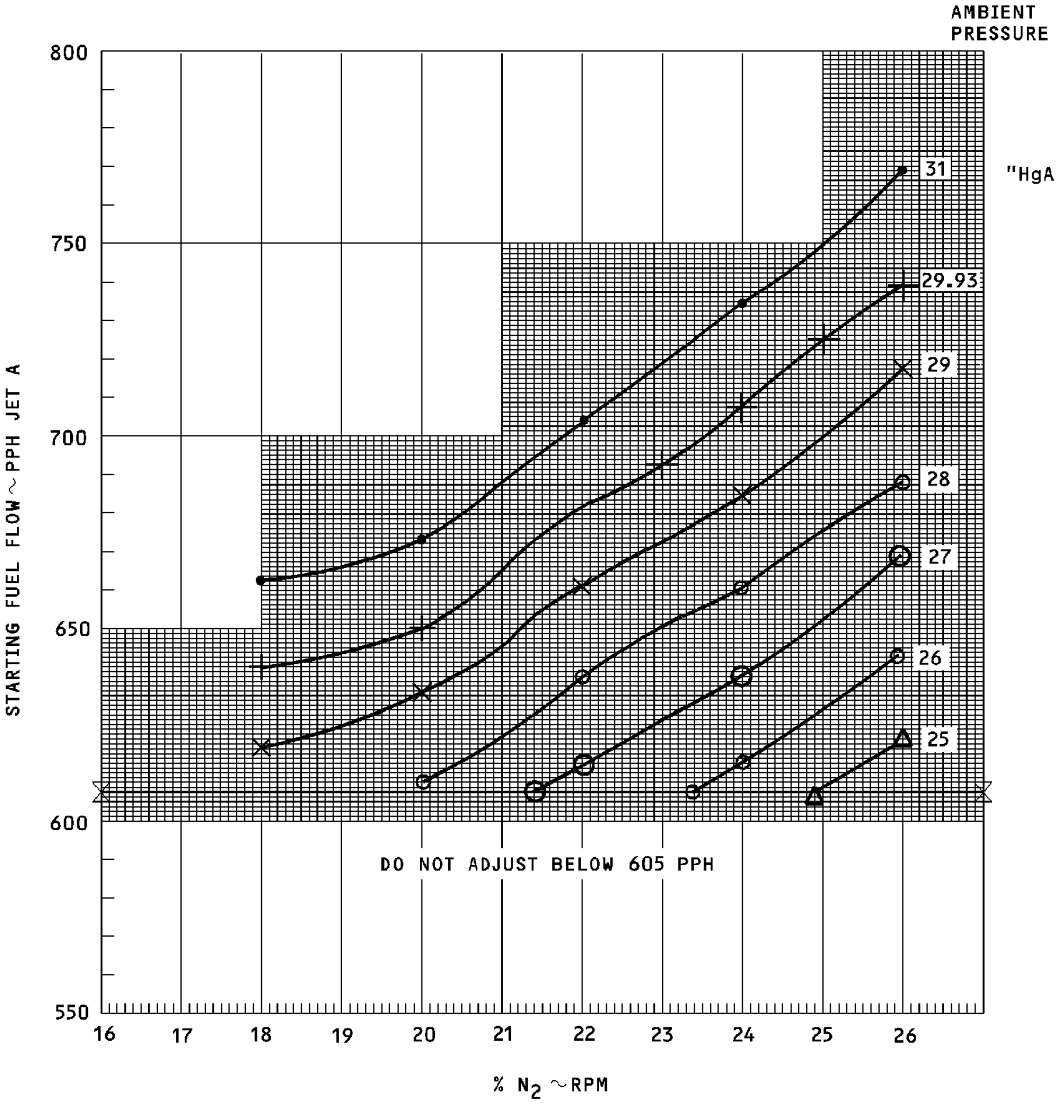
Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 8 of 10)

CONTROL P/N 769606-15, 769606-16
STARTING SCHEDULE FOR JET A FUEL



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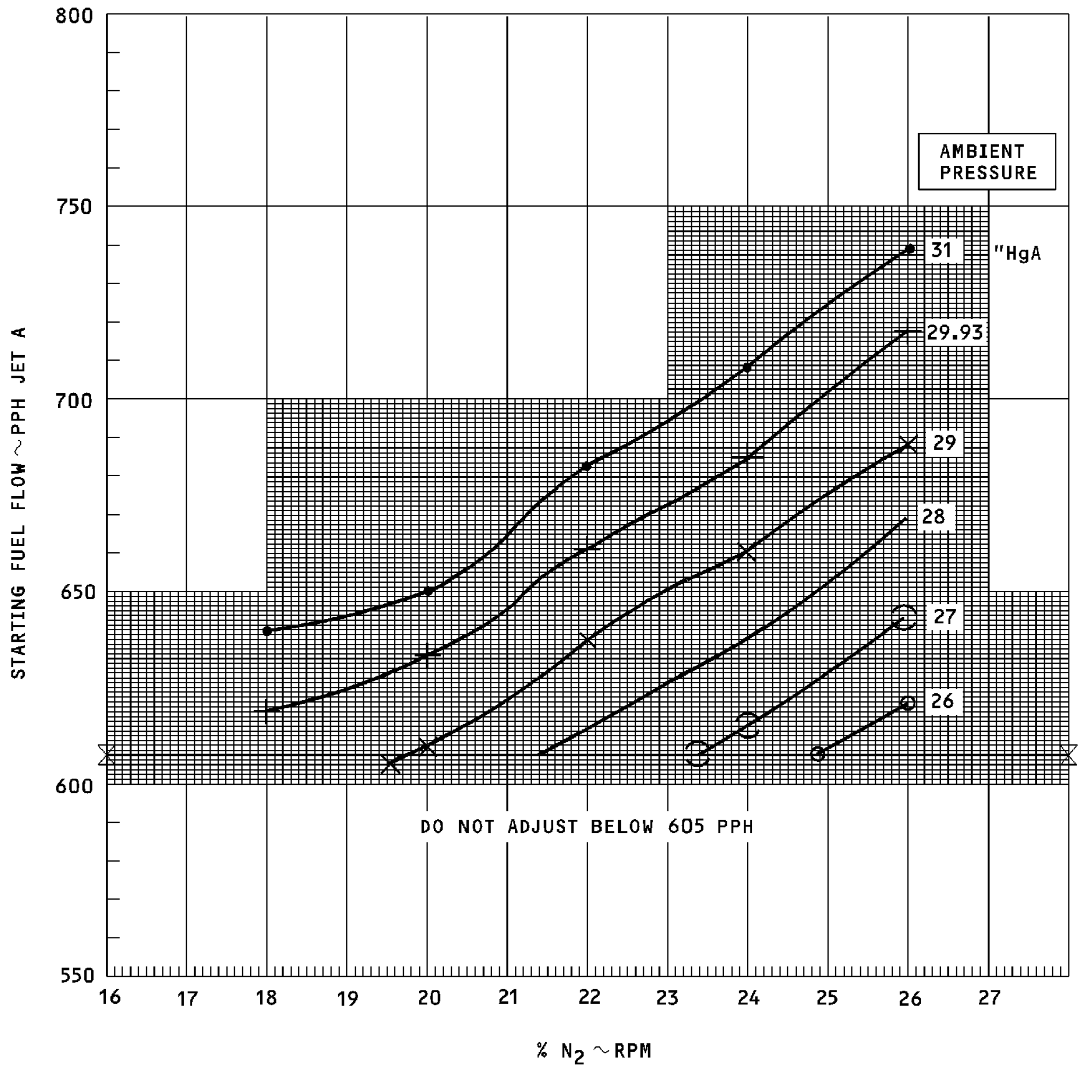
Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 9 of 10)

CONTROL P/N 769606-15, 769606-16
STARTING SCHEDULE FOR JET B FUEL



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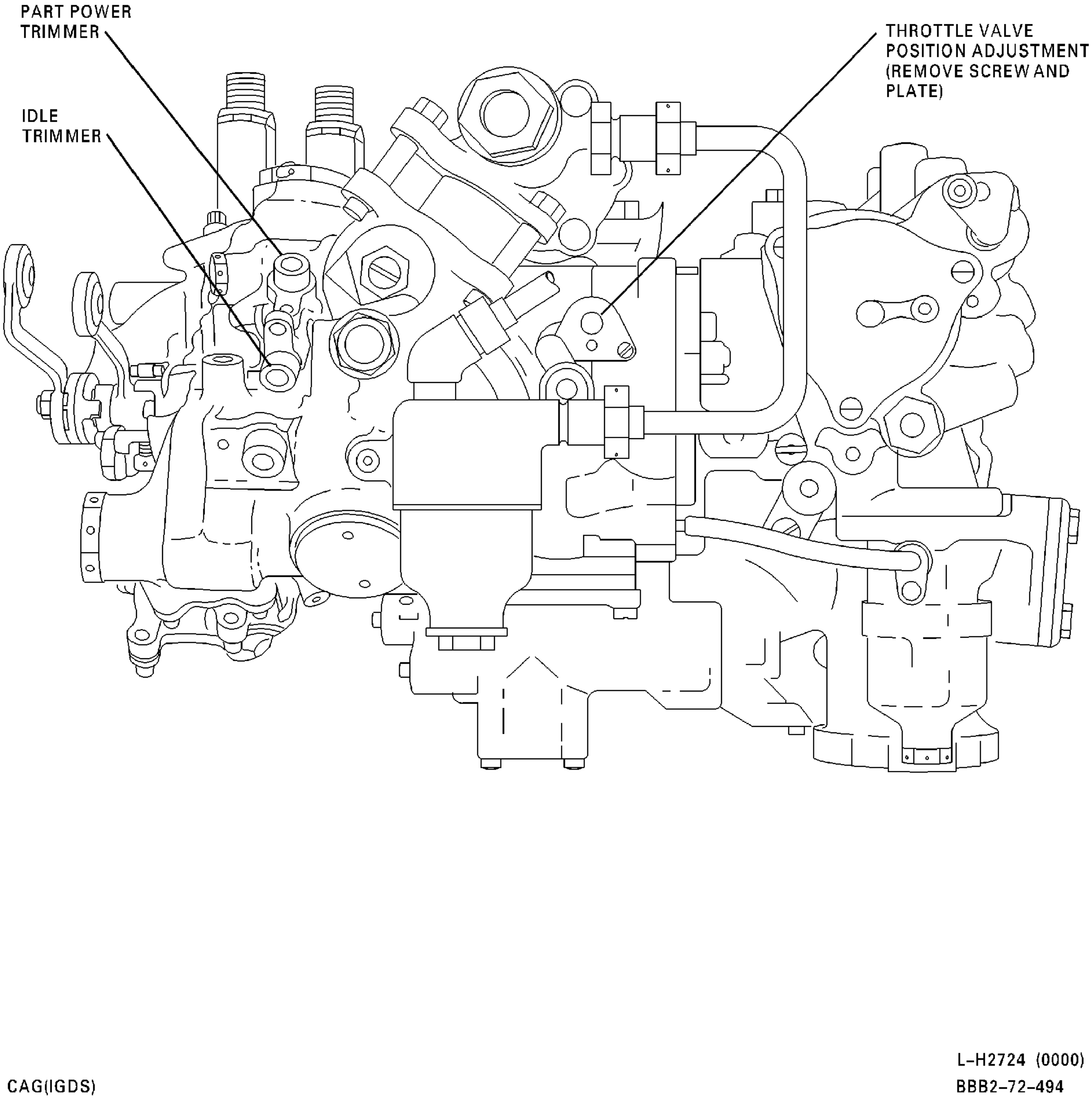
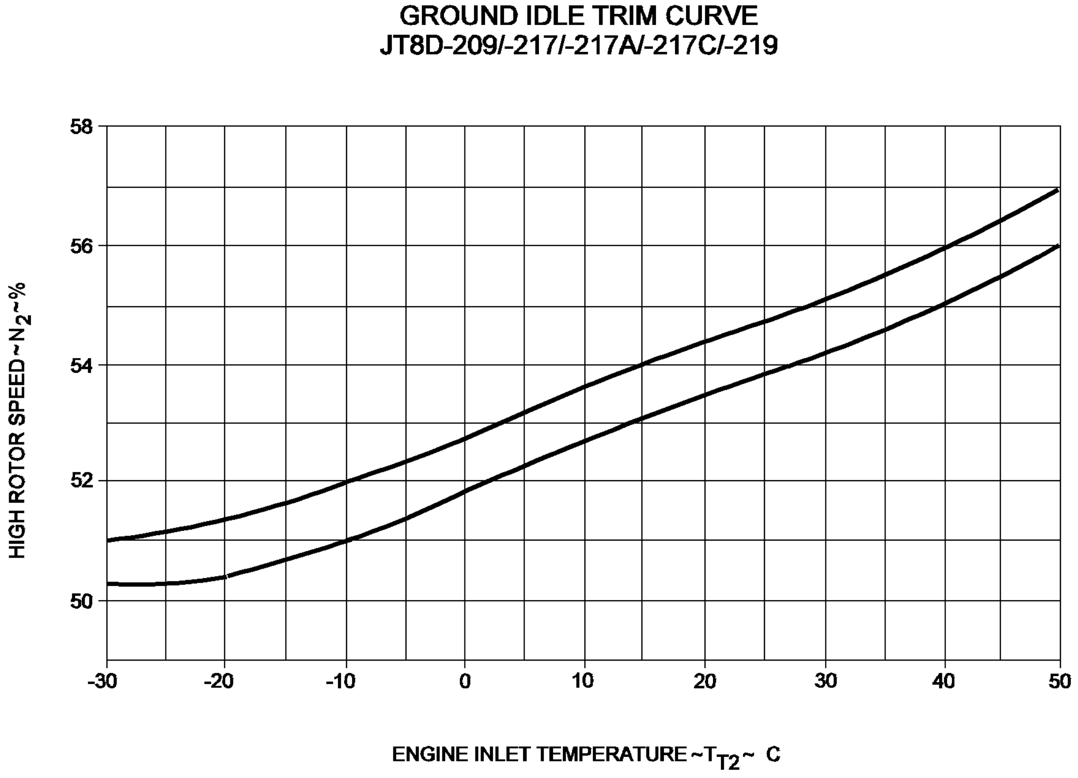
CAG(IGDS)

BBB2-72-493

Starting Schedule Limits
Figure 531/72-00-00-990-922 (Sheet 10 of 10)



Fuel Control Adjustment
Figure 532/72-00-00-990-923



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S0000306812V1

Engine Idle Trim Curve
Figure 533/72-00-00-990-C49

ENGINE GENERAL - ADJUSTMENT/TEST

1. Engine Ground Safety Precautions

A. General

(1) The operating characteristics of jet engine powered aircraft have changed the ground safety picture. To prevent injury to persons and damage to property, handling and working procedures must be modified to meet new exposures. On piston engine aircraft the propeller was carefully avoided. In the case of the jet engine powered aircraft, one must avoid not only the engine intake ducts, but also the exhaust nozzle where hot, high velocity exhaust gases are discharged. Listed below are some of the general safety items which shall be supplemented according to the needs of the job, to prevent accidents.

B. The Air Intake (Figure 501)

WARNING: ALL PERSONNEL MUST AVOID HAZARD AREAS AROUND THE POWER PLANT AND REMAIN OUTSIDE OF ENGINE SAFETY BARRIER, IF USED, DURING GROUND RUNNING OPERATIONS. THE ENGINE IS CAPABLE OF DEVELOPING ENOUGH SUCTION AT THE INLET TO PULL A PERSON UP TO OR PARTIALLY INTO THE INLET WITH POSSIBLE FATAL RESULTS. THEREFORE, WHEN APPROACHING ANY TYPE OF JET ENGINE, PRECAUTIONS MUST BE TAKEN TO KEEP CLEAR OF THE INLET AIR STREAM. THE SUCTION NEAR THE INLET CAN ALSO PULL IN HATS, GLASSES, LOOSE CLOTHING AND WIPE-RAGS FROM POCKETS. ANY LOOSE ARTICLES MUST BE MADE SECURE OR REMOVED BEFORE WORKING AROUND THE ENGINE.

C. Exhaust Characteristics (Figure 501)

(1) Velocity. At high engine speeds the exhaust may pick up and blow loose dirt, sizeable stones, sand and debris a distance of several hundred feet. Therefore, due caution must be used in parking the aircraft for run-up to avoid injury to persons or damage to property or other aircraft. A blast fence is suggested if the engines are going to be run-up for trim and power adjustment in an area where there is not sufficient space available for dissipation of the exhaust blast.

(2) Temperature. High temperature will be found up to several hundred feet from exhaust nozzle depending on wind conditions. Closer to engine, exhaust temperature is high enough to deteriorate bituminous pavement, therefore, concrete aprons are suggested for run-up areas. Occasionally when a jet engine is started, excess fuel that has accumulated in the tailpipe ignites and long flames are blown out of exhaust nozzle. Possibility of this hazard must be watched and all flammable materials kept in the clear.

(3) Toxicity. Tests have indicated that carbon monoxide content is low but other gases are present which have disagreeable odor and are irritating in effect. Exposure will usually cause watering or burning sensation of the eyes. Less noticeable but important is respiratory irritation which may be caused. For both these reasons exposure must be avoided, particularly in confined spaces or pockets where concentration may build up.

D. Engine Cool Down

WARNING: USE APPROPRIATE HAND PROTECTION WHEN WORKING AROUND ENGINE AREAS WHICH ARE LIKELY TO BE HOT.

(1) After engine operation no work or inspection shall be done on tailpipe for at least one-half hour, preferably longer. All other parts may usually be worked upon without danger.

(2) Certain parts of the engine which contain or are exposed to high compressor air, like fuel deicing air tubing and anti-icing air tubing, may be hot immediately after engine shutdown. The use of insulated gloves is recommended whenever work must be performed on the engine in the vicinity of such parts soon after engine shutdown.

E. Engine Noise

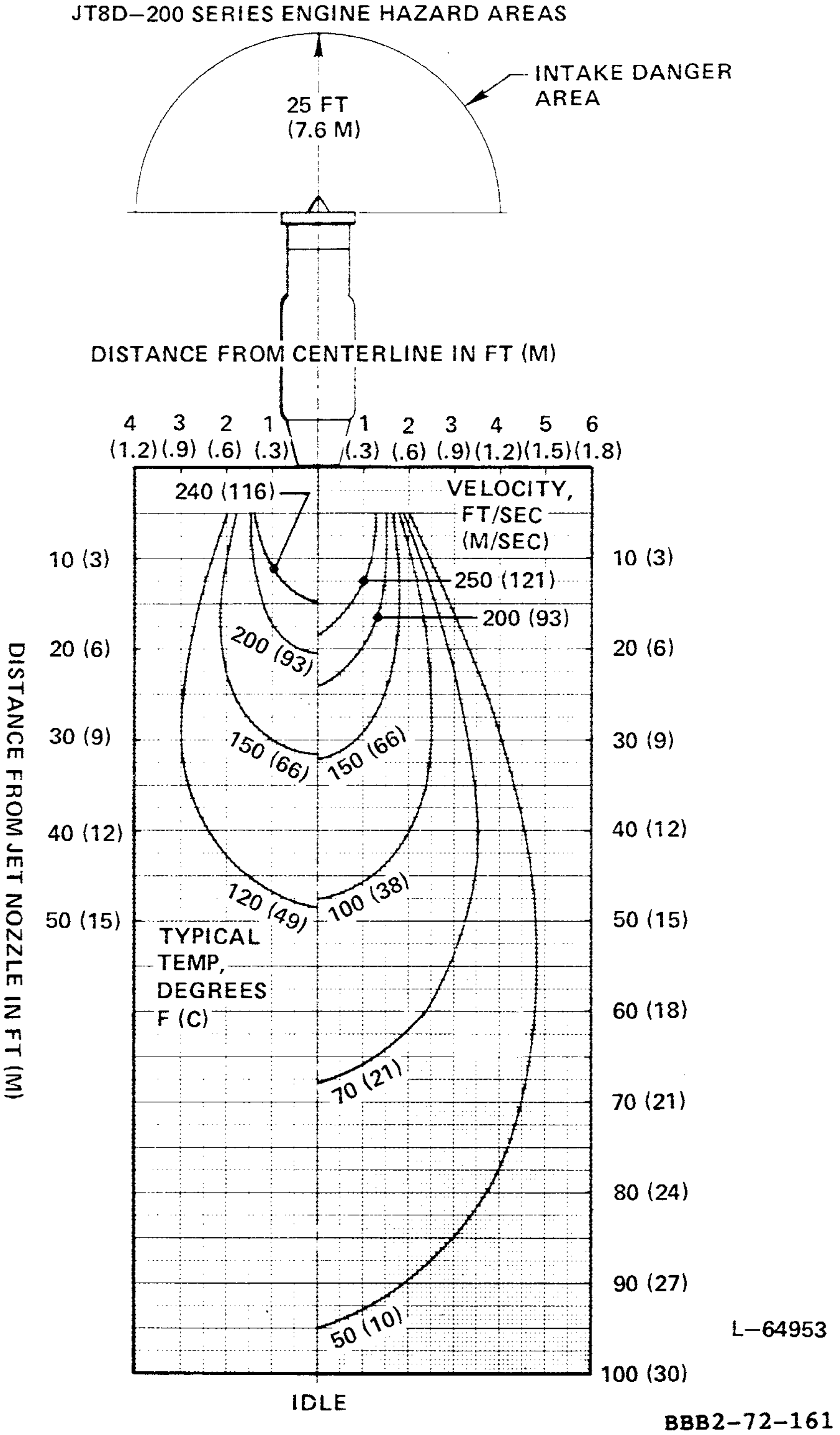
(1) Jet engines typically produce noise capable of causing temporary, as well as permanent, loss of hearing. Even short exposures to extreme noise may result in damage to ears and all personnel must use some means of protection. Noise can effect ear mechanism in such a way as to cause unsteadiness or inability to walk or stand without reeling. Therefore, use of cup type ear protection is recommended. If engines are to be serviced from aero-stands or platforms these shall be equipped with protective railings to prevent falls.

WARNING: THE JT8D ENGINE IGNITION SYSTEM IS CHARACTERISTICALLY HIGH IN ENERGY. THE NATURE OF THE SYSTEM IS SUCH AS TO RENDER IT A HAZARDOUS, POSSIBLY FATAL, SOURCE OF ELECTRICAL SHOCK UNLESS NECESSARY PRECAUTIONS ARE EXERCISED. DO NOT TOUCH IGNITER PLUGS WHEN IGNITION IS ON. DO NOT TEST IGNITION SYSTEM WHEN PERSONNEL MAY BE IN CONTACT WITH IGNITER PLUGS OR WHEN FLAMMABLE MATERIALS ARE NEARBY.

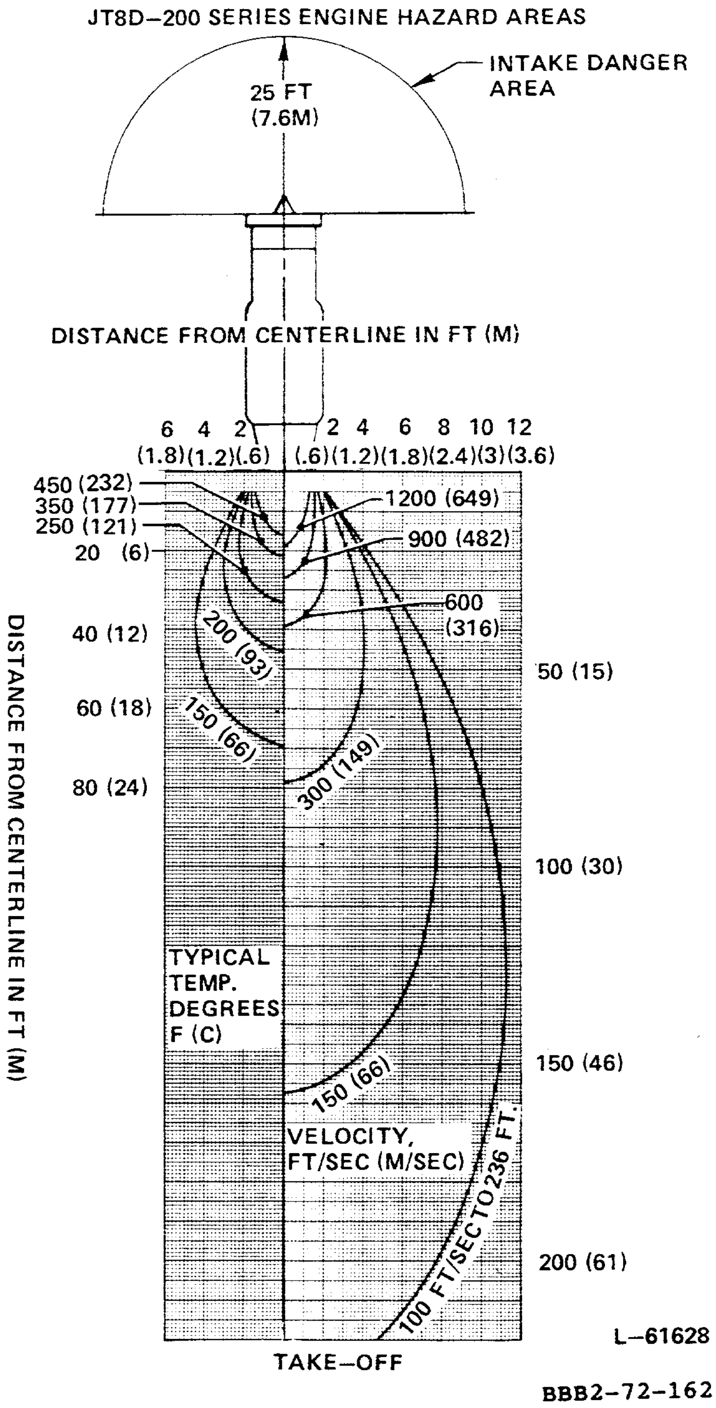
F. Engine Ignition

G. Fuel And Lubricating Oils

(1) All fuels and lubricating oils tend to dry the skin. Precautions shall be taken to avoid contact as much as possible.



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-924 (Sheet 1 of 2)



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-924 (Sheet 2 of 2)

2. Testing Information

A. General

(1) Pratt & Whitney strongly recommends that the measurement and setting of engine thrust be accomplished by use of turbine discharge pressure and compressor inlet pressure as the primary parameters, while using engine speed, tailpipe temperature, and fuel flow as secondary parameters to monitor engine condition, and as limits. Engine speed (low and high compressor RPM) is not a sufficiently accurate indicator of thrust, to provide adequate control of engine thrust and internal conditions under normal service operation. Therefore, the engine fuel control is adjusted in order to obtain desired turbine discharge pressure (P_{t7}) or engine pressure ratio (P_{t7}/P_{t2}) shown on applicable engine trim curves. Turbine discharge pressure or pressure ratio overshoot, or higher than normal reading, may be noted when power lever is first advanced to PART THRUST stop on a cold engine. For accurate indication of engine thrust during engine test or trimming, engine must be allowed to stabilize.

NOTE: It is suggested that a remote fuel control trimmer such as is available from Lear Siegler Inc. be employed when trimming engine.

(2) Whenever trimming engines installed in aircraft, aircraft manufacturer's trim curves, corrected for specific inlet duct loss, must be used.

NOTE: The procedures contained in Chapter 72 are the engine manufacturer's originated data. However, for engine operational and trimming data, refer to SUBJECT 71-00-00.

(3) Symbols have been designated for the various stations within the engine, and the external working pressures and temperatures. These variables are listed in Table 501 below:

Table 501 Engine Station Symbols

TAMB	Compressor Ambient Temperature
PAMB	Compressor Inlet Ambient Pressure
N_1	Low Pressure Compressor RPM
N_2	High Pressure Compressor RPM
Ps3	Intercompressor Static Pressure
Ps4	Bleed Annulus Static Pressure
P_{t2}	Compressor Inlet Total Pressure
T_{t7}	Turbine Discharge Total Temperature
P_{t7}	Turbine Discharge Total Pressure
P_{t7}/PAMB	Engine Pressure Ratio
PBAR	True Barometric Pressure

(4) The extent of repair and replacement will vary with each engine; therefore, the degree of test necessary to demonstrate satisfactory repair will vary also. To minimize ground running and to conserve fuel, this section provides five ground test procedures which are related to the extent of repair or replacement. Before attempting to test an engine after repair, the applicable sections of the Table Table 507 must be consulted to determine the test required for any given engine repair.

(5) The Engine Check Chart provides the general operating condition limits and references to the necessary test curves for testing an installed engine. The ratings listed in the Engine Check Chart are described as follows and are obtained by positioning the power lever to a predetermined turbine discharge pressure (P_{t7}):

(a) Maximum Takeoff - This is the maximum thrust certified for takeoff. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. In the event of an engine out situation this rating is provided by the Reserve Takeoff Thrust mechanism when operating at the Normal Takeoff rating. This rating is time-limited to a total of five (5) minutes including the time spent at the Normal Takeoff Rating.

(b) Normal Takeoff - The Normal Takeoff Rating is the maximum thrust normally set for takeoff operation. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. The rating is time limited to five (5) minutes.

(c) Maximum Continuous - The Maximum Continuous Rating is the maximum thrust certified for continuous use. For the purpose of P&W service policy coverage and prolonging engine life, this rating should be used, at the pilot's discretion, only when required to ensure safe flight. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(d) Maximum Climb - Maximum Climb thrust is the maximum thrust approved for normal climb. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(e) Maximum Cruise - This is the maximum thrust approved for cruising. The Maximum Cruise is obtained in the same manner as Maximum Climb or Maximum Continuous thrust.

(f) Idle - This is not an engine rating but, rather, a power lever position suitable for minimum thrust operation on the ground or in flight. It is obtained by positioning the power lever in the IDLE detent or the IDLE stop position.

(g) Reverse - Reverse thrust will be obtained at power lever positions below IDLE.

B. Operating Limits and Performance Data

(1) JT8D-209: See Table 502.

Table 502 Engine Check Chart For JT8D-209

Oil: PWA 521			**FUEL: SB 2016**	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Maximum Takeoff	5 (3)	1058°F (570°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Continuous	Continuous	986°F (530°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Climb	Continuous	959°F (515°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Cruise	Continuous	941°F (505°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

Table 502 Engine Check Chart For JT8D-209 (Continued)

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting				
Ground		932°F (500°C)(6)	(9)	
Flight		1058°F (570°C) (6)		
Acceleration T.O. (4)		1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.F. for procedures related to oil temperature.

C. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-209

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 7,850 RPM (95.5 percent) for N_1 and 12,150 RPM (99.2 percent) for N_2.

2) Engines run at speeds between 7,850 - 8,150 RPM (95.5 - 99.2 percent) N_1 or 12,150 - 12,370 RPM (99.2 - 101.0 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) function and determine cause and correct problem prior to reactivating ART (RTT) function.

3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,370 RPM (101.0 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.C.(1)(a)1) or Paragraph 2.C.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If visual inspection reveals physical damage, or if N_1 speed exceeds 8,450 RPM (102.8 percent), or if N_2 speed exceeds 12,550 RPM (102.5 percent) proceed as follows:

1) Remove high and low compressors and perform complete overhaul inspection.

2) Inspect all turbine disks for growth and hardness.

3) Inspect all turbine blades for stretch.

4) Inspect all disks and blades by fluorescent penetrant.

D. Overtemperature

(Figure 502), (Figure 503), (Figure 504)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition. (Figure 502), (Figure 503), (Figure 504)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C (see Figure 505 or Figure 506), it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time at peak temperature.

(5) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

E. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near or above maximum values listed above shall be investigated promptly.

F. Oil Inlet Overtemperature Limits and Procedures

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

G. Operating Limits and Performance Data

(1) JT8D-217, JT8D-217A, JT8D-217C, JT8D-219: See Table 503.

Table 503 Engine Check Chart For JT8D-217, -217A, -217C, -219

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Maximum Takeoff	5 (3)	1157°F (625°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1094°F (590°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting				
Ground		932°F (500°C)	(9)	
Flight		1157°F (625°C)(6)		
Acceleration (Maximum Takeoff) (4)	2	1166°F (630°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Acceleration (Normal Takeoff)	2	1103°F (595°C)		

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.K. for procedures related to oil temperature.

H. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-217

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 7,770 RPM (94.5 percent) for N_1 and 12,285 RPM (100.3 percent) for N_2.

2) Engines run at speeds between 7,770 - 8,150 RPM (94.5 -99.2 percent) N_1 or 12,285 - 12,550 RPM (100.3 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond permissible limits in Paragraph 2.H.(1)(a)1) or Paragraph 2.H.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,584 RPM (102.8 - 104.4 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is continued-in-service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(1)(e) below if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(1)(e) below if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(1)(e) below if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241.

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6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is returned to service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,584 RPM (104.4 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(2) JT8D-217A, -217C

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,080 RPM (98.3 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,080 - 8,350 RPM (98.3 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,459 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12.675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.H.(1)(a) or Paragraph 2.H.(1)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

   NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(2)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(2)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(2)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241.

   (PAGEBLOCK 72-00-00/601 Config 1)

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.
   a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)
   b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:
   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.
   b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is continued-in-service.

10) Visually examine the 4th stage turbine blades to make sure that no blade shrouds are missing. Repair any 4th stage turbine with missing shrouds before the engine is continued-in-service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(3) JT8D-219

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,120 RPM (98.8 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,120 - 8,350 RPM (98.8 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.H.(3)(a) or Paragraph 2.H.(3)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(3)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(3)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(3)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241.

(PAGEBLOCK 72-00-00/601 Config 1)

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

I. Overtemperature

(Figure 502)

(Figure 505)

(Figure 506)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition.

(Figure 502)

(Figure 505)

(Figure 506)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C (see Figure 505 or Figure 506), it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time peak temperature.

(5) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below Idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

J. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near, or above maximum values listed above shall be investigated promptly.

Table 504

<table>
<tr><th colspan="2">KEY TO Figure 505</th></tr>
<tr><th>CHART ZONE</th><th>ACTION</th></tr>
<tr><td>A</td><td>Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated.
Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B.
An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.</td></tr>
<tr><td colspan="2">NOTE: A 25 flight hour fly back interval is permitted before doing Zone B corrective action. Another excursion into Zone A during the fly back interval requires the completion of Zone B corrective action before the next flight. Subsequent excursions into Zone A get Zone B corrective action.</td></tr>
<tr><td>B</td><td>De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized.
Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1)
An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.</td></tr>
<tr><td>C</td><td>De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized.
Disassemble the engine hot section and do full overhaul inspection.</td></tr>
<tr><td colspan="2">NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.</td></tr>
<tr><td></td><td>or
Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1)
An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D.
Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the procedures specified for Zone D.</td></tr>
<tr><td>D</td><td>Disassemble the engine hot section and do full overhaul inspection.</td></tr>
<tr><td colspan="2">NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.</td></tr>
<tr><td>F</td><td>Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated.</td></tr>
</table>

Table 504 (Continued)

KEY TO Figure 505	
CHART ZONE	**ACTION**
	If an engine goes into Zone F four times since the last time the engine hot section got full disassembly and inspection, and an external cause for the overtemperature is not found, a borescope inspection (refer to Inspection/Check-01) can often find the problem (an internal condition can be the cause of the overtemperature).
G	No action necessary

NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades.

NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades.

NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.

Table 505

KEY TO Figure 506	
CHART ZONE	**ACTION**
A	De-energize the ART system and find the cause of the overtemperature. Correct the cause before the ART system is energized. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B. An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Disassemble the engine hot section and do full overhaul inspection.

Table 505 (Continued)

<table>
<tr><th colspan="2">KEY TO Figure 506</th></tr>
<tr><th>CHART ZONE</th><th>ACTION</th></tr>
<tr><td colspan="2">NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.</td></tr>
<tr><td></td><td>or
Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1)
An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D.
Total time in this zone must not be more than 30 seconds per event. An engine above these limits must get the procedures specified for Zone D.</td></tr>
<tr><td>D</td><td>Disassemble the engine hot section and do full overhaul inspection.</td></tr>
<tr><td colspan="2">NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.</td></tr>
<tr><td>G</td><td>No action necessary</td></tr>
<tr><td colspan="2">NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades.
NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades.
NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.</td></tr>
</table>

K. Oil Inlet Overtemperature Limits and Procedures.

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

(2) After complying with the above and providing no engine damage is indicated, engine may be continued in service.

(3) If oil-in temperature exceeds 329°F (165°C) for any interval, remove engine to overhaul and inspect all main and accessory drive bearings for hardness and condition. All main shaft seals shall be inspected for condition.

L. Engine Windmilling or Oil Pressure Interruption/Low Oil Pressure

NOTE: You must record operating conditions before and after any oil pressure interruption, low oil pressure indication, engine shutdown and windmilling to find classification of windmilling.

NOTE: The classification of windmilling is based on time and oil pressure. Although the engine must show continuous oil pressure after shutdown, the oil pressure after in-flight shutdown (IFSD) (after the engine becomes stable) is what is used for the classification of the windmilling. Because oil pressure is a function of ram air, this pressure will usually decrease to less than 10 psi (68.9 kPa) during the descent and approach phases. Also the oil pressure can show zero when the ram air can no longer cause sufficient oil pump rotation (during landing, rollout, and taxi). These conditions are acceptable and do not change the classification of windmilling.

(1) Engine Windmilling

(a) Inspect all engines that have windmilled as a result of shutdown in flight.

NOTE: Operator must also do all corrective actions necessary to find cause of in flight engine shutdown.

(b) If an engine windmilled for 30 minutes or less, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can continue in service after satisfactory inspection of main oil filter and chip detectors (if installed), servicing of engine and ground run-up.

NOTE: Ground run-up is a normal start, followed by five minutes at idle then a normal shutdown.

Chip detectors are optional equipment. If installed, they are part of windmilling inspection procedure.

(c) If an engine windmills for more than 30 minutes but less than 60 minutes, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can be continued in service after satisfactory examination of main oil filter and chip detectors (if installed), servicing of engine and ground run-up. In addition, use a Spectrometric Oil Analysis Program (SOAP) requesting concentrations of Iron (Fe), Vanadium (V) and Molybdenum (Mo) as indicators of main shaft bearing distress. Refer to JT8D Oil Monitoring Guide (P&W Part Number 821432), Section "G" for more information on SOAP. Do main oil filter, chip detectors (if installed) and SOAP inspection after first flight, at 15 hours, at 50 hours and at 100 hours. Do any corrective action required.

NOTE: JT8D Oil Monitoring Guide - Part No. 821432

This guide describes the inspections and tests that can be done to the engine oil to find if there is something that should be done before it leads to an untimely removal of the engine. This guide will show various inspections and tests, in its own section that will identify and describe each, as well as provide information as to the results that will be found and how to understand them to best maintain the engine. For this purpose, the guide also includes tables and illustrations that give guidelines or samples of “limits” used in the field for various analysis techniques.

(d) If an engine windmilled for more than 60 minutes with more than 10 psi (68.9 kPa) of continuous oil pressure after engine shutdown or engines that windmilled for any length of time with 10 psi (68.9 kPa) or less oil pressure after shutdown, operator must disassemble it for an Oil System Components Inspection.

NOTE: Oil System Components Inspection includes a visual and dimensional inspection of all Bearings (Main and Accessory), seals and gears in both Engine and Main Accessory Gearbox. Do a careful inspection of No. 2, 3, 4 and 5 bearings. Bearing cages must not show excessive wear. No ball or roller skidding, loss of hardness or shape because of overheating is permitted. Acceptable parts may be continued in service.

(2) Oil Pressure Interruption/Low Oil Pressure

CAUTION: ANY POWER OPERATION AT OR ABOVE IDLE WITH OIL PRESSURE OF 34 PSI (234.4 KPA) OR LESS REQUIRES ENGINE TO BE DISASSEMBLED FOR AN OIL SYSTEM COMPONENTS INSPECTION.

(a) Be careful to operate engine with sufficient oil pressure.

M. Breather Pressure

(1) General

(a) Breather pressure is differential between gearbox internal pressure and pressure at gearbox breather discharge port.

(b) Prior to checking breather pressure, it is important to remove all hardware for gearbox breather port, including short breather outlet duct. Experience has shown that this duct affects reading obtained, and correction factors have been unreliable.

(2) Limits

(a) During acceptance test, breather pressure as determined by the differential between engine accessory gearbox pressure and the pressure measured in the disposal system immediately adjacent to the accessory gearbox discharge port shall not exceed 1.8 psi (12.4 kPa). Allow engine to remain at Normal Takeoff two minutes minimum. Record the breather pressure (see NOTE below). Bring the engine power back to idle. Shut the engine down.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

NOTE: Engines with breather pressure tests conducted using continuous permanent recording equipment may be continued in service if the steady state limit of 1.8 psi (12.4 kPa) is exceeded for not more than 30 seconds and the pressure level does not exceed 3.0 psi (20.7 kPa). An engine accepted to this additional limit must be put on watch and a repeat test conducted every 50 cycles thereafter.

N. Fuel and Oil Leakage Limits

(1) Fuel or oil leakage from overboard drains, accessory drive seal drains, or No. 6 bearing sump is acceptable provided leakage is within the following limits:

Table 506

Location	Fluid	Allowable Leakage
Gearbox Starter Drive Overboard Drain	Oil	10 cc/hr
Gearbox Hydraulic Pump Drive Overboard Drain	Oil	10 cc/hr
No. 1, 2 And 3 Bearing Fluid Seal Drain	Oil	0.5 cc/min (10 drops per min) from each drain.
No. 4 Bearing Air Check Valve	Oil	Oil leakage from check valve at Idle power is normal.
Fuel Pump Drive Overboard Drain	Oil	10 cc/hr
Fuel Pump Drain	Fuel	60 cc/hr with engine running or shut down
Fuel Control Drain	Fuel	None
P&D Valve	Fuel	None
Exhaust Case - No. 6 Bearing Sump	Oil	Oil wetness not resulting in oil puddling within 20 minutes after engine shutdown.
Combustion Chamber Drain	Fuel	1. No leakage with engine running. 2. 90 cc maximum one time upon engine shutdown. 3. 60 cc/hr maximum after engine shutdown.
Combustion Chamber Drain and/or Wet 1st Stage Turbine Vanes/Blades	Oil	1. For engines without SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed:

NOTE: Oil leakage from the combustion chamber drain and/or wet 1st stage turbine vanes/ blades is not permitted if the engine is post SB A6196 - Improved No 5. bearing oil return and compartment sealing.

Location	Fluid	Allowable Leakage
		a. Be sure the condition seen is oil leakage and not fuel leakage.
		b. Operate the engine at idle for five minutes, then approximately cruise power or 1.8 EPR for five minutes, then at idle again for five minutes. Then shut down.
		c. After engine shutdown look for oil leakage from the combustion chamber drain (when it occurs, leakage usually starts ten minutes or less after shutdown).
		d. Engine removal for repair is necessary if oil leakage from the combustion chamber drain is more than 40 drops (or 2.0 cc), per minute. If oil leakage from the drain is less than 40 drops (or 2.0 cc), the engine can return to service with these limits:
		1) Do a breather pressure test (must be in limits).
		2) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection).

Table 506 (Continued)

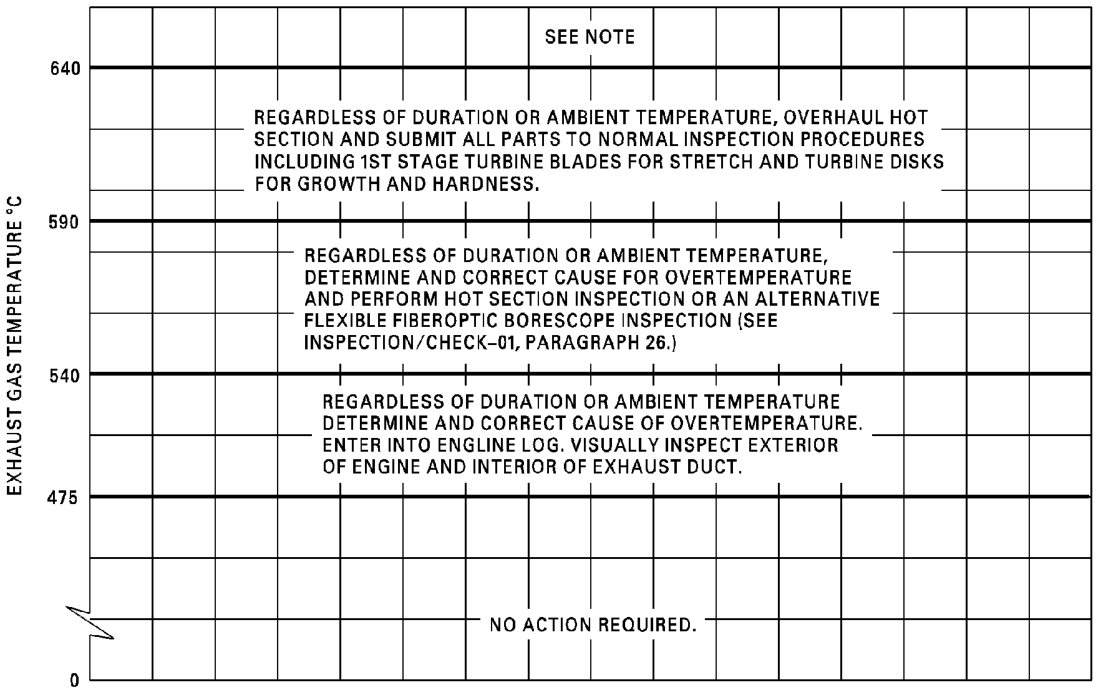
Location	Fluid	Allowable Leakage
		3) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 2. For engines with SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed: a. Be sure the condition observed is oil leakage and not fuel leakage. b. Do a visual inspection of the No. 4 - 5 scavenge oil temperature indicators as specified in SB A5944/SB 6101. c. If indicator color has changed, do corrective action as specified in SB A5944/SB 6101. d. If indicator color did not change, return engine to service with these limits: 1) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection). 2) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 3) Monitor the SB A5944/SB 6101 indicators at the intervals given in SB A5944/SB 6101.

(2) If leakage is found outside of the above limits the problem shall be repaired and the engine further tested using the following as a guide.

(a) For overboard drain leakage, run engine for five minutes at Max. Continuous and five minutes at Normal Takeoff.

(b) For accessory drive seal leakage and parting surface leakage, run engine for ten minutes at Max. Continuous and five minutes at Normal Takeoff.

JT8D-209, -217,-217A -217C, -219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, OVERHAUL HOT SECTION AND SUBMIT ALL PARTS TO NORMAL INSPECTION PROCEDURES INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND TURBINE DISKS FOR GROWTH AND HARDNESS.

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, DETERMINE AND CORRECT CAUSE FOR OVERTEMPERATURE AND PERFORM HOT SECTION INSPECTION OR AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE INSPECTION/CHECK-01, PARAGRAPH 26.)

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE. ENTER INTO ENGLINE LOG. VISUALLY INSPECT EXTERIOR OF ENGINE AND INTERIOR OF EXHAUST DUCT.

NO ACTION REQUIRED.

NOTE:

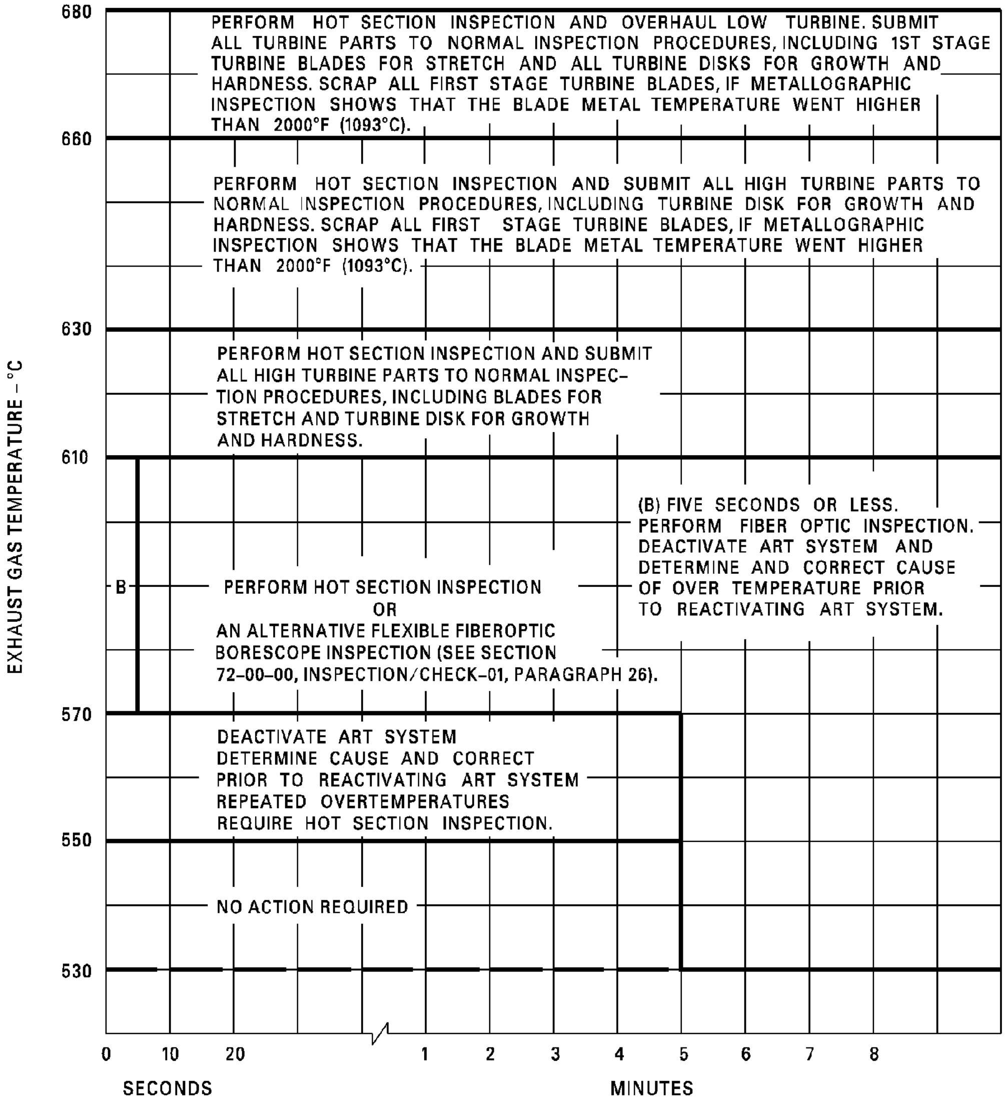
FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

CAG(IGDS)

BBB2-72-558A

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 502/72-00-00-990-925

JT8D–209
NORMAL TAKEOFF
OVERTEMPERATURE LIMITS AND INSPECTION



PERFORM HOT SECTION INSPECTION AND OVERHAUL LOW TURBINE. SUBMIT ALL TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND ALL TURBINE DISKS FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING TURBINE DISK FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING BLADES FOR STRETCH AND TURBINE DISK FOR GROWTH AND HARDNESS.

PERFORM HOT SECTION INSPECTION
OR
AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE SECTION 72–00–00, INSPECTION/CHECK–01, PARAGRAPH 26).

(B) FIVE SECONDS OR LESS. PERFORM FIBER OPTIC INSPECTION. DEACTIVATE ART SYSTEM AND DETERMINE AND CORRECT CAUSE OF OVER TEMPERATURE PRIOR TO REACTIVATING ART SYSTEM.

DEACTIVATE ART SYSTEM
DETERMINE CAUSE AND CORRECT PRIOR TO REACTIVATING ART SYSTEM
REPEATED OVERTEMPERATURES REQUIRE HOT SECTION INSPECTION.

NO ACTION REQUIRED

NOTE:

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR–COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

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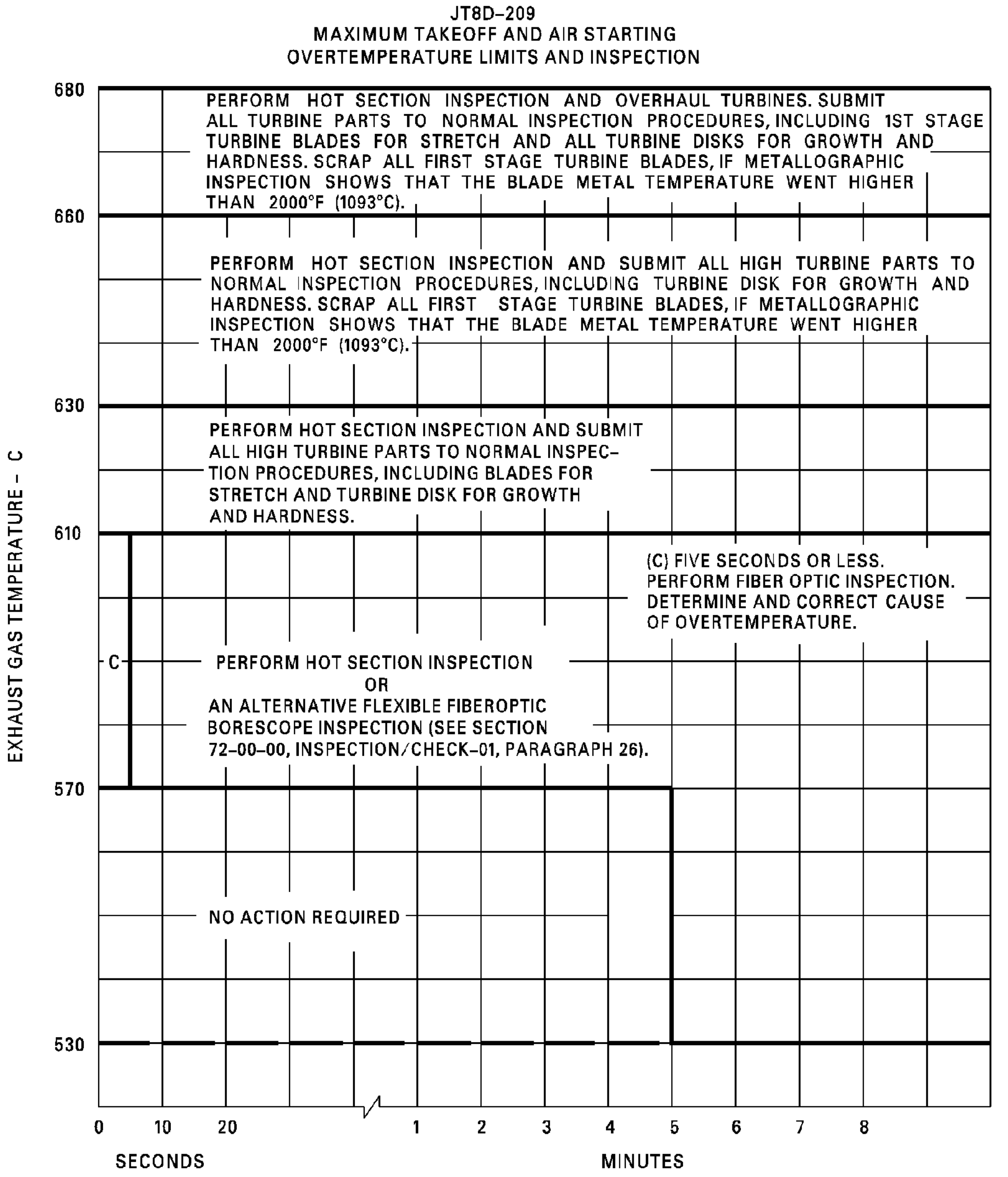
CAG(IGDS)

BBB2–72–163C

Normal Takeoff Overtemperature Limits and Inspection Procedures
Figure 503/72-00-00-990-926



PERFORM HOT SECTION INSPECTION AND OVERHAUL TURBINES. SUBMIT ALL TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND ALL TURBINE DISKS FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING TURBINE DISK FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING BLADES FOR STRETCH AND TURBINE DISK FOR GROWTH AND HARDNESS.

(C) FIVE SECONDS OR LESS. PERFORM FIBER OPTIC INSPECTION. DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE.

PERFORM HOT SECTION INSPECTION
OR
AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE SECTION 72–00–00, INSPECTION/CHECK–01, PARAGRAPH 26).

NO ACTION REQUIRED

NOTE:

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR–COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

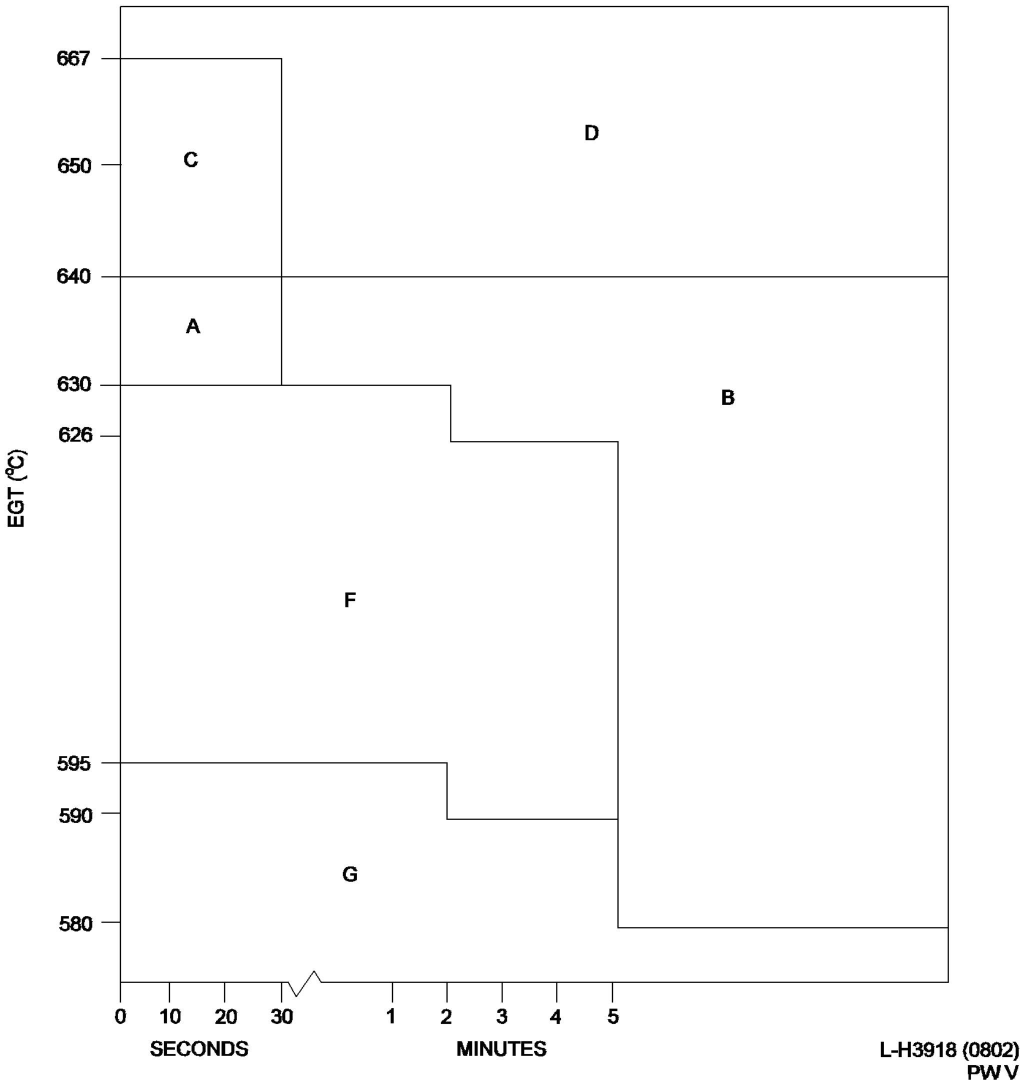
L–89087 (0299)

CAG(IGDS)

BBB2–72–164C

Maximum Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 504/72-00-00-990-927

JT8D-217, -217A, -217C, -219
NORMAL TAKEOFF AND AIR STARTING
OVERTEMPERATURE LIMITS AND INSPECTION



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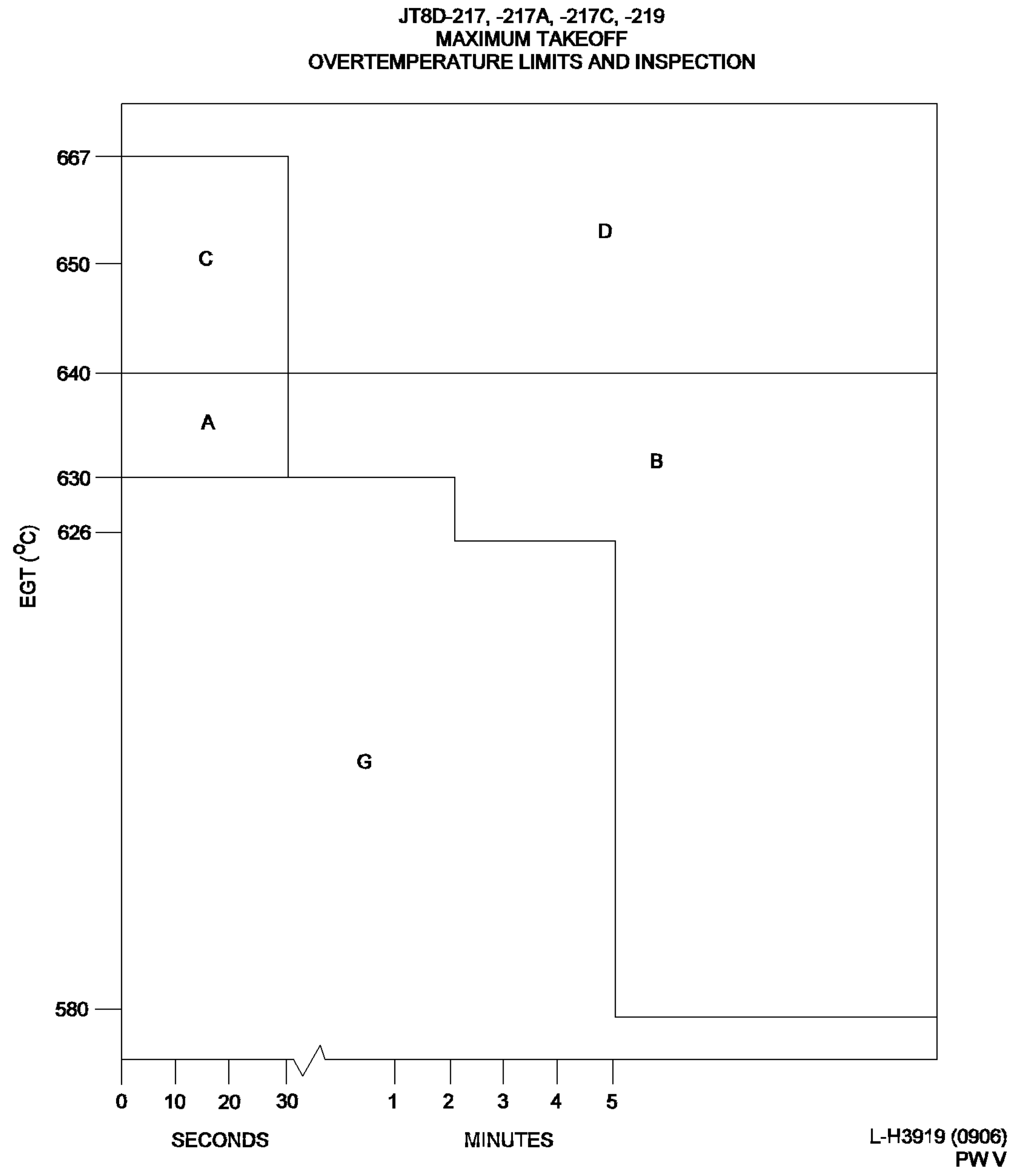
Normal Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 505/72-00-00-990-928



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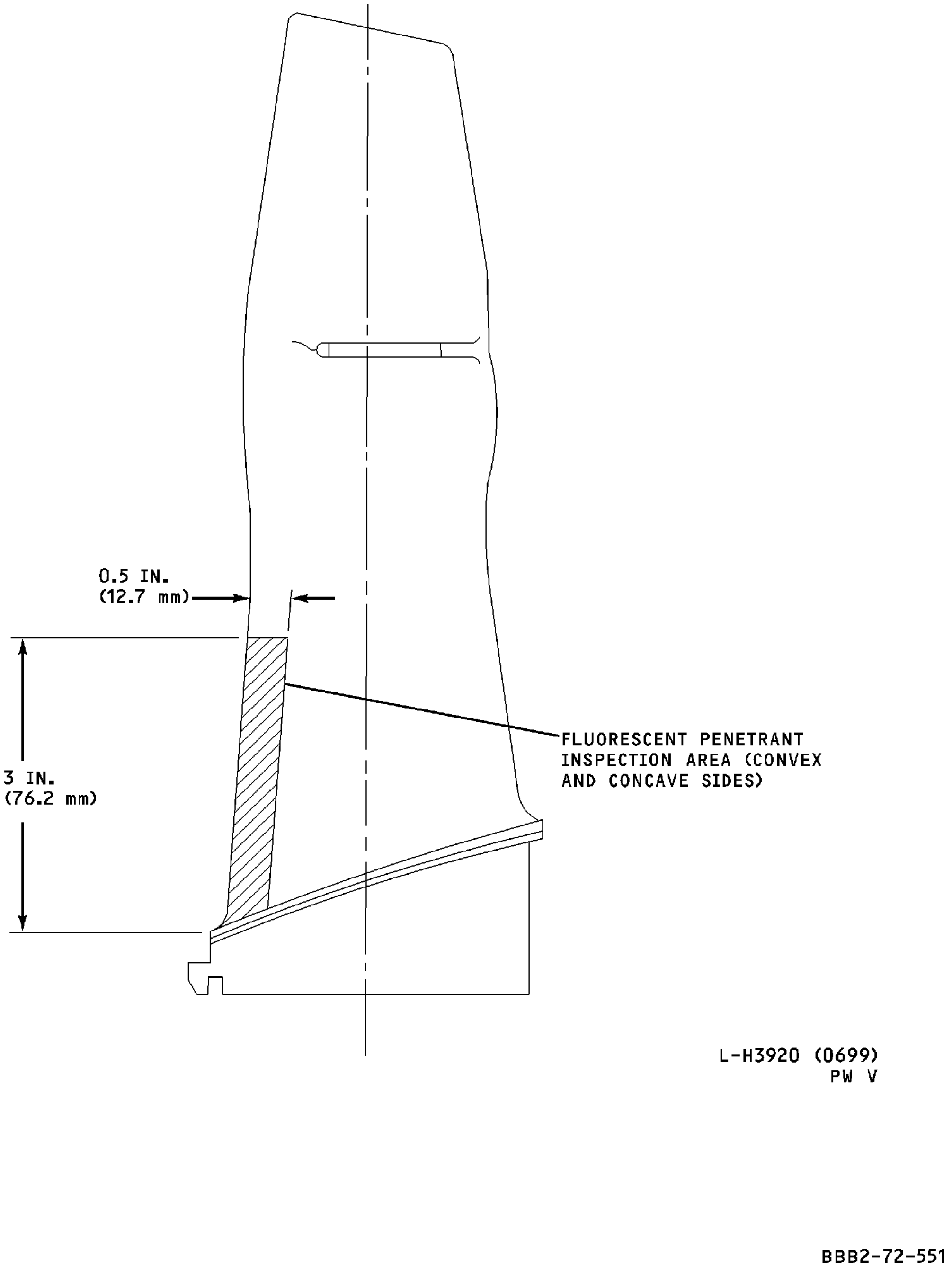
Maximum Takeoff Overtemperature Limits and Inspection Procedures
Figure 506/72-00-00-990-929



First Stage Compressor Blade Inspection Zone
Figure 507/72-00-00-990-930

3. Inspection Prior To Test

A. Fuel System Inspection

(1) Fuel System

(a) Visually check all fuel system tubes and components for security and leakage.

(b) Remove, clean if necessary and install the fuel pump filters.

(c) Remove, clean if necessary and install the fuel control filters.

(d) Check the fuel system for the presence of water.

(e) Service the fuel system with an approved fuel conforming to SB 2016.

NOTE: The engine should be ground tested and trimmed using the same grade fuel as used for flight operations. Slight variations for any given lever position will result if alternate fuels are used.

B. Oil System Inspection

(1) Oil System

(a) Remove, disassemble, clean, and reinstall the main oil strainer. Replace filter if cartridge type.

(b) Visually check all of the oil system tubes and components for security and leakage.

(c) Fill the oil tank with an approved oil conforming to Specification 521 Synthetic Oil.

NOTE: Approved oils are listed in Turbojet Engine Service Bulletin No. 238.

CAUTION: UP TO TWO GALLONS OF OIL MAY BE IN THE SCAVENGE SECTIONS; THEREFORE, OIL MUST NOT BE ADDED TO THE TANK UNTIL THE SCAVENGE SECTIONS ARE CLEANED. IF THE ABOVE PROCEDURE IS NOT FOLLOWED, EXCESSIVE OIL MAY BE ADDED WHICH WILL RESULT IN A BUILDUP OF SUFFICIENT INTERNAL PRESSURE TO RUPTURE THE TANK DURING ENGINE OPERATION.

(d) If oil is required after starting the engine, the engine shall be operated for approximately one minute at IDLE speed. This is required to make certain that any oil which may be in the scavenge section of the engine is returned to the tank, thereby assuring an accurate oil level check.

C. Electrical System Inspection

(1) Electrical System

(a) Check the ignition system components for security.

WARNING: BECAUSE THE VOLTAGE TO THE SPARK IGNITERS IS DANGEROUSLY HIGH, THE IGNITION SWITCH MUST BE IN THE "OFF" POSITION BEFORE REMOVAL OF ANY OF THE IGNITION SYSTEM COMPONENTS. APPROXIMATELY THREE MINUTES OF TIME MUST ELAPSE BETWEEN THE OPERATION OF THE IGNITION SYSTEM AND THE REMOVAL OF COMPONENTS WHEN A SPARK IGNITER LEAD IS DETACHED FROM A SPARK IGNITER, TOUCH THE END OF THE LEAD TO THE SHELL OF THE IGNITER TO DISSIPATE THE RESIDUAL ENERGY.

(b) Remove both spark igniters; check and reinstall.

D. Instrumentation System Inspection

(1) Instrumentation System

(a) Check engine instrumentation for security and general condition.

(b) Inspect the pressure sensing probes for security.

(c) Visually check all indicating thermocouples for security.

(d) Check the thermocouple harness and all lead insulations and shields for chafing and security.

E. Engine Controls Inspection

(1) Engine Controls

(a) Check the power lever for full travel, ease of movement and security.

NOTE: To prevent dilution of the bearing lubrication medium, protect the prepacked bearings used in the power cross shaft assembly during any washing process. The same precautions must be taken when fuel lines near this assembly are disconnected and fuel is, or may be, in these lines.

(b) Inspect the compressor bleed valve, override control, pressure ratio bleed control, and the air tubes for security.

F. Run-Up Area and Engine Inlet Duct Inspection

(1) Run-Up Area and Engine Inlet Duct

(a) Prior to starting the engine, the inlet must be thoroughly inspected and cleaned of possible loose nuts, bolts, tools and other objects which could cause engine damage and possible subsequent failure.

(b) Examine the inlet and exhaust areas to ensure against the presence of foreign objects which could, under some circumstances, enter the engine.

4. Engine Test Procedure

A. Starting Procedure for Pneumatic and Combustion Starters. (GENERAL, SUBJECT 71-00-00, Page 501)

B. Satisfactory Start. (GENERAL, SUBJECT 71-00-00, Page 501)

C. Unsatisfactory Start. (GENERAL, SUBJECT 71-00-00, Page 501)

D. Unsatisfactory Start Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

E. Clear Engine Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

F. Determination of Corrected N_2 Speed. (Figure 508 and Figure 509)

(1) Corrected N_2 speed is determined as shown in Figure 508.

(2) JT8D engine experience indicates a recommended high rotor data plate speed deterioration limit of plus 1.8 percent minus 0.8 percent corrected RPM be established.

G. Max. Observed Exhaust Gas Temperature & Spread Check.

(1) A check of the exhaust gas measurement system shall be made following a stabilization at Normal Takeoff power. Remove four screws and cover from thermocouple cable junction box located at 7 o'clock on rear rail of turbine exhaust outer duct. Remove nine nuts, chromel bus bar and two leads. Position PWA 45563 Adapter on the studs and secure with nuts previously removed. Torque nuts to 15 - 18 in-lb. (1.695 - 2.034 N·m), then connect instrumentation. Maximum allowable T_{t7} for any single probe reading is the maximum limit with averaging harness plus 110°F (61°C). Readings from each T_{t7} probe shall be recorded and maximum acceptable spread shall not exceed 230°F (127.8°C). Remove PWA 45563 Adapter, reinstall two leads, chromel bus bar and nine nuts. Torque nuts to 15 -18 in-lb. (1.695 - 2.034 N·m), then install and secure junction box cover.

(2) The JT8D Part Power Trim temperature spread check shall not exceed 230°F (127.8°C).

H. Shutdown Procedure. (GENERAL, SUBJECT 71-00-00, Page 501).

I. Anti-Surge Bleed Operation Limits Refer to Paragraph 6.F..

N2 CORRECTION

(1) Corrected N2 (%) $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}}$

Where: $\sqrt{\theta} = \sqrt{\dfrac{\text{Compressor Inlet Temperature}\ ^{o}\text{K}}{288}}$

(2) From the Inlet Temperature Correction Factor Chart determine N2 correction factor ($\sqrt{\theta}$) for compressor inlet temperature -

(3) Divide observed N2 speed by $\sqrt{\theta}$ -

Example: Inlet temperature = 30°C (86°F)

$\sqrt{\theta}$ (From the Inlet Temperature Correction Factor Chart) = 1.026

Observed N2 = 87.5%

Corrected N2 $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}} = \dfrac{87.5\%}{1.026} = 85.3\%$

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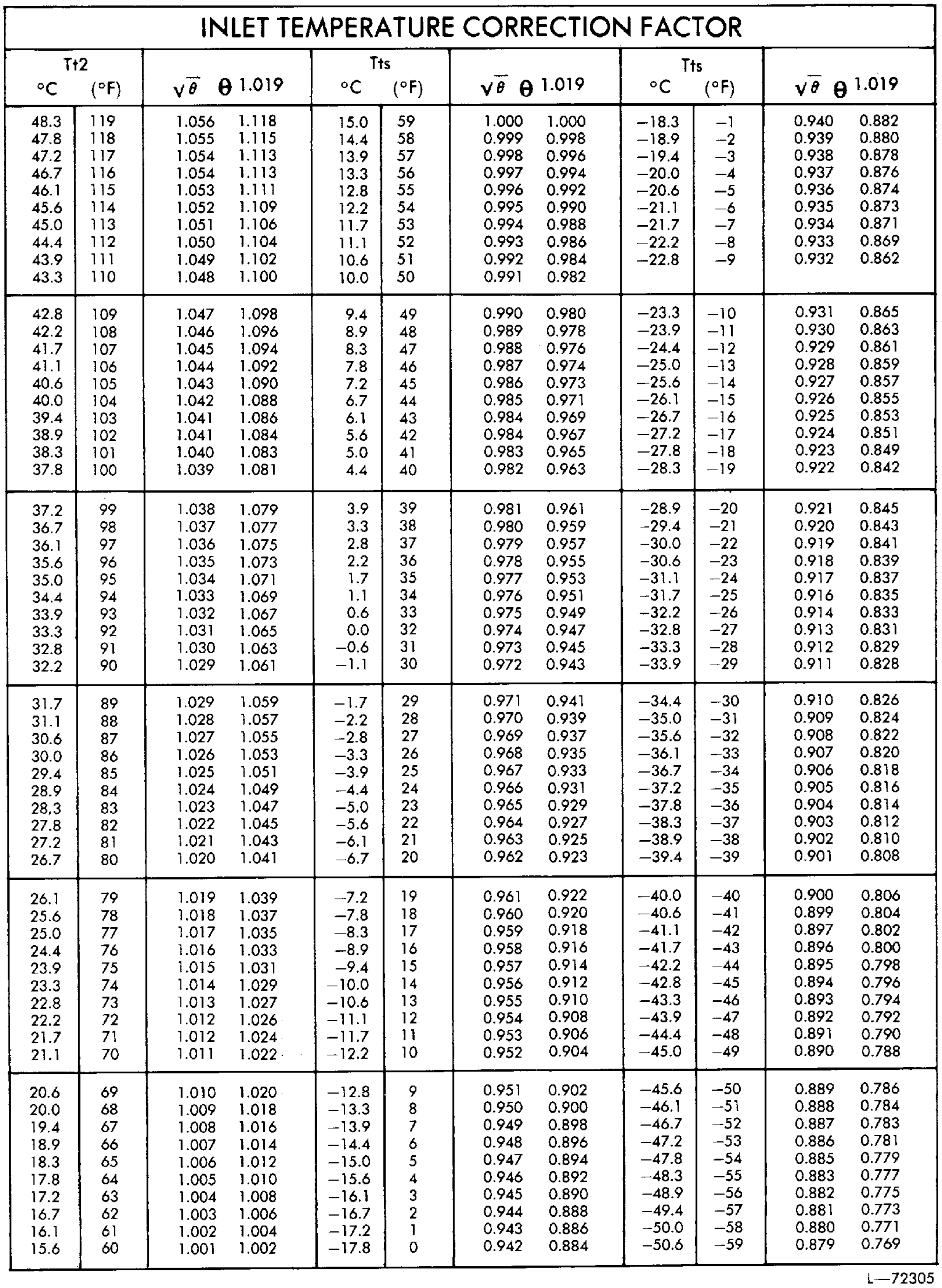
Rotor Speed Correction
Figure 508/72-00-00-990-931



INLET TEMPERATURE CORRECTION FACTOR

Tt2 °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	Tts °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	Tts °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$
48.3	119	1.056	1.118	15.0	59	1.000	1.000	−18.3	−1	0.940	0.882
47.8	118	1.055	1.115	14.4	58	0.999	0.998	−18.9	−2	0.939	0.880
47.2	117	1.054	1.113	13.9	57	0.998	0.996	−19.4	−3	0.938	0.878
46.7	116	1.054	1.113	13.3	56	0.997	0.994	−20.0	−4	0.937	0.876
46.1	115	1.053	1.111	12.8	55	0.996	0.992	−20.6	−5	0.936	0.874
45.6	114	1.052	1.109	12.2	54	0.995	0.990	−21.1	−6	0.935	0.873
45.0	113	1.051	1.106	11.7	53	0.994	0.988	−21.7	−7	0.934	0.871
44.4	112	1.050	1.104	11.1	52	0.993	0.986	−22.2	−8	0.933	0.869
43.9	111	1.049	1.102	10.6	51	0.992	0.984	−22.8	−9	0.932	0.862
43.3	110	1.048	1.100	10.0	50	0.991	0.982				
42.8	109	1.047	1.098	9.4	49	0.990	0.980	−23.3	−10	0.931	0.865
42.2	108	1.046	1.096	8.9	48	0.989	0.978	−23.9	−11	0.930	0.863
41.7	107	1.045	1.094	8.3	47	0.988	0.976	−24.4	−12	0.929	0.861
41.1	106	1.044	1.092	7.8	46	0.987	0.974	−25.0	−13	0.928	0.859
40.6	105	1.043	1.090	7.2	45	0.986	0.973	−25.6	−14	0.927	0.857
40.0	104	1.042	1.088	6.7	44	0.985	0.971	−26.1	−15	0.926	0.855
39.4	103	1.041	1.086	6.1	43	0.984	0.969	−26.7	−16	0.925	0.853
38.9	102	1.041	1.084	5.6	42	0.984	0.967	−27.2	−17	0.924	0.851
38.3	101	1.040	1.083	5.0	41	0.983	0.965	−27.8	−18	0.923	0.849
37.8	100	1.039	1.081	4.4	40	0.982	0.963	−28.3	−19	0.922	0.842
37.2	99	1.038	1.079	3.9	39	0.981	0.961	−28.9	−20	0.921	0.845
36.7	98	1.037	1.077	3.3	38	0.980	0.959	−29.4	−21	0.920	0.843
36.1	97	1.036	1.075	2.8	37	0.979	0.957	−30.0	−22	0.919	0.841
35.6	96	1.035	1.073	2.2	36	0.978	0.955	−30.6	−23	0.918	0.839
35.0	95	1.034	1.071	1.7	35	0.977	0.953	−31.1	−24	0.917	0.837
34.4	94	1.033	1.069	1.1	34	0.976	0.951	−31.7	−25	0.916	0.835
33.9	93	1.032	1.067	0.6	33	0.975	0.949	−32.2	−26	0.914	0.833
33.3	92	1.031	1.065	0.0	32	0.974	0.947	−32.8	−27	0.913	0.831
32.8	91	1.030	1.063	−0.6	31	0.973	0.945	−33.3	−28	0.912	0.829
32.2	90	1.029	1.061	−1.1	30	0.972	0.943	−33.9	−29	0.911	0.828
31.7	89	1.029	1.059	−1.7	29	0.971	0.941	−34.4	−30	0.910	0.826
31.1	88	1.028	1.057	−2.2	28	0.970	0.939	−35.0	−31	0.909	0.824
30.6	87	1.027	1.055	−2.8	27	0.969	0.937	−35.6	−32	0.908	0.822
30.0	86	1.026	1.053	−3.3	26	0.968	0.935	−36.1	−33	0.907	0.820
29.4	85	1.025	1.051	−3.9	25	0.967	0.933	−36.7	−34	0.906	0.818
28.9	84	1.024	1.049	−4.4	24	0.966	0.931	−37.2	−35	0.905	0.816
28,3	83	1.023	1.047	−5.0	23	0.965	0.929	−37.8	−36	0.904	0.814
27.8	82	1.022	1.045	−5.6	22	0.964	0.927	−38.3	−37	0.903	0.812
27.2	81	1.021	1.043	−6.1	21	0.963	0.925	−38.9	−38	0.902	0.810
26.7	80	1.020	1.041	−6.7	20	0.962	0.923	−39.4	−39	0.901	0.808
26.1	79	1.019	1.039	−7.2	19	0.961	0.922	−40.0	−40	0.900	0.806
25.6	78	1.018	1.037	−7.8	18	0.960	0.920	−40.6	−41	0.899	0.804
25.0	77	1.017	1.035	−8.3	17	0.959	0.918	−41.1	−42	0.897	0.802
24.4	76	1.016	1.033	−8.9	16	0.958	0.916	−41.7	−43	0.896	0.800
23.9	75	1.015	1.031	−9.4	15	0.957	0.914	−42.2	−44	0.895	0.798
23.3	74	1.014	1.029	−10.0	14	0.956	0.912	−42.8	−45	0.894	0.796
22.8	73	1.013	1.027	−10.6	13	0.955	0.910	−43.3	−46	0.893	0.794
22.2	72	1.012	1.026	−11.1	12	0.954	0.908	−43.9	−47	0.892	0.792
21.7	71	1.012	1.024	−11.7	11	0.953	0.906	−44.4	−48	0.891	0.790
21.1	70	1.011	1.022	−12.2	10	0.952	0.904	−45.0	−49	0.890	0.788
20.6	69	1.010	1.020	−12.8	9	0.951	0.902	−45.6	−50	0.889	0.786
20.0	68	1.009	1.018	−13.3	8	0.950	0.900	−46.1	−51	0.888	0.784
19.4	67	1.008	1.016	−13.9	7	0.949	0.898	−46.7	−52	0.887	0.783
18.9	66	1.007	1.014	−14.4	6	0.948	0.896	−47.2	−53	0.886	0.781
18.3	65	1.006	1.012	−15.0	5	0.947	0.894	−47.8	−54	0.885	0.779
17.8	64	1.005	1.010	−15.6	4	0.946	0.892	−48.3	−55	0.883	0.777
17.2	63	1.004	1.008	−16.1	3	0.945	0.890	−48.9	−56	0.882	0.775
16.7	62	1.003	1.006	−16.7	2	0.944	0.888	−49.4	−57	0.881	0.773
16.1	61	1.002	1.004	−17.2	1	0.943	0.886	−50.0	−58	0.880	0.771
15.6	60	1.001	1.002	−17.8	0	0.942	0.884	−50.6	−59	0.879	0.769

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Inlet Temperature Correction Factor Chart
Figure 509/72-00-00-990-932

5. Repair/Test Reference

(Table 507)

A. General

(1) Repair/test reference table lists various repairs, replacements and reinstallations and corresponding test to be performed following these actions. When more than one maintenance action has been done, combine different features of two or more tests, eliminate duplication, and perform resultant test during one period of operation. Where multiple tests each require single power setting, higher power setting shall be used.

(2) In order to achieve high degree of accuracy, it is recommended that all tests be conducted in P&W approved indoor test facility previous to installing engine in aircraft. However, in cases where such test facility was not available or if operator prefers to test engine on aircraft, test requirements are indicated in Table 507.

(3) It should be understood that quality of test data from an on-the-wing engine test may not be as accurate as data generated from indoor engine test facility. While quality of on-the-wing test data should be sufficient to determine if engine is acceptable, operator should be willing to sacrifice certain degree of troubleshooting or trend monitoring capability when relying on installed engine data.

Table 507 Repair/Test Reference

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Accessory Drive Seals	A
Anti-icing Air Shutoff Actuator And Valve	*[2]
Average Pressure Probe P_{t7} (8 Required)	B
Combustion Area Inspection	B
Combustion Chambers	B
Combustion Chamber Duct	F
Combustion Chamber Inner Case	F
Combustion Chamber And Turbine Fan Ducts	C
Compressor Inlet Duct	A
Compressor Inlet Group	A
Compressor Inlet and Front Compressor Section	B, I
Compressor Intermediate Group	F
Constant Speed Drive/Alternator Drive Oil Seal	A
Differential Fluid Pressure Switch	C
Diffuser Group	F
Diffuser Outer Fan Duct Group	C
Eighth Stage Bleed Valve	E
Engine Exhaust Case Section	G
Engine Oil Tank	A
Engine Oil Tank Drain Valve	None

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Fan Exhaust (Mixer) Rear Outer Duct	None
Fan Exhaust Outer Rear (Transition) Duct	None
Fan And Turbine Exhaust Duct (Mixer)	None
Fan Exit Stator Segments	None
First Stage Compressor (Fan) Blades	I(4)
First Stage Compressor Disk And Blade Assembly (Fan)	G(5), I(4)
First Stage Turbine Vanes (Through Hot Section With Turbines Installed)	B, H
First Stage Turbine Vanes (Turbines Removed)	F
Front Accessory Drive Group	A
Front Compressor Drive Turbine Group	F
Front Compressor Drive Turbine Group And Engine Exhaust Case Section Group	F
Front Compressor Drive Turbine Rotor And Stator Assembly	F
Front Compressor Rotor And Stator Assembly	G, I
Front Fan Case	A
Fuel Control (Replacement Fuel Control)	D, H
Fuel Control Condensation Trap	None
Fuel Control Main Filter	C
Fuel Deicing Air Shutoff Actuator And Valve	*[2]
Fuel Deicing Heater Assembly	C
Fuel Nozzle And Support Assemblies	B, H
Fuel Manifold Assembly	B, H
Fuel/Oil Cooler And Seals	C (6)
Fuel/Oil Cooler Bypass Valve And Seals	C (6)
Fuel/Oil Cooler Inlet Tube And Seals	C (6)
Fuel/Oil Cooler Outlet Sensing Tube And Seals	C (6)
Fuel Pressurizing And Dump Valve	C(3)
Fuel Pressurizing And Dump Valve Strainer	C
Fuel Pump (Same Fuel Control)	B(2), H
Fuel Pump Drive Oil Seal	A
Fuel Pump Filter	C
Fuel Pump And Fuel Control Package (Different Fuel Control)	D(2), H
Gearbox Coupling (Constant Speed Drive)	A
Gearbox Deairator Oil Seal	A
Hydraulic Pump Drive Oil Seal	A

Table 507   Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Igniter Plug (2 Required)	*[1]
Ignition Cable (2 Required)	*[1]
Ignition Exciter	*[1]
Main Accessory Gearbox Assembly (Same Fuel Control)	B
Main Accessory Gearbox Group (Same Fuel Control) (And Fuel Control Connecting Linkage)	B
Main Gearbox Drive Bevel Gearshaft And Bearings	B
Main Oil Filter (Strainer) And Seals	C (6)
Main Oil Pump And Seals	C (6)
N_1 Tachometer Drive Oil Seal	A
N_2 Tachometer Drive Gearshaft Oil Seal	A
No. 1 Bearing	G, I
No. 1 Bearing Air Sealing Ring And Seal Assembly	G, I
No. 1 Bearing Oil Scavenge Pump	A
No. 2 Bearing	F
No. 2 Bearing Seal Assembly	G, I
No. 3 Bearing And Seal	F
No. 4 Bearing	F
No. 4 Bearing Seal Assembly	F
No. 4 Bearing Sealing Ring	F
No. 4 And 5 Bearing Oil Pressure/Scavenge Tube (External) And Seals	A
No. 4 And 5 Bearing Oil Breather Tube (External) And Seals	B
No. 4 And 5 Bearing Oil Scavenge Pump	F
No. 4 1/2 Bearing, Seals And Seal Spacers	F
No. 5 Bearing And Seal Assembly	F
No. 6 Bearing And Seals	G, I
No. 6 Bearing Oil Scavenge Pump	A
Oil Filter Pressure Relief Valve And Seals	C (6)
Oil Pressure Relief Valve Assembly	C(1), (6)
Power Lever Cross Shafts	B
Pressure Ratio Bleed Control	E
Rear Compressor And Diffuser Section	F
Rear Compressor Drive Turbine Rotor And Shaft Assembly	F
Rear Compressor Drive Turbine Group	F

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Rear Compressor Exit Stator Assembly	F
Rear Compressor Through The Rear Compressor Drive Turbine Section	F
Rear Compressor Rotor And Stator Assembly	F
Rear Fan Case	G
Starter Drive Gearshaft Coupling	A
Starter Drive Oil Seal	A
Thermocouple - T_{t7} (8 Required)	None
Thermocouple Box And Cable Assembly - T_{t7}	None
Total Pressure Probe - P_{t2}	E
Turbine Exhaust Cone And Duct	None
Turbine Nozzle Group	F
Turbine Shaft Inner Heat shield Assembly	F
Turbine Shaft Outer Heat shield Assembly	F
13th Stage Bleed Valve	E
13th Stage Compressor Sealing Ring	F

(1) When engine oil pressure adjustment is required, install 0 - 50 PSIG (0.0 - 344.7 kPa) direct-reading gage to LP2 tap on main oil pressure manifold, vented to LV3 tap on main accessory gearbox housing. Adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa at Idle. 100°F (38°C) oil temperature is recommended during oil pressure adjustment. See Paragraph 8..

(2) After replacing fuel pump and performing engine test run, torque fuel pump quick-disconnect nut per PAGEBLOCK 73-00-00/601.

(3) During and after this test, carefully inspect for fuel leakage at fuel manifold inlet tube to P&D valve tube end fittings. No Leakage is permitted.

(4) See the locations that follow for a 24 hour flyback time limit permitted before the vibration check is necessary:

(a) Section PAGEBLOCK 72-00-00/601 Config 1 - Inspect First Stage Compressor Blades.

(b) Section PAGEBLOCK 72-33-21/401 - Replace First Stage Compressor Blades.

(c) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.

(5) See the location that follows for a 24 hour flyback time limit permitted before the breather pressure check is necessary:

(a) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.

(6) Test A (Ground Check at Idle) is an option to Test C for leak check of these replaced parts, but Test A will not give the increased oil pressure that is typical during engine accelerations. If an oil leak problem is possible, use Test C (with the thrust level modification specified for leak check) to see if there are oil leaks.

*[1] Aural Check Igniter Firing With Engine Not Running.

*[2] Observe Valve Position While Actuating Valve With Engine Not Running.

6. Test For Repaired Engines

A. When cleaning engines prior to test, following precautions must be taken.

CAUTION: IF FUEL LINES ARE TO BE DISCONNECTED, PRE-PACKED BEARINGS IN THE AREA MUST BE PROTECTED FROM ANY LOST FUEL.

(1) Protect all prepacked bearings, such as cross-shaft or control rod linkage bearings.

(2) Protect pressure ratio bleed control.

(3) Protect silicone rubber shock mounts on oil tank and oil tank strap. Wash down area as soon as possible after washing with cleaning solution.

B. Test A - Ground Check at Idle

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Allow engine to run at IDLE for minimum of three minutes for oil system repair/replacement as required for oil temperature to reach 100°F (38°C).

(4) Shut down. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

C. Test B - Ground Check at Normal Takeoff

(1) Inspect and clean engine test area.

(2) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Operate engine at IDLE until readings have stabilized and oil temperature reaches minimum of 100°F (38°C).

(4) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(5) Stabilize for three minutes at Normal Takeoff.

(6) Check that oil pressure, oil temperature and EGT are within limits of Table 502

(7) Retard power lever to IDLE and operate engine for five minutes.

(8) Shut down engine (GENERAL, SUBJECT 71-00-00, Page 501) and perform normal engine inspection procedures. (GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 72-00-00/201)

NOTE: It is not necessary to inspect the oil filter if the oil system was not disturbed and no oil wetted components were replaced during the maintenance action.

D. Test C - Ground Check at 3000 lb/hr (1360 kg) Fuel Flow

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start engine (GENERAL, SUBJECT 71-00-00, Page 501 and allow to stabilize at idle for minimum of three minutes.

(3) Advance power lever as necessary until minimum of 3000 lb/hr of fuel flow is observed. Maintain for minimum of two minutes.

(4) After completion of check, return power lever to IDLE.

(5) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

E. Test D - Part Power Trim Check. (GENERAL, SUBJECT 71-00-00, Page 501).

F. Test E - Ground Check for Bleed System Operation. (Figure 510)

NOTE: This check is only applicable to the engine surge bleed system. With engines which have a 6th stage bleed system, refer to PAGEBLOCK 72-00-03/101 for a functional check. It is not possible to do a ground check of the 6th stage bleed system because the bleed closure and opening does not give a satisfactory engine parameter change.

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Run engine at IDLE until oil temperature reaches 100°F (38°C) minimum.

(4) Slowly accelerate engine and record N_1 speed at which anti-surge bleed valves close. Bleed closing is indicated by sudden increase in EPR.

(5) Slowly decelerate engine from stabilized point just above bleed valve closing and record N_1 speed at which anti-surge bleed valves open. Bleed valve opening is indicated by sudden decrease in EPR.

(6) Check bleed valve opening and closing per Figure 510.

(7) Retard power lever to Idle and shut down engine.

(8) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

(9) If anti-surge bleed valves do not open and close within limits of Figure 510, refer to PAGEBLOCK 72-00-03/101.

G. Test F - Acceptance and Performance

(1) Instrumentation Required

(a) N_1 - cockpit

(b) N_2 - cockpit

(c) EGT - cockpit

(d) EPR - cockpit

(e) Fuel Flow - cockpit

(f) Oil pressure - cockpit

(g) Oil temperature - cockpit

(h) PCP - external instrumentation - 0 - 200 psi (0.0 - 1379.0 kPa) range, measured at PCP fitting located on left side of engine diffuser case high pressure service bleed port near PS3 filter.

(i) PS4 - external instrumentation - 0 - 300 psi (0.0 - 2068.4 kPa) range, measured at PS4 fitting located on right side of engine diffuser case high pressure service bleed port at upper end of bleed valve actuation pressure supply line.

(j) P_{t7} - external instrumentation - 0 - 50 psi (0.0 - 344.7 kPa) range measured at P_{t7} line test fitting.

(k) Breather pressure - external instrumentation - 09 - 30 psi (0.0 - 206.8 kPa) range. Refer to Paragraph 6.H. for installation.

(l) Ambient temperature - Laboratory Quality Mercury Thermometer

(m) Ambient pressure - Local facilities

(n) Install vibration pickups at locations indicated in Figure 512. Connect to vibration monitoring instrumentation, including low frequency (40 cps) filter.

(2) To ensure accuracy of P_{t7} system, pressure check system as follows:

(a) Connect PWA 46415 (formerly 45513) Adapter to P_{t7} manifold outlet and attach source of dry, filtered compressed air, with PWA 21875 Regulator.

(b) Apply 35 - 45 PSIG (241.3 - 310.3 kPa) air pressure to P_{t7} system.

(c) Use soap and water solution, check each connection in manifold and at probes for leakage. No leakage is permitted.

(d) Disconnect and remove test equipment and reconnect manifold outlet.

(3) Verify proper exhaust nozzle area as specified by airframe manufacturer.

NOTE: Engine bleed and electrical loads must be minimized during test. Fuel heater, generator, air conditioning packs, anti-icing and low pressure airbleed must be off. However, generator cooling airbleed and hydraulic pumps shall be set as "low" or "no load".

(4) Inspect and clean engine test area.

(5) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Operate engine at idle for two minutes until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(7) Shut down engine and conduct Part Power Trim check per GENERAL, SUBJECT 71-00-00, Page 501.

(8) Service engine oil system and record oil level.

(9) Restart engine.(GENERAL, SUBJECT 71-00-00, Page 501) Inspect engine for evidence of fuel or oil leak.

(10) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(a) During acceleration, check that operation of anti-surge bleed valves is within limits of Figure 510, or applicable limits in airframe manufacturer's maintenance manual. If bleed valve operation is not within limits of Figure 510, refer to PAGEBLOCK 72-00-03/101.

(b) During acceleration, mark point on power lever pedestal where EPR is 0.03 EPR ratios above bleed closing point and preserve this mark for deceleration bleed control system check.

(c) Monitor engine vibration during acceleration to Normal Takeoff.

(d) Stabilize for three minutes at Normal Takeoff. Record a full set of the readings in Paragraph 6.G.(1) and make a mark to record the power lever position. Calculate 95 percent of Normal Takeoff N_2 and keep this result for the acceleration check.

(e) Check operation of fuel deicing system during this Normal Takeoff running. Open deicing air valve and observe change in fuel temperature using cockpit instrumentation. Fuel temperature must increase minimum of 104°F (58°C) in less than one minute after valve is opened. Do not adjust power lever for resultant loss of EPR. Do not allow fuel temperature to exceed 176°F (80°C). Close fuel deicing air valve.

(f) During Takeoff running, actuate engine anti-icing system. EPR should decrease by 0.08 - 0.11 ratio, when engine anti-icing air is turned on. Do not adjust power lever for resultant loss of EPR. Close engine anti-icing valves.

(11) Retard power lever to Descent/Ground Idle and deenergize idle select solenoid. Stabilize for seven minutes. Adjust idle speed to limits specified by airframe manufacturer.

(12) Operate the engine at Approach Idle for five minutes. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, calculate Normal Takeoff EPR and do the procedure again from Paragraph 6.G.(13).

(13) Advance power lever slowly (in 30 seconds minimum) to Normal Takeoff EPR determined in Paragraph 6.G.(10) and stabilize for no more and no less than 60 seconds.

(14) Retard the power lever to Approach Idle, and in not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the mark made on the quadrant in Paragraph 6.G.(10)(d), in not more than one second.

(15) Record with a stop watch the time from when the power lever starts to move to when the engine gets to the 95 percent N_2 limit as calculated in Paragraph 6.G.(10)(d).

(16) Go back to Approach Idle and do Paragraph 6.G.(12) thru Paragraph 6.G.(14) two times again.

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(17) Calculate the average of all three acceleration times and compare this average to the limit curve calculated by the airframe manufacturer for this procedure.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in this maintenance procedure (in which a stop watch is used) are to make sure that the acceleration time is accurately calculated, with the same result each time. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Takeoff N_2) as calculated from test cell procedures.

(18) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

(19) Retard power lever to EPR = 1.75. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(20) Retard power lever to EPR = 1.65. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(21) Advance power lever to EPR = 1.8. Stabilize for 30 seconds then snap power lever in one second or less to point on pedestal marked in Paragraph 6.G.(10)(b) just above bleed closing point. Deceleration bleed system is operating normally if bleed valve supply pressure (PS4) drops to near ambient pressure and then increases to normal PS4 pressure.

(22) Retard power lever to Idle. During deceleration, monitor engine vibration. Also check that anti-surge bleed valves open within limits of Figure 510.

(23) Conduct functional check of reverse thrust system per airframe manufacturer's maintenance manual instructions.

(24) Perform functional check of Reserve Takeoff Thrust system as specified by airframe manufacturer's instructions.

(25) Shut down engine and perform normal engine inspection procedures as specified by airframe manufacturer, including oil filter inspection. (GENERAL, SUBJECT 71-00-00, Page 501)

(26) Service engine oil tank as necessary. Record amount of oil added.

(27) Compute oil consumption for acceptance test. Oil consumption shall not exceed 0.1 gal/hr.

(28) Corrected N_1 vs EPR should be checked per Figure 513. This curve is designed to verify accuracy of the EPR system. During Takeoff and part power, record N_1 speed, EPR and T_{t2} at both part power and Takeoff after engine has stabilized. Check corrected N_1 according to Figure 513.

(a) Engines which plot in band of Figure 513 are acceptable if all other operating limits are met.

(b) Engine plotting above band should be investigated for cause of high N_1. Troubleshooting must include leak check of P_{t7} indicating system. If no leaks are found, following items may also be investigated for cause of high N_1:

1) Inspect fan for FOD, blended blades.

2) Check N_1 indication system.

3) Waterwash engine per airframe manufacturer's instructions.

(c) If none of above items reduce high N_1 condition but all other operating limits are met, engine is acceptable. However, high N_1 condition may result in N_1 redline limiting situation on hot days.

(d) Engines which plot below band should be checked for N_1 indicating system problems and proper size exhaust nozzle. If N_1 indicating system is not cause of low N_1 speed, but all other engine operating limits are met, engine is acceptable.

(29) EGT shall be within recommended guidelines as specified in Figure 514. Available EGT margin at Normal Takeoff rating may be determined by calculating corrected EGT from data point observed EGT and TAMB as shown in notes on Figure 514 and computing difference relative to curve in Figure 514 at constant EPR.

(30) Oil pressure and oil temperature shall not exceed limits as specified in Table 508.

(31) Measure and record the turbine cooling air pressure ratio (TCAR) Pcp/Ps4) and compare it to the limits in Figure 515.

FIGURE 72-00-00-990-938	NOTE
Sheet 3	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 4	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 5	A. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is in the range shown (between the Minimum limit and the lower limit), do the sub-idle leak check specified in the test.
	B. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is less than the lower limit, it will be necessary to remove the engine for disassembly and corrective action.

(a) If a JT8D-217C/219 engine (which is post-SB 6128 and pre-SB 6196) has a Pcp/Ps4 ratio less than the Minimum limit in Figure 515 (Sheet 5), do a sub-idle leak test as follows:

1) Attach containers to the No. 4 bearing scupper drain and the No. 5 bearing area (combution section) drain.

NOTE: For all engines a Pcp transducer (with an accuracy of ±0.1 psig) will be necessary to measure the low Pcp values at idle and lower accurately. You must not do an engine shutdown during the test procedure.

2) Do the usual acceptance test as specified in this section (but do not do an engine shutdown when the test is completed). Adjust the idle trim N2 to 46 percent (+0, -0.2 percent) and the maximum oil pressure to 50.0 psig (344.7 kPa) (-0, +0.5 psi (3.4 kPa)). Operate the engine at Idle for 20 minutes. Increase the Idle N2 to the Figure 533 limits, then do an engine shutdown.

a) Record the Pcp on all data points at idle or lower with the transducer specified above. If it is difficult to trim to low idle, or if the idle speed does not stay stable, tell Pratt & Whitney Engineering immediately.

3) After the test, look for streaks in the tailpipe and remove the drain bottles (record what is found in them). Attach new bottles, then (after an hour) remove these bottles and record what is in them.

4) Do a borescope inspection of the 1st stage turbine vane area (through the igniter plug ports) and look for wet surfaces or puddles of oil. Record the inspection results.

5) If no oil leaks are found, the engine is satisfactory. If oil leaks are found, remove the engine for disassembly to correct the leaks.

(32) Breather pressure shall not exceed limit given in Paragraph 2.M.(2).

(33) Vibration shall not exceed limits given in Table 508.

NOTE: If the engine vibration is above the limits, the operator can trim balance the engine on the aircraft to decrease vibration levels. However, trim balance only those engines on which the fan is replaced. See Paragraph 7..

Table 508 Acceptance Limits Vibration Amplitudes

Pickup Location	Single Amplitude	Double Amplitude
INLET SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
REAR SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
NOTE: The limits in this table are valid only when vibration pickups are mounted at locations specified and only when the low frequency filter (40 CPS) is selected in the vibration monitoring circuit.		

H. Test G - Breather Pressure Check (Figure 516 and Figure 517)

(1) Disconnect airframe breather duct from engine gearbox and leave gearbox port open.

(2) On engines with oil pressure transmitter vented to gearbox, disconnect airframe vent tube from gearbox LV3 fitting and remove fitting from gearbox port. On engines with oil pressure transmitter vented to ambient, remove fitting from gearbox LV3 port.

(3) Connect 0 - 10 PSIG (0.0 - 68.9 kPa) gage to LV3 port with the gage held above the LV3 port at all times (loops in the gage line can collect oil and cause false readings). Gage should be maximum-indication type with dial marker. Wire equipment securely to protect it from vibration. (Figure 516)

NOTE: If desired, PWA 33784 Cap may be used to obtain breather pressure measurement. Make sure the gage is held above the oil tank cap at all times to keep loops out of the gage line. See Figure 517. Breather pressure measured at this location will approximate breather pressure at gearbox LV3 port. If pressure reading obtained in the following procedure is close to or higher than limits given, procedure should be repeated with pressure gage connected to gearbox LV3 port.

WARNING: OBSERVE PROPER SAFETY PRECAUTIONS AROUND RUNNING ENGINE. WEAR EAR PROTECTORS AND STAY CLEAR OF ENGINE HAZARD AREAS. SEE "ENGINE GROUND SAFETY PRECAUTIONS" FOR ENGINE HAZARD DESCRIPTION.

(4) Start engine and operate at Idle for five minutes. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Slowly accelerate (60 seconds) to Normal Takeoff power (accelerate slowly to avoid possible overshoot on 0 - 10 psi (0.0 - 68.9 kPa) gage).

WARNING: OBSERVE PROPER SAFETY PRECAUTIONS AROUND RUNNING ENGINE. WEAR EAR PROTECTORS AND STAY CLEAR OF ENGINE HAZARD AREAS. SEE "ENGINE GROUND SAFETY PRECAUTIONS" FOR ENGINE HAZARD DESCRIPTION.

(6) After engine has stabilized at Normal Takeoff (two minutes minimum), retard engine power to Idle and record breather pressure.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

(7) Compare recorded breather pressure with maximum limit given in Paragraph 2.M.(2).

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

CAUTION: DO NOT RETURN ENGINE TO SERVICE IF IT HAS HIGH BREATHER PRESSURE. HIGH BREATHER PRESSURE IS AN INDICATION THAT HIGH TEMPERATURE, HIGH PRESSURE AIR MAY BE LEAKING INTO A BEARING COMPARTMENT, CREATING A POTENTIALLY DANGEROUS SITUATION.

(9) If observed breather pressure is not within limits, investigate and correct as necessary. Remove engine for inspection if necessary.

NOTE: If pressure reading from oil tank mounted gage fitting is close to limits, repeat engine test with gage mounted at gearbox. See Note after Paragraph 6.H.(3).

(10) Remove test equipment and reinstall engine fittings.

I. Test H - Acceleration Check

(1) Make sure the engine test area is clean.

(2) Start the engine (use the approved aircraft maintenance procedures).

(3) Set the flight deck switches in the correct positions to make sure that there is no engine air bleed or power extraction.

NOTE: Make sure that test instruments are kept sufficiently cool during the test procedure.

(4) Operate the engine at Idle until indications are stable and the oil temperature is at 100°F (38°C) minimum.

(5) Set the Approach Idle switch to On. Engine N_2 must increase to Approach Idle level.

(6) Operate the engine at Approach Idle for five minutes, until the N_2 is stable.

(7) Calculate the Normal Takeoff EPR limit from barometric pressure and temperature (refer to the airframe manufacturer's data).

(8) Advance the power lever slowly (in 30 seconds minimum) to the Normal Takeoff EPR limit calculated in Paragraph 6.I.(7). Keep the engine at this power level for no more and no less than 60 seconds.

(9) With the engine at Normal Takeoff EPR, make a mark to record the power lever position. Record EPR, N_1, EGT, and N_2. Calculate and record 95 percent of N_2 (as seen on the flight deck instrument).

(10) Retard the power lever to Approach Idle. In not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the Normal Takeoff mark made on the quadrant in Paragraph 6.I.(9) in not more than one second. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, then do the procedure again from Paragraph 6.I.(7).

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(11) Record with a stop watch the time from when the power lever started to move to when the engine gets to the 95 percent N_2 limit calculated in Paragraph 6.I.(9).

(12) Go back to Approach Idle and do Paragraph 6.I.(6) thru Paragraph 6.I.(11) two times again.

(13) After three accelerations are completed, retard the power lever to Idle and do the approved airframe powerplant shutdown procedure.

(14) Calculate the average of all three acceleration times. Compare this average to the limit curve given by the airframe manufacturer.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in the maintenance procedure in this manual (in which a stop watch is used and an average is calculated) are to keep variations to a minimum in this less accurate procedure. This average time value will give results that are as much the same each time as the more accurate test cell procedure. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Normal Takeoff N_2) as calculated from test cell procedures.

(15) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

J. Test I - Vibration Check

(1) Install vibration pickups at locations indicated in Figure 520. Connect pickups to vibration monitoring instrumentation, including low frequency filter (40 CPS).

(2) Inspect and clean test area.

(3) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(4) Operate engine at Idle until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(5) Make a slow (two to three minute) acceleration from Idle to Normal Takeoff EPR as specified by airframe manufacturer for ambient conditions. Monitor inlet and rear case vibration during acceleration. Record peak observed inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

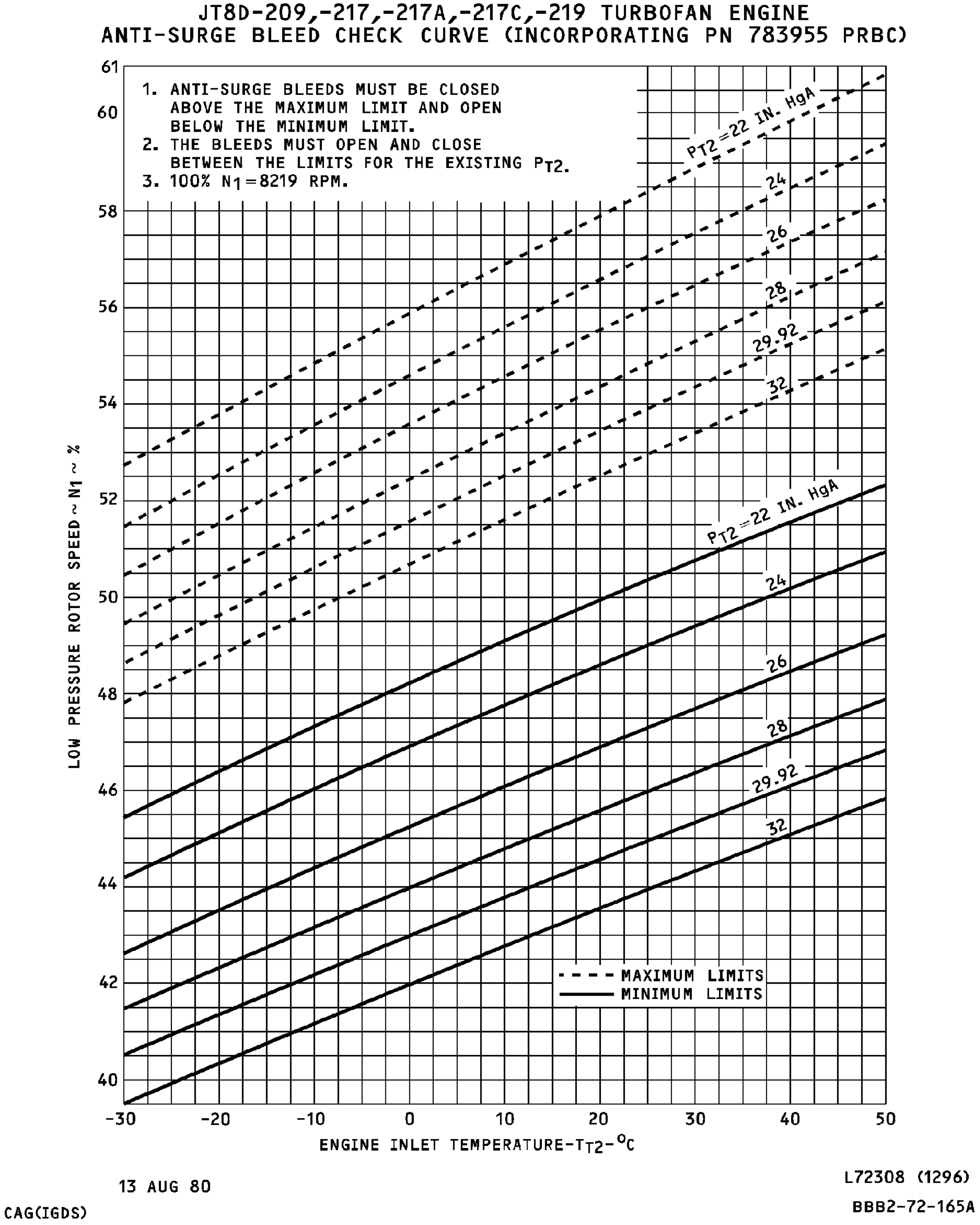
(6) Stabilize 30 seconds at Normal Takeoff EPR.

(7) Retard power lever slowly (two to three minutes) to Idle. Monitor inlet and rear case vibration during deceleration. Record Peak inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

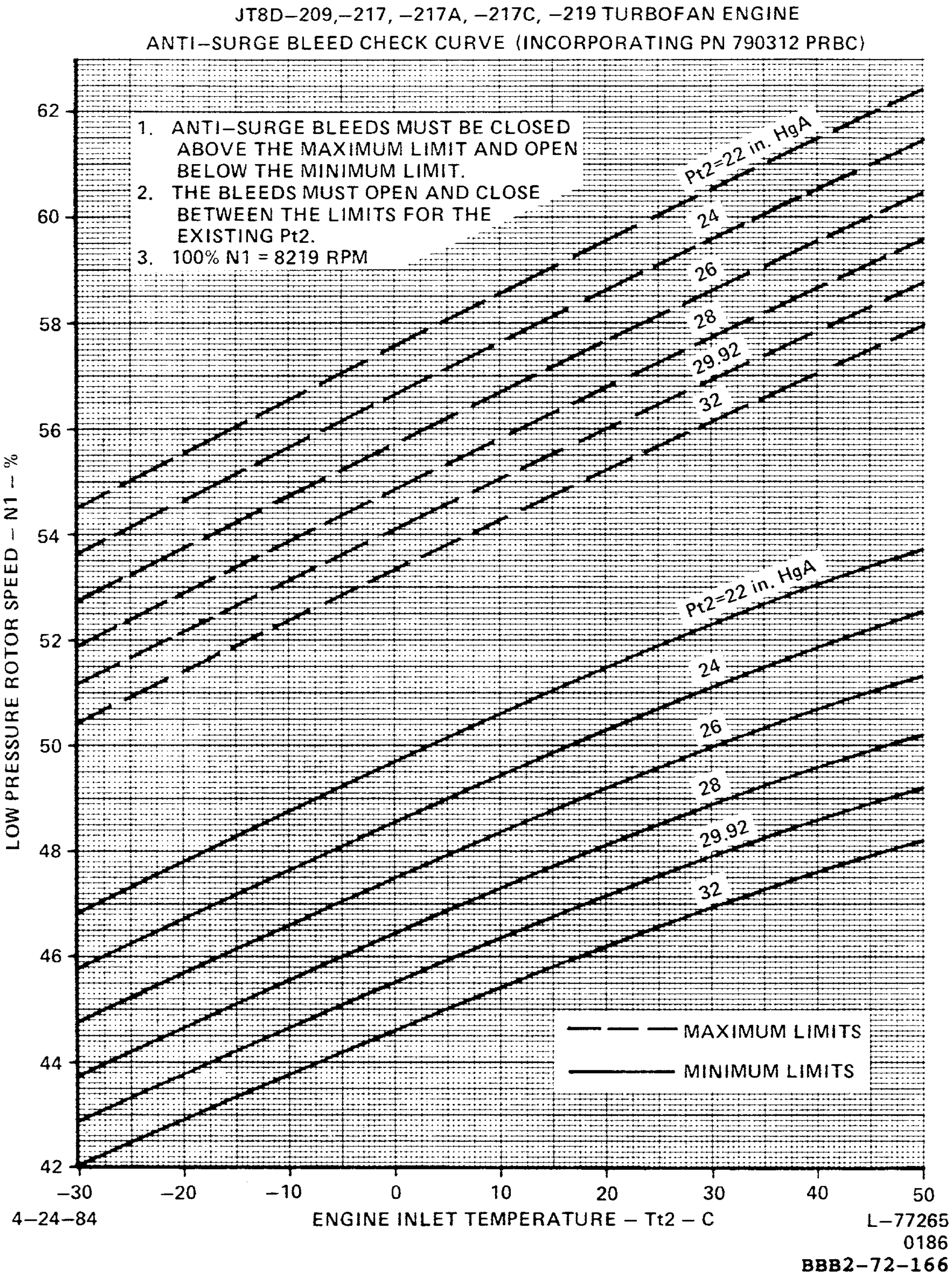
(9) Peak vibration shall not exceed limits in Table 508.

NOTE: The operator can trim balance repaired engines on the aircraft to decreased vibration levels. See Paragraph 9..

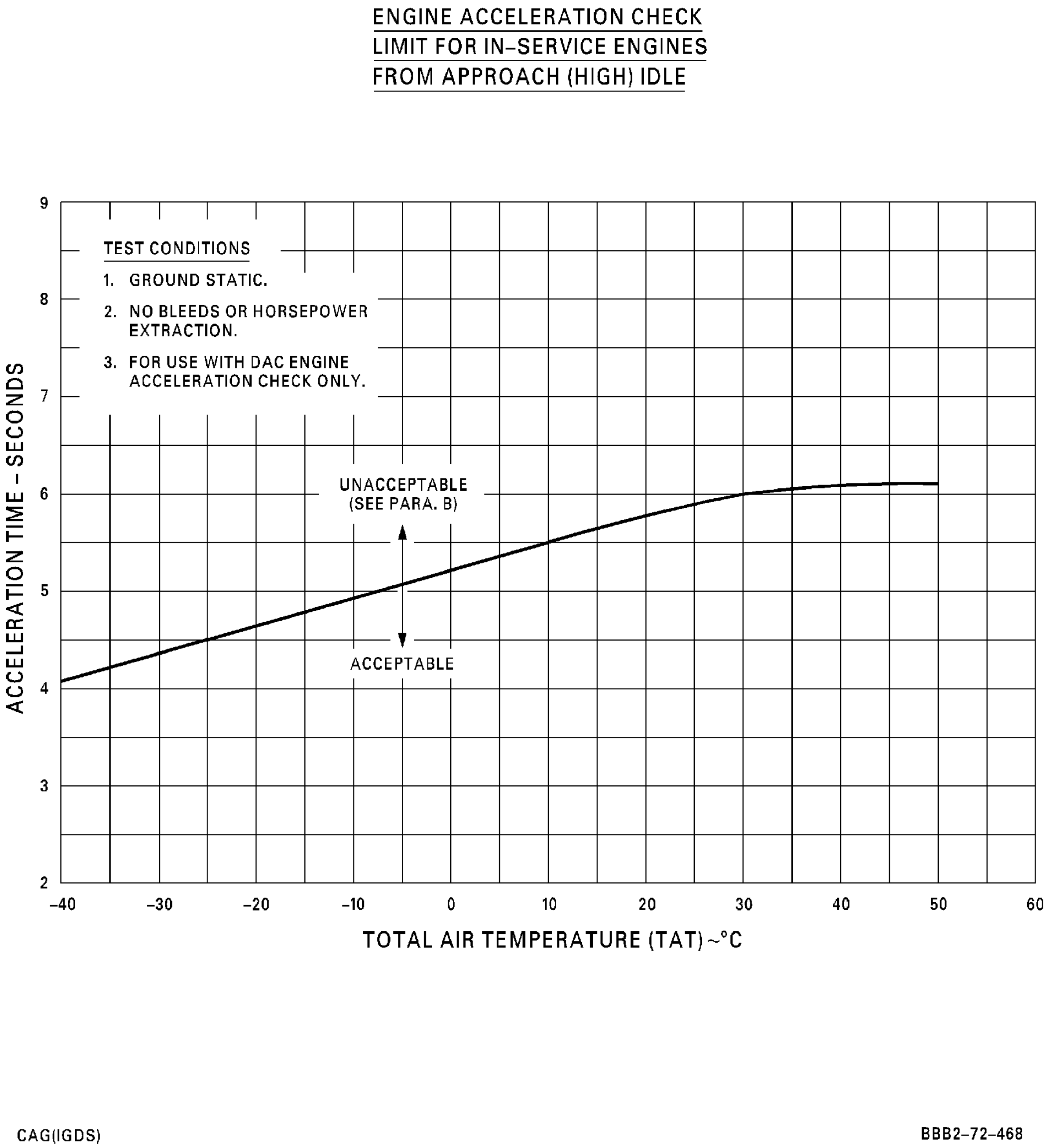


1. ANTI-SURGE BLEEDS MUST BE CLOSED ABOVE THE MAXIMUM LIMIT AND OPEN BELOW THE MINIMUM LIMIT.
2. THE BLEEDS MUST OPEN AND CLOSE BETWEEN THE LIMITS FOR THE EXISTING P_{T2}.
3. 100% N_1 = 8219 RPM.

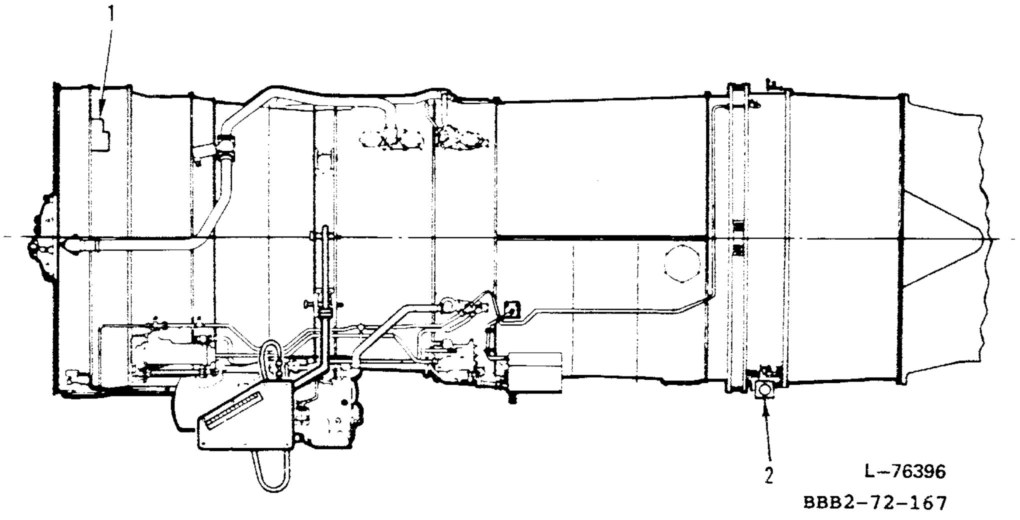
Anti-Surge Bleed Chart
Figure 510/72-00-00-990-933 (Sheet 1 of 2)



Anti-Surge Bleed Chart
Figure 510/72-00-00-990-933 (Sheet 2 of 2)



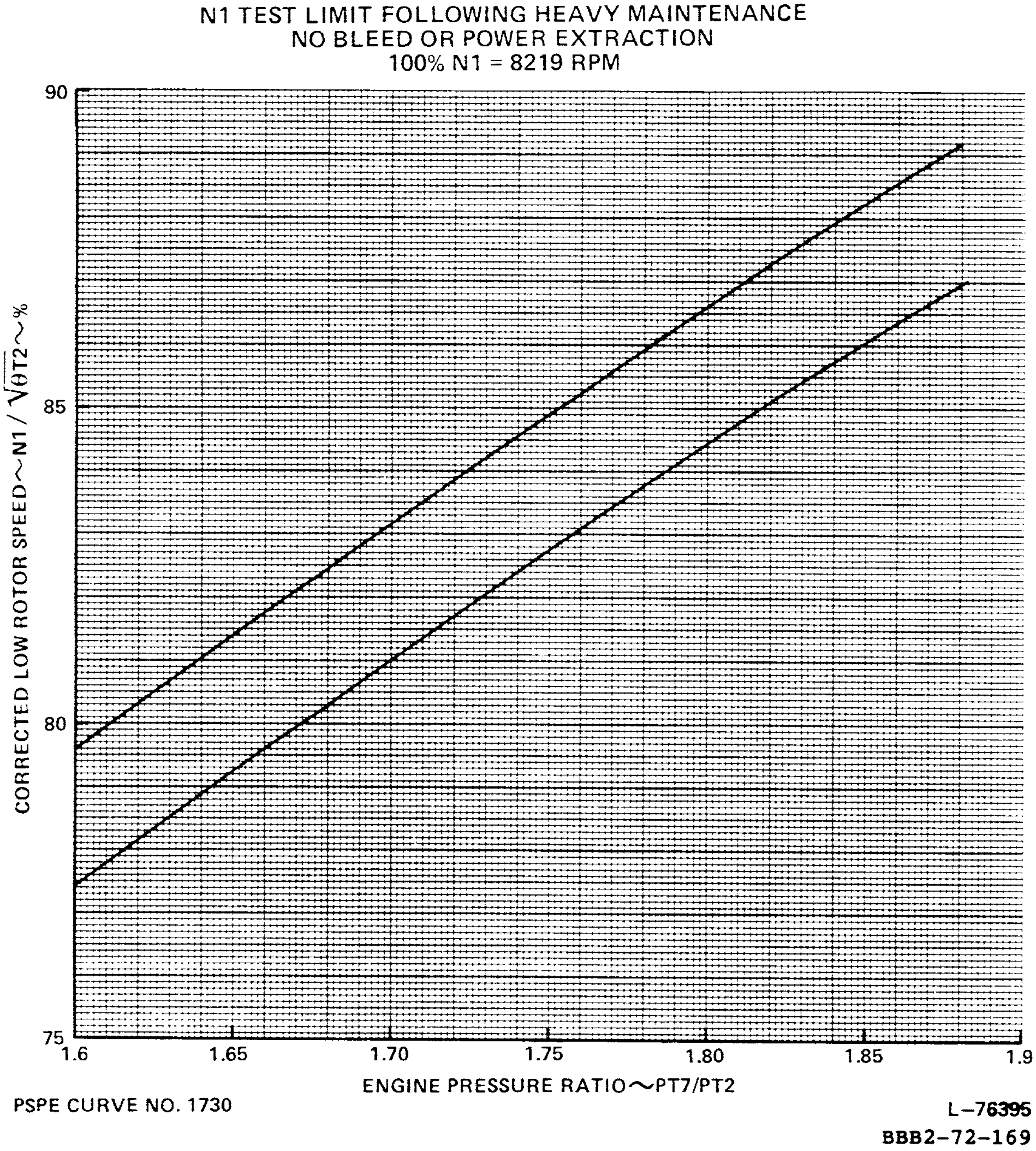
Acceleration Time Limit From Approach Idle
Figure 511/72-00-00-990-935



LEFT SIDE VIEW

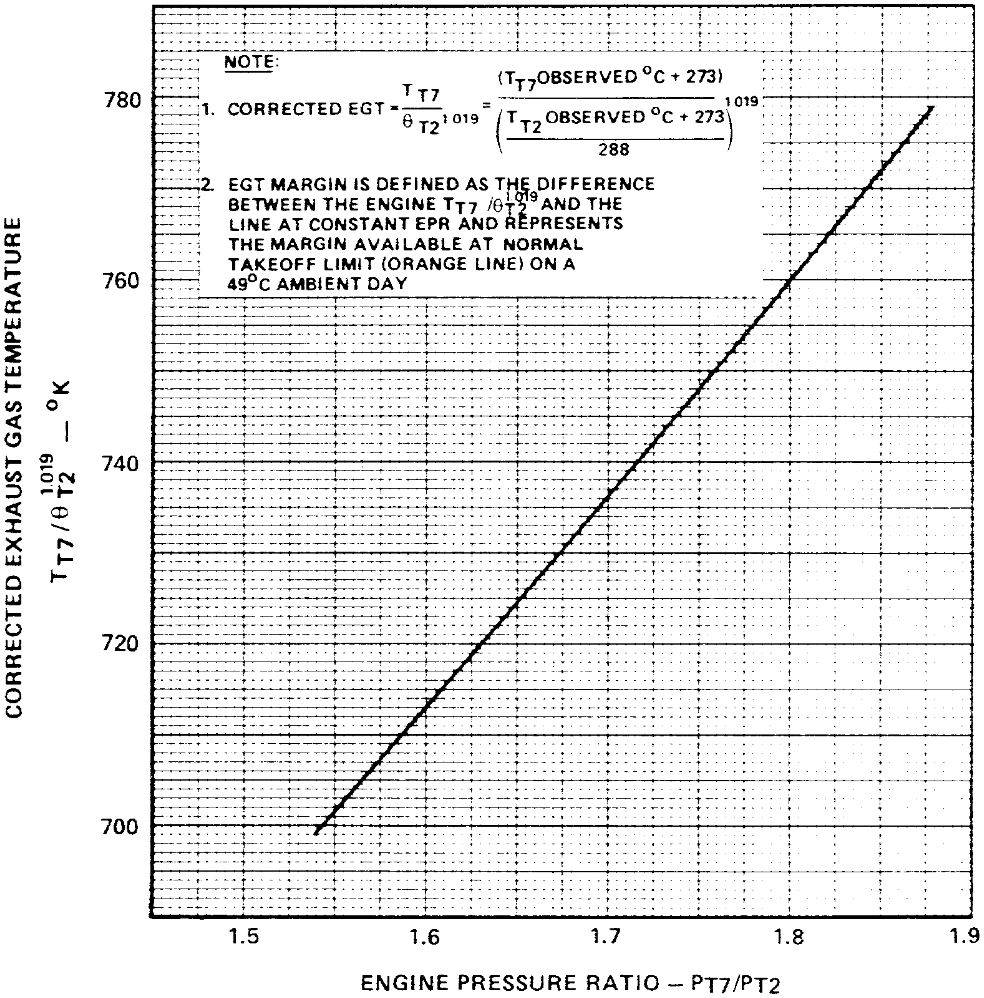
1. Front Vibration Pickup
2. Rear Vibration Pickup

Location Of Vibration Pickups
Figure 512/72-00-00-990-934



Low Rotor Speed Limit Curve
Figure 513/72-00-00-990-936

JT8D–209 TURBOFAN
EGT MARGIN CHECK CURVE



NOTE:

1. CORRECTED EGT $= \dfrac{T_{T7}}{\theta_{T2}^{1.019}} = \dfrac{(T_{T7}\text{OBSERVED }^{\circ}C + 273)}{\left(\dfrac{T_{T2}\text{ OBSERVED }^{\circ}C + 273}{288}\right)^{1.019}}$

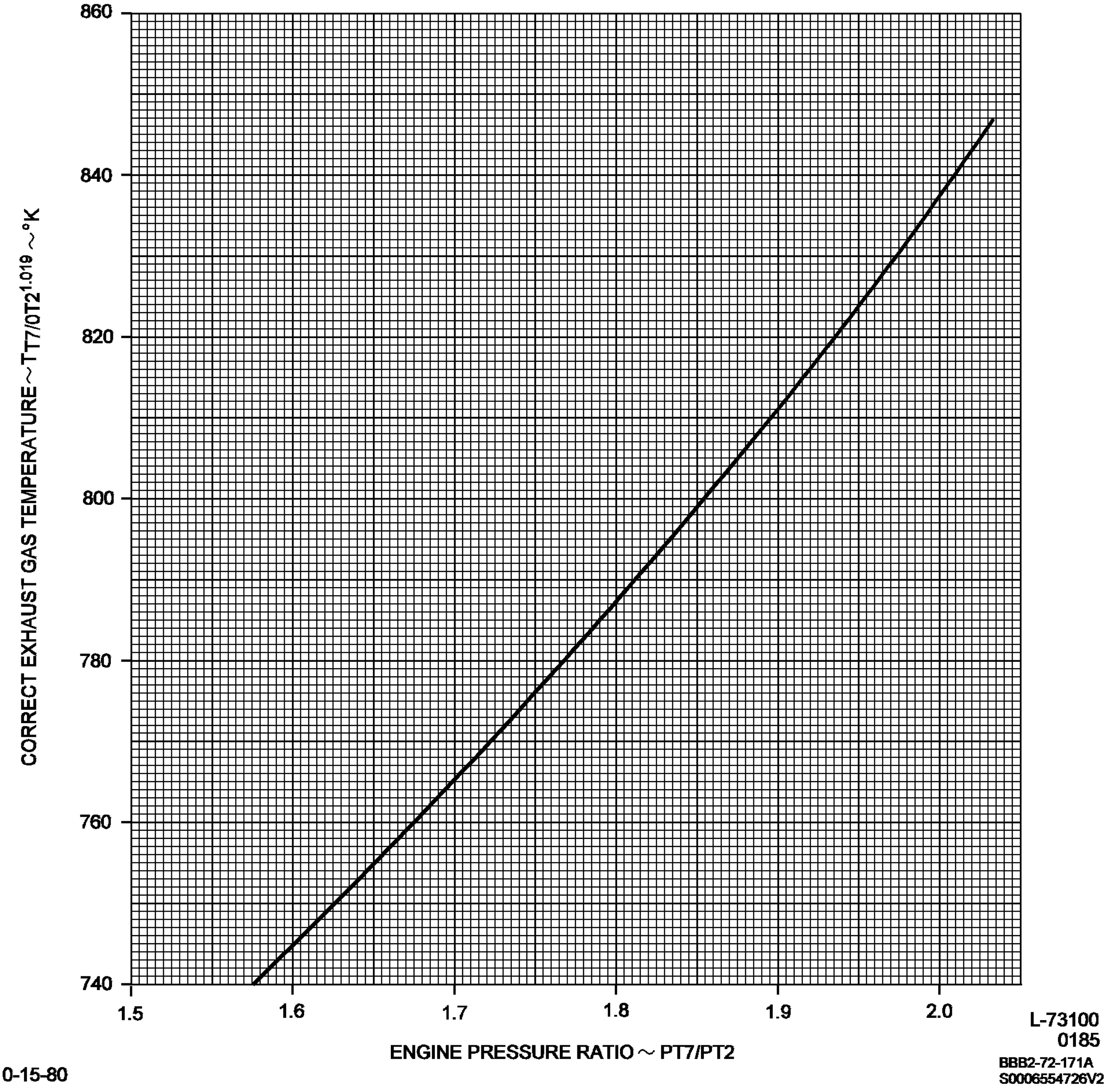
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7}/\theta_{T2}^{1.019}$ AND THE LINE AT CONSTANT EPR AND REPRESENTS THE MARGIN AVAILABLE AT NORMAL TAKEOFF LIMIT (ORANGE LINE) ON A 49°C AMBIENT DAY

EGT Margin Check Curve
Figure 514/72-00-00-990-937 (Sheet 1 of 3)

JT8D-217, -217A TURBOFAN
EGT MARGIN CHECK

NOTE:

1. CORRECTED EGT= $\dfrac{(T_{T7}\ \text{OBSERVED}\ ^{\circ}\text{C} + 273)}{\left(\dfrac{T_{T2}{}^{\circ}\text{C} + 273}{288}\right)^{1.019}}$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7/0T2}{}^{1.019}$ AND THE LINE AT CONSTANT EPR.
3. A COMPLETE HIGH QUALITY REFURBISHMENT OF BOTH HOT AND COLD SECTION MODULES SHOULD RESULT IN EGT MARGIN OF 15 - 20 °C.

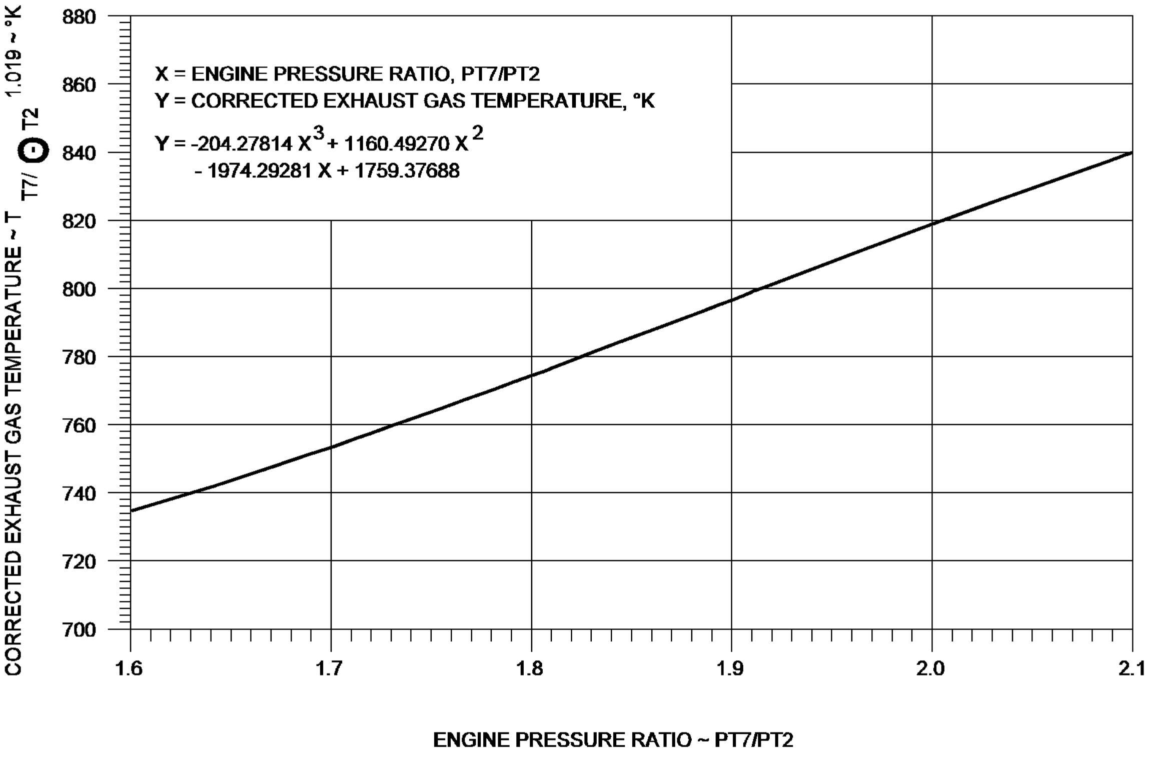


EGT Margin Check Curve
Figure 514/72-00-00-990-937 (Sheet 2 of 3)

JT8D-217C-219 TURBOFAN
EGT MARGIN CHECK

NOTES:

1. $$\text{CORRECTED EGT} = \frac{(T_{T7}\ \text{OBSERVED}\ \text{°C}+273)}{\left(\dfrac{T_{T2}\,\text{°C}+273}{288}\right)^{1.019}}$$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7}/\Theta_{T2}^{\ 1.019}$ AND THE LINE AT CONSTANT EPR
3. THE EGT LIMIT REPRESENTS AN ENGINE WITH ZERO MARGIN TO THE NORMAL TAKE-OFF LIMIT (ORANGE LINE) ON A 29 °C AMBIENT DAY.



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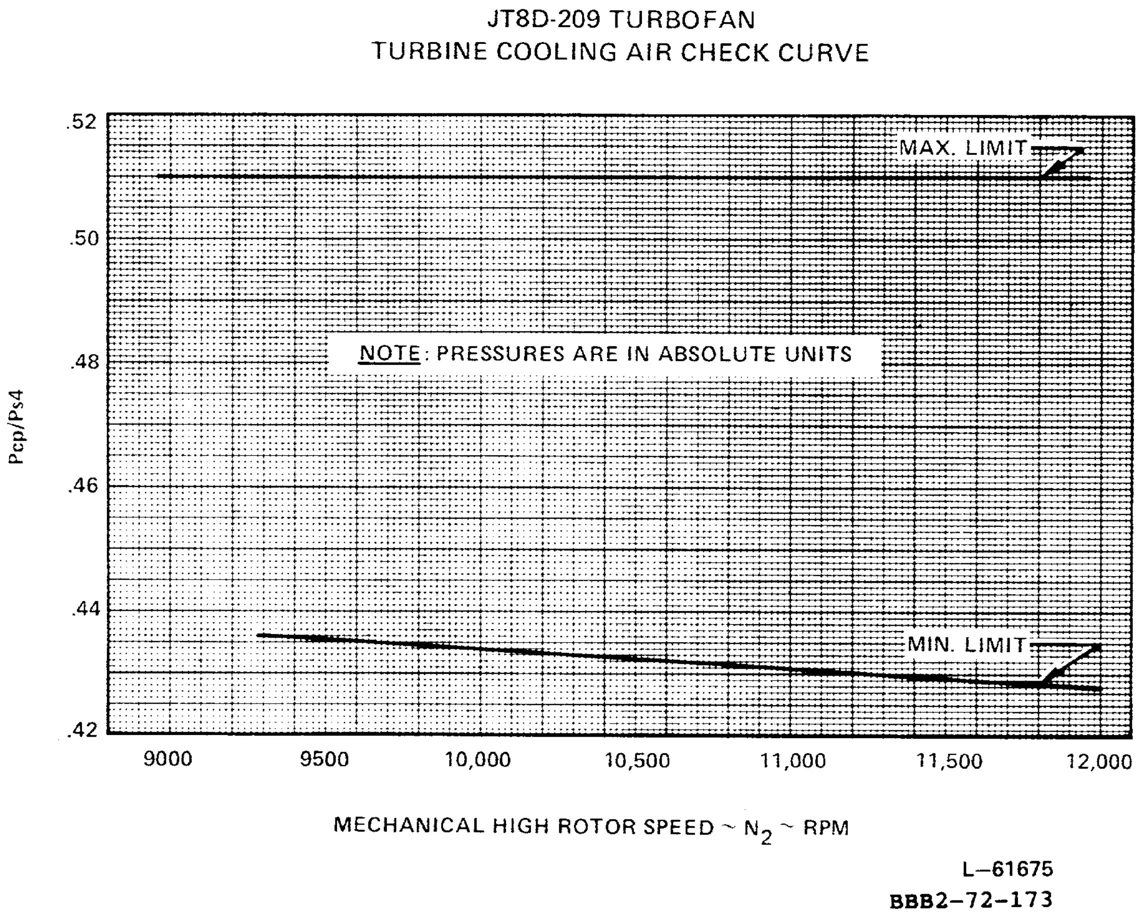
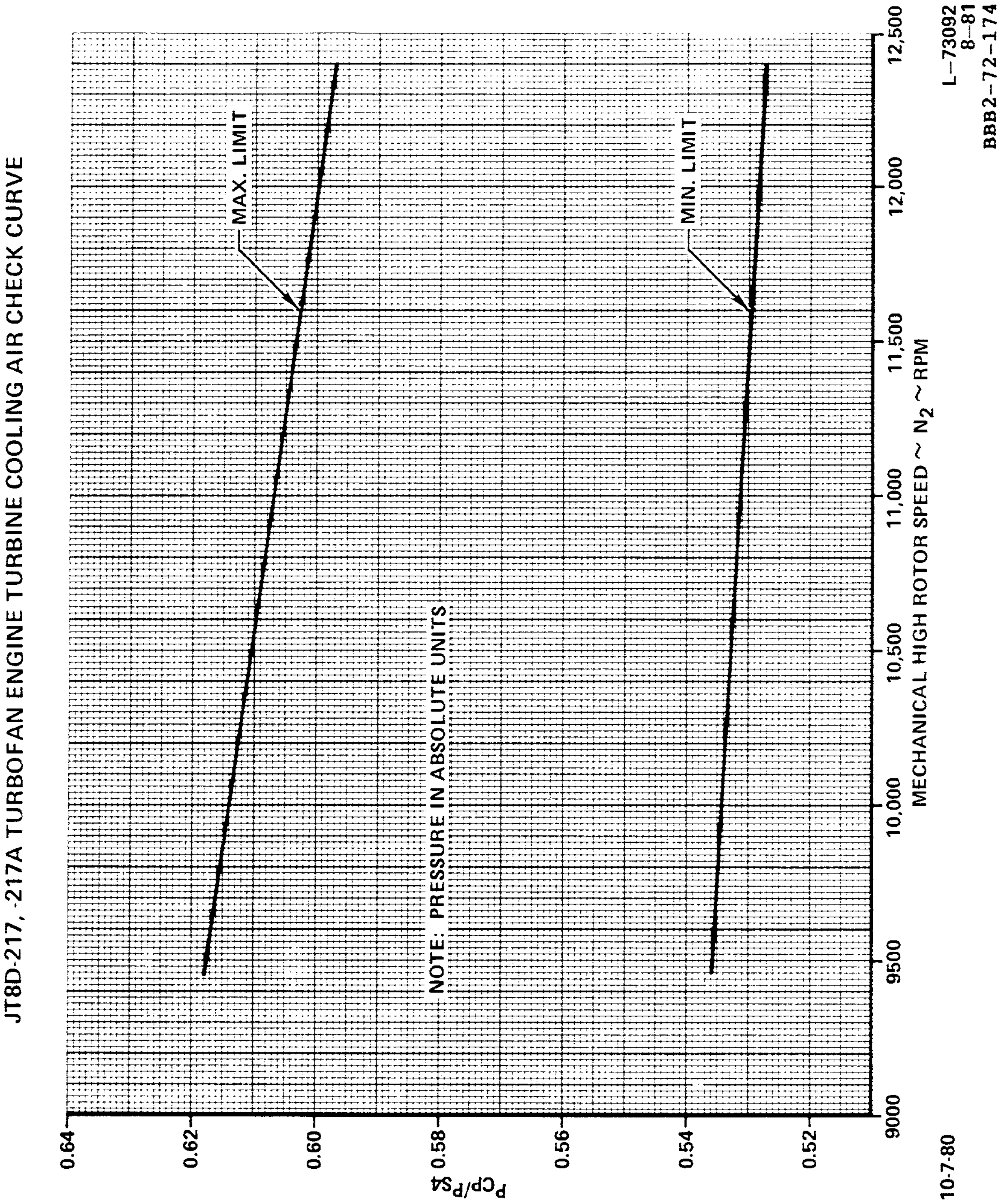
EGT Margin Check Curve
Figure 514/72-00-00-990-937 (Sheet 3 of 3)



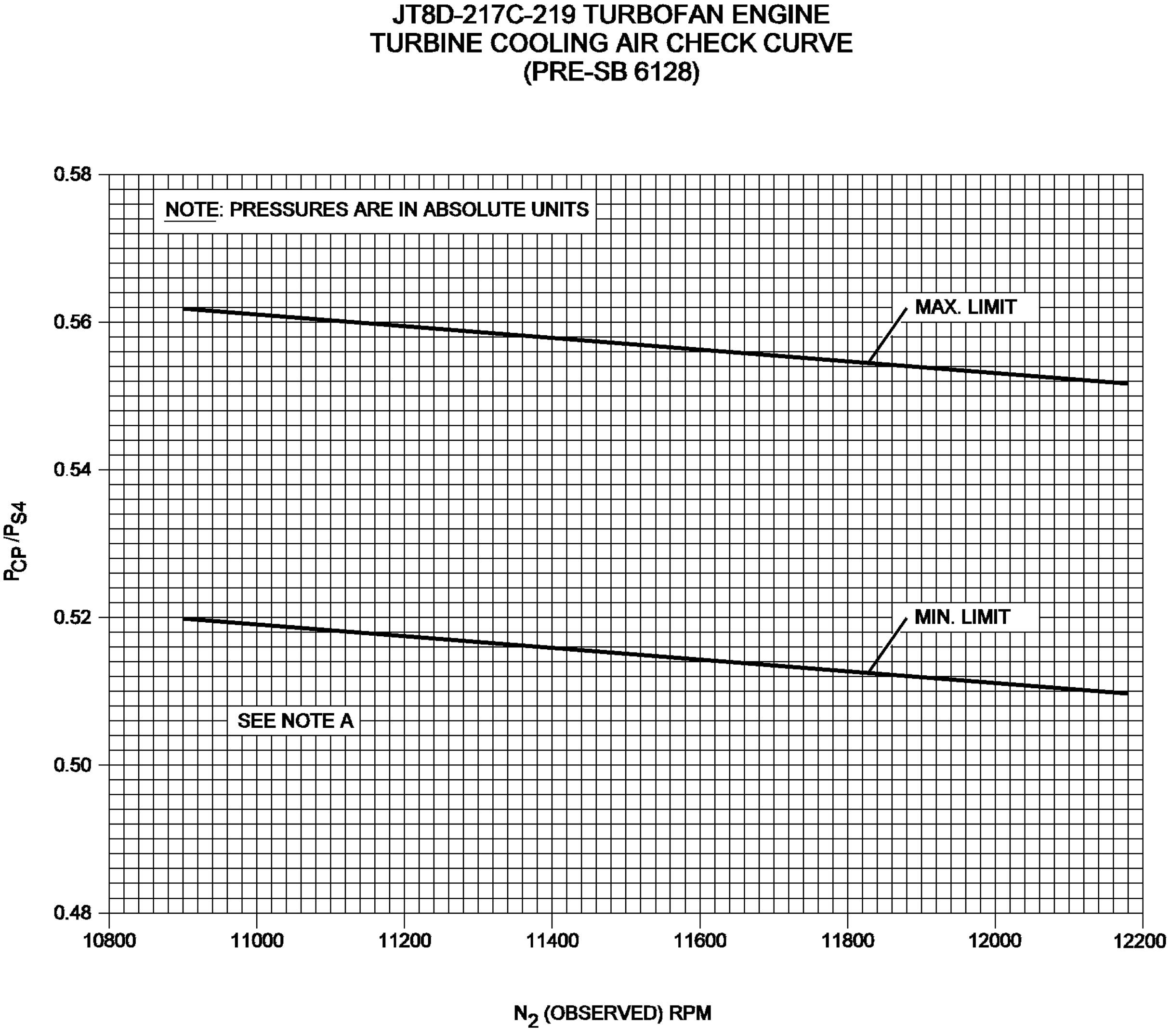
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-938 (Sheet 1 of 5)



JT8D-217, -217A TURBOFAN ENGINE TURBINE COOLING AIR CHECK CURVE

NOTE: PRESSURE IN ABSOLUTE UNITS

Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-938 (Sheet 2 of 5)



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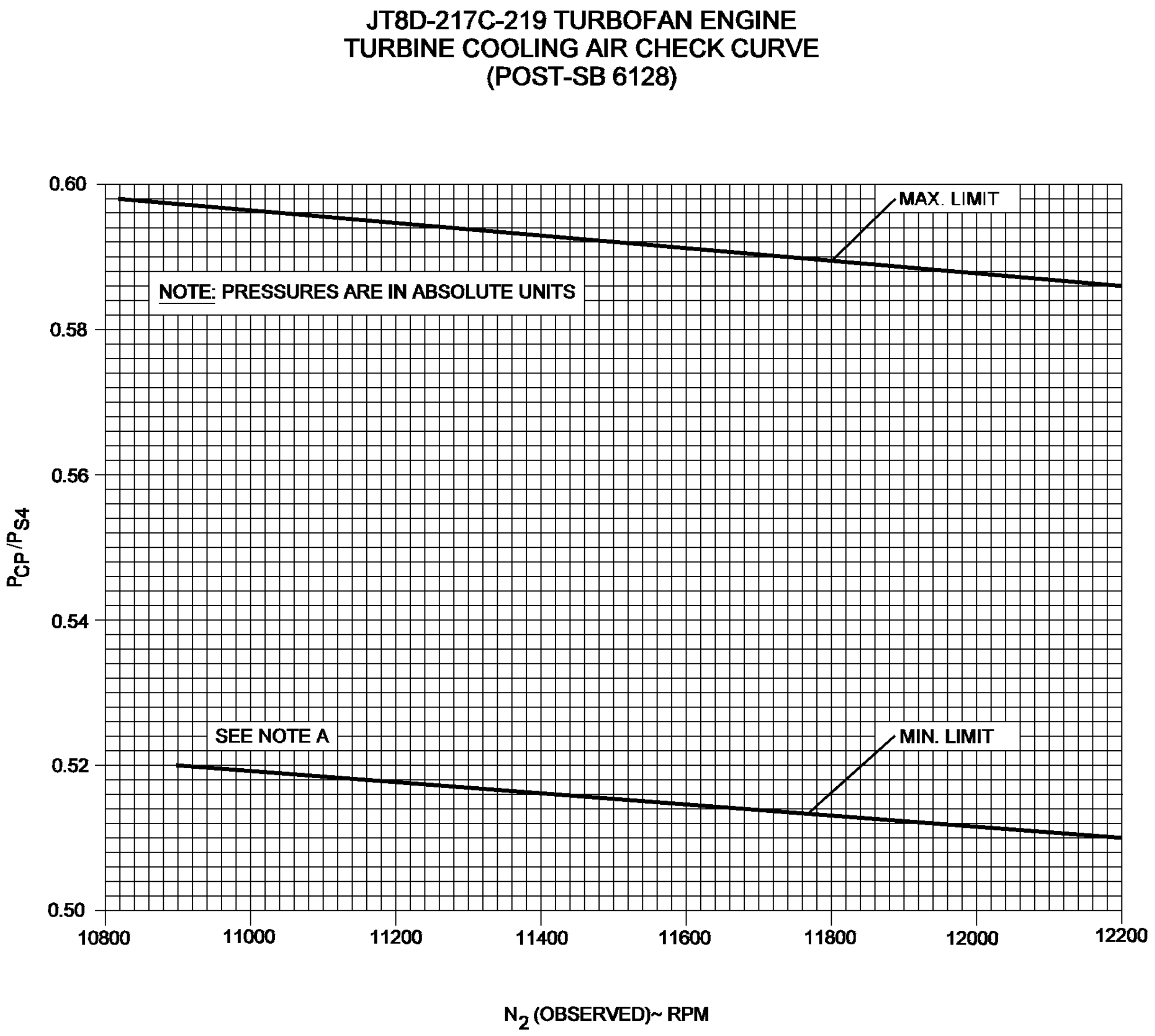
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-938 (Sheet 3 of 5)



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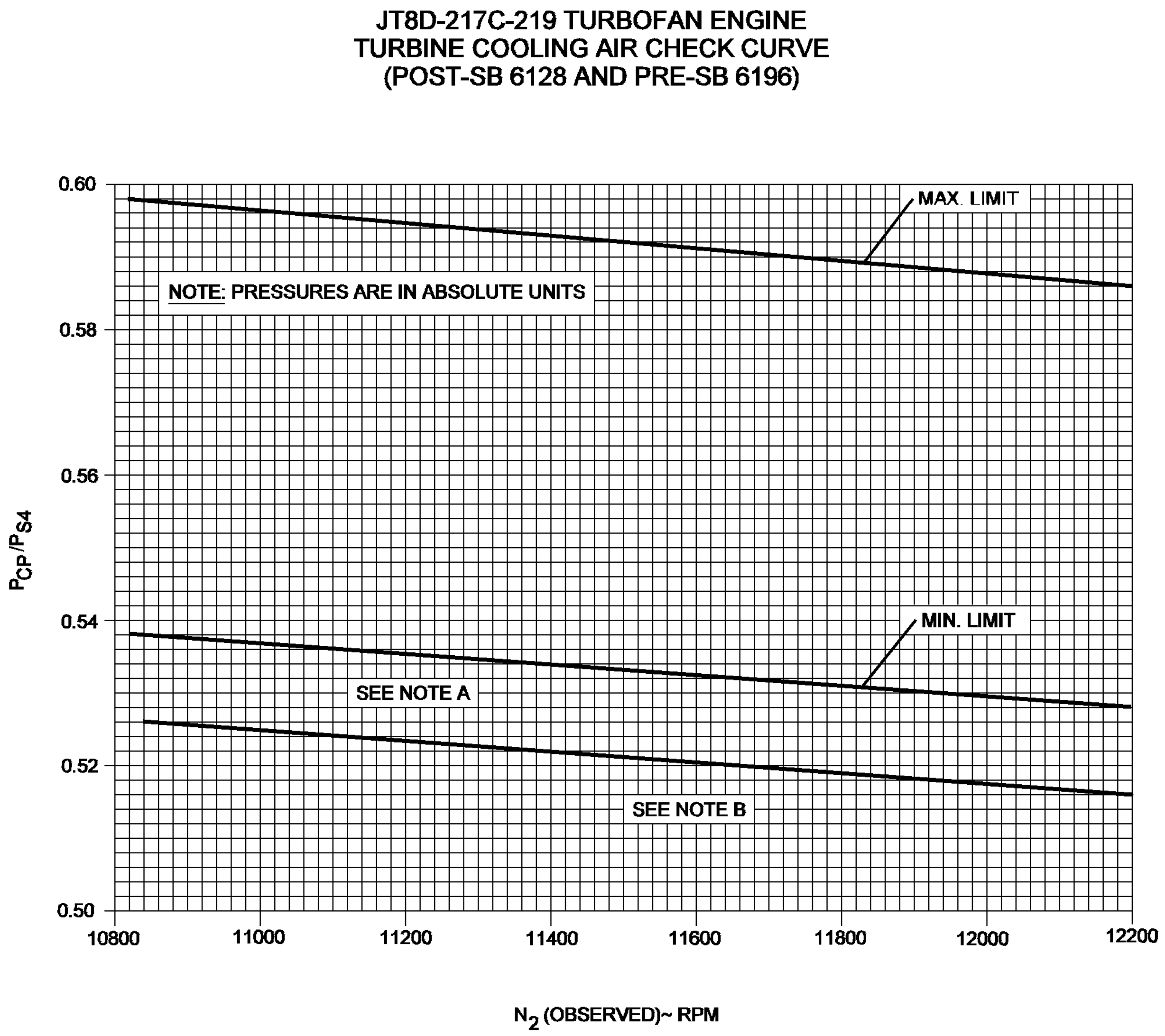
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-938 (Sheet 4 of 5)



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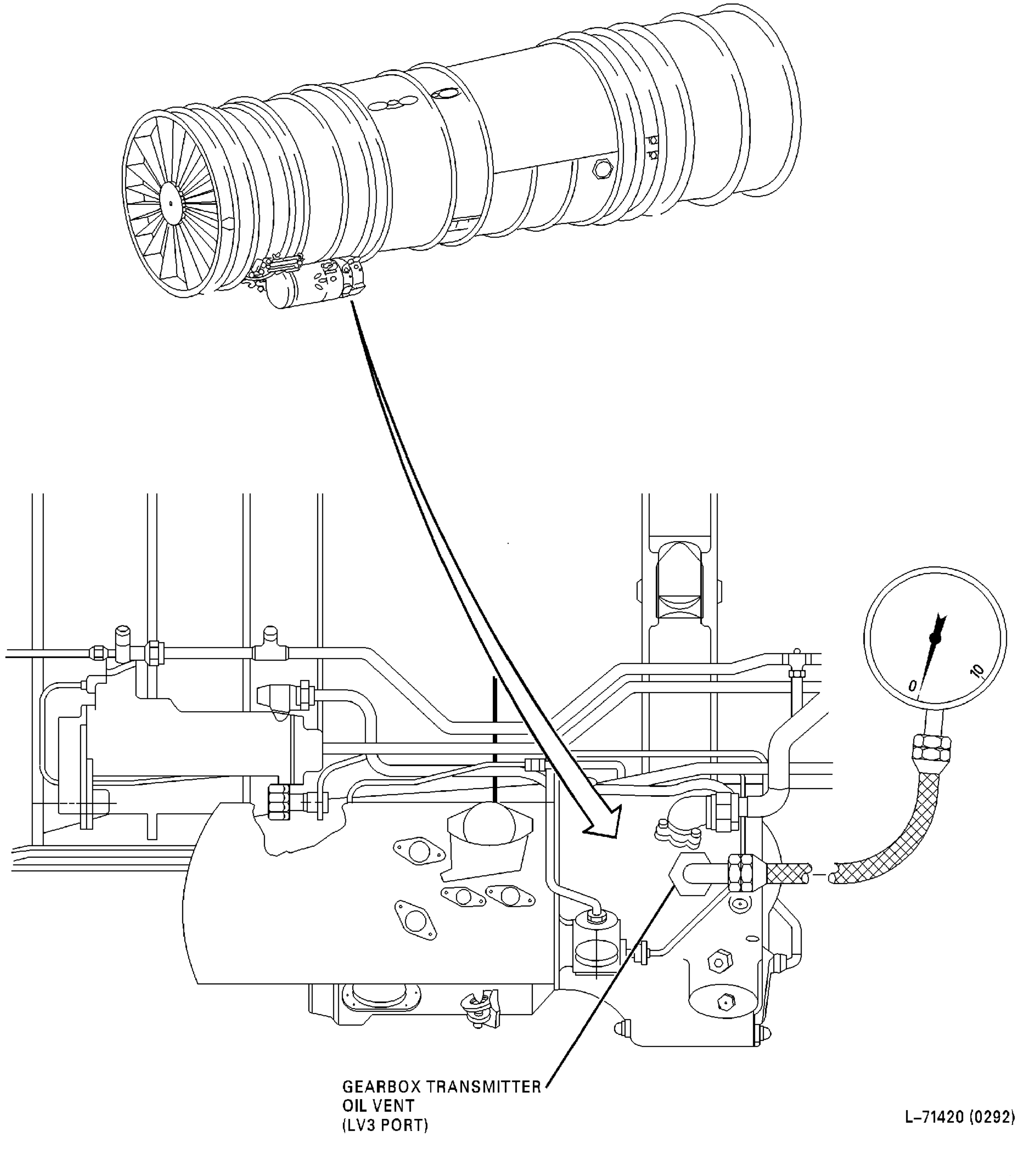
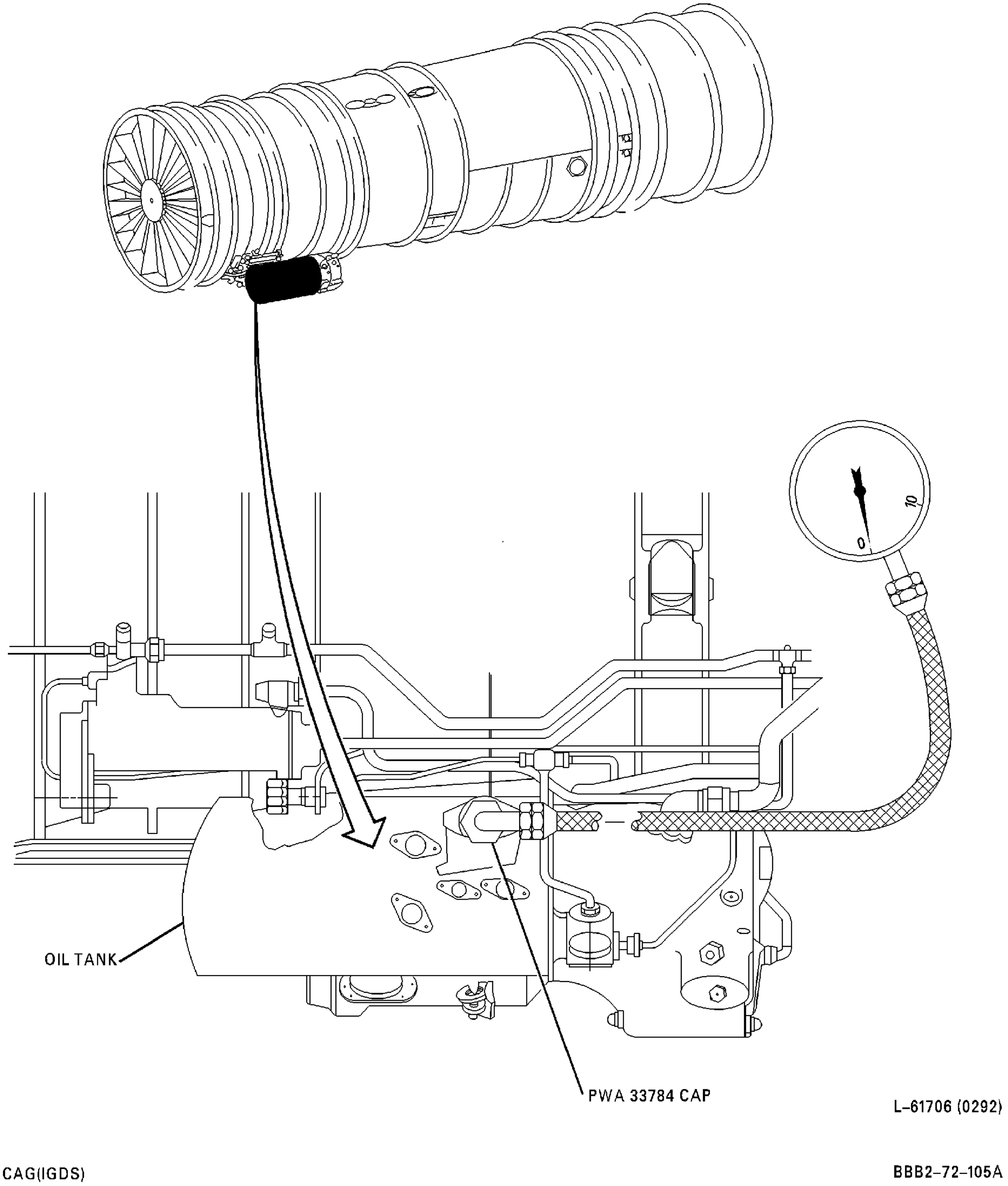
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-938 (Sheet 5 of 5)



Gearbox Housing Breather Pressure Instrumentation
Figure 516/72-00-00-990-939



Oil Tank Breather Pressure Instrumentation
Figure 517/72-00-00-990-940

7. Engine Deterioration Ground Check (For Installations Not Equipped With In-Flight Monitoring)

(Figure 518)

A. Procedure

(1) Prior to each removal for hot section inspection perform following ground check to detect engine deterioration.

(2) The following instrumentation is necessary for ground check:

(a) Absolute pressure gage to indicate 13th stage air pressure (Ps4). Special fitting is provided on right-hand side of engine at upper end of bleed valve actuation pressure supply line near high pressure (diffuser) service bleed point. Calibrated accuracy of gage should be ± 0.5 psi (25.4 mm Hg) absolute in range between 150 and 175 psi (7757 - 9050 mm HG) absolute. Maximum instrument requirement is 250 psi (12929 mm Hg) absolute.

NOTE: This measurement will indicate PS4 only when operating above bleed valve actuation point dictated by pressure ratio bleed control.

(b) Laboratory quality mercury thermometer to indicate ambient temperature.

(c) Local facilities (such as airport control tower) for indicating barometric pressure.

(d) Absolute pressure gage to indicate P_{t7}. Calibrated accuracy of gage should be ± 0.2 psi (10.3 mm Hg) absolute in range between 0 and 50 psi (2586 mm Hg) absolute.

(e) Instrumentation to check P_{t7} and EGT and provide comparison with cockpit instrumentation of EPR (P_{t7}/P_{t2}) and EGT. If cockpit EGT instrumentation and accurate null-balance test instrumentation cannot be read simultaneously, EGT may be measured at stabilized condition with test instrument and then with cockpit instrument circuit under same stabilized conditions. Respective readings should then be compared. As alternate method, cockpit instrument system may be calibrated with standard test equipment designed for this purpose.

(3) Use following test procedure:

(a) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(b) With all nonessential aircraft airbleed and electrical systems shut off, set engine power to EPR (P_{t7}/P_{t2}) of 1.65.

(c) Warm up engine for five minutes and reset power to EPR of 1.65 as required.

(d) Read and record following:

1) P_{t7}
2) EPR (aircraft instrument)
3) Ps4
4) EGT (accurate null-balance instrument)
5) EGT (aircraft instrument)
6) Percent N_1 (aircraft instrument)
7) Percent N_2 (aircraft instrument)
8) Ambient temperature
9) Barometric pressure
10) Fuel Flow

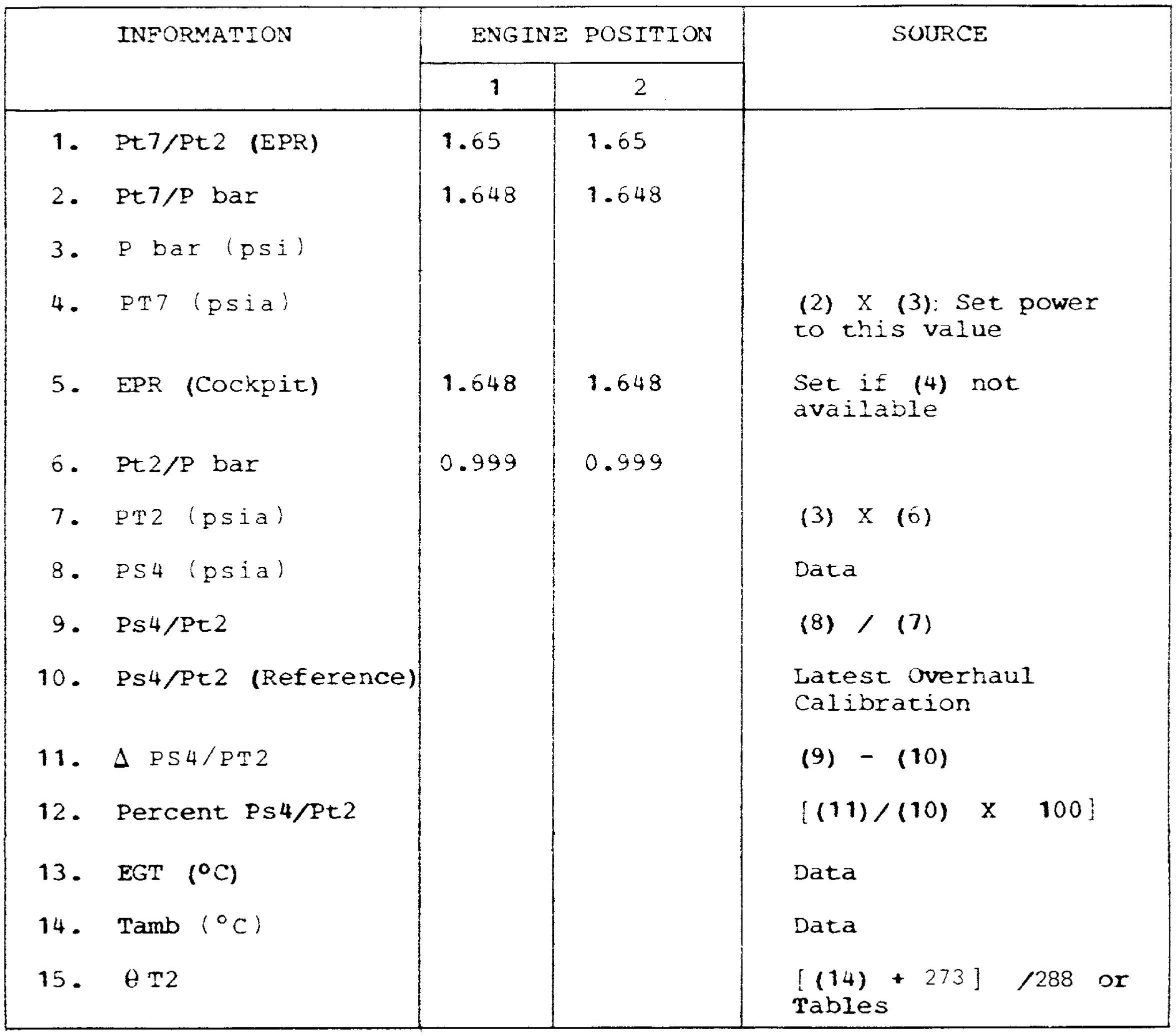
(e) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(f) Use Figure 518, Figure 519 and Figure 520 to process data. Repair consisting of, replacement of 1st stage turbine vanes, combustion chambers, transition ducts, turbine outer air seals, fuel nozzles, etc. may be necessary if test reveals any of following:

1) Reduction of 3.5 percent Ps4/P_{t2} relative to new engine acceptance test, last complete overhaul, or last repair in which 1st stage turbine vane area was rebuilt within engine manual limits.

2) Corrected maximum T_{t7} more than shown in Figure 514.

3) Minus 100 RPM (minus 0.82 percent tachometer) N_2 theta T2 relative to data plate N_2 RPM.



INFORMATION	ENGINE POSITION		SOURCE
	1	2	
1. Pt7/Pt2 (EPR)	1.65	1.65	
2. Pt7/P bar	1.648	1.648	
3. P bar (psi)			
4. PT7 (psia)			(2) X (3): Set power to this value
5. EPR (Cockpit)	1.648	1.648	Set if (4) not available
6. Pt2/P bar	0.999	0.999	
7. PT2 (psia)			(3) X (6)
8. PS4 (psia)			Data
9. Ps4/Pt2			(8) / (7)
10. Ps4/Pt2 (Reference)			Latest Overhaul Calibration
11. Δ PS4/PT2			(9) - (10)
12. Percent Ps4/Pt2			[(11)/(10) X 100]
13. EGT (°C)			Data
14. Tamb (°C)			Data
15. θ T2			[(14) + 273] /288 or Tables

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 518/72-00-00-990-941 (Sheet 1 of 2)

INFORMATION	ENGINE POSITION		SOURCE
	1	2	
15A. $\theta\ T2^{1.019}$			(15) to exponent 1.019 or Figure 505
16. $\sqrt{\theta\ T2}$			$\sqrt{(15)}$ or Fugure 505
17. EGT (°K)			(13) + 273
18. EGT/ $\theta\ T2^{1.019}$ (°K)			(17)/(15A)
19. EGT/ $\theta\ T2^{1.019}$ (°C)			(18) – 273
20. % N2 (Tach.)			Data
21. % N2/ $\sqrt{\theta\ T2}$			(20)/(16)
22. D.P. N2 %			Data Plate
23. % N2/ $\sqrt{\theta\ T2}$ – D.P. N2			(21) – (22)
24. % N1 (Tach.)			Data
25. % N1/ $\sqrt{\theta\ T2}$			(24)/(26)
26. Ref. N1	80.5	80.5	*or latest overhaul calibration
27. % N1/ $\sqrt{\theta\ T2}$ – Ref. N1			(25) – (26)
28. $\delta\ T2$			(7)/14.70 or Figure 516
29. Fuel Flow Wf pph			Data
29A. Kc			Figure 517
30. Wf/Kc X $\delta\ T2$			(29)/[Kc X (28)]
31. Ref. Wf	6980	6980	*or latest overhaul calibration
32. Δ Wf/Kc $\delta\ T2$			(30) – (31)
33. % Wf/Kc $\delta\ T2$			(32)/(31) X 100

*Reference Values given are from O.I. 309 and are good for all new engines. Overhauled engines should use last calibration.

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 518/72-00-00-990-941 (Sheet 2 of 2)

8. Oil Pressure Adjustment

(Figure 521)

NOTE: At ground/descent Idle, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages and does not require adjustment.

A. Engine Preparation

(1) Ensure that engine has been properly serviced and is ready for operation.

(2) Install 0 - 50 PSIG (0.0 - 344.7 kPa) direct reading gage to LP2 tap on main oil pressure manifold and vent to LV3 tap on main accessory gearbox housing.

(3) Start engine and run at IDLE for two to five minutes, to stabilize power level and allow oil temperature to reach 100°F (38°C) minimum.

B. Pressure Relief Valve Adjustment

CAUTION: WHEN REMOVING OUTER PLUG, DO NOT ALLOW INNER PLUG OR VALVE HOUSING TO TURN. LOSS OF OIL AND LOSS OF VALVE SECURITY CAN RESULT FROM LOOSENING OF THESE PARTS.

(1) Hold pressure relief valve inner plug hex firmly with wrench and remove outer plug.

NOTE: Cut lockwire from outer plug only; lockwire from inner plug to valve housing and from valve housing to gearbox should be left intact.

(2) Hold adjusting screw stationary with screwdriver and loosen locknut. If desired, fabricate valve adjusting tool from 7/16 inch deep socket with angled handle welded to side to allow screwdriver to pass through center. Such a tool will allow turning locknut while holding adjusting screw stationary.

(3) Using screwdriver, adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa) with engine at IDLE. Clockwise rotation will increase pressure; counterclockwise rotation will decrease pressure.

NOTE: One full turn of adjusting screw will change pressure approximately two psi (13.8 kPa).

Key To Figure 521	
1.	Pressure Relief Valve
2.	Locknut
3.	Adjusting Screw
4.	Outer Plug
5.	Packing
6.	Inner Plug
7.	Check This Screw Height After Adjustment (See Text).

CAUTION: AFTER OIL PRESSURE ADJUSTMENT IS COMPLETED, CHECK INDEX 7 DIMENSION IN FIGURE. MEASURED VALUE OF 0.280 INCH (7.112 MM) OR LESS IF NOT CONSIDERED NORMAL AND MAY INDICATE REQUIREMENT FOR OIL SYSTEM TROUBLESHOOTING.

(4) Hold adjusting screw steady and torque locknut. See tool description in Paragraph 8.B.(2).

(5) Install outer plug, with new packing, and torque to 150 - 160 in-lb. (16.948 - 18.078 N·m). Lockwire outer plug to inner plug.

RELATIVE PRESSURE

DELTA $(\delta) = \frac{P}{PO} = \frac{P}{29.92}$ INCHES HGA = PSIA (2.036)

P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ
40.0	1.337						
39.9	1.334	32.9	1.100	25.9	0.8656	18.9	0.6317
39.8	1.330	32.8	1.096	25.8	0.8623	18.8	0.6283
39.7	1.327	32.7	1.093	25.7	0.8586	18.7	0.6250
39.6	1.324	32.6	1.090	25.6	0.8556	18.6	0.6216
39.5	1.320	32.5	1.086	25.5	0.8523	18.5	0.6183
39.4	1.317	32.4	1.083	25.4	0.8489	18.4	0.6150
39.3	1.313	32.3	1.080	25.3	0.8456	18.3	0.6116
39.2	1.310	32.2	1.076	25.2	0.8422	18.2	0.6083
39.1	1.307	32.1	1.073	25.1	0.8389	18.1	0.6050
39.0	1.303	32.0	1.070	25.0	0.8356	18.0	0.6016
38.9	1.300	31.9	1.066	24.9	0.8322	17.9	0.5983
38.8	1.297	31.8	1.063	24.8	0.8289	17.8	0.5949
38.7	1.293	31.7	1.059	24.7	0.8255	17.7	0.5916
38.6	1.290	31.6	1.056	24.6	0.8222	17.6	0.5882
38.5	1.287	31.5	1.053	24.5	0.8188	17.5	0.5849
38.4	1.283	31.4	1.049	24.4	0.8155	17.4	0.5815
38.3	1.280	31.3	1.046	24.3	0.8122	17.3	0.5782
38.2	1.277	31.2	1.043	24.2	0.8088	17.2	0.5749
38.1	1.273	31.1	1.039	24.1	0.8055	17.1	0.5715
38.0	1.270	31.0	1.036	24.0	0.8021	17.0	0.5682
37.9	1.267	30.9	1.033	23.9	0.7988	16.9	0.5648
37.8	1.263	30.8	1.029	23.8	0.7954	16.8	0.5615
37.7	1.260	30.7	1.026	23.7	0.7921	16.7	0.5581
37.6	1.257	30.6	1.023	23.6	0.7888	16.6	0.5548
37.5	1.253	30.5	1.019	23.5	0.7854	16.5	0.5515
37.4	1.250	30.4	1.016	23.4	0.7821	16.4	0.5481
37.3	1.247	30.3	1.013	23.3	0.7787	16.3	0.5448
37.2	1.243	30.2	1.009	23.2	0.7754	16.2	0.5414
37.1	1.240	30.1	1.006	23.1	0.7720	16.1	0.5381
37.0	1.237	30.0	1.003	23.0	0.7687	16.0	0.5348
36.9	1.233	29.9	0.9993	22.9	0.7654	15.9	0.5314
36.8	1.230	29.8	0.9960	22.8	0.7620	15.8	0.5281
36.7	1.227	29.7	0.9926	22.7	0.7587	15.7	0.5247
36.6	1.223	29.6	0.9893	22.6	0.7553	15.6	0.5214
36.5	1.220	29.5	0.9859	22.5	0.7520	15.5	0.5180
36.4	1.217	29.4	0.9826	22.4	0.7487	15.4	0.5147
36.3	1.213	29.3	0.9793	22.3	0.7453	15.3	0.5224
36.2	1.210	29.2	0.9759	22.2	0.7420	15.2	0.5080
36.1	1.207	29.1	0.9726	22.1	0.7386	15.1	0.5047
36.0	1.203	29.0	0.9692	22.0	0.7353	15.0	0.5013
35.9	1.200	28.9	0.9659	21.9	0.7319	14.9	0.4980
35.8	1.196	28.8	0.9626	21.8	0.7286	14.8	0.4946
35.7	1.193	28.7	0.9592	21.7	0.7253	14.7	0.4913
35.6	1.190	28.6	0.9559	21.6	0.7219	14.6	0.4880
35.5	1.186	28.5	0.9525	21.5	0.7186	14.5	0.4846
35.4	1.183	28.4	0.9492	21.4	0.7152	14.4	0.4813
35.3	1.180	28.3	0.9458	21.3	0.7119	14.3	0.4779
35.2	1.176	28.2	0.9425	21.2	0.7085	14.2	0.4746
35.1	1.173	28.1	0.9392	21.1	0.7052	14.1	0.4713
35.0	1.170	28.0	0.9358	21.0	0.7019	14.0	0.4679
34.9	1.166	27.9	0.9325	20.9	0.6985	13.9	0.4646
34.8	1.163	27.8	0.9291	20.8	0.6952	13.8	0.4612
34.7	1.160	27.7	0.9258	20.7	0.6918	13.7	0.4579
34.6	1.156	27.6	0.9224	20.6	0.6885	13.6	0.4545
34.5	1.153	27.5	0.9191	20.5	0.6852	13.5	0.4512
34.4	1.150	27.4	0.9158	20.4	0.6818	13.4	0.4479
34.3	1.146	27.3	0.9124	20.3	0.6785	13.3	0.4445
34.2	1.143	27.2	0.9091	20.2	0.6751	13.2	0.4412
34.1	1.140	27.1	0.9057	20.1	0.6718	13.1	0.4378
34.0	1.136	27.0	0.9024	20.0	0.6684	13.0	0.4345
33.9	1.133	26.9	0.8990	19.9	0.6651	12.9	0.4311
33.8	1.130	26.8	0.8957	19.8	0.6618	12.8	0.4278
33.7	1.126	26.7	0.8924	19.7	0.6584	12.7	0.4245
33.6	1.123	26.6	0.8890	19.6	0.6551	12.6	0.4211
33.5	1.120	26.5	0.8857	19.5	0.6517	12.5	0.4178
33.4	1.116	26.4	0.8823	19.4	0.6484	12.4	0.4144
33.3	1.113	26.3	0.8790	19.3	0.6450	12.3	0.4111
33.2	1.110	26.2	0.8757	19.2	0.6417	12.2	0.4077
33.1	1.106	26.1	0.8723	19.1	0.6384	12.1	0.4044
33.0	1.103	26.0	0.8690	19.0	0.6350	12.0	0.4011

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Relative Pressure
Figure 519/72-00-00-990-942

TEMPERATURE CORRECTION FOR FUEL FLOW

Tt2			Tt2			Tt2		
°C	°F	Kc	°C	°F	Kc	°C	°F	Kc
–40	–40.0	0.8798	–6	21.2	0.9542	28	82.4	1.0286
–39	–38.2	0.8820	–5	23.0	0.9564	29	84.2	1.0308
–38	–36.4	0.8842	–4	24.8	0.9585	30	86.0	1.0329
–37	–34.6	0.8863	–3	26.6	0.9607	31	87.8	1.0351
–36	–32.8	0.8885	–2	28.4	0.9629	32	89.6	1.0373
–35	–31.0	0.8907	–1	30.2	0.9651	33	91.4	1.0395
–34	–29.2	0.8929	0	32.0	0.9673	34	93.2	1.0417
–33	–27.4	0.8951	1	33.8	0.9695	35	95.0	1.0439
–32	–25.6	0.8973	2	35.6	0.9717	36	96.8	1.0461
–31	–23.8	0.8995	3	37.4	0.9739	37	98.6	1.0483
–30	–22.0	0.9017	4	39.2	0.9761	38	100.4	1.0504
–29	–20.2	0.9038	5	41.0	0.9782	39	102.2	1.0526
–28	–18.4	0.9060	6	42.8	0.9804	40	104.0	1.0548
–27	–16.6	0.9082	7	44.6	0.9826	41	105.8	1.0570
–26	–14.8	0.9104	8	46.4	0.9848	42	107.6	1.0592
–25	–13.0	0.9126	9	48.2	0.9870	43	109.4	1.0614
–24	–11.2	0.9148	10	50.0	0.9892	44	111.2	1.0636
–23	– 9.4	0.9170	11	51.8	0.9914	45	113.0	1.0658
–22	– 7.6	0.9192	12	53.6	0.9936	46	114.8	1.0679
–21	– 5.8	0.9214	13	55.4	0.9957	47	116.6	1.0701
–20	– 4.0	0.9235	14	57.2	0.9979	48	118.4	1.0723
–19	– 2.2	0.9257	15	59.0	1.0001	49	120.2	1.0745
–18	– 0.4	0.9279	16	60.8	1.0023	50	122.0	1.0767
–17	1.4	0.9301	17	62.6	1.0045	51	123.8	1.0789
–16	3.2	0.9323	18	64.4	1.0067	52	125.6	1.0811
–15	5.0	0.9345	19	66.2	1.0089	53	127.4	1.0833
–14	6.8	0.9367	20	68.0	1.0111	54	129.2	1.0855
–13	8.6	0.9389	21	69.8	1.0132	55	131.0	1.0876
–12	10.4	0.9410	22	71.6	1.0154	56	132.8	1.0898
–11	12.2	0.9432	23	73.4	1.0176	57	134.6	1.0920
–10	14.0	0.9454	24	75.2	1.0198	58	136.4	1.0942
–9	15.8	0.9476	25	77.0	1.0220	59	138.2	1.0964
–8	17.6	0.9498	26	78.8	1.0242	60	140.0	1.0986
–7	19.4	0.9520	27	80.6	1.0264			

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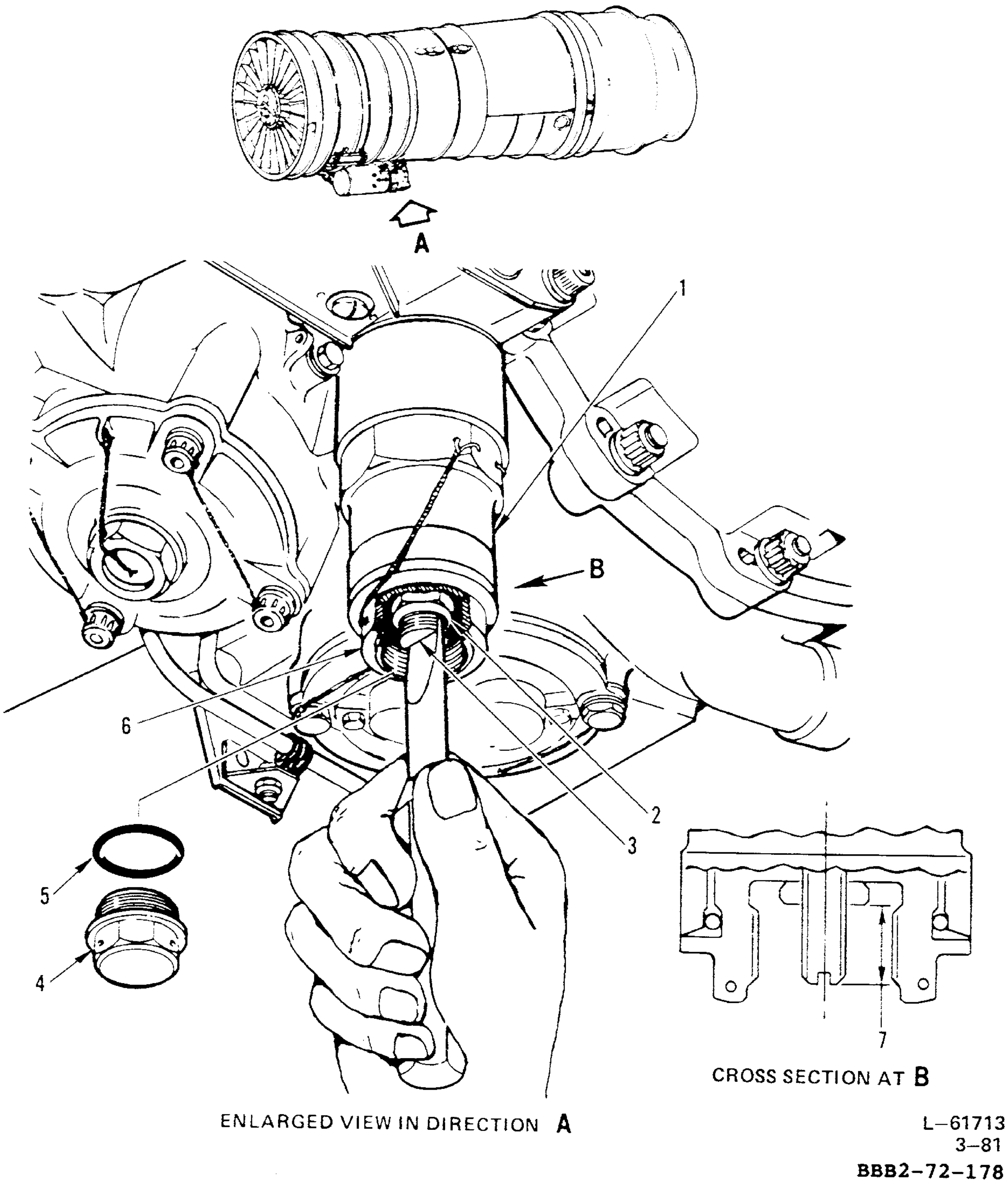
Temperature Correction For Fuel Flow
Figure 520/72-00-00-990-943



Oil Pressure Adjustment
Figure 521/72-00-00-990-945

9. Trim Balance Of Engine Installed In Aircraft

A. On-Wing Trim Balancing - General

CAUTION: APPLICATION OF TRIM BALANCING MUST MEET FOLLOWING PREREQUISITES: TRIM BALANCE IS TO BE USED ONLY ON NEW AND OVERHAULED ENGINES AND ON THOSE REPAIR ENGINES (HEAVY MAINTENANCE) WHICH HAVE HAD LOW COMPRESSOR AND LOW TURBINE ROTORS DISASSEMBLED, INSPECTED, AND REASSEMBLED ACROSS BALANCE MACHINE, EXCEPT AS NOTED BELOW. THOSE ENGINES WITH EXCESSIVE HIGH ROTOR VIBRATION OR LOW ROTOR VIBRATION WHICH EXCEED LIMITS AS SPECIFIED IN PROCEDURE MAY NOT BE TRIM BALANCED.

(1) Engine whose rotating parts are balanced will normally have some residual unbalance which will result in detectable vibration at engine operating condition. This vibration may be minimized by trim balancing, which entails addition of weight positioned to offset residual unbalance in compressor front balance plane and turbine rear balance plane.

NOTE: (Heavy Maintenance) repair engines which do not exceed normal acceptable vibration limits may be trim balanced to lower amplitude, if desired.

B. Equipment For Trim Balance

(1) Vibration Pickups: Phased velocity type, CEC 4-123A or equivalent.

(2) Speed Signal: An exact one-pulse-per revolution is required as the reference signal. Special tachometer and adapter with ratio of 24 to 47 must be mounted in place of any other tachometer or adapter on N_1 tachometer pad. Index rotor by aligning single tooth of tachometer with tip of impulse pickup. Small hole in fact of tachometer is provided for this purpose. In order to reindex rotor after running without having to make above observation, make mark with layout dye on blade and engine case.

Tach. Adapter: Model B1692-2, Ratio 24/47 (Exact)

Vendor: The Electric Tachometer Corporation 68th & Upland Streets Philadelphia, PA 19142, U.S.A.

Pulse Generator: Model HB 163212, one triangular tooth, 0.062 inch (1.588 mm) flat

Vendor: H And B Tool And Engineering Co., 481 Sullivan Ave., South Windsor, CT 06074, U.S.A.

(3) Trim Balance Analyzer: Spectral Dynamics Model SD-119-B, or equivalent.

(a) With vibration data signal (from a velocity, acceleration or non-contacting displacement pickup) and one-pulse-per-revolution reference signal, analyzer provides the following information needed for balancing an engine:

1) Amplitude of vibration

2) Phase angle between reference point and point of maximum unbalance, i.e., location of unbalance.

3) Speed in RPM of engine (N_1).

(b) To provide these operating parameters, balance analyzer accepts signal from vibration pickup and passes it through integrator for conversion to displacement signal. For signal from a displacement pickup or accelerometer, integrator is bypassed.

(c) Displacement signal is then passed through dynamic tracking filter, which is tuned by one-per-revolution signal from tachometer mounted on engine. Pulse-to-sinewave converter uses tachometer signal to provide necessary sinewave for track filter. Converter is phase-locked to tachometer signal for absolute tuning of tracking filter and absolute phase (i.e., balance location) reference. Because it is frequency tuned by speed signal, tracking filter eliminates all frequency signals other than rotor fundamental. Output of tracking filter is displayed as displacement.

(d) Difference in angular degrees between vibration signal (at one-per-revolution tuning frequency) and one-per-revolution reference frequency derived from tachometer through converter is measured by phase meter. Output of phase meter is displayed as phase. Output of pulse-to-sinewave converter is multiplied by 60 factor and displayed as speed in RPM.

C. Setup Of Equipment

(Figure 522)

(1) Install vibration pickups. (Figure 512)

(2) Check vibration pickups to ensure that they are in phase (positive outward displacement gives positive voltage output).

(3) Install special tachometer adapter and reference signal generator in place of engine adapter (if any) and N_1 tachometer.

(4) With generator in "firing position", reference front compressor (low) rotor to engine case using layout dye.

NOTE: Turn rotor in direction of engine rotation to take up backlash of tachometer drive, that is, clockwise (counterclockwise facing engine fan inlet case).

(5) Set up and operate balance analyzer per manufacturer's instructions.

D. Trim Balance Procedures

(Figure 523), (Figure 524), (Figure 525), (Figure 526)

(1) The following procedure establishes a uniform method of approaching trim balance. Phase angle lag and sensitivity data must be determined as a result of trim balance experience. No data is currently available.

(a) Definition of Terms

1) 1EL - The low speed rotor fundamental vibration amplitude.

2) 1EH - The high speed rotor fundamental vibration amplitude.

3) Cw - Calibration weight (serially numbered Cw1, Cw2, etc.) of stainless steel wire used to balance engine. Replaced by equivalent PN balance weight after trim balance.

4) Class - Category into which engine is placed based on prebalance vibration survey. (No data is currently available.)

5) Phase Angle - Phase meter reading. Phase angle by which integrated vibration signal lags reference signal.

6) Phase Angle Lag - Calculated angle indicating lag between passing of unbalance weight and response signal.

7) Assumed Phase Angle Lag - Weighted average of phase angle lags determined from previous balance attempts. Also, correction angle used in "one-shot" method.

8) VD - Vector difference from Point A to Point C.

(b) Trim Balance Sequence

1) Conduct prebalance vibration survey to determine suitability of engine for trim balance and to provide basis for classification.
2) Run "As Is" speed points as prescribed for class engine being balanced.
3) Run "As Is" data, plot A vector on polar paper, angle being laid out counter to engine rotation from 12 o'clock location. Draw R vector equal and opposite A vector. (Figure 523)
4) Apply assumed phase angle lag given for class to which engine has been assigned. Assumed phase angle lag is laid off from R in direction of rotation and indicates angular location of Cw1.
5) Apply assumed sensitivity given in respective trim balance procedures assigned engine class. Multiply amplitude of vector A and sensitivity value to give oz-in required for Cw1.
6) Install Cw1 which may be either stainless steel wire or permanent weight as described previously. See Figure 522 or Figure 525 for computation of wire necessary to correct imbalance. Wire weight is installed on nearest blade to location to that designated by steps outlined in Paragraph 9.D.(1)(b)4) above.
7) Rerun engine as in Paragraph 9.D.(1)(b)2) above repeating each speed point within ± 0.2 rev/sec on counter at time base of 10 sec. Record all data.
8) In conjunction with Paragraph 9. above observe O/A (overall) mils vibration throughout engine speed range to determine if all vibration is within acceptance limits.
9) If engine is acceptable, replace wire trial weight with equivalent weight in 1st stage compressor hub, when applicable. No changes are required if no wire weight was used.
10) If engine is unacceptable, calculate and apply Cw2 as described in specific counterweight installation procedure. All weight runs (Cw1, Cw2 ... Cwn) are calculated with respect to "As Is" data.
11) Continue to trim balance engine as required.
12) Complete trim balance report, shown in Figure 526, and file report with engine records.

(2) Hypothetical Example of Vector Balance Method

(a) Assume:

Vibration survey has shown need to trim balance (± 2.0 mils) (0.05 mm) at 6000 N_1. Engine is classified as "Class X." (Acceptance limits ± 1 mil) (0.03 mm). Procedure calls for a compressor trim at 6000 N_1 RPM, assumed phase angle lag of 130 degrees and sensitivity of 1.0 oz-in/mil (720 g.mm/0.03 mm).

(b) Record inlet pickup phase angle and amplitude at 6000 N_1 RPM. In this example let ± 2.0 mil (0.05 mm) at 300 degrees be the recorded data for run No. 1.

(c) Plot vector A (± 2.0 mil) (0.05 mm) at 300 degrees on polar paper. Lay out angle counter to engine rotation from 12 o'clock location. Draw vector R equal and opposite vector A. (See plot on Figure 523).

(d) Apply assumed phase angle lag (130 degrees) laying it off from R in direction of rotation. This indicates that Cw1 should be applied at 350 degrees as measured from 12 o'clock reference location counter to engine rotation.

(e) Apply assumed sensitivity. Multiple amplitude of A vector (± 2.0 mil) (0.05 mm) by assumed sensitivity (1.0 oz-in/mil) (720 g.mm/0.03 mm). Magnitude of Cw1 should be 2 oz-in (1440 g.mm).

(f) Install Cw1. Wire weight may be installed on nearest blade to 350 degrees. In this example let blade No. 2, shown on plot, be chosen (349 degrees).

(g) Rerun balance point and record phase angle and amplitude resulting from addition of Cw1. Run No. 2.

(h) In conjunction with previous Paragraph 9.D.(2)(g), observe O/A mils throughout engine speed range to determine if all vibration is within acceptance limits.

(i) Let data from Run No. 2 be ± 1.3 mils (0.03 mm) at 20 degrees. Plot data as vector C on polar paper. Lay out angle counter to engine rotation from 12 o'clock location.

(j) Plot Vector Difference (VD) by subtracting vector A from vector C. Draw VD from A to C, arrow pointing to C. Translate VD vector to origin of diagram. In this example VD is ± 2.2 mils (0.06 mm) at 84 degrees. VD represents effect of Cw1 alone, both in magnitude and direction. To eliminate unbalance (A vector), VD must bed rotated and adjusted in length to coincide with R vector.

(k) Calculate location and size of required balance weight, Cw2.

1) Size of correction weight = size of trial

$$\text{weight} \quad \times \quad \frac{\text{A mils}}{\text{VD mils}}$$

$$\text{Cw2} = 2 \quad \times \quad \frac{2}{2.2} = 1.82 \text{ oz-in.}$$

2) Location of correction weight: In this example, angular amount between VD (84 degrees) and R (120 degrees) is 36 degrees counter to engine rotation. Remove Cw1, move from its location 36 degrees counter to engine rotation to 25 degrees. Apply Cw2 (1.82 oz-in.) (1310 g.mm) at 25 degree (blade No. 32). This should cause VD to coincide with R.

(l) Above procedure can be repeated using second correction weight as new calibration weight. Data from new weight and "As-Is" data can be used to calculate third correction weight and thereby refine balance.

(m) Determine phase angle lag and vibration sensitivity. (Although not required for any specific engine balance, average values calculated from several engine balances are considered valuable guide for follow-on balance jobs).

1) Phase Angle Lag: Unbalance vectors are measured in terms of amplitude and phase angle (phase meter reading) and are plotted referenced to 12 o'clock location in direction counter to rotation to indicate "lag". Normal plotting procedure locates reference point at top of engine vertical centerline designated as 12 o'clock. this point is shown on the plot as 0 degrees.

Balance weights are located on rotor after rotor has been turned (indexed) to locate pulse generator tooth directly under pulse pickup. Angular location of the weight is then measured in direction counter to rotation referenced to 12 o'clock.

To determine phase angle lag, unbalance vectors and weight locations must be given common frame of reference. Angular location corresponding to 12 o'clock is taken as common reference point. Phase angle lag is angle by which response (VD) lags calibration weight. Graphically, it is angle from calibration weight to VD measured counter to engine rotation. In this example, phase lag is 96 degrees.

2) Sensitivity: Sensitivity can be calculated at any given speed point by dividing weight amplitude (Cw1 = 2.0 oz-in.) (1440 g.mm) by measured response (VD - ± 2.2 mils) (0.06 mm). In this example calculated sensitivity is 0.91 oz-in. per mil (655 g.mm per 0.03 mm).

(n) The purpose of calculating phase angle lag and sensitivity is to provide information to assist in future balances. Weighted average of these data for number of balances provide assumed phase angle lag and assumed sensitivity which, when applied to "As Is" data, established "one shot" balance method. In this example let assumed phase angle lag equal 95 degrees. After plotting information described in Paragraph 9.D.(2)(a) the 95 degree angle is now laid out from R vector in direction of engine rotation and establishes Cw1 location. Amount of weight required is established by multiplying A vector amplitude (+ mils) (+ mm) by sensitivity (oz-in./mil) (g.mm/mm) which, for this example, gives 1.82 oz-in. (1310 g.mm) required. It can now be seen that engine would be balanced by this Cw1 and no further runs are necessary.

E. Trim Balance Limits And Procedures

(1) Trim Balance Limits

(a) Engines that experience vibration at N_1 rotational frequency at inlet case and/or exhaust duct up to and including 0.002 inch single amplitude may be trim balanced to bring them within acceptable limits.

(b) Maximum correction (all trim weights) for trim balance of the front compressor at the front plane must be a vector sum of no more than 7.0 oz-in. (5040. g.mm). The total number of trim weights used on the inner balance rib of the front hub must not be more than five.

(c) Maximum correction (all trim weights) for trim balancing front compressor drive turbine at rear plane shall not exceed total vector sum of 10.5 oz-in. when combined with weights previously installed while balancing turbine rotor. Previously installed weights may be moved or replaced, but total number of weights used on turbine rotor assembly shall not exceed five and total vector sum shall not exceed 10.5 oz-in. (7560 g.mm).

(d) After completing installation of final trim balance weights, conduct vibration survey to ensure that vibration levels are within acceptance limits.

(2) Trim Balance Weight Installation

(a) Front Plane

1) Remove front accessory drive group. (PAGEBLOCK 72-21-00/401)

2) Remove retaining ring holding front accessory drive gearshaft in front hub. Engage PWA 45009 Puller behind gearshaft gearteeth and remove gearshaft carefully with knocker action.

3) Find the applicable counterweight (0 - 5) as shown in Figure 527.

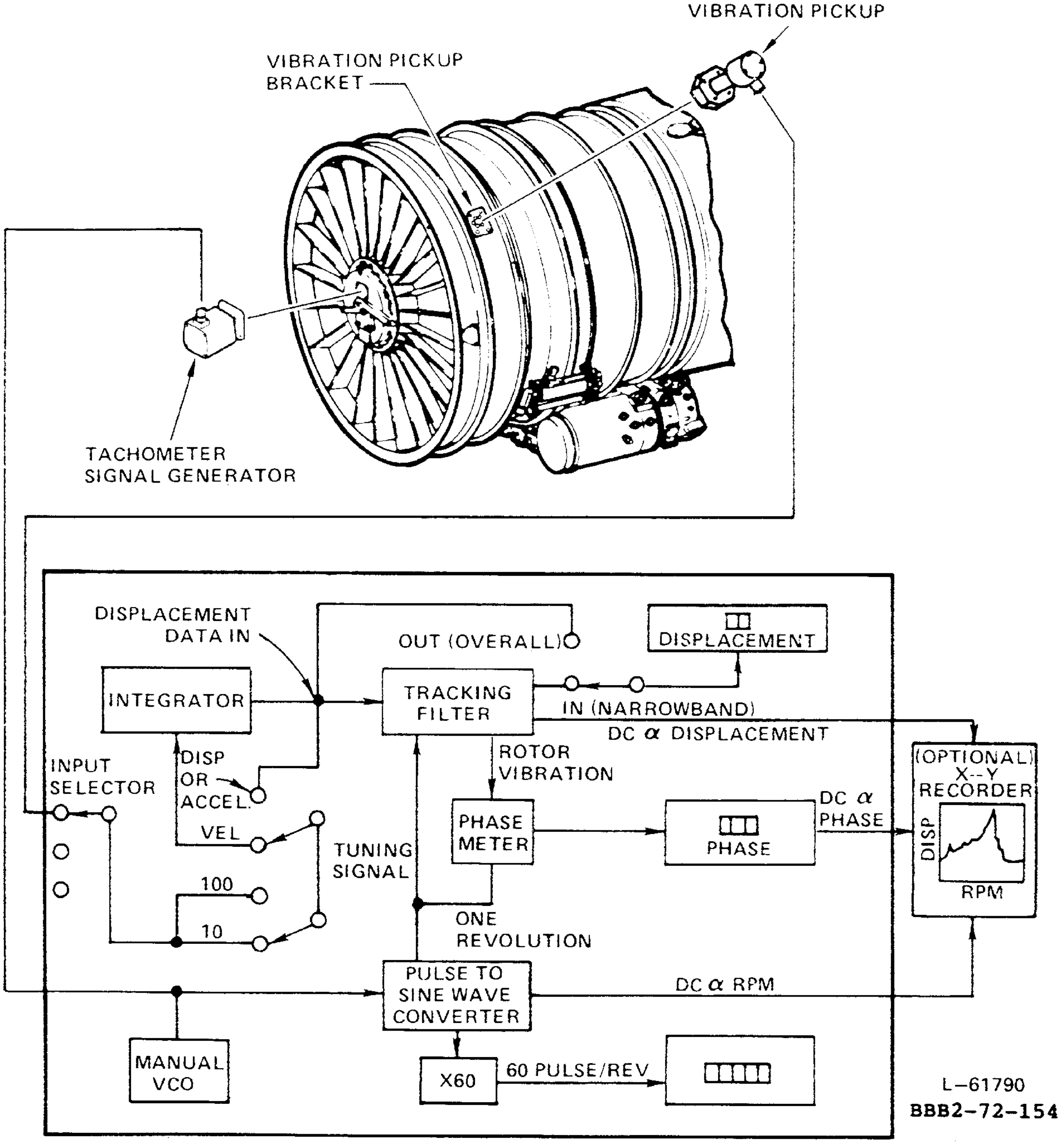
4) Install counterweight inside front hub on balancing rib as close to required angular location as possible. Compress counterweight shank against spring pressure and release shank when weight straddles balancing rib and hook section of shank is in line with hole in rib. Figure 527

5) Install a packing, lubricated with PWA 36500 Assembly Fluid, on the front accessory drive gearshaft and install the shaft on the front hub. Hold the gearshaft in position with a retaining ring.

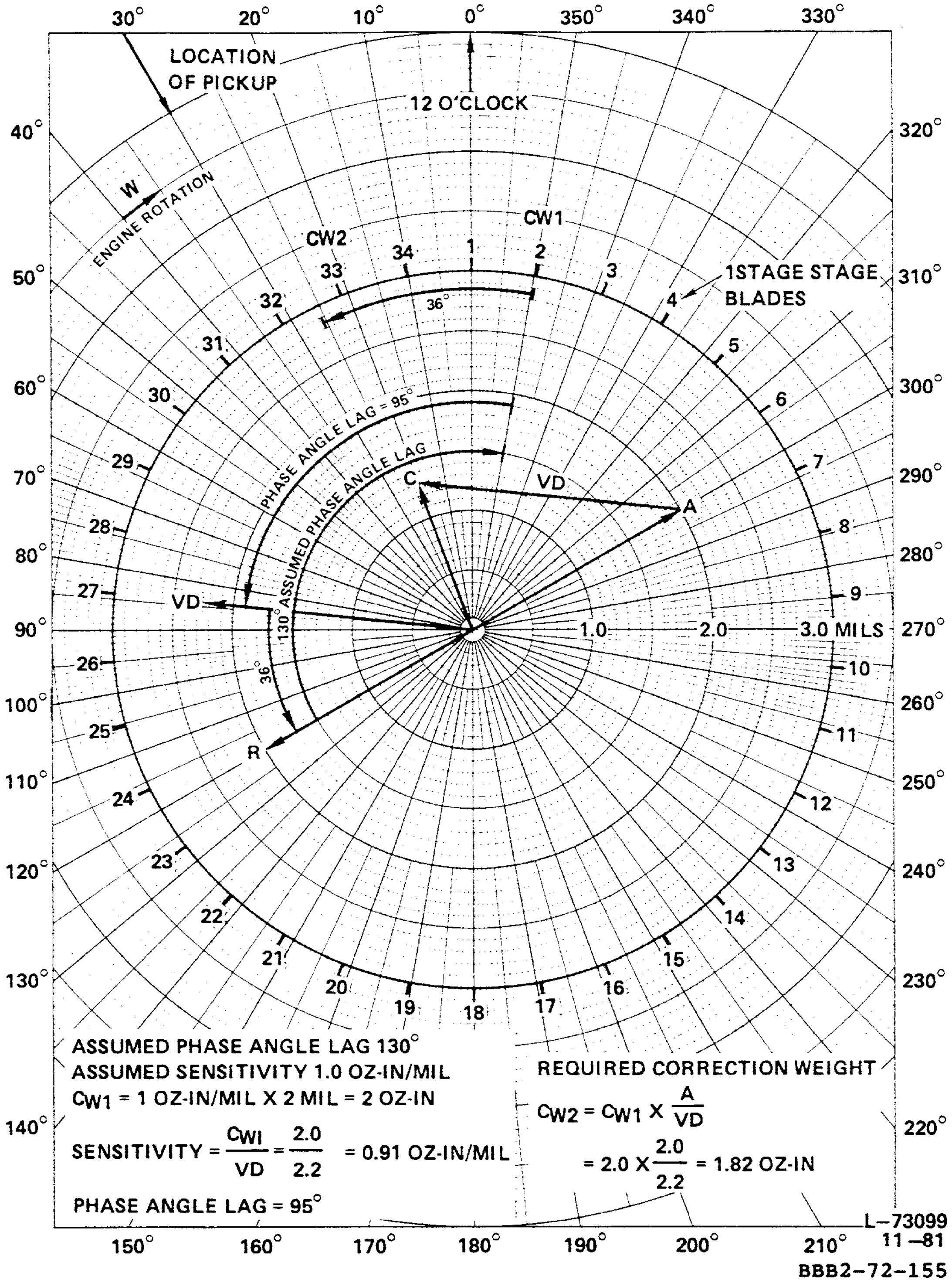
6) Install front accessory group. (PAGEBLOCK 72-21-00/401)

(b) Rear Plane

1) Remove the fan and turbine exhaust duct (mixer) for access to the rear of the turbine.
2) Add counterweights (or remove and replace counterweights found on the rear of the 4th stage turbine disk). Refer to the limits in Paragraph 9.E.(1). (Figure 528)
3) Attach counterweights with rivets (rivet heads pointed to the disk surface). Flare the rivet ends to 0.125 inch (3.175 mm) diameter minimum (PWA 46320 Riveter is available to do this).
4) Install the fan and turbine exhaust duct (mixer).



Instrumentation Block
Figure 522/72-00-00-990-944



ASSUMED PHASE ANGLE LAG 130°
ASSUMED SENSITIVITY 1.0 OZ-IN/MIL
C_{W1} = 1 OZ-IN/MIL X 2 MIL = 2 OZ-IN

$$\text{SENSITIVITY} = \frac{C_{WI}}{VD} = \frac{2.0}{2.2} = 0.91 \text{ OZ-IN/MIL}$$

PHASE ANGLE LAG = 95°

REQUIRED CORRECTION WEIGHT

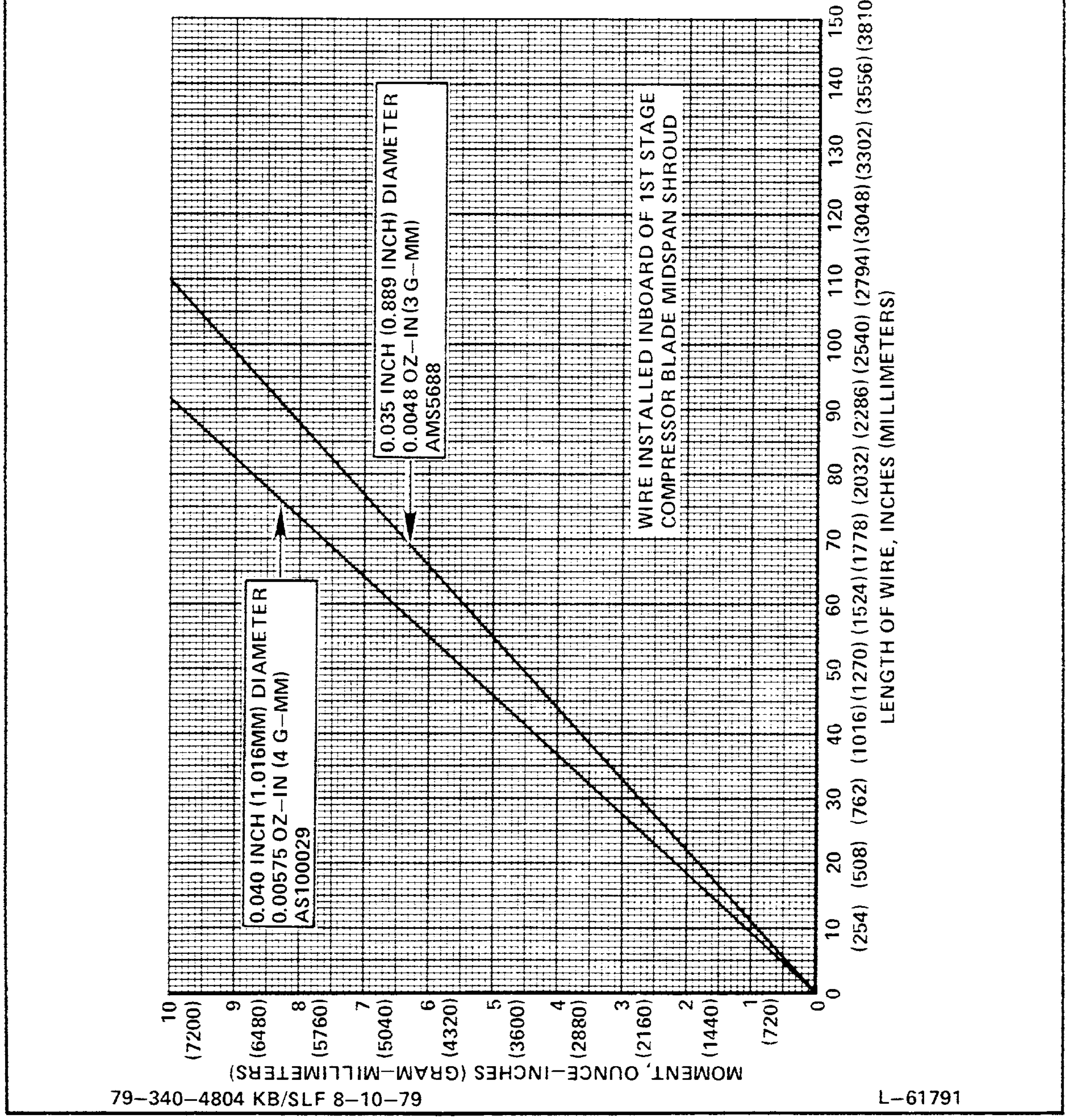
$$C_{W2} = C_{W1} \times \frac{A}{VD}$$

$$= 2.0 \times \frac{2.0}{2.2} = 1.82 \text{ OZ-IN}$$

Trim Balance Calculation Diagram
Figure 523/72-00-00-990-946

FIRST STAGE COMPRESSOR

OUNCE–INCH MOMENT VS LENGTH OF WIRE



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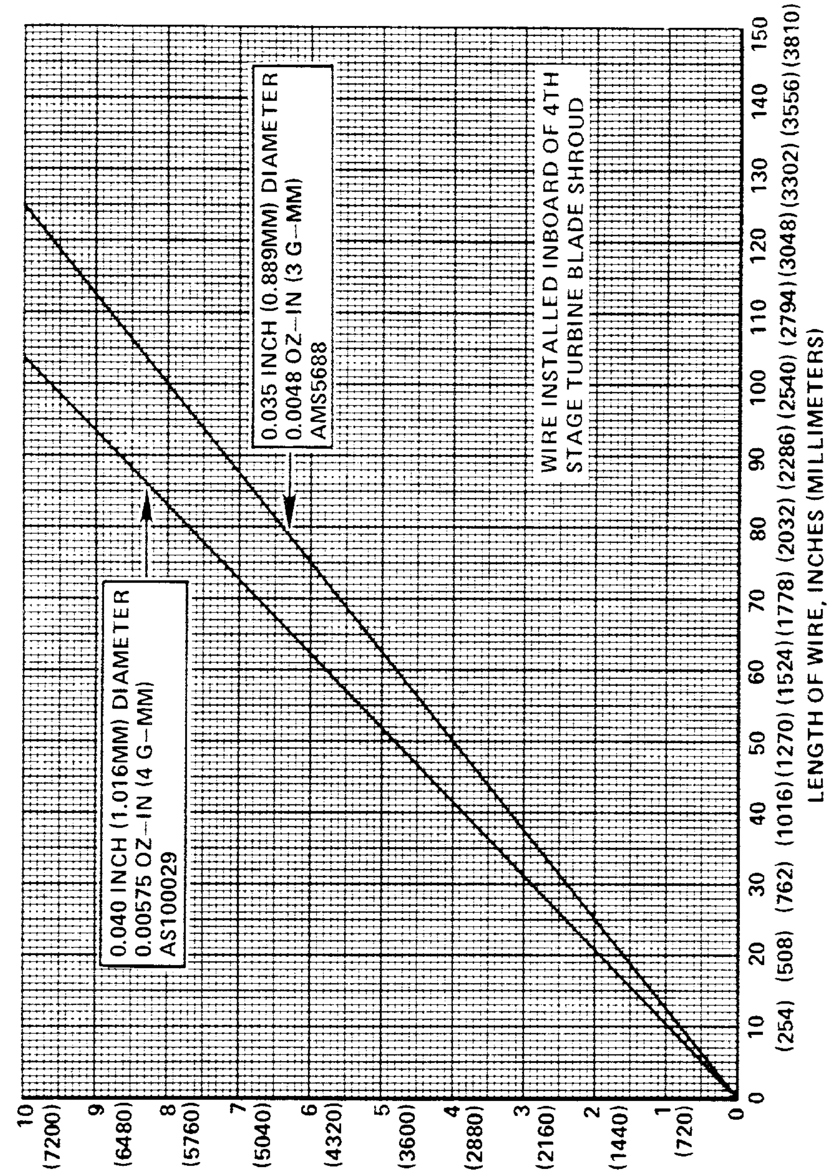
Ounce-Inch Moment Vs. Length Of Wire (First Stage Compressor)
Figure 524/72-00-00-990-947

FOURTH STAGE TURBINE

OUNCE–INCH MOMENT VS LENGTH OF WIRE



79–340–4804 KB/SLF 8–10–79

L–61792

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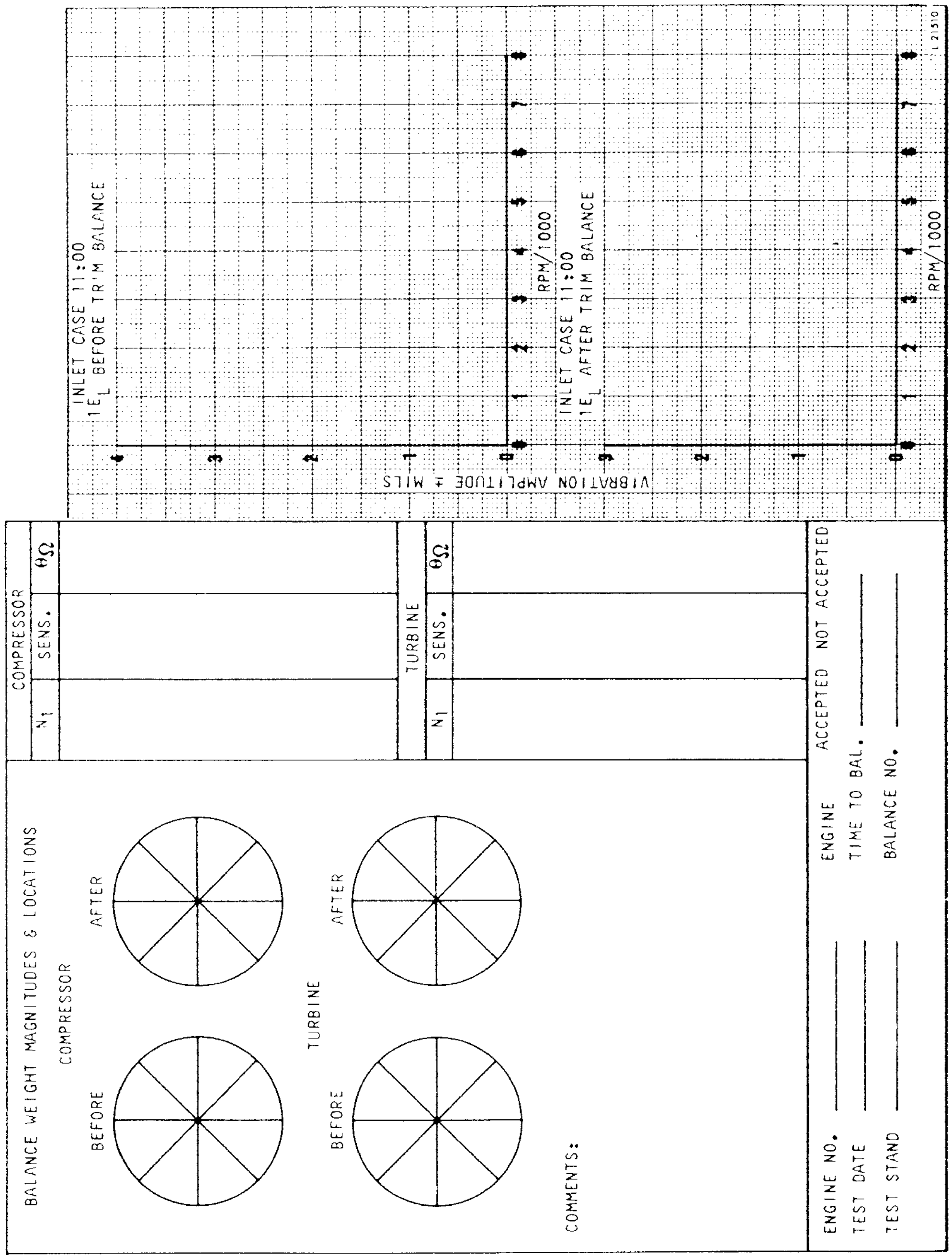
Ounce-Inch Moment Vs. Length of Wire (Fourth Stage Turbine)
Figure 525/72-00-00-990-948



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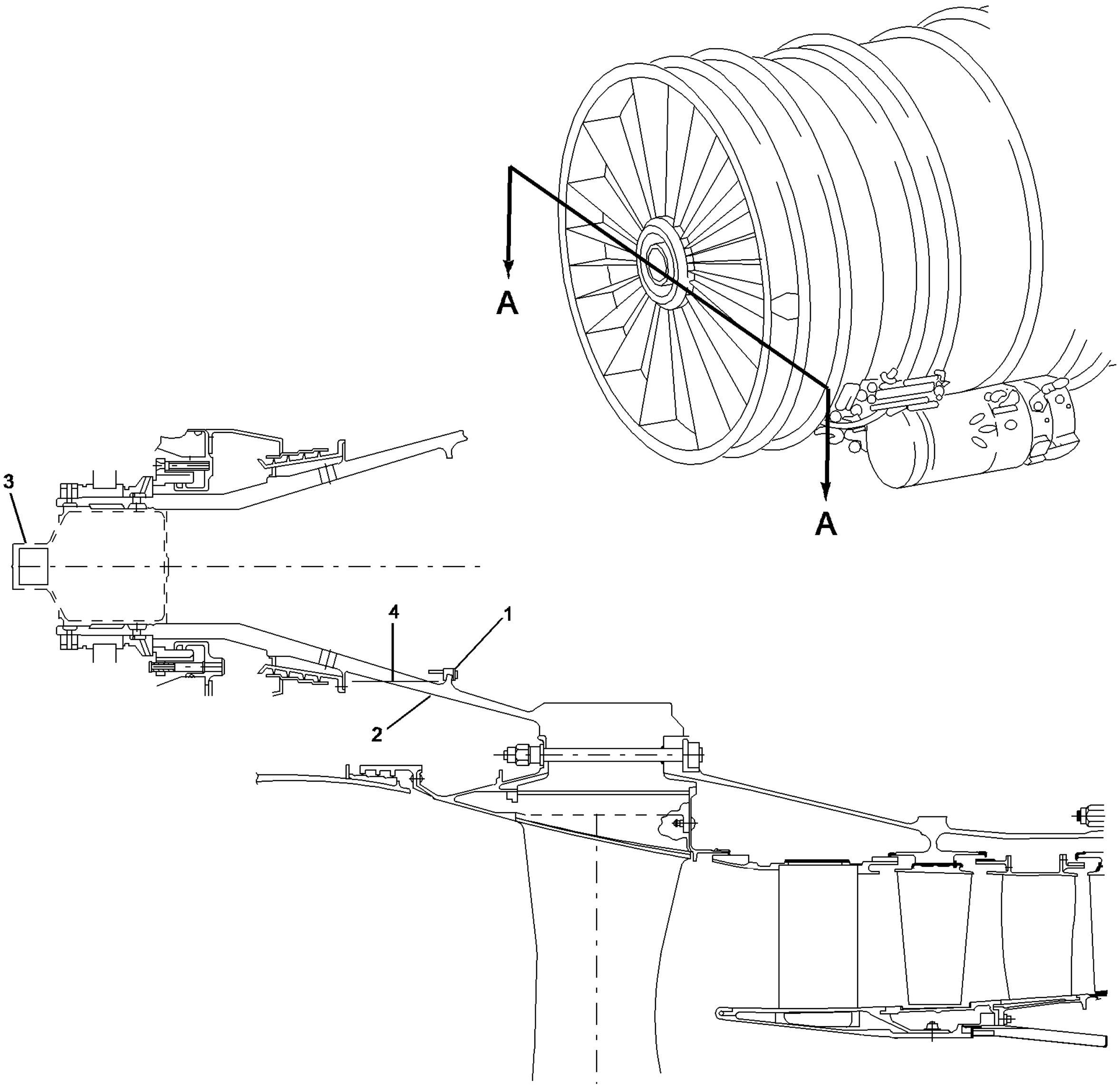
Trim Balance Report
Figure 526/72-00-00-990-949



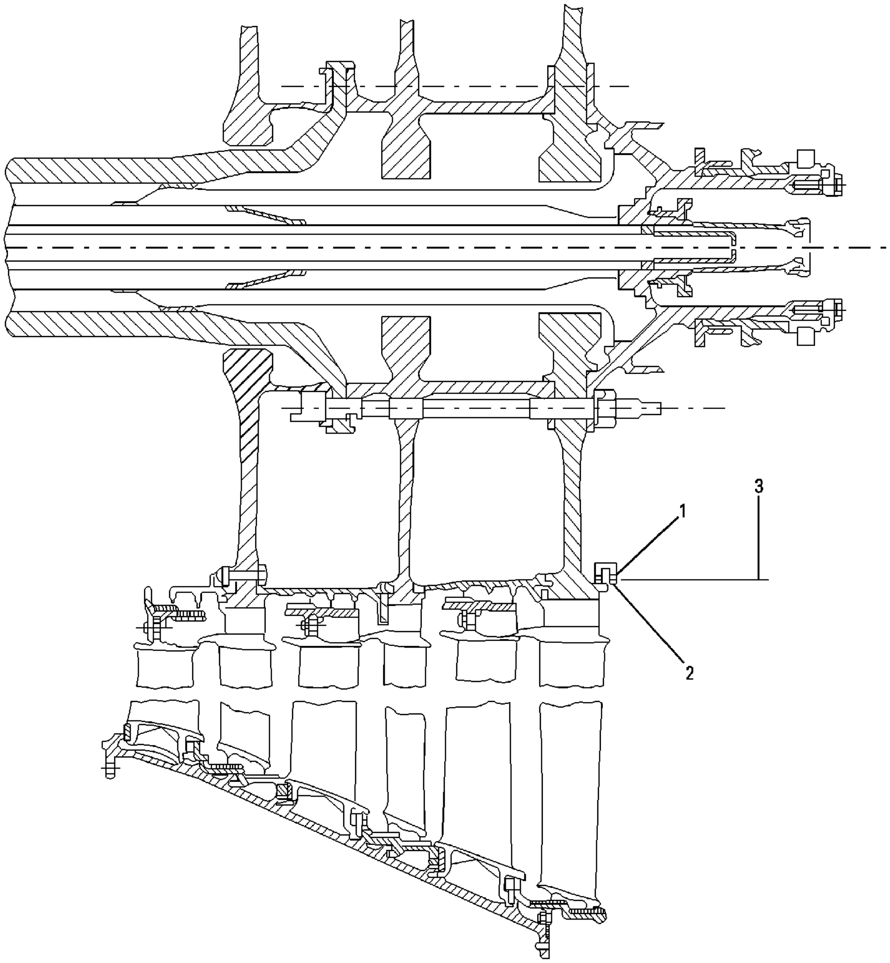
SECTION A-A

LEGEND:
1. COUNTERWEIGHT PN 658339, 658341 (CLASS 1 OR 2) OR 761787, 0 - 5 AS REQUIRED
2. FRONT COMPRESSOR FRONT HUB
3. GEARSHAFT (REMOVED FOR ACCESS)
4. 4.000 in. (101.600 mm) BALANCING RADIUS (REFERENCE)

L-83887

BBB2-72-159A
S0006554749V2

Front Compressor Trim Balancing
Figure 527/72-00-00-990-950



1. PN 534492, 584943, OR 584994 COUNTERWEIGHTS. SELECT CLASS AS NECESSARY AND INSTALL, REMOVE, OR REPLACE BY THE LIMITS IN THE TEXT. IT IS PERMITTED TO INSTALL PN 534492 EITHER SIDE OF THE DISK FLANGE.
2. RIVET (PN 4028248) (USE WITH PN 584943 OR 584944).
3. 7.715 INCHES (195.961 MM) BALANCE RADIUS (REFERENCE)

L-84125

CAG(IGDS)

BBB2-72-518

Rear Turbine Trim Balance
Figure 528/72-00-00-990-951

10. Fuel Control Starting Schedule Adjustment

A. General

(1) Fuel control removals have occurred on engines that had what could become "hot starts" and also on engines which had slow acceleration. Experience shows that fuel control linkages can have wear or part movement which can cause changes in the starting flow schedule, in either the rich or the lean direction. A rich change in fuel flow can cause hot starts. A lean change in fuel flow can cause slow acceleration. Adjustments to the fuel control to put the start schedule back in its initial calibration limits, as specified in the CMM, can decrease the number of fuel control removals which are the result of possible hot start or slow acceleration.

(2) It is possible to do this adjustment on a fuel control only two times, in the upward or downward direction. If a fuel control continues to be part of a hot start or slow acceleration problem, remove the control for approved component repair or calibration.

(3) This procedure is approved for all dash numbers of Hamilton Standard (HSD) PN 769606 fuel controls.

(4) Before fuel control adjustment, do all other applicable procedures in PAGEBLOCK 72-00-04/101 to make sure that there are no other possible causes of the hot start or slow acceleration problem.

(5) Adjustments to the fuel control other than what is specified in the procedures in this section are not permitted.

B. Procedure

(Figure 529), (Figure 530), (Figure 531), (Figure 532)

CAUTION: DO NOT USE AN ABSOLUTE PRESSURE GAGE TO MEASURE PRIMARY FUEL PRESSURES. THIS TYPE OF GAGE WILL NOT GIVE CORRECT READINGS FOR THIS PROCEDURE.

(1) Attach a gage, STD-14581 to the pressurizing and dump valve FP4 port as shown in (Figure 529).

(2) Wet motor the engine for ten (10) seconds minimum after the N_2 speed becomes stable.

(3) Measure the fuel pressure at the FP4 port.

(4) Record the engine speed and the ambient atmospheric pressure (in inches Hg).

(5) Use Figure 529 to convert the primary fuel pressure at the FP4 port to fuel flow (primary fuel pressure versus primary nozzle pressure).

(6) Find the nominal fuel flow (Wf) for the N_2 speed from the applicable starting schedule. (Figure 531, Sheets 1 thru 10)

(7) Add and subtract 30 PPH to get a plus or minus 30 PPH acceptance band.

(8) If the fuel flow (Wf) in Paragraph 10.B.(5) is in the band of fuel flow (Wf) set in Paragraph 10.B.(6), do not adjust the fuel control.

(9) If the fuel flow (Wf) in Paragraph 10.B.(5) is more than the higher fuel flow (Wf) set in Paragraph 10.B.(7), turn the throttle valve position adjustment counterclockwise to decrease the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(10) If the fuel flow (Wf) in Paragraph 10.B.(5) is less than the lower fuel flow (WF) set in Paragraph 10.B.(7), turn the throttle valve position adjustment clockwise to increase the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(11) Adjust the throttle valve position adjustment as follows: (Figure 508)

  (a) Remove the screw and plate from the fuel control as shown in Figure 532.

(b) Use a 3/32 inch hex wrench to turn the adjustment in the necessary direction.

NOTE: The adjustment has a limit of 230 PPH for a fuel control between bench calibrations (this will be approximately 0.3 turn). This adjustment will make a change of 800 PPH per turn. Make the last adjustment in a clockwise direction. To get a decrease in fuel flow, turn the adjustment counterclockwise one eighth (1/8) turn past the necessary position, then turn it clockwise to the necessary position.

(c) Install the plate and attach it with the screw and washer after the adjustment is completed.

(12) After all adjustments, do this procedure to make sure that the schedule mechanism is stable:

(a) Get the engine to a stable motoring speed.

(b) Set the condition lever to ON for ten (10) seconds and record the primary nozzle pressure at the P&D valve FP4 port.

(c) Set the condition lever to OFF for ten (10) seconds.

(d) Do Paragraph 10.B.(12)(b) and Paragraph 10.B.(12)(c) again.

(e) Do Paragraph 10.B.(12)(b) again.

(f) If the pressure recorded in Paragraph 10.B.(12)(e) is not plus or minus 2 psi of the pressure recorded in Paragraph 10.B.(12)(d), stop the motoring procedure and do Paragraph 10.B.(12)(a) thru Paragraph 10.B.(12)(e) again.

(g) Use Figure 530 to convert primary nozzle pressures recorded in Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) to fuel flow (Wf).

(h) The average of the fuel flow (Wf) readings from Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) will usually be plus or minus 25 PPH from the nominal fuel flow (Wf) in Paragraph 10.B.(6). If the average fuel flow (Wf) is more than this limit, adjust the starting fuel flow (Wf) and do all of Paragraph 10.B.(12) again.

NOTE: It is possible to do an engine run to Idle as an alternate to Paragraph 10.B.(12)(b) thru Paragraph 10.B.(12)(e), with only one pressure measured during a motoring procedure.

(13) Make sure that an increase or decrease in starting fuel flow (Wf) shows on the flight deck indicator as well as during the primary pressure flow check at the P&D valve. If the two indications are not the same, this can be a result of contamination in the primary fuel nozzles, or a problem with the flight deck instrumentation.

(14) After the adjustment, make sure that the necessary fuel control trim parameters are in limits. These parameters will include Idle and Part Power trim limits, and Takeoff, acceleration, and deceleration checks. Refer to the airframe manufacturer's trim information.

(15) Sample Calculation

(a) Sample A

1) Conditions:

a) 22 percent N_2 motoring speed

b) Fuel: Jet A

c) Pamb: 29.92 inches Hg

d) Primary fuel nozzle pressure measured at 100 PSIG

(b) Sample B

1) From Figure 531 (for -7 and -08 fuel controls) the nominal fuel flow (Wf) for 22 percent N_2 at 29.92 inches hg ambient pressure will be 730 PPH.

2) Add and subtract 30 PPH as shown in Paragraph 10.B.(7):

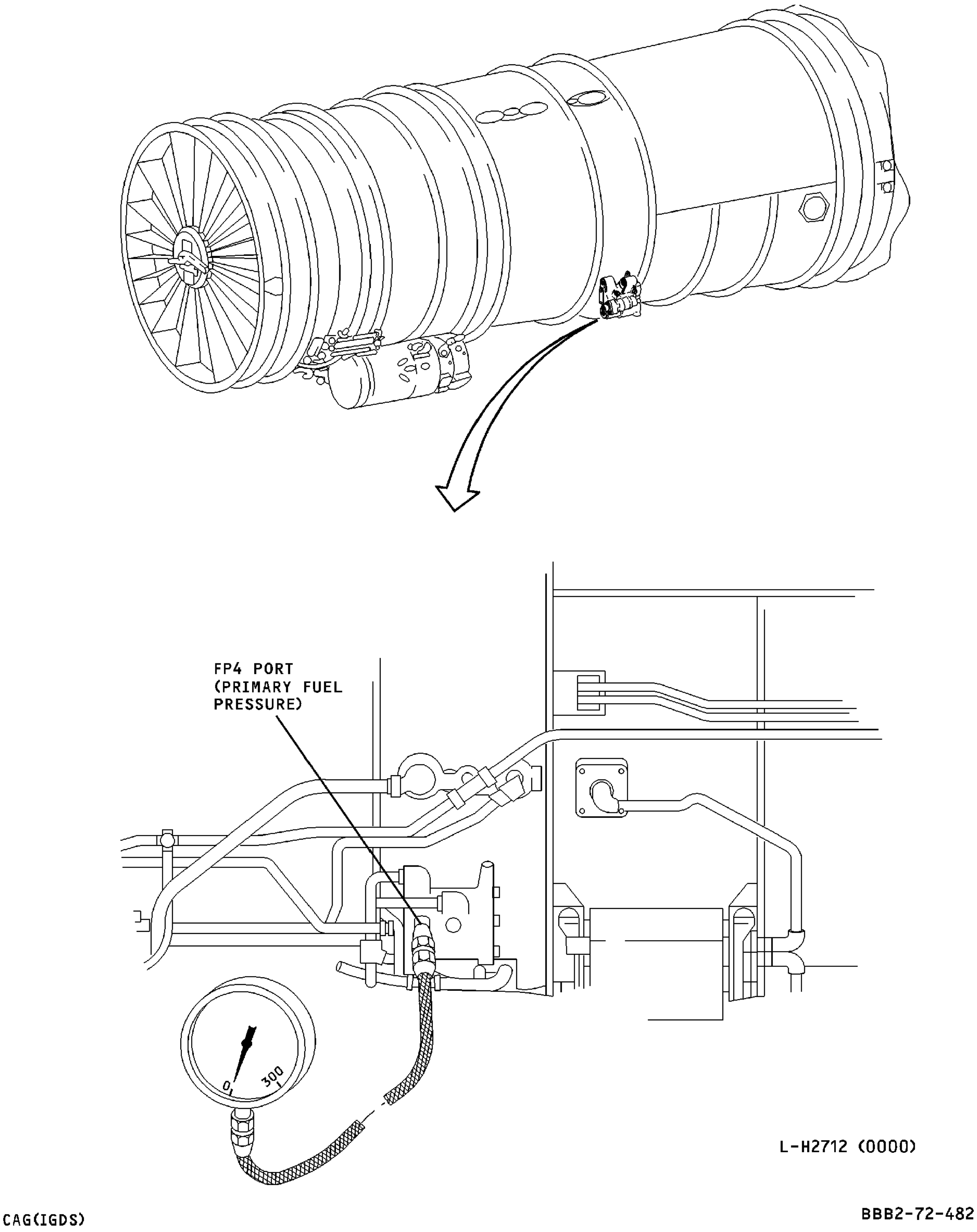
730 + 30 = 760 pph

730 - 30 = 700 pph

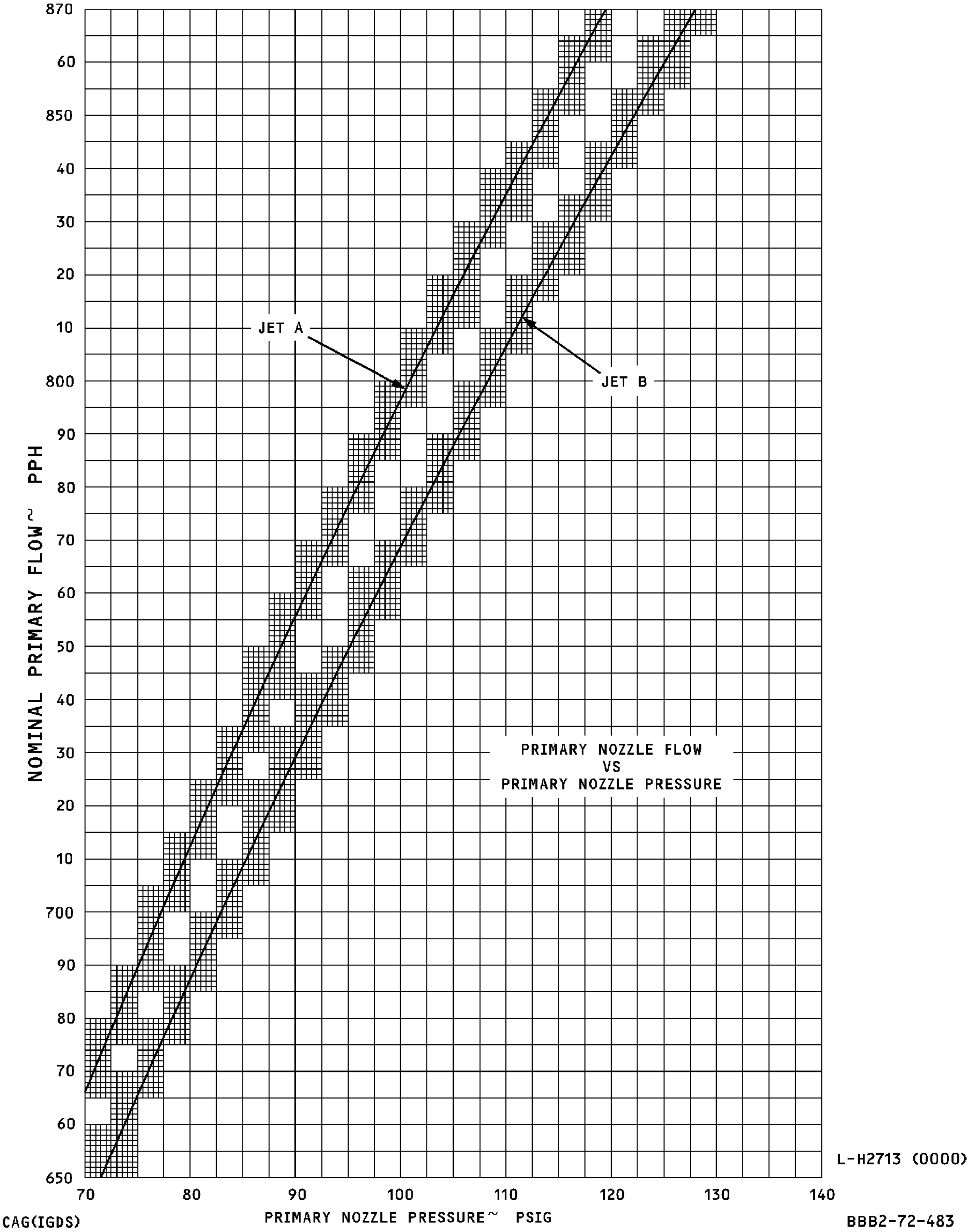
3) In this example the fuel flow (Wf) from Paragraph 10.B.(15)(a) is more than the higher fuel flow (Wf) in Paragraph 10.B.(15)(b). Therefore, it will be necessary to decrease the flow to 730 ±25 PPH. Turn the throttle valve position adjustment counterclockwise to get a primary nozzle pressure of 84 PSIG. Make the last adjustment in a clockwise direction as shown in Paragraph 10.B.(9). Refer to Table 509 for typical adjustment limits.

Table 509 Fuel Control Fuel Flow Adjustment

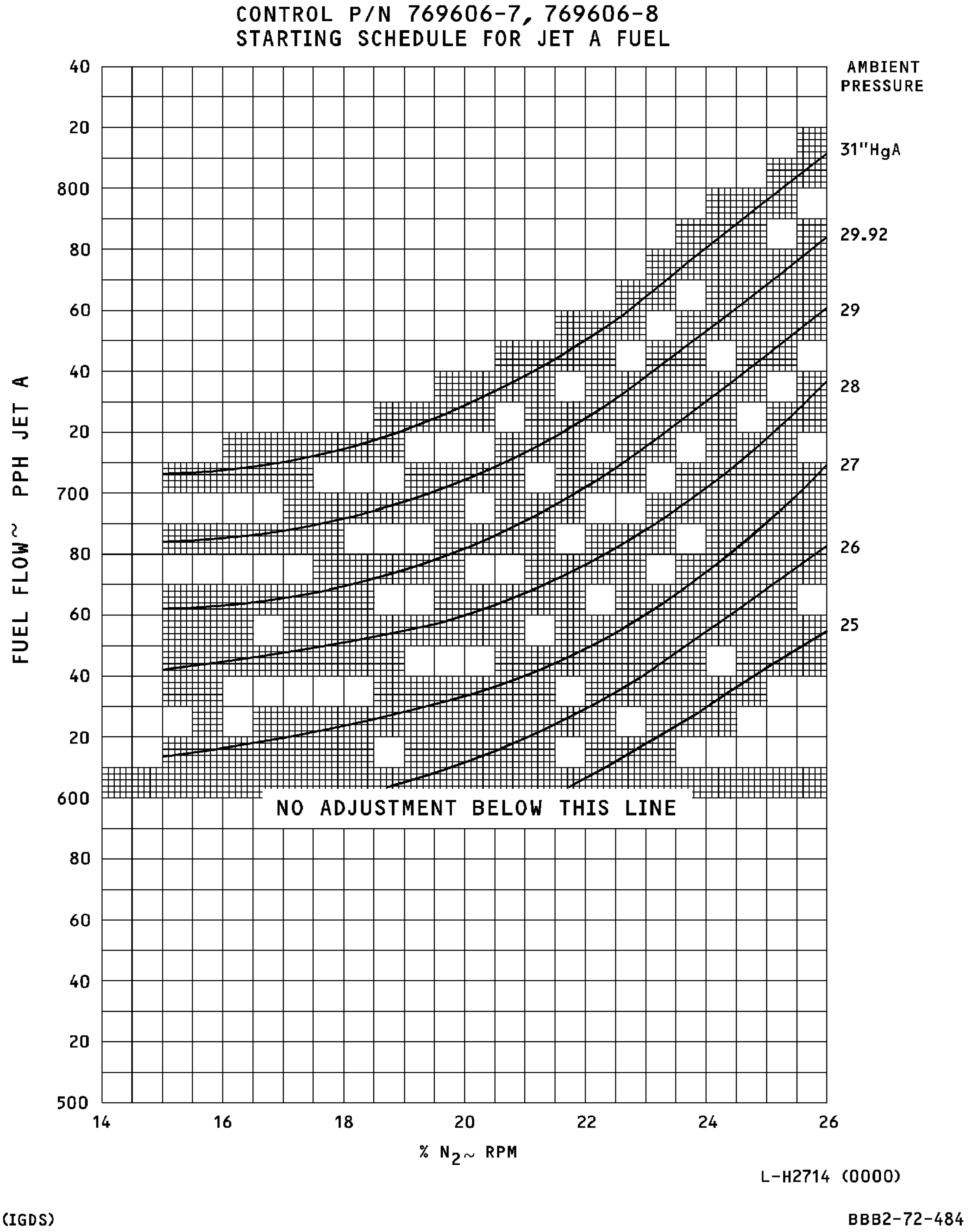
Fuel Control Throttle Valve Position Adjustment Turns	Fuel Flow (Wf) Difference (PPH)
Clockwise:	
1/16	50
1/8	100
3/16	150
1/4	200
5/16	250
3/8	300
Counterclockwise:	
1/16	-50
1/8	-100
3/16	-150
1/4	-200
5/16	-250
3/8	-300



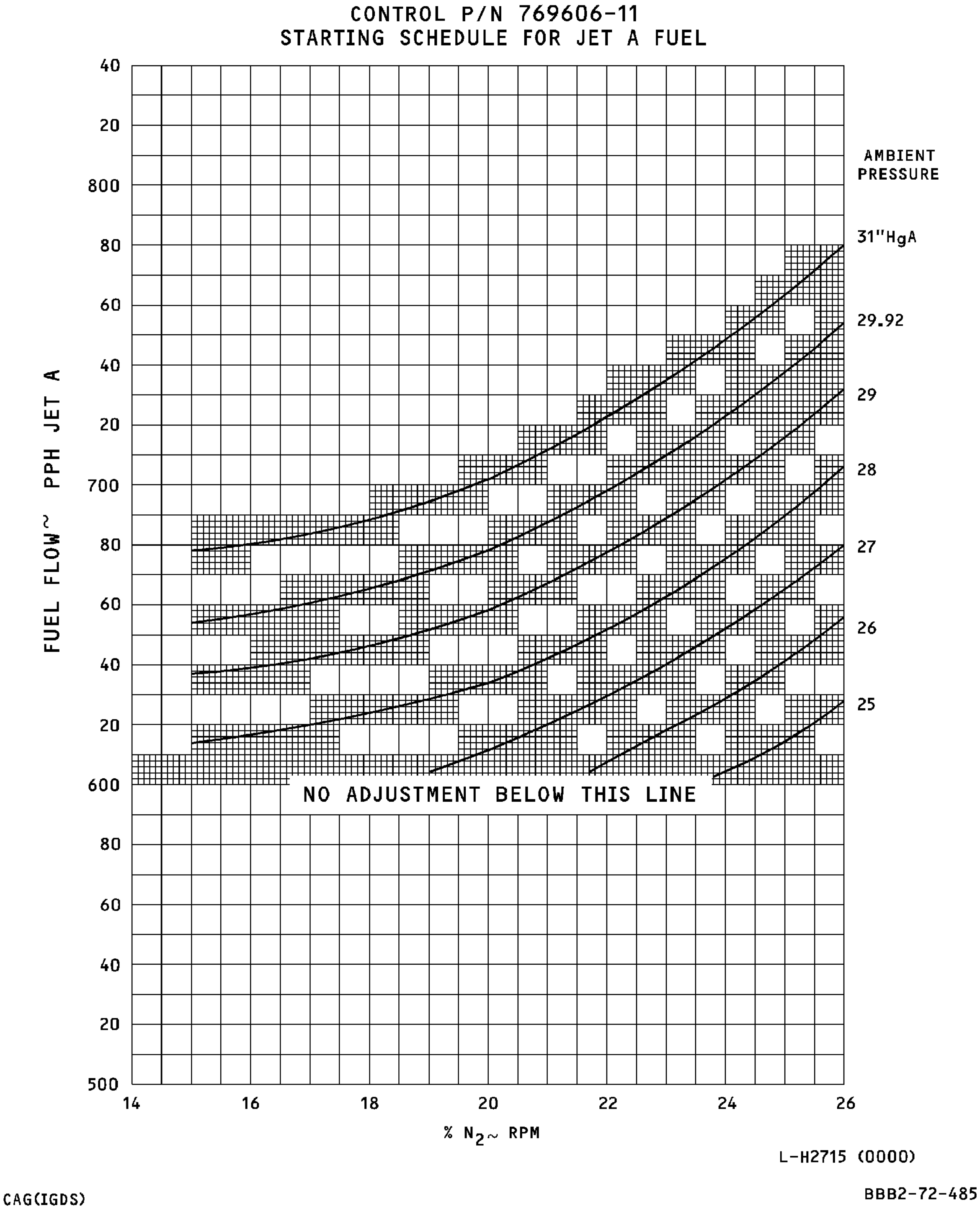
Pressurizing and Dump Valve
Figure 529/72-00-00-990-952



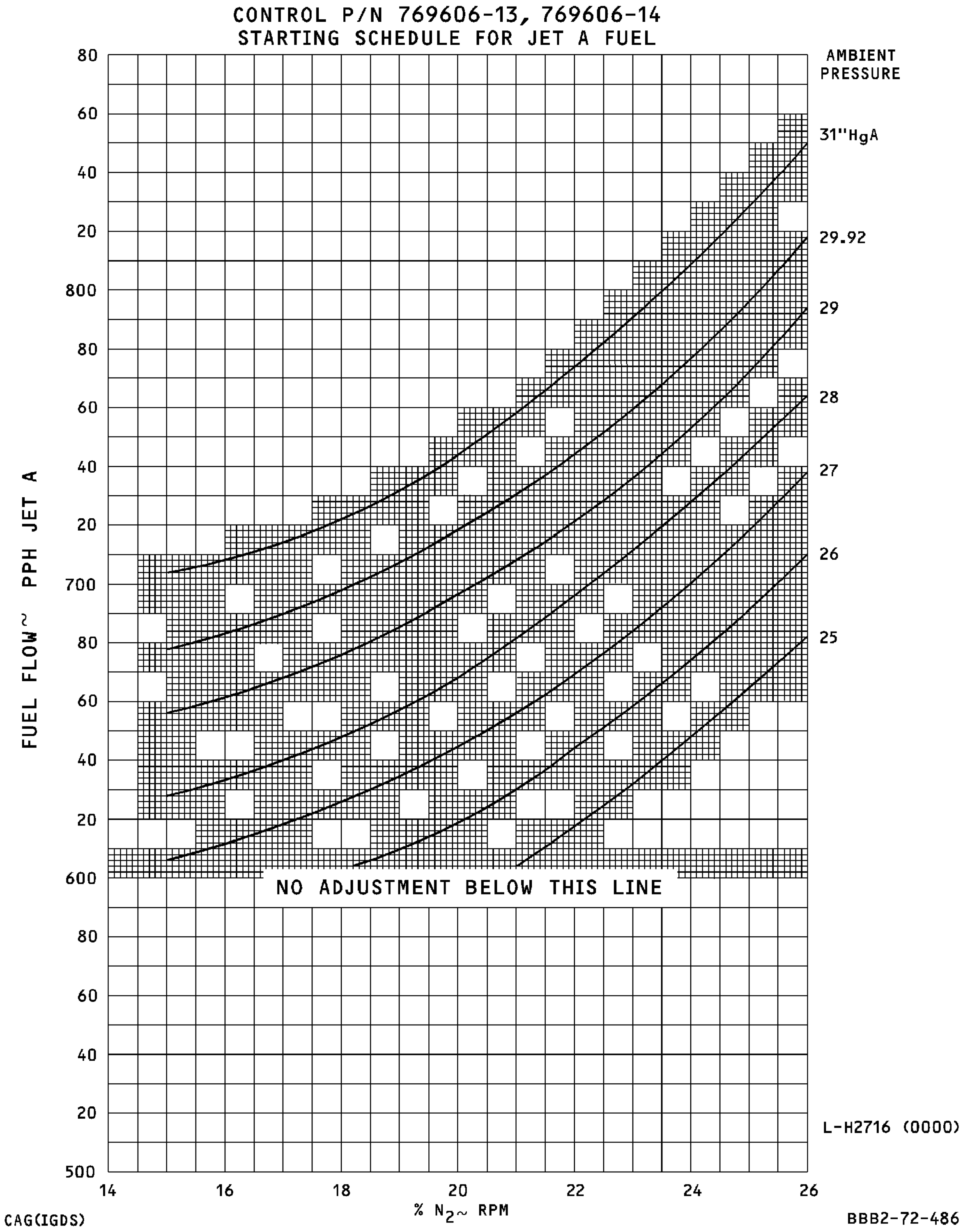
Fuel Pressure to Flow Conversion
Figure 530/72-00-00-990-953



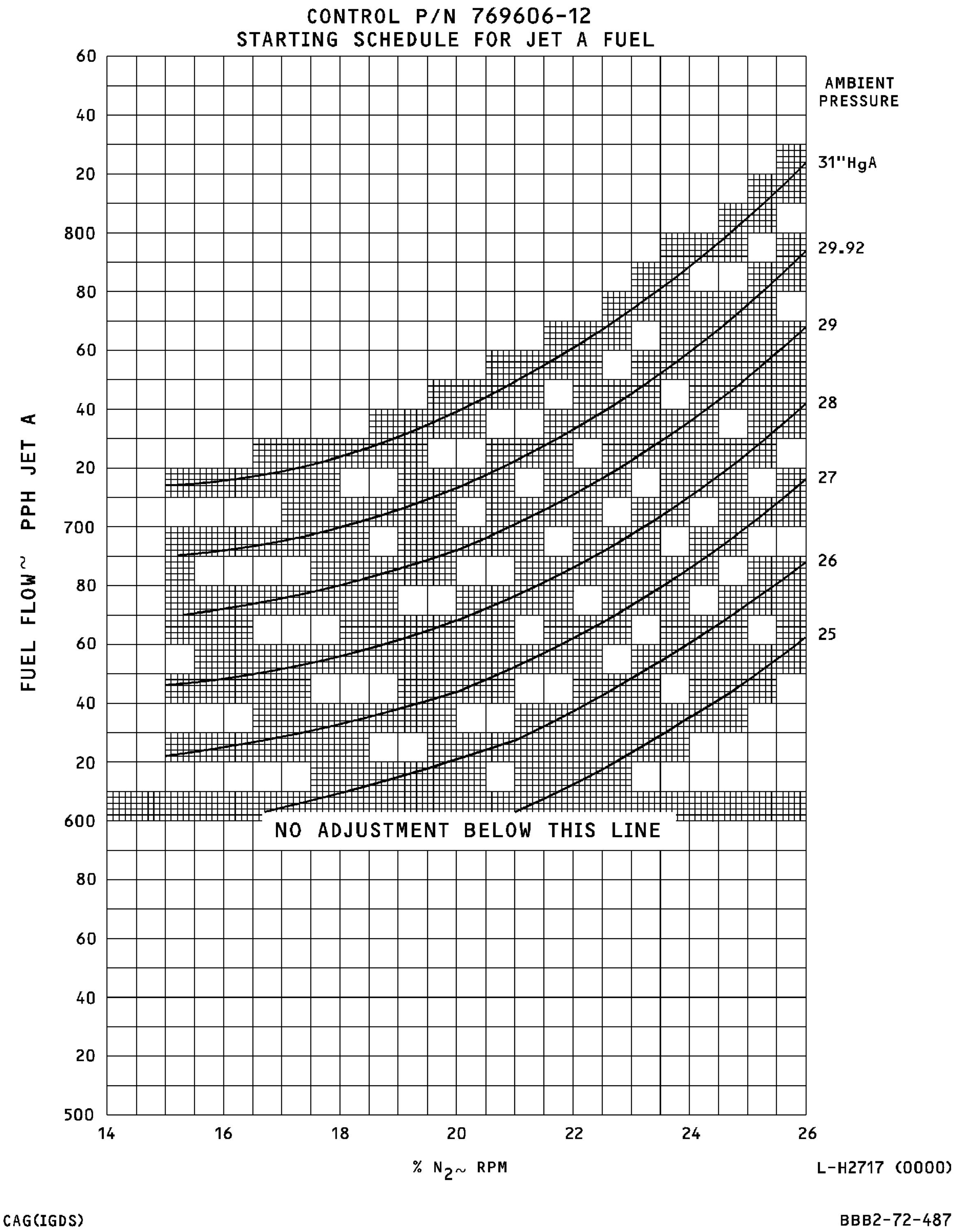
Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 1 of 10)



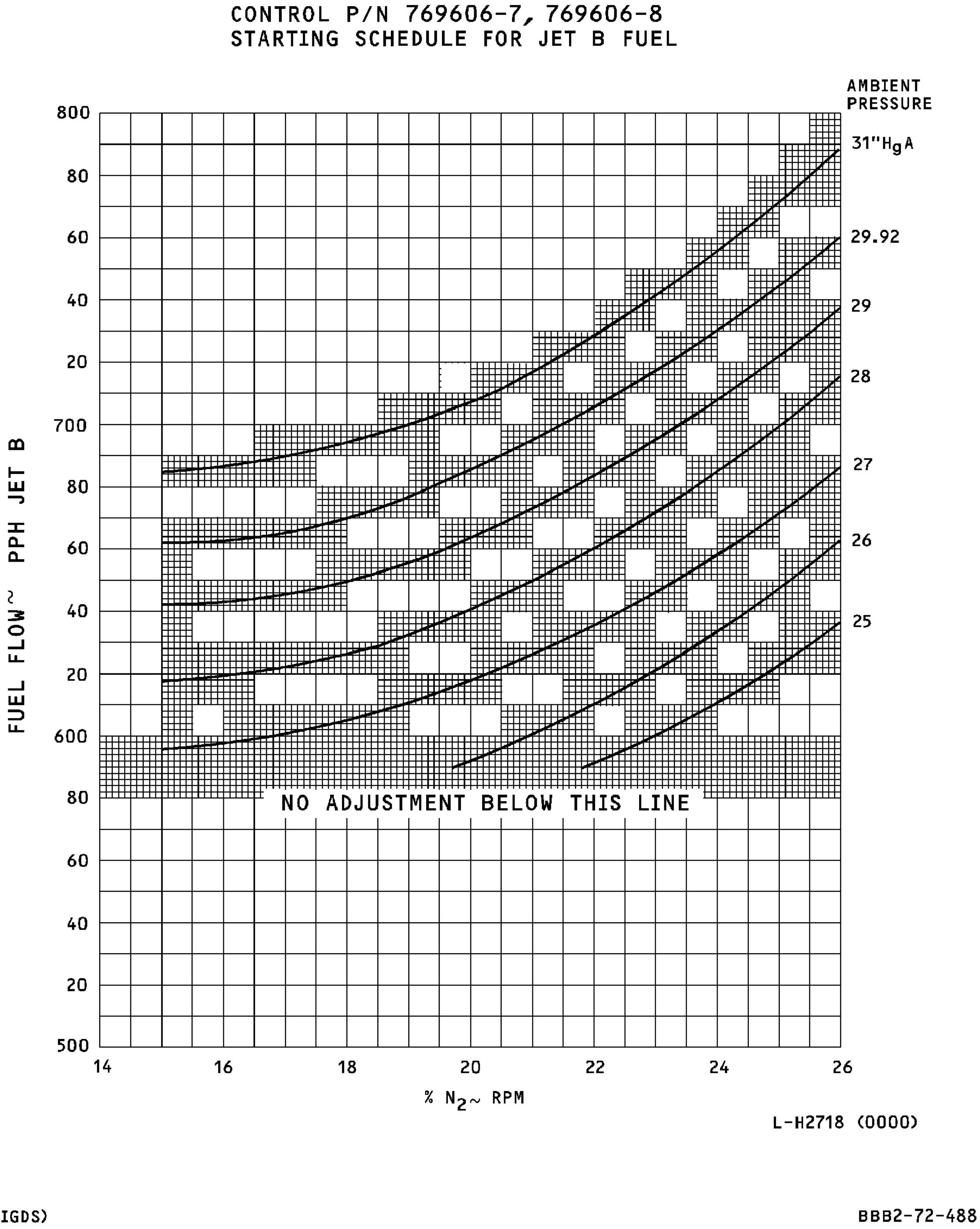
Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 2 of 10)



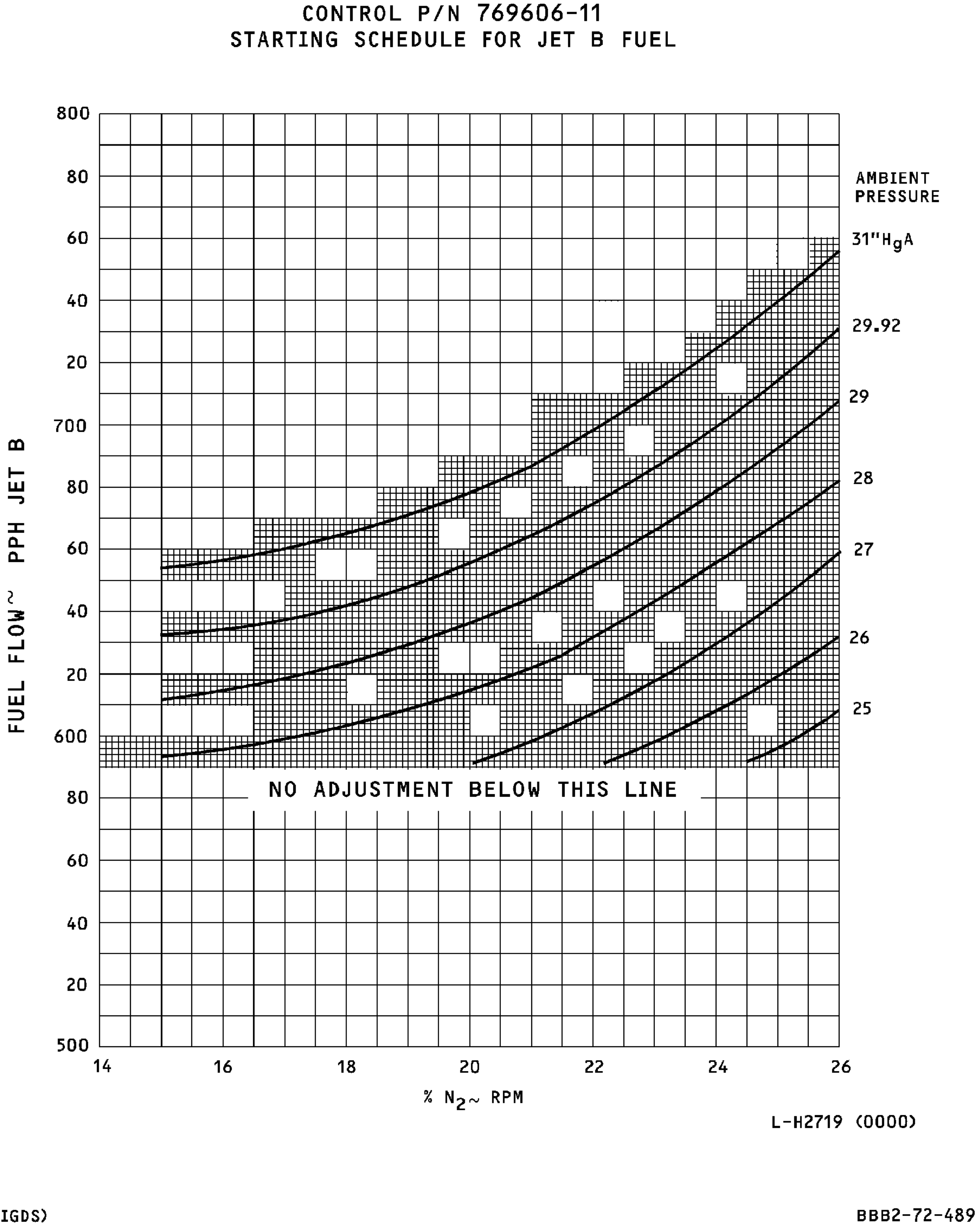
Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 3 of 10)



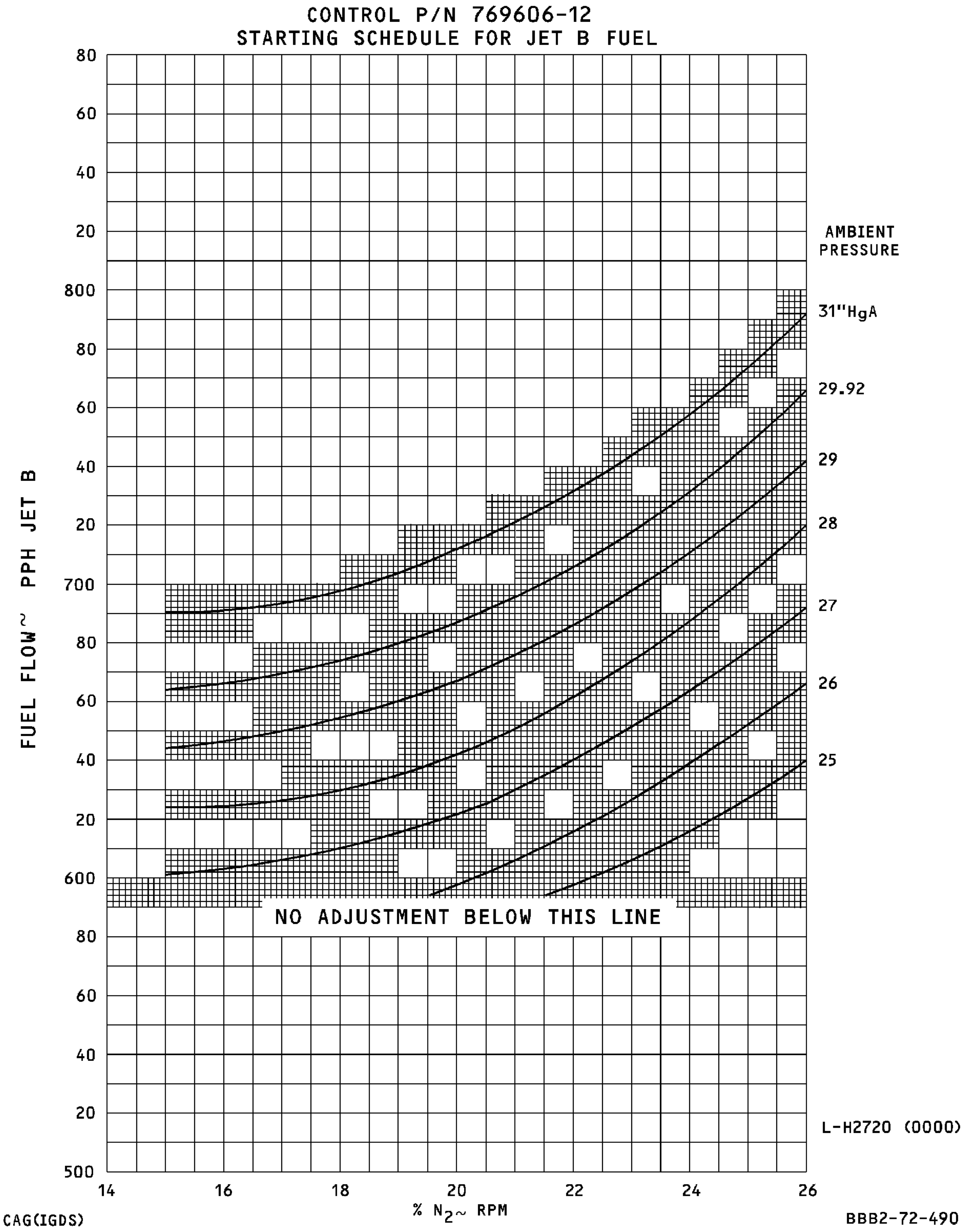
Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 4 of 10)



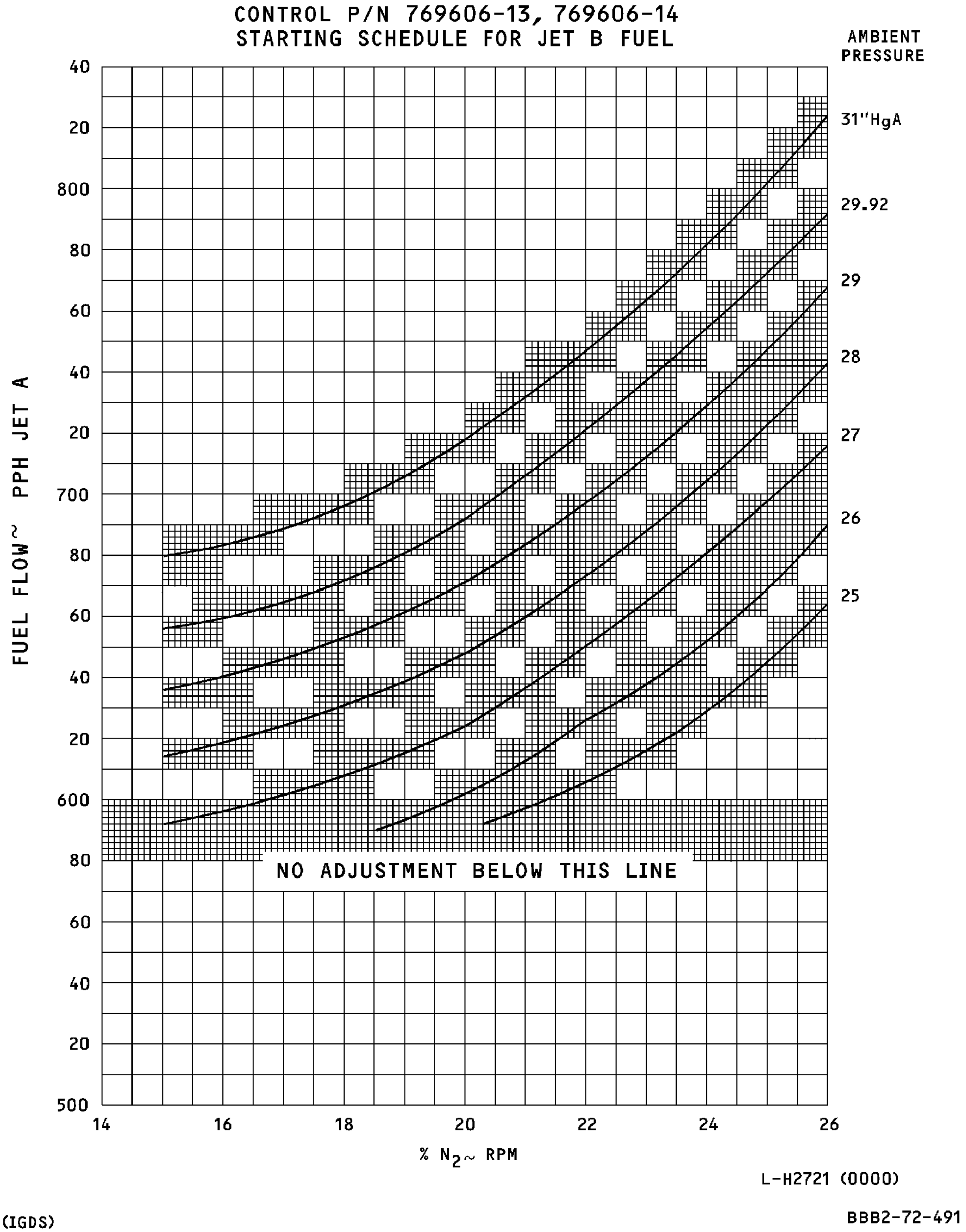
Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 5 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 6 of 10)

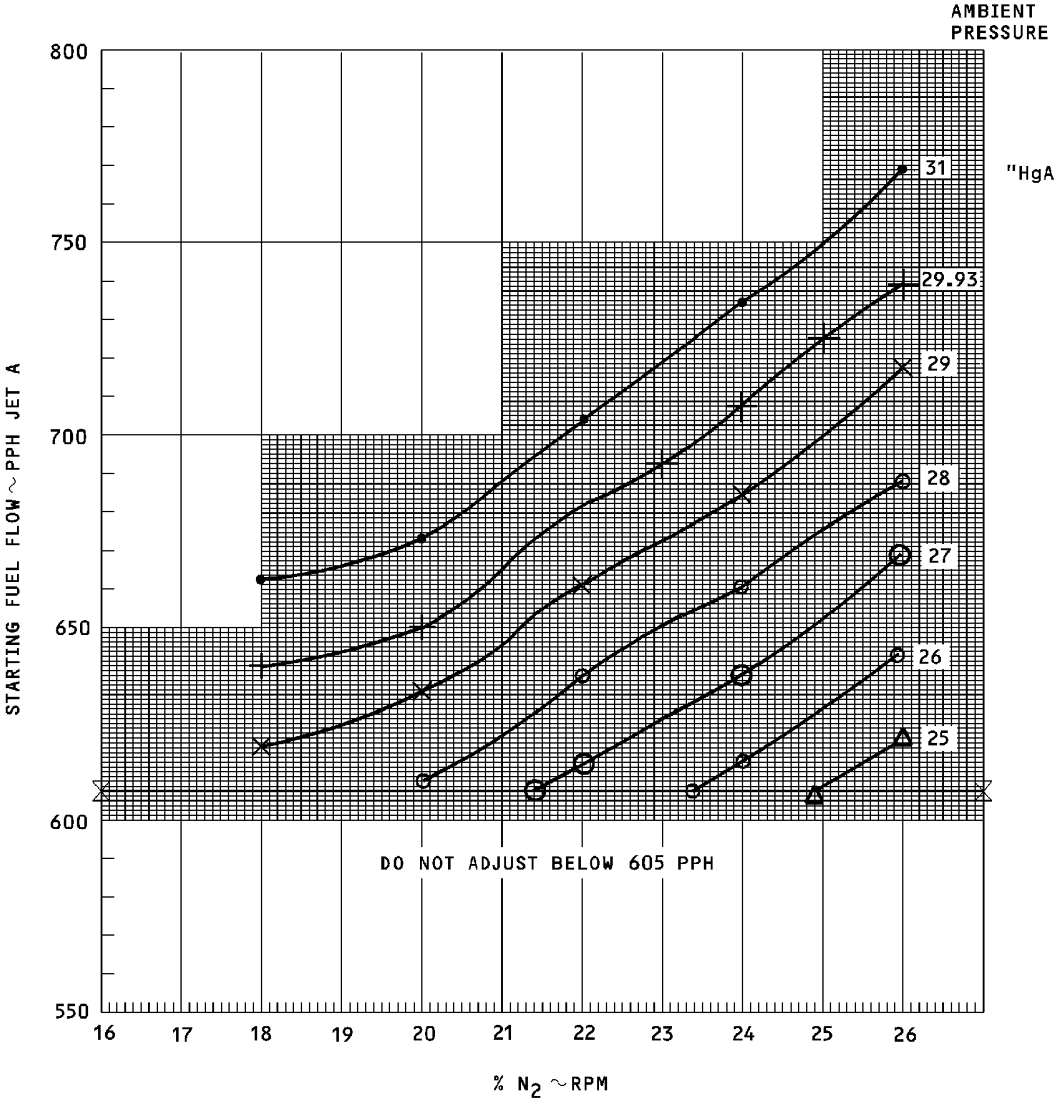


Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 7 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 8 of 10)

CONTROL P/N 769606-15, 769606-16
STARTING SCHEDULE FOR JET A FUEL

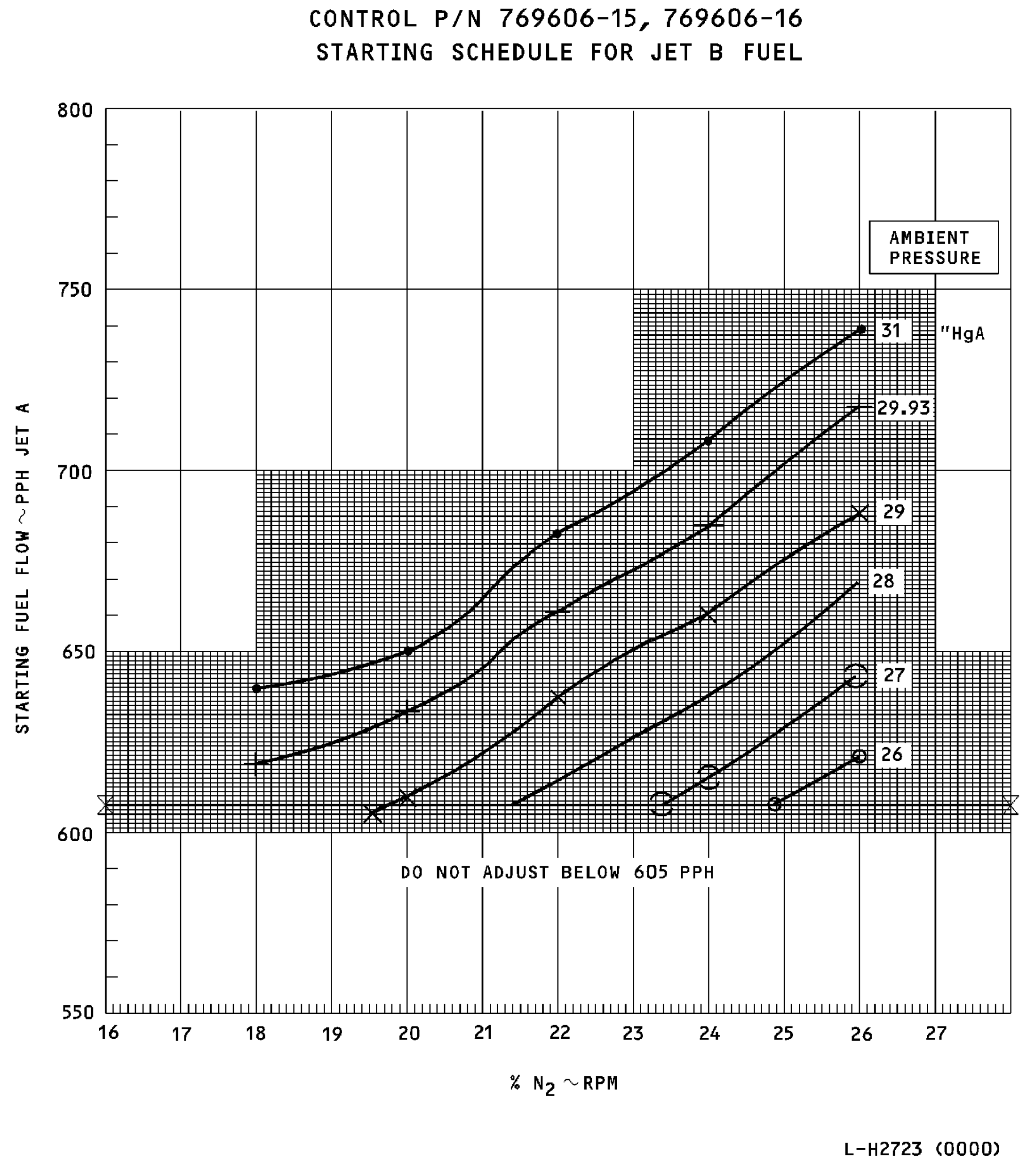


L-H2722 (0000)

CAG(IGDS)

BBB2-72-492

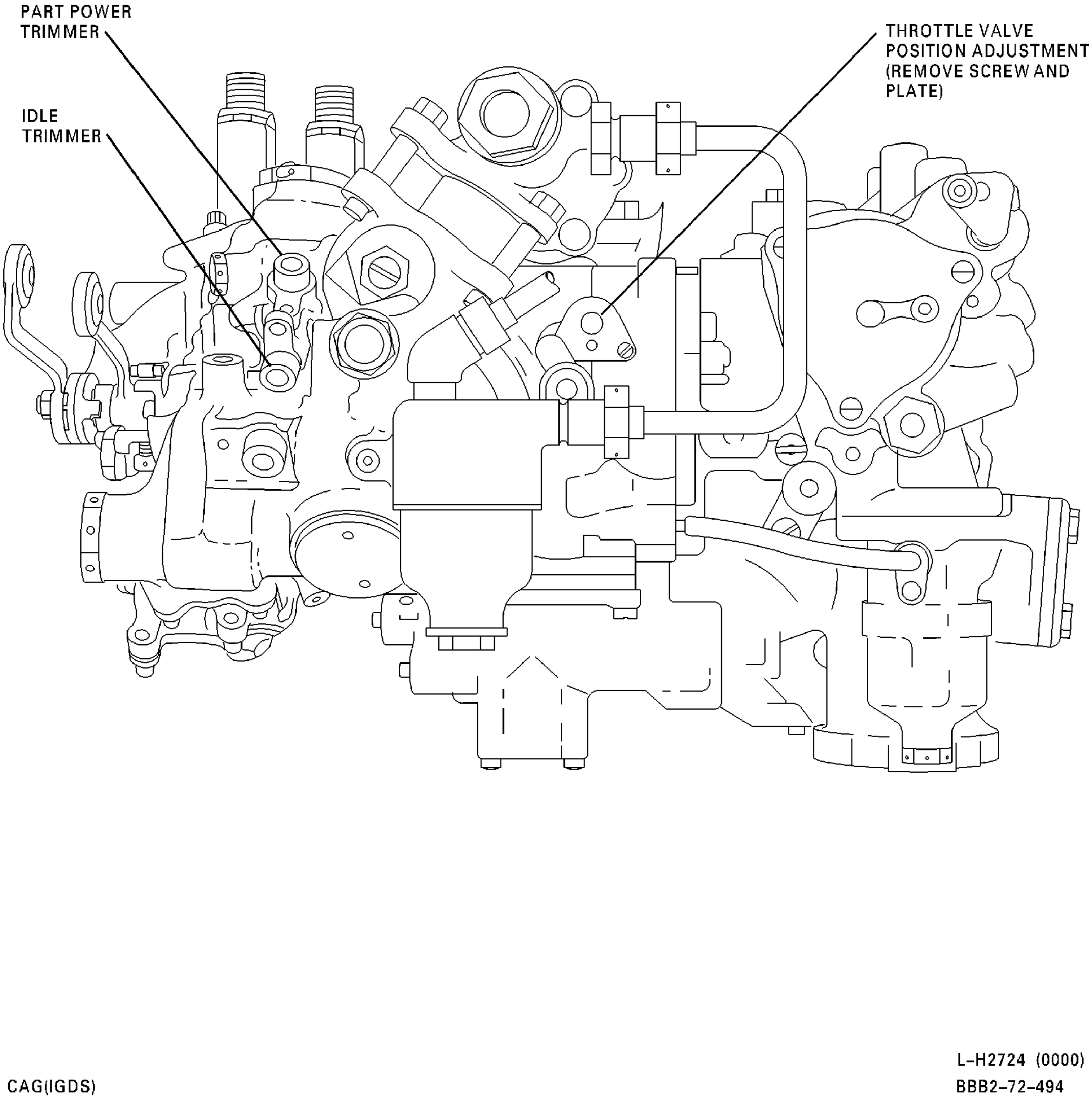
Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 9 of 10)



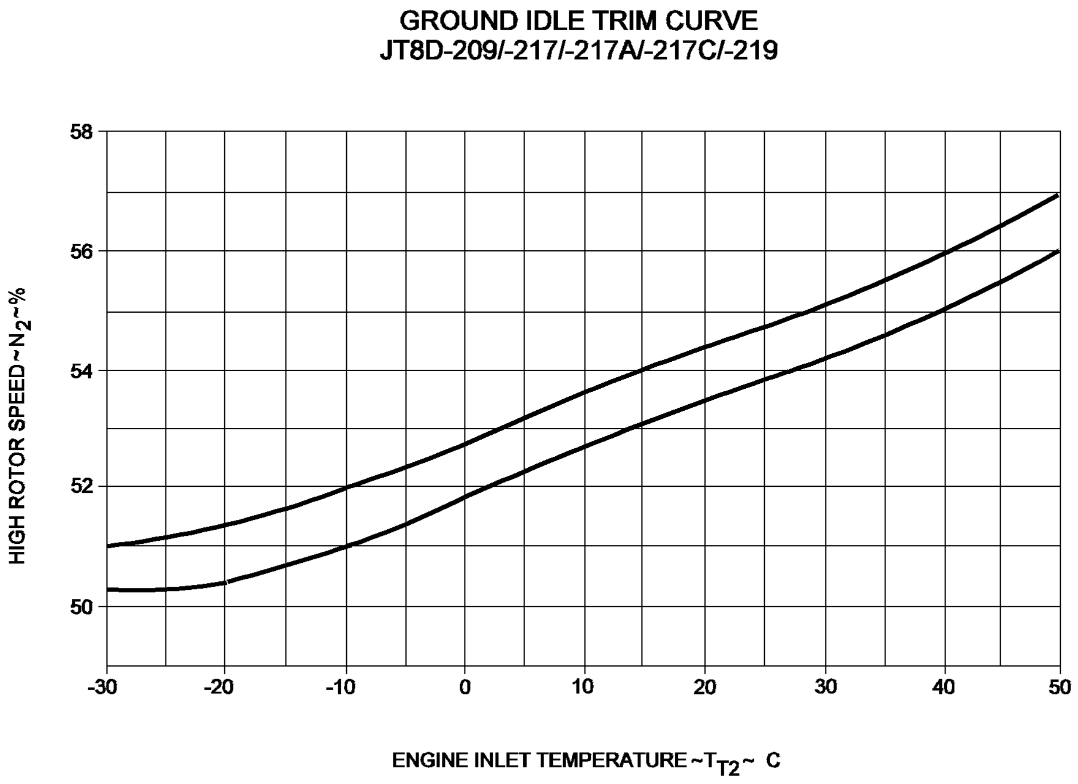
CAG(IGDS)

BBB2-72-493

Starting Schedule Limits
Figure 531/72-00-00-990-954 (Sheet 10 of 10)



Fuel Control Adjustment
Figure 532/72-00-00-990-955



L-77635
0186

BBB2-72-629
S0000306812V1

Engine Idle Trim Curve
Figure 533/72-00-00-990-C50

ENGINE GENERAL - ADJUSTMENT/TEST

1. Engine Ground Safety Precautions

A. General

(1) The operating characteristics of jet engine powered aircraft have changed the ground safety picture. To prevent injury to persons and damage to property, handling and working procedures must be modified to meet new exposures. On piston engine aircraft the propeller was carefully avoided. In the case of the jet engine powered aircraft, one must avoid not only the engine intake ducts, but also the exhaust nozzle where hot, high velocity exhaust gases are discharged. Listed below are some of the general safety items which shall be supplemented according to the needs of the job, to prevent accidents.

B. The Air Intake (Figure 501)

WARNING: ALL PERSONNEL MUST AVOID HAZARD AREAS AROUND THE POWER PLANT AND REMAIN OUTSIDE OF ENGINE SAFETY BARRIER, IF USED, DURING GROUND RUNNING OPERATIONS. THE ENGINE IS CAPABLE OF DEVELOPING ENOUGH SUCTION AT THE INLET TO PULL A PERSON UP TO OR PARTIALLY INTO THE INLET WITH POSSIBLE FATAL RESULTS. THEREFORE, WHEN APPROACHING ANY TYPE OF JET ENGINE, PRECAUTIONS MUST BE TAKEN TO KEEP CLEAR OF THE INLET AIR STREAM. THE SUCTION NEAR THE INLET CAN ALSO PULL IN HATS, GLASSES, LOOSE CLOTHING AND WIPE-RAGS FROM POCKETS. ANY LOOSE ARTICLES MUST BE MADE SECURE OR REMOVED BEFORE WORKING AROUND THE ENGINE.

C. Exhaust Characteristics (Figure 501)

(1) Velocity. At high engine speeds the exhaust may pick up and blow loose dirt, sizeable stones, sand and debris a distance of several hundred feet. Therefore, due caution must be used in parking the aircraft for run-up to avoid injury to persons or damage to property or other aircraft. A blast fence is suggested if the engines are going to be run-up for trim and power adjustment in an area where there is not sufficient space available for dissipation of the exhaust blast.

(2) Temperature. High temperature will be found up to several hundred feet from exhaust nozzle depending on wind conditions. Closer to engine, exhaust temperature is high enough to deteriorate bituminous pavement, therefore, concrete aprons are suggested for run-up areas. Occasionally when a jet engine is started, excess fuel that has accumulated in the tailpipe ignites and long flames are blown out of exhaust nozzle. Possibility of this hazard must be watched and all flammable materials kept in the clear.

(3) Toxicity. Tests have indicated that carbon monoxide content is low but other gases are present which have disagreeable odor and are irritating in effect. Exposure will usually cause watering or burning sensation of the eyes. Less noticeable but important is respiratory irritation which may be caused. For both these reasons exposure must be avoided, particularly in confined spaces or pockets where concentration may build up.

D. Engine Cool Down

WARNING: USE APPROPRIATE HAND PROTECTION WHEN WORKING AROUND ENGINE AREAS WHICH ARE LIKELY TO BE HOT.

(1) After engine operation no work or inspection shall be done on tailpipe for at least one-half hour, preferably longer. All other parts may usually be worked upon without danger.

(2) Certain parts of the engine which contain or are exposed to high compressor air, like fuel deicing air tubing and anti-icing air tubing, may be hot immediately after engine shutdown. The use of insulated gloves is recommended whenever work must be performed on the engine in the vicinity of such parts soon after engine shutdown.

E. Engine Noise

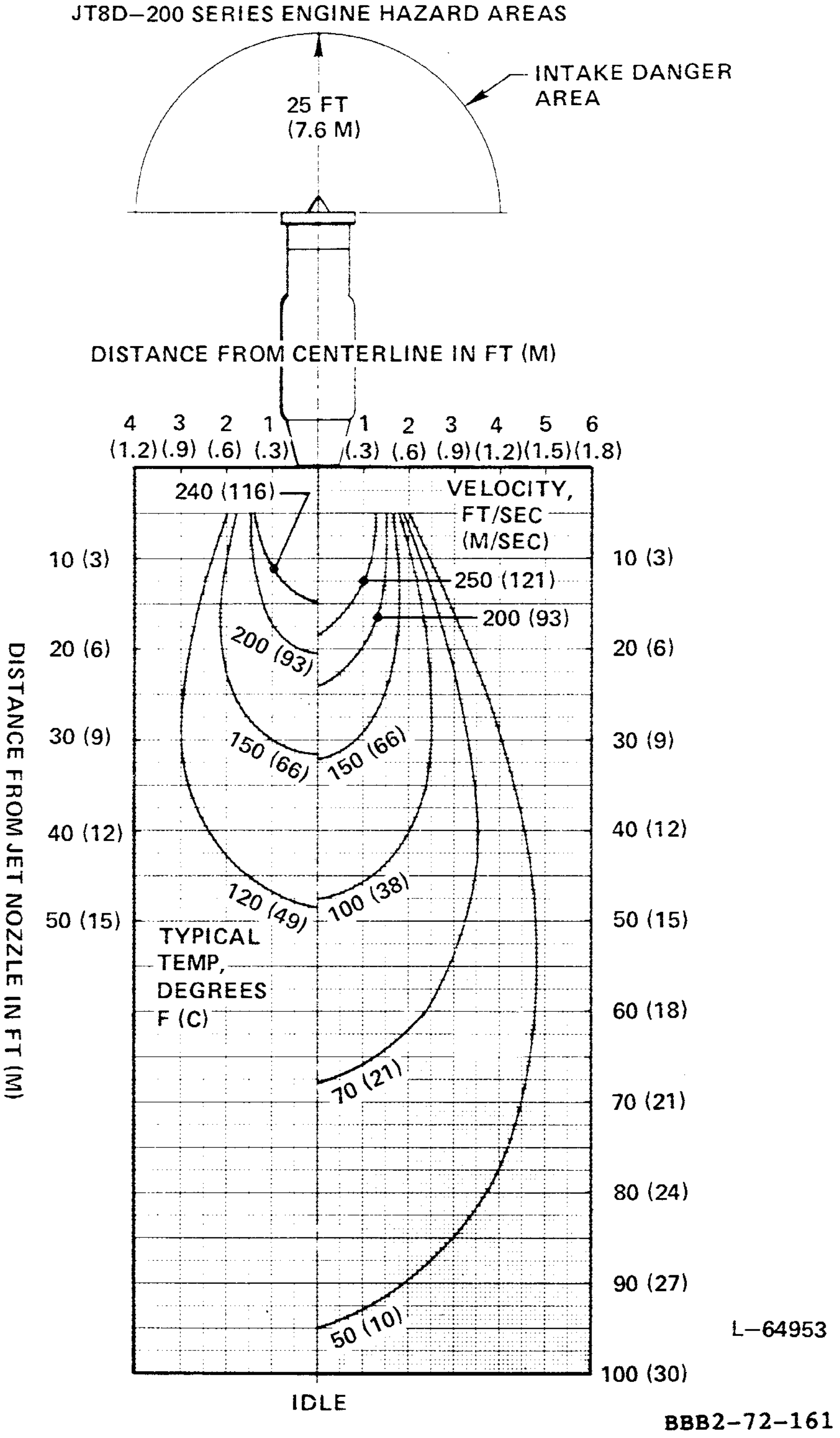
(1) Jet engines typically produce noise capable of causing temporary, as well as permanent, loss of hearing. Even short exposures to extreme noise may result in damage to ears and all personnel must use some means of protection. Noise can effect ear mechanism in such a way as to cause unsteadiness or inability to walk or stand without reeling. Therefore, use of cup type ear protection is recommended. If engines are to be serviced from aero-stands or platforms these shall be equipped with protective railings to prevent falls.

WARNING: THE JT8D ENGINE IGNITION SYSTEM IS CHARACTERISTICALLY HIGH IN ENERGY. THE NATURE OF THE SYSTEM IS SUCH AS TO RENDER IT A HAZARDOUS, POSSIBLY FATAL, SOURCE OF ELECTRICAL SHOCK UNLESS NECESSARY PRECAUTIONS ARE EXERCISED. DO NOT TOUCH IGNITER PLUGS WHEN IGNITION IS ON. DO NOT TEST IGNITION SYSTEM WHEN PERSONNEL MAY BE IN CONTACT WITH IGNITER PLUGS OR WHEN FLAMMABLE MATERIALS ARE NEARBY.

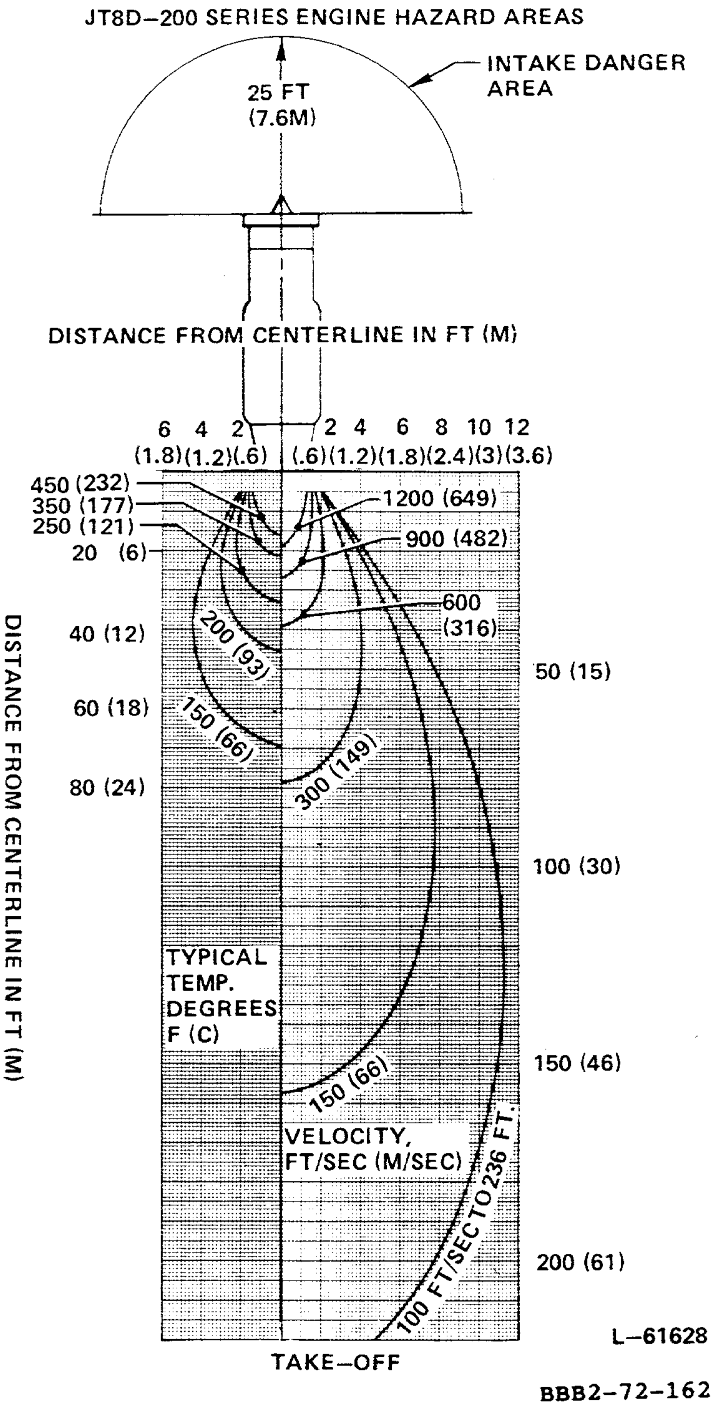
F. Engine Ignition

G. Fuel And Lubricating Oils

(1) All fuels and lubricating oils tend to dry the skin. Precautions shall be taken to avoid contact as much as possible.



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-956 (Sheet 1 of 2)



Inlet/Exhaust Hazard Areas (Idle)
Figure 501/72-00-00-990-956 (Sheet 2 of 2)

2. Testing Information

A. General

(1) Pratt & Whitney strongly recommends that the measurement and setting of engine thrust be accomplished by use of turbine discharge pressure and compressor inlet pressure as the primary parameters, while using engine speed, tailpipe temperature, and fuel flow as secondary parameters to monitor engine condition, and as limits. Engine speed (low and high compressor RPM) is not a sufficiently accurate indicator of thrust, to provide adequate control of engine thrust and internal conditions under normal service operation. Therefore, the engine fuel control is adjusted in order to obtain desired turbine discharge pressure (P_{t7}) or engine pressure ratio (P_{t7}/P_{t2}) shown on applicable engine trim curves. Turbine discharge pressure or pressure ratio overshoot, or higher than normal reading, may be noted when power lever is first advanced to PART THRUST stop on a cold engine. For accurate indication of engine thrust during engine test or trimming, engine must be allowed to stabilize.

NOTE: It is suggested that a remote fuel control trimmer such as is available from Lear Siegler Inc. be employed when trimming engine.

(2) Whenever trimming engines installed in aircraft, aircraft manufacturer's trim curves, corrected for specific inlet duct loss, must be used.

NOTE: The procedures contained in Chapter 72 are the engine manufacturer's originated data. However, for engine operational and trimming data, refer to SUBJECT 71-00-00.

(3) Symbols have been designated for the various stations within the engine, and the external working pressures and temperatures. These variables are listed in Table 501 below:

Table 501 Engine Station Symbols

TAMB	Compressor Ambient Temperature
PAMB	Compressor Inlet Ambient Pressure
N_1	Low Pressure Compressor RPM
N_2	High Pressure Compressor RPM
Ps3	Intercompressor Static Pressure
Ps4	Bleed Annulus Static Pressure
P_{t2}	Compressor Inlet Total Pressure
T_{t7}	Turbine Discharge Total Temperature
P_{t7}	Turbine Discharge Total Pressure
P_{t7}/PAMB	Engine Pressure Ratio
PBAR	True Barometric Pressure

(4) The extent of repair and replacement will vary with each engine; therefore, the degree of test necessary to demonstrate satisfactory repair will vary also. To minimize ground running and to conserve fuel, this section provides five ground test procedures which are related to the extent of repair or replacement. Before attempting to test an engine after repair, the applicable sections of the Table Table 507 must be consulted to determine the test required for any given engine repair.

(5) The Engine Check Chart provides the general operating condition limits and references to the necessary test curves for testing an installed engine. The ratings listed in the Engine Check Chart are described as follows and are obtained by positioning the power lever to a predetermined turbine discharge pressure (P_{t7}):

(a) Maximum Takeoff - This is the maximum thrust certified for takeoff. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. In the event of an engine out situation this rating is provided by the Reserve Takeoff Thrust mechanism when operating at the Normal Takeoff rating. This rating is time-limited to a total of five (5) minutes including the time spent at the Normal Takeoff Rating.

(b) Normal Takeoff - The Normal Takeoff Rating is the maximum thrust normally set for takeoff operation. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio. The rating is time limited to five (5) minutes.

(c) Maximum Continuous - The Maximum Continuous Rating is the maximum thrust certified for continuous use. For the purpose of P&W service policy coverage and prolonging engine life, this rating should be used, at the pilot's discretion, only when required to ensure safe flight. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(d) Maximum Climb - Maximum Climb thrust is the maximum thrust approved for normal climb. The rating is set by adjusting the throttle to obtain a predetermined engine pressure ratio.

(e) Maximum Cruise - This is the maximum thrust approved for cruising. The Maximum Cruise is obtained in the same manner as Maximum Climb or Maximum Continuous thrust.

(f) Idle - This is not an engine rating but, rather, a power lever position suitable for minimum thrust operation on the ground or in flight. It is obtained by positioning the power lever in the IDLE detent or the IDLE stop position.

(g) Reverse - Reverse thrust will be obtained at power lever positions below IDLE.

B. Operating Limits and Performance Data

(1) JT8D-209: See Table 502.

Table 502 Engine Check Chart For JT8D-209

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Maximum Takeoff	5 (3)	1058°F (570°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Continuous	Continuous	986°F (530°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Climb	Continuous	959°F (515°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Max. Cruise	Continuous	941°F (505°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

Table 502 Engine Check Chart For JT8D-209 (Continued)

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			Operating Limits	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting				
Ground		932°F (500°C)(6)	(9)	
Flight		1058°F (570°C)(6)		
Acceleration T.O. (4)		1022°F (550°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.F. for procedures related to oil temperature.

C. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-209

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 7,850 RPM (95.5 percent) for N_1 and 12,150 RPM (99.2 percent) for N_2.

2) Engines run at speeds between 7,850 - 8,150 RPM (95.5 - 99.2 percent) N_1 or 12,150 - 12,370 RPM (99.2 - 101.0 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) function and determine cause and correct problem prior to reactivating ART (RTT) function.

3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,370 RPM (101.0 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,370 - 12,550 RPM (101.0 - 102.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.C.(1)(a)1) or Paragraph 2.C.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If visual inspection reveals physical damage, or if N_1 speed exceeds 8,450 RPM (102.8 percent), or if N_2 speed exceeds 12,550 RPM (102.5 percent) proceed as follows:

1) Remove high and low compressors and perform complete overhaul inspection.

2) Inspect all turbine disks for growth and hardness.

3) Inspect all turbine blades for stretch.

4) Inspect all disks and blades by fluorescent penetrant.

D. Overtemperature

(Figure 502), (Figure 503), (Figure 503)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition. (Figure 502), (Figure 503), (Figure 503)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C (see Figure 505 or Figure 506), it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time at peak temperature.

(5) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

E. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near or above maximum values listed above shall be investigated promptly.

F. Oil Inlet Overtemperature Limits and Procedures

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

G. Operating Limits and Performance Data

(1) For JT8D-217, JT8D-217A,: JT8D-217C, JT8D-219: See Table 503.

Table 503 Engine Check Chart For JT8D-217, -217A, -217C, -219

Oil: PWA 521			FUEL: SB 2016	
Operating Conditions			**Operating Limits**	
Thrust Setting	**Time Limit (Minutes)**	**Max. Observed Exhaust Gas Temp. °F/(°C)**	**Oil Pressure (PSIG) Normal (7) (8)**	**Maximum Oil Temperature °F(°C) (10)**
Maximum Takeoff	5 (3)	1157°F (625°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Normal Takeoff	5	1094°F (590°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Idle	Continuous	896°F (480°C) (5)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Starting				
Ground		932°F (500°C)	(9)	
Flight		1157°F (625°C) (6)		
Acceleration (Maximum Takeoff) (4)	2	1166°F (630°C)	40-55 (275.8 - 379.2 kPa)	275°F (135°C)
Acceleration (Normal Takeoff)	2	1103°F (595°C)		

(a) NOTES:

1) Whenever any of the operating limits shown in the ENGINE CHECK CHART and accompanying NOTES are exceeded, the operating crew must take whatever action is necessary, flight condition permitting, to return operation within limits. All such incidents should be recorded in the Aircraft Flight Log, stating the maximum values observed and the length of time above limits or (in the case of low oil pressure) below the limit. This information is essential for effective incident investigation by maintenance personnel. Refer to Troubleshooting, for required maintenance actions.

2) Maximum Climb, Maximum Continuous and Maximum Cruise thrust varies with altitude and with ambient temperature relative to standard and standard + 10°C (+ 18°F). (Refer to Engine Ratings and Throttle Settings).

3) Maximum Takeoff Thrust (in Automatic Reserve Thrust Mode) is time-limited to total of five minutes including operating time at both Normal Takeoff and Maximum Takeoff Thrust Levels.

4) During an engine acceleration, the EGT must not exceed, and should stabilize at or below; the rated limit within two minutes of advancing the throttle.

5) 480°C applies when airbleed or power extraction is being used. When no airbleed or power extraction is used, 420°C applies. This is a reference temperature which, if exceeded, would indicate an abnormal engine operating condition. Further operation of an engine exhibiting this condition should be at the discretion of the operator.

6) These temperatures are time-limited to momentary for starting. If the maximum allowable starting temperature is exceeded, the engine should be shut down and inspected per the instructions in this section. The starting period ends when N_2 RPM essentially stabilizes with the aircraft throttle in the Idle detent. The higher in-flight starting temperature limit is required since consistent airstarts are not obtainable at or below the lower ground-start temperature limit.

7) Oil pressure is difference between main oil pump output oil pressure and oil scavenge pump compartment pressure. Oil pressure can be read directly from cockpit gage if transmitter is vented to scavenge compartment of engine; if transmitter is not vented to scavenge compartment, oil pressure may be calculated as follows:

   a) Determine scavenge compartment breather pressure.

   b) Subtract scavenge compartment breather pressure from aircraft oil pressure gage reading to determine main oil pressure.

8) Normal oil pressure range is 40 - 55 PSIG (275.8 - 379.2 kPa). When oil pressure above normal is encountered, other engine instruments should be monitored closely for the remainder of the flight, since high oil pressure may indicate a developing internal malfunction. At Idle power level, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages.

   At Idle and above, oil pressure between 35 - 40 psi (241.3 - 275.8 kPa) is undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting.

   Minimum oil pressure is 35 PSIG (241.3 kPa). Oil pressure below 35 psi (241.3 kPa) may result in engine damage and should be avoided whenever possible. If continued operation of an affected engine is considered necessary, its thrust should be reduced to as low a level as flight conditions permit, until a landing is accomplished.

   Oil pressure above and below normal should be reported as an engine discrepancy and should be corrected for the next takeoff.

9) During cold weather starting, oil pressure in excess of 55 PSIG (379.2 kPa) may be evidenced until oil viscosities are reduced by increasing oil temperature. Engine operation is limited to idle power when oil pressure is in excess of 55 PSIG (379.2 kPa) during cold weather starts.

10) See Paragraph 2.F. for procedures related to oil temperature.

H. Engine Overspeed

NOTE: 100 percent N_1 and N_2 speeds are 8,219 RPM and 12,245 RPM, respectively.

(1) JT8D-217

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 7,770 RPM (94.5 percent) for N_1 and 12,285 RPM (100.3 percent) for N_2.

2) Engines run at speeds between 7,770 - 8,150 RPM (94.5 -99.2 percent) N_1 or 12,285 - 12,550 RPM (100.3 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,150 RPM (99.2 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,150 - 8,450 RPM (99.2 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond permissible limits in Paragraph 2.H.(1)(a)1) or Paragraph 2.H.(1)(b)1) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,584 RPM (102.8 - 104.4 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is continued-in-service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(1)(e) below if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(1)(e) below if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(1)(e) below if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and (PAGEBLOCK 72-00-00/601 Config 1).

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

   a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

   b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

   a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is returned to service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,584 RPM (104.4 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(2) JT8D-217A, -217C

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,080 RPM (98.3 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,080 - 8,350 RPM (98.3 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,459 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12.675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.H.(2)(a) or Paragraph 2.H.(2)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(2)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(2)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(2)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and PAGEBLOCK 72-00-00/601 Config 1.

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

    a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

    b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

    a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

    b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

9) If an engine has 5th stage compressor blades PN 778505, disassemble the front compressor and replace these blades before the engine is continued-in-service.

10) Visually examine the 4th stage turbine blades to make sure that no blade shrouds are missing. Repair any 4th stage turbine with missing shrouds before the engine is continued-in-service.

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

(3) JT8D-219

(a) Normal Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,120 RPM (98.8 percent) for N_1 and 12,350 RPM (100.9 percent) for N_2.

2) Engines run at speeds between 8,120 - 8,350 RPM (98.8 - 101.6 percent) N_1 or 12,350 - 12,550 RPM (100.9 - 102.5 percent) N_2 at Normal Takeoff power: deactivate ART (RTT) system and determine cause and correct problem prior to reactivating ART (RTT) system.

3) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Normal Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(b) Maximum Takeoff power level engine speed limits.

1) Maximum permissible operating speeds are 8,350 RPM (101.6 percent) for N_1 and 12,550 RPM (102.5 percent) for N_2.

2) Engines run at speeds between 8,350 - 8,450 RPM (101.6 - 102.8 percent) N_1 or 12,550 - 12,675 RPM (102.5 - 103.5 percent) N_2 at Maximum Takeoff power must be given thorough visual inspection, rotors must be checked for free rotation, and cause of overspeed must be determined and corrected prior to continuing engine in service.

(c) All excursions beyond allowable limits in Paragraph 2.H.(3)(a) or Paragraph 2.H.(3)(b) must be reported as engine discrepancies. Discrepancy report shall include maximum rotor speed attained and exposure time of rotor to speed above limits.

(d) If an engine operates between 8,450 - 8,795 RPM (102.8 - 107.0 percent) N_1, examine the engine to make sure that the rotors turn freely. Find and correct the cause of the overspeed before the engine is returned to service. These procedures are also applicable:

1) If more than one engine on an aircraft has an overspeed event above 8,450 RPM (102.8 percent), it will be necessary to replace all engines except one before continued service (there must be one or more engines on the aircraft which did not have an overspeed).

NOTE: It is permitted to install an engine with an overspeed, without overhaul, on an aircraft if all overspeed and overtemperature procedures are completed.

2) Do the inspections specified in Paragraph 2.H.(3)(e) if the overspeed is the second event since the last engine disassembly and overhaul.

3) Do the inspections specified in Paragraph 2.H.(3)(e) if there was more than one surge during the overspeed event.

4) Do the inspections specified in Paragraph 2.H.(3)(e) if N_1 went above 8,450 RPM for more than 60 seconds.

5) Do a visual inspection of the 1st stage compressor blades. Refer to Alert Service Bulletin A6241 and PAGEBLOCK 72-00-00/601 Config 1.

6) Do a local fluorescent penetrant inspection of the 1st stage compressor blades by SPOP 70 (ultra-high sensitivity). No crack indications are permitted.

a) Remove the inlet case to get access to the 1st stage compressor stage for fluorescent penetrant inspection. (SUBJECT 72-23-00)

b) Do fluorescent penetrant inspection of the concave and convex surfaces of the blade airfoil, from the root platform radially outward from the leading edge to one-half inch (12.7 mm) axially rearward along the chord of the blade. (Figure 507)

7) Do the turbine blade shroud tightness check in SB 6224 or its equivalent on the 3rd and 4th stage turbine blades within:

a) 20 hours/cycles (whichever comes first) if SB 6224 or its equivalent was not incorporated before.

b) 100 hours/cycles (whichever comes first) if SB 6224 was incorporated before.

8) There cannot be more than one engine on an aircraft which had overspeed events (if an engine was disassembled and given overhaul inspection because of overspeed, and was found to be in good condition, this is not applicable).

(e) If visual inspection finds physical damage, or if N_1 went above 8,795 RPM (107.0 percent), or if N_2 went above 12,675 RPM (103.5 percent), do these procedures:

1) Remove the front or rear compressor drive rotor which had the overspeed and do a full overhaul inspection.

2) Do growth and hardness inspections on the disks of a rotor which had the overspeed.

3) If the N_2 had the overspeed, do a stretch inspection of the 1st stage turbine blades.

4) Do fluorescent penetrant inspection of all disks in rotors which had this overspeed event.

I. Overtemperature

(Figure 502)

(Figure 505)

(Figure 506)

(1) Conditions of overtemperature may be incurred either in the aircraft or on the test stand. Such conditions may be anticipated by excessively rapid increase in fuel flow, high pressure compressor RPM and/or temperature. When an overtemperature condition is anticipated or has occurred on the test stand, perform normal engine shutdown. Avoid an emergency shutdown unless it is obvious that continued engine operation would result in more than overtemperature damage. The engine should not be restarted until the cause of the overtemperature is corrected and inspection shows that both compressors will rotate normally.

(2) Several momentarily high overtemperatures have as profound an effect on the expected service life of an engine as a single prolonged overtemperature of lesser degree. The higher the overtemperature, the less the time interval before serious engine damage occurs and, therefore, the more extensive the inspection required. Conversely, the lower the overtemperature the more time before serious damage occurs and the less stringent the inspection required.

(3) The overtemperature limits present the inspection procedures to be followed after an engine has been subject to an overtemperature condition.

(Figure 502)

(Figure 505)

(Figure 506)

(a) All turbine parts must get the usual overhaul inspections (to include blade stretch inspection and disk growth and hardness inspection).

(b) Discard turbine blades and vanes if they show indications of overtemperature (refer to the JT8D Engine Manual).

(c) If the engine had more than one surge during an overtemperature event, send the engine to overhaul for disassembly and overhaul inspection.

(4) When the EGT on more than one engine on an aircraft goes into Area C (see Figure 505 or Figure 506), it will be necessary to replace all engines except one on the aircraft before continued service (there must be one or more engines on the aircraft which did not have an overtemperature).

NOTE: It is permitted to install an engine with an overtemperature, without overhaul, on a different aircraft if all overspeed and overtemperature procedures are completed.

Action required as a result of an overtemperature occurrence is based on the following:

1. Temperature band that peak engine temperature reaches.

2. Where time limit such as "five seconds or less" is specified in figure, time limit applies to time within applicable temperature band and not to time peak temperature.

(5) It is always possible that a high temperature indication is not correct, that it is the result of other causes. Operators sometimes find overtemperature indications that are apparently incorrect. Full scale indications, indications that are intermittent or do not show on the scale, or indications over the usual EGT limits can be incorrect if engine EPR, fuel flow, N_1, and N_2 are at their usual levels. When there is an EGT increase, there is usually an increase in fuel flow.

NOTE: See Troubleshooting (Indication System) and Troubleshooting (Power and Engine Response - Hot Start) for procedures to find EGT indication problems which are apparently not related to engine condition.

(a) To find if overtemperature indications are correct, do an analysis of the engine operation data from the aircraft DFDR, or other systems that record (at the minimum) EGT, EPR, and fuel flow. N_1 and N_2 will help in this analysis also (it is very possible that the pilot did not have time to record these parameters when the EGT went above limits). All data recorded during the indication will help to find if the overtemperature indication is correct or incorrect.

(b) If the engine power was stable in its EPR, N_1, and N_2 indications, the apparent overtemperature indication is incorrect if the fuel flow did not change (this is not applicable to hung starts or other conditions when N_2 is below Idle).

(c) If analysis of the engine data finds that the EGT indication was not correct, the overtemperature limits and procedures in this section are not applicable. Do all necessary inspection and repair of the EGT system to correct the defect.

NOTE: Borescope inspection of the 2nd stage turbine blades and vanes is a recommended precaution.

J. Guideline Oil Consumption Values

(1) Normal oil consumption is between 0.0125 U.S. gallons (48 cc) per hour and 0.16 U.S. gallons (606 cc) per hour in normal operation.

(2) Sudden increase or continually increasing trend in oil consumption to a value near, or above maximum values listed above shall be investigated promptly.

Table 504

KEY TO Figure 505

CHART ZONE	ACTION
A	Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B. An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.
	NOTE: A 25 flight hour fly back interval is permitted before doing Zone B corrective action. Another excursion into Zone A during the fly back interval requires the completion of Zone B corrective action before the next flight. Subsequent excursions into Zone A get Zone B corrective action.
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Disassemble the engine hot section and do full overhaul inspection.
	NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.
	or Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the procedures specified for Zone D.
D	Disassemble the engine hot section and do full overhaul inspection.
	NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.
F	Deactivate the ART system and find the cause of the overtemperature. Correct the cause before the ART system is actuated.

Table 504 (Continued)

KEY TO Figure 505	
CHART ZONE	**ACTION**
	If an engine goes into Zone F four times since the last time the engine hot section got full disassembly and inspection, and an external cause for the overtemperature is not found, a borescope inspection (refer to Inspection/Check-01) can often find the problem (an internal condition can be the cause of the overtemperature).
G	No action necessary

NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades.

NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades.

NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.

Table 505

KEY TO Figure 506	
CHART ZONE	**ACTION**
A	De-energize the ART system and find the cause of the overtemperature. Correct the cause before the ART system is energized. Total time in this zone must not be more than 30 seconds per event. After a longer time the engine must get the actions specified in Zone B. An engine which goes into Zone A four times since its last hot section disassembly and inspection must get the procedures specified for Zone B.
B	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone B four times since its last hot section disassembly and inspection must get hot section disassembly and inspection.
C	De-energize the ART system. Determine the cause of the overtemperature and correct the cause before the ART system is energized. Disassemble the engine hot section and do full overhaul inspection.

Table 505 (Continued)

KEY TO Figure 506	
CHART ZONE	**ACTION**
NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.	
	or Do the Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred). (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1) An engine which goes into Zone C two times since its last hot section disassembly and inspection must get the procedures specified for Zone D. Total time in this zone must not be more than 30 seconds per event. An engine above these limits must get the procedures specified for Zone D.
D	Disassemble the engine hot section and do full overhaul inspection.
NOTE: Do an optical metallographic inspection of one (1) 1st stage turbine blade by the JT8D-200 Engine Manual, Section 72-52-01, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000°F (1093°C), the 1st stage turbine blades have an overtemperature condition and it is necessary to discard all the 1st stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-52-01, Inspection-01 to all the 1st stage turbine blades.	
G	No action necessary
NOTE: If the 1st stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 2nd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-11, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 2nd stage turbine blades have an overtemperature condition and it is necessary to discard all the 2nd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-11, Inspection-01 to all the 2nd stage turbine blades. NOTE: If the 2nd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 3rd stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-12, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 3rd stage turbine blades have an overtemperature condition and it is necessary to discard all the 3rd stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-12, Inspection-01 to all the 3rd stage turbine blades. NOTE: If the 3rd stage turbine blades had an overtemperature condition, do an optical metallographic inspection of one (1) 4th stage turbine blade by the JT8D-200 Engine Manual, Section 72-53-13, Inspection-02. If this inspection shows that the blade had a temperature of more than 2000~F (1093~C), the 4th stage turbine blades have an overtemperature condition and it is necessary to discard all the 4th stage turbine blades in the rotor. If the test blade does not have an overtemperature condition, do the procedures in the Engine Manual, Section 72-53-13, Inspection-01 to all the 4th stage turbine blades.	

K. Oil Inlet Overtemperature Limits and Procedures.

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 275°F (135°C) for not more than 15 minutes, the engine may be continued in service only after cause of temperature has been determined and corrected. If oil-in temperature exceeds maximum steady state temperature limit of 275°F (135°C) for more than 15 minutes but does not exceed 329°F (165°C), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

(2) After complying with the above and providing no engine damage is indicated, engine may be continued in service.

(3) If oil-in temperature exceeds 329°F (165°C) for any interval, remove engine to overhaul and inspect all main and accessory drive bearings for hardness and condition. All main shaft seals shall be inspected for condition.

L. Engine Windmilling or Oil Pressure Interruption/Low Oil Pressure

NOTE: You must record operating conditions before and after any oil pressure interruption, low oil pressure indication, engine shutdown and windmilling to find classification of windmilling.

NOTE: The classification of windmilling is based on time and oil pressure. Although the engine must show continuous oil pressure after shutdown, the oil pressure after in-flight shutdown (IFSD) (after the engine becomes stable) is what is used for the classification of the windmilling. Because oil pressure is a function of ram air, this pressure will usually decrease to less than 10 psi (68.9 kPa) during the descent and approach phases. Also the oil pressure can show zero when the ram air can no longer cause sufficient oil pump rotation (during landing, rollout, and taxi). These conditions are acceptable and do not change the classification of windmilling.

(1) Engine Windmilling

(a) Inspect all engines that have windmilled as a result of shutdown in flight.

NOTE: Operator must also do all corrective actions necessary to find cause of in flight engine shutdown.

(b) If an engine windmilled for 30 minutes or less, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can continue in service after satisfactory inspection of main oil filter and chip detectors (if installed), servicing of engine and ground run-up.

NOTE: Ground run-up is a normal start, followed by five minutes at idle then a normal shutdown.

Chip detectors are optional equipment. If installed, they are part of windmilling inspection procedure.

(c) If an engine windmills for more than 30 minutes but less than 60 minutes, with more than 10 psi (68.9 kPa) of continuous oil pressure after shutdown, it can be continued in service after satisfactory examination of main oil filter and chip detectors (if installed), servicing of engine and ground run-up. In addition, use a Spectrometric Oil Analysis Program (SOAP) requesting concentrations of Iron (Fe), Vanadium (V) and Molybdenum (Mo) as indicators of main shaft bearing distress. Refer to JT8D Oil Monitoring Guide (P&W Part Number 821432), Section "G" for more information on SOAP. Do main oil filter, chip detectors (if installed) and SOAP inspection after first flight, at 15 hours, at 50 hours and at 100 hours. Do any corrective action required.

NOTE: JT8D Oil Monitoring Guide - Part No. 821432

This guide describes the inspections and tests that can be done to the engine oil to find if there is something that should be done before it leads to an untimely removal of the engine. This guide will show various inspections and tests, in its own section that will identify and describe each, as well as provide information as to the results that will be found and how to understand them to best maintain the engine. For this purpose, the guide also includes tables and illustrations that give guidelines or samples of “limits” used in the field for various analysis techniques.

(d) If an engine windmilled for more than 60 minutes with more than 10 psi (68.9 kPa) of continuous oil pressure after engine shutdown or engines that windmilled for any length of time with 10 psi (68.9 kPa) or less oil pressure after shutdown, operator must disassemble it for an Oil System Components Inspection.

NOTE: Oil System Components Inspection includes a visual and dimensional inspection of all Bearings (Main and Accessory), seals and gears in both Engine and Main Accessory Gearbox. Do a careful inspection of No. 2, 3, 4 and 5 bearings. Bearing cages must not show excessive wear. No ball or roller skidding, loss of hardness or shape because of overheating is permitted. Acceptable parts may be continued in service.

(2) Oil Pressure Interruption/Low Oil Pressure

CAUTION: ANY POWER OPERATION AT OR ABOVE IDLE WITH OIL PRESSURE OF 34 PSI (234.4 KPA) OR LESS REQUIRES ENGINE TO BE DISASSEMBLED FOR AN OIL SYSTEM COMPONENTS INSPECTION.

(a) Be careful to operate engine with sufficient oil pressure.

M. Breather Pressure

(1) General

(a) Breather pressure is differential between gearbox internal pressure and pressure at gearbox breather discharge port.

(b) Prior to checking breather pressure, it is important to remove all hardware for gearbox breather port, including short breather outlet duct. Experience has shown that this duct affects reading obtained, and correction factors have been unreliable.

(2) Limits

(a) During acceptance test, breather pressure as determined by the differential between engine accessory gearbox pressure and the pressure measured in the disposal system immediately adjacent to the accessory gearbox discharge port shall not exceed 1.8 psi (12.4 kPa). Allow engine to remain at Normal Takeoff two minutes minimum. Record the breather pressure (see NOTE below). Bring the engine power back to idle. Shut the engine down.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

NOTE: Engines with breather pressure tests conducted using continuous permanent recording equipment may be continued in service if the steady state limit of 1.8 psi (12.4 kPa) is exceeded for not more than 30 seconds and the pressure level does not exceed 3.0 psi (20.7 kPa). An engine accepted to this additional limit must be put on watch and a repeat test conducted every 50 cycles thereafter.

N. Fuel and Oil Leakage Limits

(1) Fuel or oil leakage from overboard drains, accessory drive seal drains, or No. 6 bearing sump is acceptable provided leakage is within the following limits:

Table 506

Location	Fluid	Allowable Leakage
Gearbox Starter Drive Overboard Drain	Oil	10 cc/hr
Gearbox Hydraulic Pump Drive Overboard Drain	Oil	10 cc/hr
No. 1, 2 And 3 Bearing Fluid Seal Drain	Oil	0.5 cc/min (10 drops per min) from each drain.
No. 4 Bearing Air Check Valve	Oil	Oil leakage from check valve at Idle power is normal.
Fuel Pump Drive Overboard Drain	Oil	10 cc/hr
Fuel Pump Drain	Fuel	60 cc/hr with engine running or shut down
Fuel Control Drain	Fuel	None
P&D Valve	Fuel	None
Exhaust Case - No. 6 Bearing Sump	Oil	Oil wetness not resulting in oil puddling within 20 minutes after engine shutdown.
Combustion Chamber Drain	Fuel	1. No leakage with engine running. 2. 90 cc maximum one time upon engine shutdown. 3. 60 cc/hr maximum after engine shutdown.
Combustion Chamber Drain and/or Wet 1st Stage Turbine Vanes/Blades	Oil	1. For engines without SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed: a. Be sure the condition seen is oil leakage and not fuel leakage. b. Operate the engine at idle for five minutes, then approximately cruise power or 1.8 EPR for five minutes, then at idle again for five minutes. Then shut down. c. After engine shutdown look for oil leakage from the combustion chamber drain (when it occurs, leakage usually starts ten minutes or less after shutdown). d. Engine removal for repair is necessary if oil leakage from the combustion chamber drain is more than 40 drops (or 2.0 cc), per minute. If oil leakage from the drain is less than 40 drops (or 2.0 cc), the engine can return to service with these limits: 1) Do a breather pressure test (must be in limits). 2) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection).

NOTE: Oil leakage from the combustion chamber drain and/or wet 1st stage turbine vanes/ blades is not permitted if the engine is post SB A6196 - Improved No 5. bearing oil return and compartment sealing.

Table 506 (Continued)

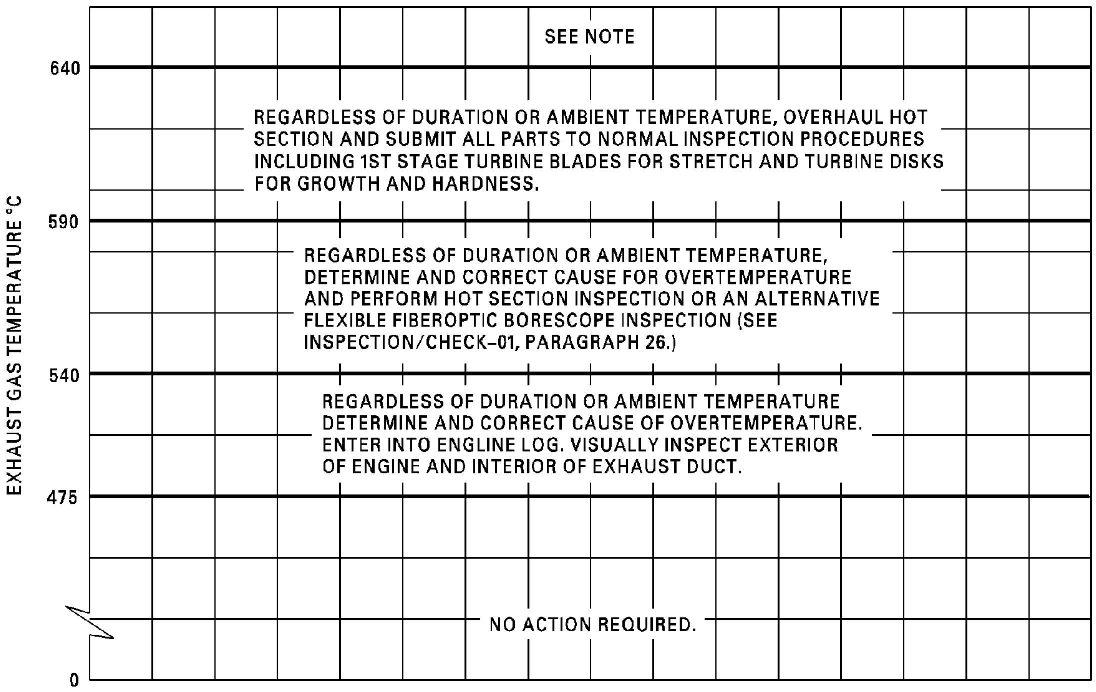
Location	Fluid	Allowable Leakage
		3) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 2. For engines with SB A5944/SB 6101 No. 4 and 5 scavenge oil temperature indicators previously installed: a. Be sure the condition observed is oil leakage and not fuel leakage. b. Do a visual inspection of the No. 4 - 5 scavenge oil temperature indicators as specified in SB A5944/SB 6101. c. If indicator color has changed, do corrective action as specified in SB A5944/SB 6101. d. If indicator color did not change, return engine to service with these limits: 1) Monitor engine oil consumption. If there is a sudden increase, or if consumption increases and continues to increase above the maximum value specified in this section, examine the engine to find the cause (include the above items in the inspection). 2) Monitor the main oil inlet temperature. (This temperature must be within the Maintenance Manual limits). 3) Monitor the SB A5944/SB 6101 indicators at the intervals given in SB A5944/SB 6101.

(2) If leakage is found outside of the above limits the problem shall be repaired and the engine further tested using the following as a guide.

(a) For overboard drain leakage, run engine for five minutes at Max. Continuous and five minutes at Normal Takeoff.

(b) For accessory drive seal leakage and parting surface leakage, run engine for ten minutes at Max. Continuous and five minutes at Normal Takeoff.

JT8D-209, -217,-217A -217C, -219
GROUND STARTING OVERTEMPERATURE
AND INSPECTION PROCEDURE



REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, OVERHAUL HOT SECTION AND SUBMIT ALL PARTS TO NORMAL INSPECTION PROCEDURES INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND TURBINE DISKS FOR GROWTH AND HARDNESS.

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, DETERMINE AND CORRECT CAUSE FOR OVERTEMPERATURE AND PERFORM HOT SECTION INSPECTION OR AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE INSPECTION/CHECK-01, PARAGRAPH 26.)

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE DETERMINE AND CORRECT CAUSE OF OVERTEMPERATURE. ENTER INTO ENGLINE LOG. VISUALLY INSPECT EXTERIOR OF ENGINE AND INTERIOR OF EXHAUST DUCT.

NO ACTION REQUIRED.

NOTE:

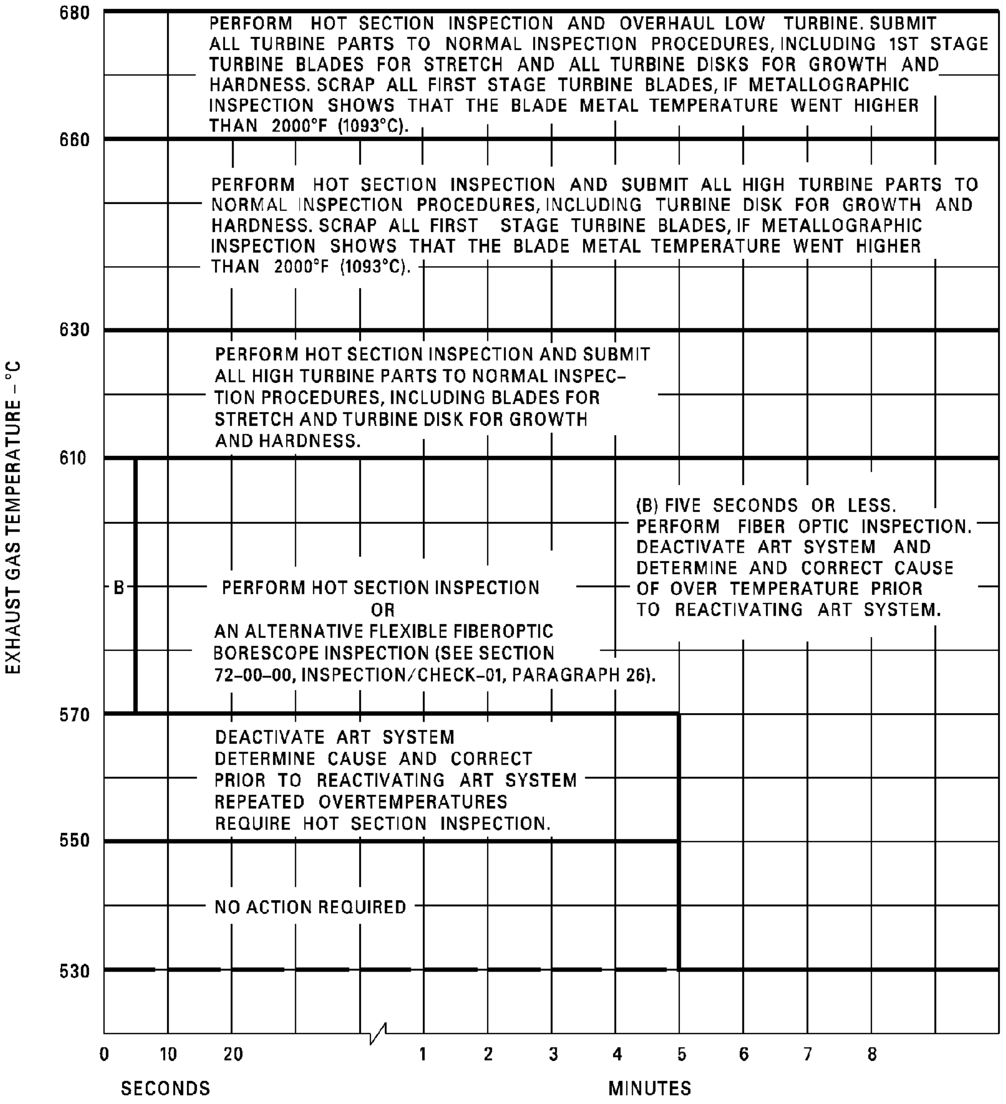
FOR EXHAUST GAS TEMPERATURES IN EXCESS OF 1184°F (640°C), REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION, HAS NOT EXCEEDED 2000°F (1093°C), AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000°F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS FOR GROWTH AND HARDNESS.

CAG(IGDS)

BBB2-72-558A

Ground Starting Overtemperature Limits and Inspection Procedures
Figure 502/72-00-00-990-957

JT8D–209
NORMAL TAKEOFF
OVERTEMPERATURE LIMITS AND INSPECTION



PERFORM HOT SECTION INSPECTION AND OVERHAUL LOW TURBINE. SUBMIT ALL TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING 1ST STAGE TURBINE BLADES FOR STRETCH AND ALL TURBINE DISKS FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING TURBINE DISK FOR GROWTH AND HARDNESS. SCRAP ALL FIRST STAGE TURBINE BLADES, IF METALLOGRAPHIC INSPECTION SHOWS THAT THE BLADE METAL TEMPERATURE WENT HIGHER THAN 2000°F (1093°C).

PERFORM HOT SECTION INSPECTION AND SUBMIT ALL HIGH TURBINE PARTS TO NORMAL INSPECTION PROCEDURES, INCLUDING BLADES FOR STRETCH AND TURBINE DISK FOR GROWTH AND HARDNESS.

PERFORM HOT SECTION INSPECTION
OR
AN ALTERNATIVE FLEXIBLE FIBEROPTIC BORESCOPE INSPECTION (SEE SECTION 72–00–00, INSPECTION/CHECK–01, PARAGRAPH 26).

(B) FIVE SECONDS OR LESS. PERFORM FIBER OPTIC INSPECTION. DEACTIVATE ART SYSTEM AND DETERMINE AND CORRECT CAUSE OF OVER TEMPERATURE PRIOR TO REACTIVATING ART SYSTEM.

DEACTIVATE ART SYSTEM
DETERMINE CAUSE AND CORRECT PRIOR TO REACTIVATING ART SYSTEM
REPEATED OVERTEMPERATURES REQUIRE HOT SECTION INSPECTION.

NO ACTION REQUIRED

NOTE:

REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR–COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

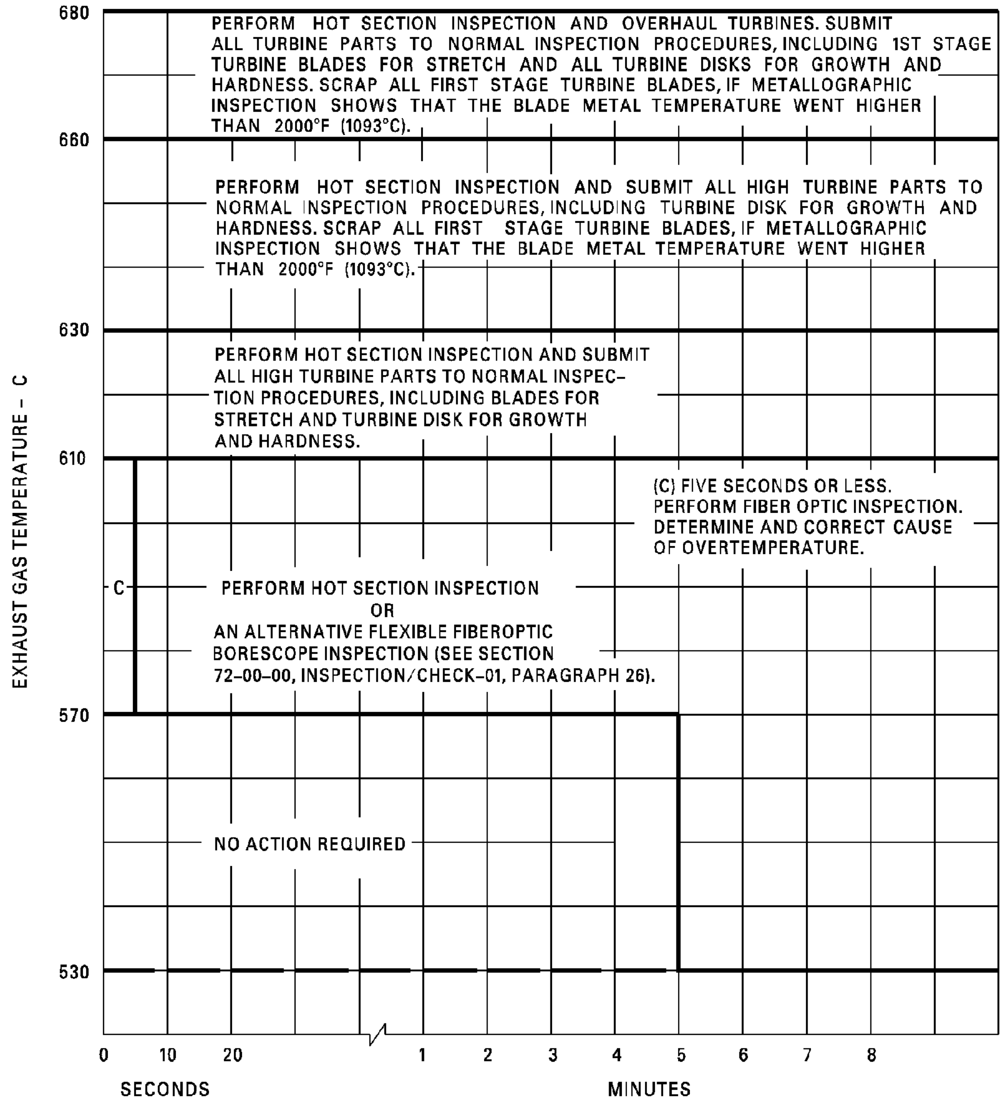
L–89086 (0299)

CAG(IGDS)

BBB2–72–163C

Normal Takeoff Overtemperature Limits and Inspection Procedures
Figure 503/72-00-00-990-958

JT8D-209
MAXIMUM TAKEOFF AND AIR STARTING
OVERTEMPERATURE LIMITS AND INSPECTION



NOTE:

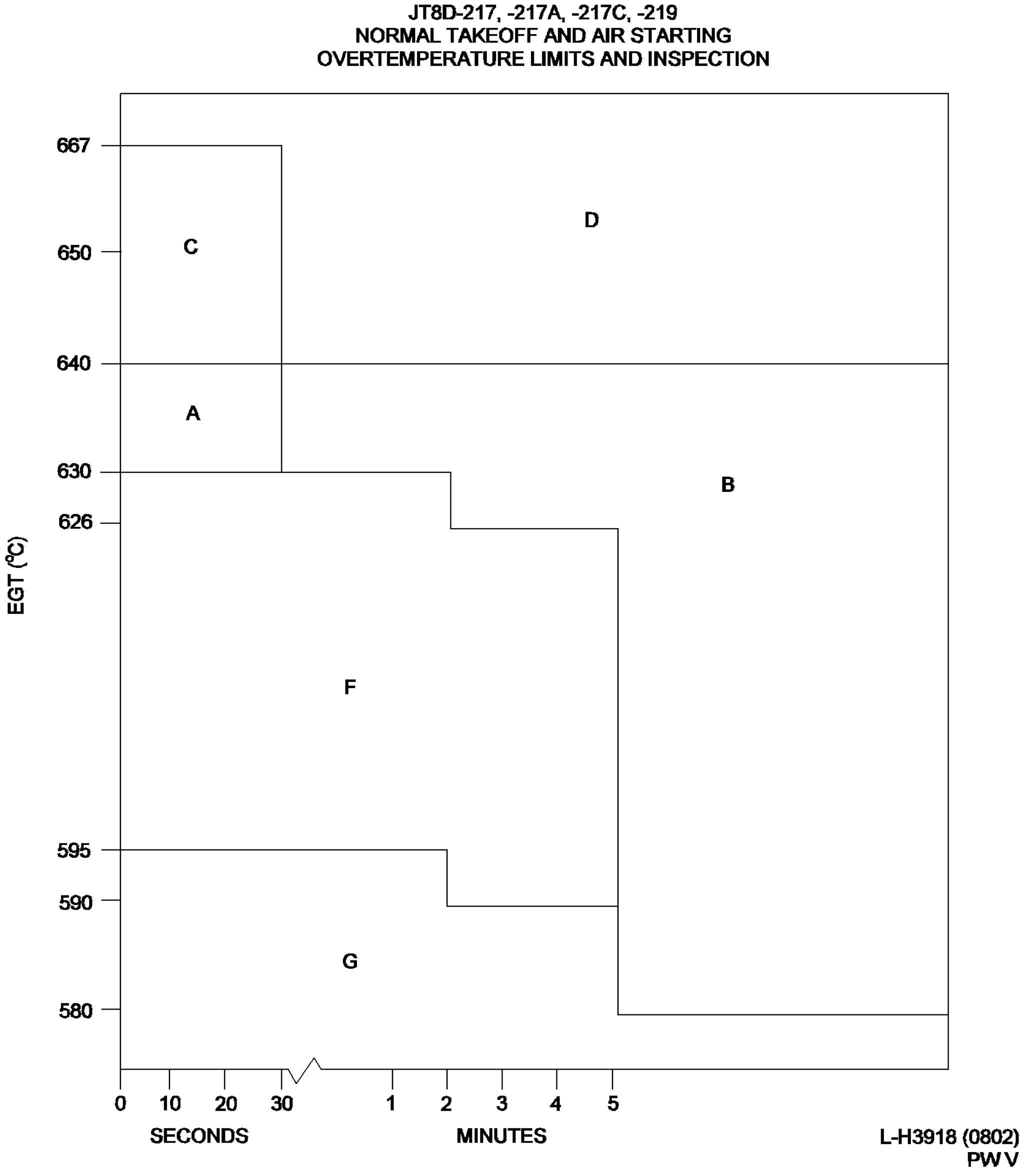
REGARDLESS OF DURATION OR AMBIENT TEMPERATURE, 1ST AND 2ND STAGE BLADES AND 2ND AND 3RD STAGE VANES MAY BE REUSED PROVIDING MAXIMUM METAL TEMPERATURE, DETERMINED BY OPTICAL METALLOGRAPHIC EXAMINATION HAS NOT EXCEEDED 2000°F (1093°C) AND BLADES MEET ALL OTHER INSPECTION CRITERIA. BLADES WHICH HAVE EXCEEDED TEMPERATURE OF 2000 F (1093°C) SHALL BE SCRAPPED. AIR-COOLED 1ST STAGE VANES AND 4TH STAGE VANES AND 3RD AND 4TH STAGE BLADES MAY BE REUSED IF INSPECTION, ZYGLO, AND MEASUREMENT PROVE THEM SERVICEABLE. INSPECT ALL TURBINE DISKS GROWTH AND HARDNESS.

L-89087 (0299)

CAG(IGDS)

BBB2-72-164C

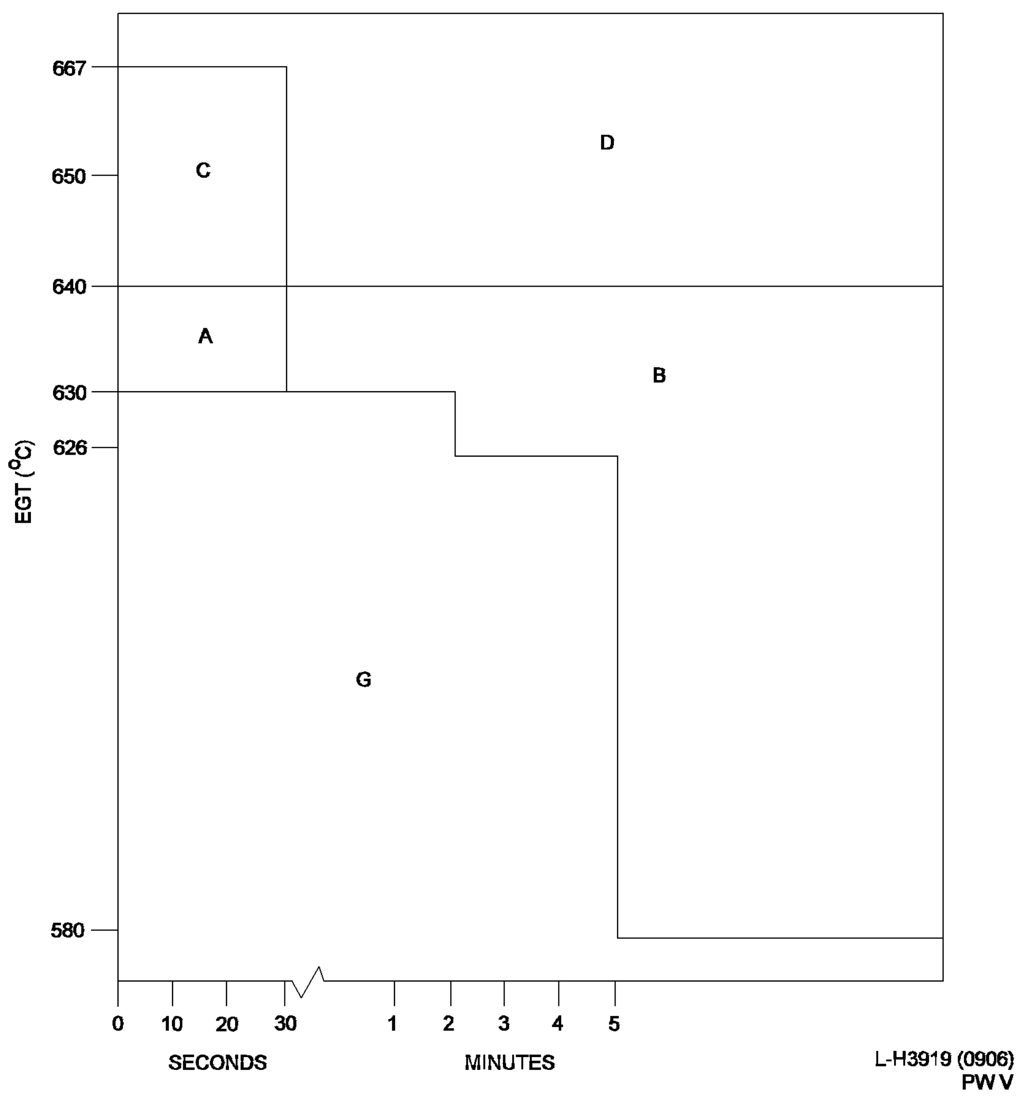
Maximum Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 504/72-00-00-990-959



BBB2-72-549A
S0006554693V2

Normal Takeoff and Airstarting Overtemperature Limits and Inspection Procedures
Figure 505/72-00-00-990-960

JT8D-217, -217A, -217C, -219
MAXIMUM TAKEOFF
OVERTEMPERATURE LIMITS AND INSPECTION



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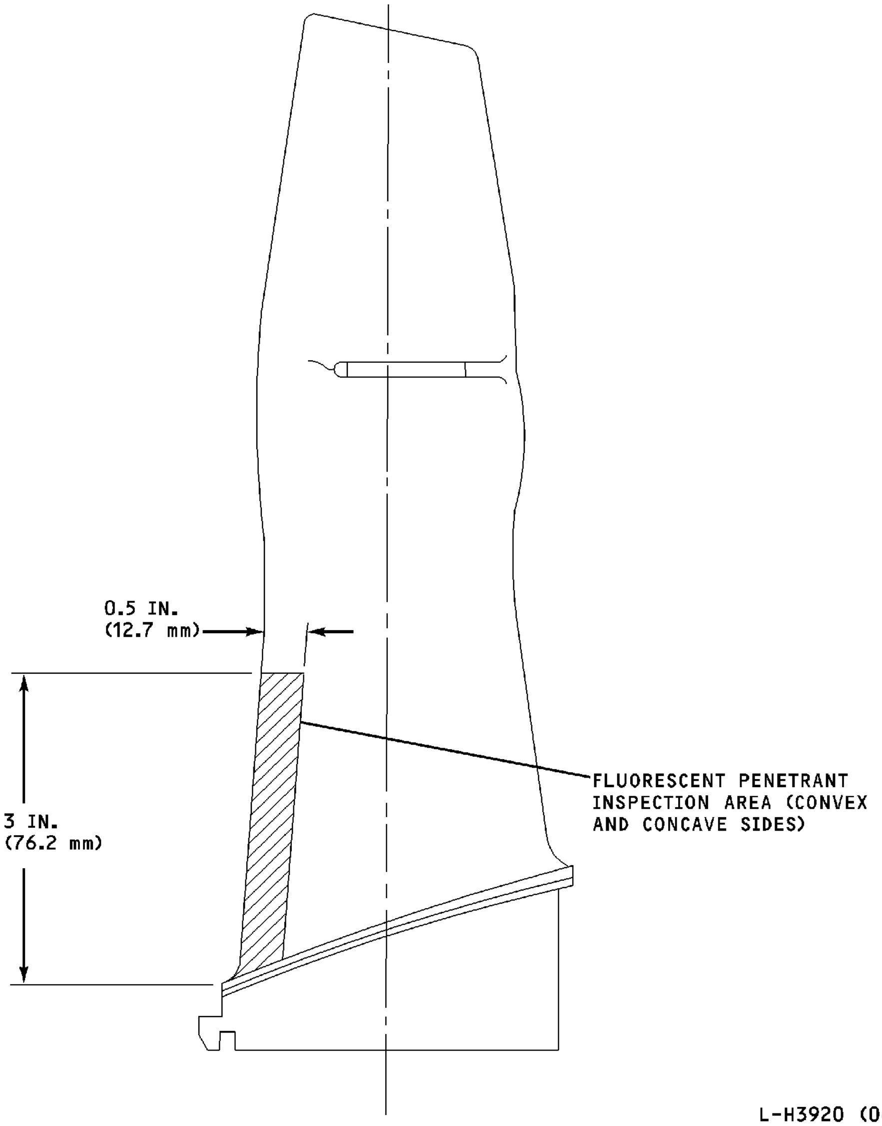
Maximum Takeoff Overtemperature Limits and Inspection Procedures
Figure 506/72-00-00-990-961



First Stage Compressor Blade Inspection Zone
Figure 507/72-00-00-990-962

3. Inspection Prior To Test

A. Fuel System Inspection

(1) Fuel System

(a) Visually check all fuel system tubes and components for security and leakage.

(b) Remove, clean if necessary and install the fuel pump filters.

(c) Remove, clean if necessary and install the fuel control filters.

(d) Check the fuel system for the presence of water.

(e) Service the fuel system with an approved fuel conforming to SB 2016.

NOTE: The engine should be ground tested and trimmed using the same grade fuel as used for flight operations. Slight variations for any given lever position will result if alternate fuels are used.

B. Oil System Inspection

(1) Oil System

(a) Remove, disassemble, clean, and reinstall the main oil strainer. Replace filter if cartridge type.

(b) Visually check all of the oil system tubes and components for security and leakage.

(c) Fill the oil tank with an approved oil conforming to Specification 521 Synthetic Oil.

NOTE: Approved oils are listed in Turbojet Engine Service Bulletin No. 238.

CAUTION: UP TO TWO GALLONS OF OIL MAY BE IN THE SCAVENGE SECTIONS; THEREFORE, OIL MUST NOT BE ADDED TO THE TANK UNTIL THE SCAVENGE SECTIONS ARE CLEANED. IF THE ABOVE PROCEDURE IS NOT FOLLOWED, EXCESSIVE OIL MAY BE ADDED WHICH WILL RESULT IN A BUILDUP OF SUFFICIENT INTERNAL PRESSURE TO RUPTURE THE TANK DURING ENGINE OPERATION.

(d) If oil is required after starting the engine, the engine shall be operated for approximately one minute at IDLE speed. This is required to make certain that any oil which may be in the scavenge section of the engine is returned to the tank, thereby assuring an accurate oil level check.

C. Electrical System Inspection

(1) Electrical System

(a) Check the ignition system components for security.

WARNING: BECAUSE THE VOLTAGE TO THE SPARK IGNITERS IS DANGEROUSLY HIGH, THE IGNITION SWITCH MUST BE IN THE "OFF" POSITION BEFORE REMOVAL OF ANY OF THE IGNITION SYSTEM COMPONENTS. APPROXIMATELY THREE MINUTES OF TIME MUST ELAPSE BETWEEN THE OPERATION OF THE IGNITION SYSTEM AND THE REMOVAL OF COMPONENTS WHEN A SPARK IGNITER LEAD IS DETACHED FROM A SPARK IGNITER, TOUCH THE END OF THE LEAD TO THE SHELL OF THE IGNITER TO DISSIPATE THE RESIDUAL ENERGY.

(b) Remove both spark igniters; check and reinstall.

D. Instrumentation System Inspection

(1) Instrumentation System

(a) Check engine instrumentation for security and general condition.

(b) Inspect the pressure sensing probes for security.

(c) Visually check all indicating thermocouples for security.

(d) Check the thermocouple harness and all lead insulations and shields for chafing and security.

E. Engine Controls Inspection

(1) Engine Controls

(a) Check the power lever for full travel, ease of movement and security.

NOTE: To prevent dilution of the bearing lubrication medium, protect the prepacked bearings used in the power cross shaft assembly during any washing process. The same precautions must be taken when fuel lines near this assembly are disconnected and fuel is, or may be, in these lines.

(b) Inspect the compressor bleed valve, override control, pressure ratio bleed control, and the air tubes for security.

F. Run-Up Area and Engine Inlet Duct Inspection

(1) Run-Up Area and Engine Inlet Duct

(a) Prior to starting the engine, the inlet must be thoroughly inspected and cleaned of possible loose nuts, bolts, tools and other objects which could cause engine damage and possible subsequent failure.

(b) Examine the inlet and exhaust areas to ensure against the presence of foreign objects which could, under some circumstances, enter the engine.

4. Engine Test Procedure

A. Starting Procedure for Pneumatic and Combustion Starters. (GENERAL, SUBJECT 71-00-00, Page 501)

B. Satisfactory Start. (GENERAL, SUBJECT 71-00-00, Page 501)

C. Unsatisfactory Start. (GENERAL, SUBJECT 71-00-00, Page 501)

D. Unsatisfactory Start Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

E. Clear Engine Procedure. (GENERAL, SUBJECT 71-00-00, Page 501)

F. Determination of Corrected N_2 Speed. (Figure 508 and Figure 509)

(1) Corrected N_2 speed is determined as shown in Figure 508.

(2) JT8D engine experience indicates a recommended high rotor data plate speed deterioration limit of plus 1.8 percent minus 0.8 percent corrected RPM be established.

G. Max. Observed Exhaust Gas Temperature & Spread Check.

(1) A check of the exhaust gas measurement system shall be made following a stabilization at Normal Takeoff power. Remove four screws and cover from thermocouple cable junction box located at 7 o'clock on rear rail of turbine exhaust outer duct. Remove nine nuts, chromel bus bar and two leads. Position PWA 45563 Adapter on the studs and secure with nuts previously removed. Torque nuts to 15 - 18 in-lb. (1.695 - 2.034 N·m), then connect instrumentation. Maximum allowable T_{t7} for any single probe reading is the maximum limit with averaging harness plus 110°F (61°C). Readings from each T_{t7} probe shall be recorded and maximum acceptable spread shall not exceed 230°F (127.8°C). Remove PWA 45563 Adapter, reinstall two leads, chromel bus bar and nine nuts. Torque nuts to 15 -18 in-lb. (1.695 - 2.034 N·m), then install and secure junction box cover.

(2) The JT8D Part Power Trim temperature spread check shall not exceed 230°F (127.8°C).

H. Shutdown Procedure. (GENERAL, SUBJECT 71-00-00, Page 501).

I. Anti-Surge Bleed Operation Limits Refer to Paragraph 6.F..

N2 CORRECTION

(1) Corrected N2 (%) $= \dfrac{\text{Observed N2 (\%)}}{\sqrt{\theta}}$

Where: $\sqrt{\theta} = \sqrt{\dfrac{\text{Compressor Inlet Temperature}\ ^{\circ}\text{K}}{288}}$

(2) From the Inlet Temperature Correction Factor Chart determine N2 correction factor ($\sqrt{\theta}$) for compressor inlet temperature -

(3) Divide observed N2 speed by $\sqrt{\theta}$ -

Example: Inlet temperature = 30°C (86°F)

$\sqrt{\theta}$ (From the Inlet Temperature Correction Factor Chart) = 1.026

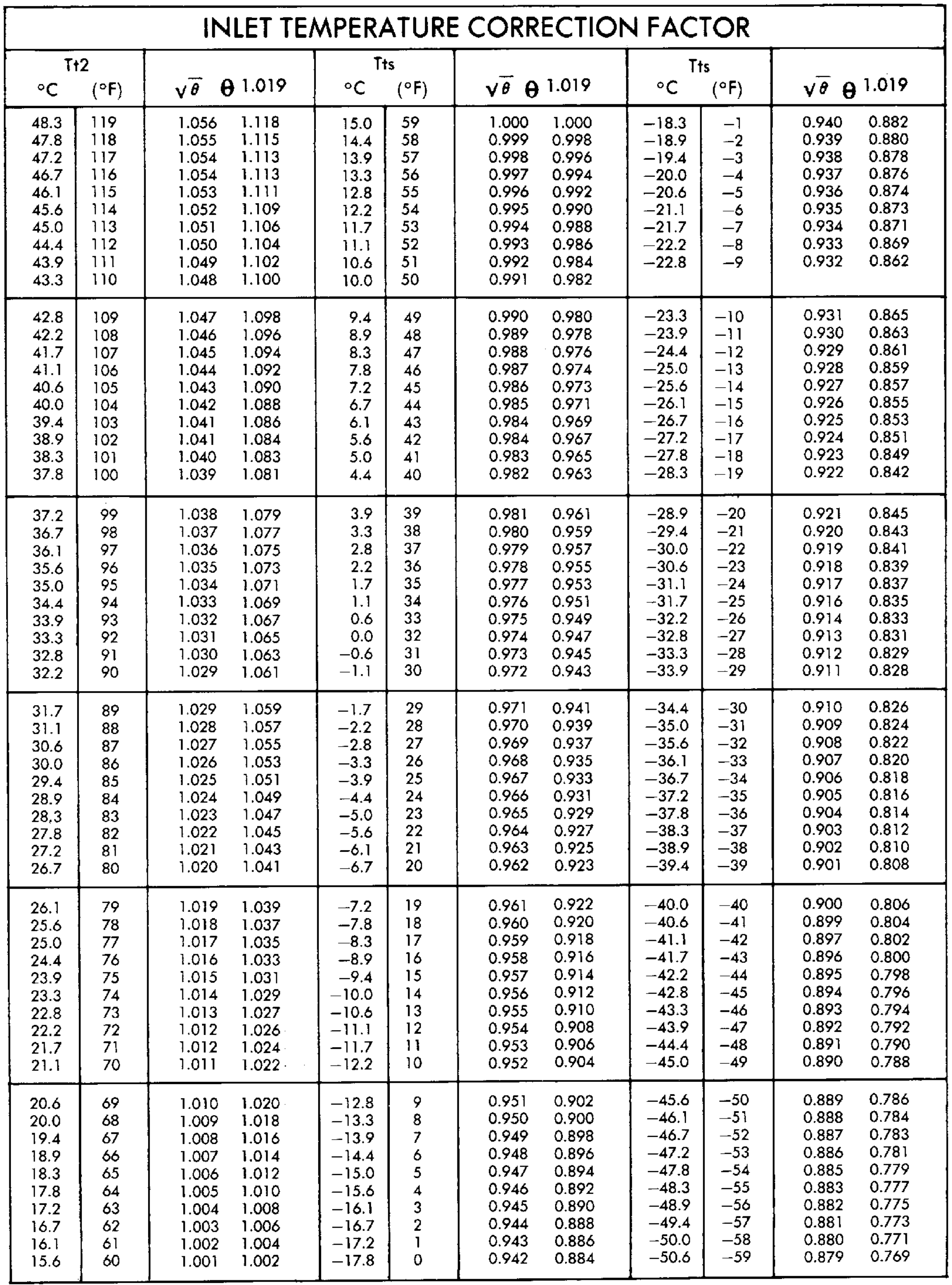
Observed N2 = 87.5%

$$\text{Corrected N2} = \frac{\text{Observed N2 (\%)}}{\sqrt{\theta}} = \frac{87.5\%}{1.026} = 85.3\%$$

L-73295

BBB2-72-54A
S0006554700V2

Rotor Speed Correction
Figure 508/72-00-00-990-963



INLET TEMPERATURE CORRECTION FACTOR

Tt2 °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	Tts °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$	Tts °C	(°F)	$\sqrt{\theta}$	$\theta^{1.019}$
48.3	119	1.056	1.118	15.0	59	1.000	1.000	−18.3	−1	0.940	0.882
47.8	118	1.055	1.115	14.4	58	0.999	0.998	−18.9	−2	0.939	0.880
47.2	117	1.054	1.113	13.9	57	0.998	0.996	−19.4	−3	0.938	0.878
46.7	116	1.054	1.113	13.3	56	0.997	0.994	−20.0	−4	0.937	0.876
46.1	115	1.053	1.111	12.8	55	0.996	0.992	−20.6	−5	0.936	0.874
45.6	114	1.052	1.109	12.2	54	0.995	0.990	−21.1	−6	0.935	0.873
45.0	113	1.051	1.106	11.7	53	0.994	0.988	−21.7	−7	0.934	0.871
44.4	112	1.050	1.104	11.1	52	0.993	0.986	−22.2	−8	0.933	0.869
43.9	111	1.049	1.102	10.6	51	0.992	0.984	−22.8	−9	0.932	0.862
43.3	110	1.048	1.100	10.0	50	0.991	0.982				
42.8	109	1.047	1.098	9.4	49	0.990	0.980	−23.3	−10	0.931	0.865
42.2	108	1.046	1.096	8.9	48	0.989	0.978	−23.9	−11	0.930	0.863
41.7	107	1.045	1.094	8.3	47	0.988	0.976	−24.4	−12	0.929	0.861
41.1	106	1.044	1.092	7.8	46	0.987	0.974	−25.0	−13	0.928	0.859
40.6	105	1.043	1.090	7.2	45	0.986	0.973	−25.6	−14	0.927	0.857
40.0	104	1.042	1.088	6.7	44	0.985	0.971	−26.1	−15	0.926	0.855
39.4	103	1.041	1.086	6.1	43	0.984	0.969	−26.7	−16	0.925	0.853
38.9	102	1.041	1.084	5.6	42	0.984	0.967	−27.2	−17	0.924	0.851
38.3	101	1.040	1.083	5.0	41	0.983	0.965	−27.8	−18	0.923	0.849
37.8	100	1.039	1.081	4.4	40	0.982	0.963	−28.3	−19	0.922	0.842
37.2	99	1.038	1.079	3.9	39	0.981	0.961	−28.9	−20	0.921	0.845
36.7	98	1.037	1.077	3.3	38	0.980	0.959	−29.4	−21	0.920	0.843
36.1	97	1.036	1.075	2.8	37	0.979	0.957	−30.0	−22	0.919	0.841
35.6	96	1.035	1.073	2.2	36	0.978	0.955	−30.6	−23	0.918	0.839
35.0	95	1.034	1.071	1.7	35	0.977	0.953	−31.1	−24	0.917	0.837
34.4	94	1.033	1.069	1.1	34	0.976	0.951	−31.7	−25	0.916	0.835
33.9	93	1.032	1.067	0.6	33	0.975	0.949	−32.2	−26	0.914	0.833
33.3	92	1.031	1.065	0.0	32	0.974	0.947	−32.8	−27	0.913	0.831
32.8	91	1.030	1.063	−0.6	31	0.973	0.945	−33.3	−28	0.912	0.829
32.2	90	1.029	1.061	−1.1	30	0.972	0.943	−33.9	−29	0.911	0.828
31.7	89	1.029	1.059	−1.7	29	0.971	0.941	−34.4	−30	0.910	0.826
31.1	88	1.028	1.057	−2.2	28	0.970	0.939	−35.0	−31	0.909	0.824
30.6	87	1.027	1.055	−2.8	27	0.969	0.937	−35.6	−32	0.908	0.822
30.0	86	1.026	1.053	−3.3	26	0.968	0.935	−36.1	−33	0.907	0.820
29.4	85	1.025	1.051	−3.9	25	0.967	0.933	−36.7	−34	0.906	0.818
28.9	84	1.024	1.049	−4.4	24	0.966	0.931	−37.2	−35	0.905	0.816
28,3	83	1.023	1.047	−5.0	23	0.965	0.929	−37.8	−36	0.904	0.814
27.8	82	1.022	1.045	−5.6	22	0.964	0.927	−38.3	−37	0.903	0.812
27.2	81	1.021	1.043	−6.1	21	0.963	0.925	−38.9	−38	0.902	0.810
26.7	80	1.020	1.041	−6.7	20	0.962	0.923	−39.4	−39	0.901	0.808
26.1	79	1.019	1.039	−7.2	19	0.961	0.922	−40.0	−40	0.900	0.806
25.6	78	1.018	1.037	−7.8	18	0.960	0.920	−40.6	−41	0.899	0.804
25.0	77	1.017	1.035	−8.3	17	0.959	0.918	−41.1	−42	0.897	0.802
24.4	76	1.016	1.033	−8.9	16	0.958	0.916	−41.7	−43	0.896	0.800
23.9	75	1.015	1.031	−9.4	15	0.957	0.914	−42.2	−44	0.895	0.798
23.3	74	1.014	1.029	−10.0	14	0.956	0.912	−42.8	−45	0.894	0.796
22.8	73	1.013	1.027	−10.6	13	0.955	0.910	−43.3	−46	0.893	0.794
22.2	72	1.012	1.026	−11.1	12	0.954	0.908	−43.9	−47	0.892	0.792
21.7	71	1.012	1.024	−11.7	11	0.953	0.906	−44.4	−48	0.891	0.790
21.1	70	1.011	1.022	−12.2	10	0.952	0.904	−45.0	−49	0.890	0.788
20.6	69	1.010	1.020	−12.8	9	0.951	0.902	−45.6	−50	0.889	0.786
20.0	68	1.009	1.018	−13.3	8	0.950	0.900	−46.1	−51	0.888	0.784
19.4	67	1.008	1.016	−13.9	7	0.949	0.898	−46.7	−52	0.887	0.783
18.9	66	1.007	1.014	−14.4	6	0.948	0.896	−47.2	−53	0.886	0.781
18.3	65	1.006	1.012	−15.0	5	0.947	0.894	−47.8	−54	0.885	0.779
17.8	64	1.005	1.010	−15.6	4	0.946	0.892	−48.3	−55	0.883	0.777
17.2	63	1.004	1.008	−16.1	3	0.945	0.890	−48.9	−56	0.882	0.775
16.7	62	1.003	1.006	−16.7	2	0.944	0.888	−49.4	−57	0.881	0.773
16.1	61	1.002	1.004	−17.2	1	0.943	0.886	−50.0	−58	0.880	0.771
15.6	60	1.001	1.002	−17.8	0	0.942	0.884	−50.6	−59	0.879	0.769

L—72305

BBB2-72-23

Inlet Temperature Correction Factor Chart
Figure 509/72-00-00-990-964

5. Repair/Test Reference

(Table 507)

A. General

(1) Repair/test reference table lists various repairs, replacements and reinstallations and corresponding test to be performed following these actions. When more than one maintenance action has been done, combine different features of two or more tests, eliminate duplication, and perform resultant test during one period of operation. Where multiple tests each require single power setting, higher power setting shall be used.

(2) In order to achieve high degree of accuracy, it is recommended that all tests be conducted in P&W approved indoor test facility previous to installing engine in aircraft. However, in cases where such test facility was not available or if operator prefers to test engine on aircraft, test requirements are indicated in Table 507.

(3) It should be understood that quality of test data from an on-the-wing engine test may not be as accurate as data generated from indoor engine test facility. While quality of on-the-wing test data should be sufficient to determine if engine is acceptable, operator should be willing to sacrifice certain degree of troubleshooting or trend monitoring capability when relying on installed engine data.

Table 507 Repair/Test Reference

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Accessory Drive Seals	A
Anti-icing Air Shutoff Actuator And Valve	*[2]
Average Pressure Probe P_{t7} (8 Required)	B
Combustion Area Inspection	B
Combustion Chambers	B
Combustion Chamber Duct	F
Combustion Chamber Inner Case	F
Combustion Chamber And Turbine Fan Ducts	C
Compressor Inlet Duct	A
Compressor Inlet Group	A
Compressor Inlet and Front Compressor Section	B, I
Compressor Intermediate Group	F
Constant Speed Drive/Alternator Drive Oil Seal	A
Differential Fluid Pressure Switch	C
Diffuser Group	F
Diffuser Outer Fan Duct Group	C
Eighth Stage Bleed Valve	E
Engine Exhaust Case Section	G
Engine Oil Tank	A
Engine Oil Tank Drain Valve	None

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Fan Exhaust (Mixer) Rear Outer Duct	None
Fan Exhaust Outer Rear (Transition) Duct	None
Fan And Turbine Exhaust Duct (Mixer)	None
Fan Exit Stator Segments	None
First Stage Compressor (Fan) Blades	I(4)
First Stage Compressor Disk And Blade Assembly (Fan)	G(5), I(4)
First Stage Turbine Vanes (Through Hot Section With Turbines Installed)	B, H
First Stage Turbine Vanes (Turbines Removed)	F
Front Accessory Drive Group	A
Front Compressor Drive Turbine Group	F
Front Compressor Drive Turbine Group And Engine Exhaust Case Section Group	F
Front Compressor Drive Turbine Rotor And Stator Assembly	F
Front Compressor Rotor And Stator Assembly	G, I
Front Fan Case	A
Fuel Control (Replacement Fuel Control)	D, H
Fuel Control Condensation Trap	None
Fuel Control Main Filter	C
Fuel Deicing Air Shutoff Actuator And Valve	*[2]
Fuel Deicing Heater Assembly	C
Fuel Nozzle And Support Assemblies	B, H
Fuel Manifold Assembly	B, H
Fuel/Oil Cooler And Seals	C (6)
Fuel/Oil Cooler Bypass Valve And Seals	C (6)
Fuel/Oil Cooler Inlet Tube And Seals	C (6)
Fuel/Oil Cooler Outlet Sensing Tube And Seals	C (6)
Fuel Pressurizing And Dump Valve	C(3)
Fuel Pressurizing And Dump Valve Strainer	C
Fuel Pump (Same Fuel Control)	B(2), H
Fuel Pump Drive Oil Seal	A
Fuel Pump Filter	C
Fuel Pump And Fuel Control Package (Different Fuel Control)	D(2), H
Gearbox Coupling (Constant Speed Drive)	A
Gearbox Deairator Oil Seal	A
Hydraulic Pump Drive Oil Seal	A

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Igniter Plug (2 Required)	*[1]
Ignition Cable (2 Required)	*[1]
Ignition Exciter	*[1]
Main Accessory Gearbox Assembly (Same Fuel Control) (And Fuel Control Connecting Linkage)	B
Main Accessory Gearbox Group (Same Fuel Control)	B
Main Gearbox Drive Bevel Gearshaft And Bearings	B
Main Oil Filter (Strainer) And Seals	C (6)
Main Oil Pump And Seals	C (6)
N_1 Tachometer Drive Oil Seal	A
N_2 Tachometer Drive Gearshaft Oil Seal	A
No. 1 Bearing	G, I
No. 1 Bearing Air Sealing Ring And Seal Assembly	G, I
No. 1 Bearing Oil Scavenge Pump	A
No. 2 Bearing	F
No. 2 Bearing Seal Assembly	G, I
No. 3 Bearing And Seal	F
No. 4 Bearing	F
No. 4 Bearing Seal Assembly	F
No. 4 Bearing Sealing Ring	F
No. 4 And 5 Bearing Oil Pressure/Scavenge Tube (External) And Seals	A
No. 4 And 5 Bearing Oil Breather Tube (External) And Seals	B
No. 4 And 5 Bearing Oil Scavenge Pump	F
No. 4 1/2 Bearing, Seals And Seal Spacers	F
No. 5 Bearing And Seal Assembly	F
No. 6 Bearing And Seals	G, I
No. 6 Bearing Oil Scavenge Pump	A
Oil Filter Pressure Relief Valve And Seals	C (6)
Oil Pressure Relief Valve Assembly	C(1), (6)
Power Lever Cross Shafts	B
Pressure Ratio Bleed Control	E
Rear Compressor And Diffuser Section	F
Rear Compressor Drive Turbine Rotor And Shaft Assembly	F
Rear Compressor Drive Turbine Group	F

Table 507 Repair/Test Reference (Continued)

UNITS REPAIRED, REPLACED OR REINSTALLED	TEST REQUIRED
Rear Compressor Exit Stator Assembly	F
Rear Compressor Through The Rear Compressor Drive Turbine Section	F
Rear Compressor Rotor And Stator Assembly	F
Rear Fan Case	G
Starter Drive Gearshaft Coupling	A
Starter Drive Oil Seal	A
Thermocouple - T_{t7} (8 Required)	None
Thermocouple Box And Cable Assembly - T_{t7}	None
Total Pressure Probe - P_{t2}	E
Turbine Exhaust Cone And Duct	None
Turbine Nozzle Group	F
Turbine Shaft Inner Heat shield Assembly	F
Turbine Shaft Outer Heat shield Assembly	F
13th Stage Bleed Valve	E
13th Stage Compressor Sealing Ring	F

(1) When engine oil pressure adjustment is required, install 0 - 50 PSIG (0.0 - 344.7 kPa) direct-reading gage to LP2 tap on main oil pressure manifold, vented to LV3 tap on main accessory gearbox housing. Adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa at Idle. 100°F (38°C) oil temperature is recommended during oil pressure adjustment. See Paragraph 8..

(2) After replacing fuel pump and performing engine test run, torque fuel pump quick-disconnect nut per PAGEBLOCK 73-00-00/601.

(3) During and after this test, carefully inspect for fuel leakage at fuel manifold inlet tube to P&D valve tube end fittings. No Leakage is permitted.

(4) See the locations that follow for a 24 hour flyback time limit permitted before the vibration check is necessary:

(a) Section PAGEBLOCK 72-00-00/601 Config 1 - Inspect First Stage Compressor Blades.

(b) Section PAGEBLOCK 72-33-21/401 - Replace First Stage Compressor Blades.

(c) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.

(5) See the location that follows for a 24 hour flyback time limit permitted before the breather pressure check is necessary:

(a) Section PAGEBLOCK 72-33-02/401 - Remove First Stage Compressor Disk And Blades Assembly.

(6) Test A (Ground Check at Idle) is an option to Test C for leak check of these replaced parts, but Test A will not give the increased oil pressure that is typical during engine accelerations. If an oil leak problem is possible, use Test C (with the thrust level modification specified for leak check) to see if there are oil leaks.

*[1] Aural Check Igniter Firing With Engine Not Running.

*[2] Observe Valve Position While Actuating Valve With Engine Not Running.

6. Test For Repaired Engines

A. When cleaning engines prior to test, following precautions must be taken.

CAUTION: IF FUEL LINES ARE TO BE DISCONNECTED, PRE-PACKED BEARINGS IN THE AREA MUST BE PROTECTED FROM ANY LOST FUEL.

(1) Protect all prepacked bearings, such as cross-shaft or control rod linkage bearings.

(2) Protect pressure ratio bleed control.

(3) Protect silicone rubber shock mounts on oil tank and oil tank strap. Wash down area as soon as possible after washing with cleaning solution.

B. Test A - Ground Check at Idle

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Allow engine to run at IDLE for minimum of three minutes for oil system repair/replacement as required for oil temperature to reach 100°F (38°C).

(4) Shut down. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

C. Test B - Ground Check at Normal Takeoff

(1) Inspect and clean engine test area.

(2) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Operate engine at IDLE until readings have stabilized and oil temperature reaches minimum of 100°F (38°C).

(4) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(5) Stabilize for three minutes at Normal Takeoff.

(6) Check that oil pressure, oil temperature and EGT are within limits of Table 502

(7) Retard power lever to IDLE and operate engine for five minutes.

(8) Shut down engine (GENERAL, SUBJECT 71-00-00, Page 501) and perform normal engine inspection procedures. (GENERAL - MAINTENANCE PRACTICES, PAGEBLOCK 72-00-00/201)

NOTE: It is not necessary to inspect the oil filter if the oil system was not disturbed and no oil wetted components were replaced during the maintenance action.

D. Test C - Ground Check at 3000 lb/hr (1360 kg) Fuel Flow

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start engine (GENERAL, SUBJECT 71-00-00, Page 501) and allow to stabilize at idle for minimum of three minutes.

(3) Advance power lever as necessary until minimum of 3000 lb/hr of fuel flow is observed. Maintain for minimum of two minutes.

(4) After completion of check, return power lever to IDLE.

(5) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

E. Test D - Part Power Trim Check. (GENERAL, SUBJECT 71-00-00, Page 501).

F. Test E - Ground Check for Bleed System Operation. (Figure 510)

NOTE: This check is only applicable to the engine surge bleed system. With engines which have a 6th stage bleed system, refer to PAGEBLOCK 72-00-03/101 for a functional check. It is not possible to do a ground check of the 6th stage bleed system because the bleed closure and opening does not give a satisfactory engine parameter change.

(1) Inspect and clean test area, engine, and engine operating components.

(2) Start Engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(3) Run engine at IDLE until oil temperature reaches 100°F (38°C) minimum.

(4) Slowly accelerate engine and record N_1 speed at which anti-surge bleed valves close. Bleed closing is indicated by sudden increase in EPR.

(5) Slowly decelerate engine from stabilized point just above bleed valve closing and record N_1 speed at which anti-surge bleed valves open. Bleed valve opening is indicated by sudden decrease in EPR.

(6) Check bleed valve opening and closing per Figure 510.

(7) Retard power lever to Idle and shut down engine.

(8) Inspect engine for evidence of fuel and/or oil leaks. See Paragraph 2.N..

(9) If anti-surge bleed valves do not open and close within limits of Figure 510, refer to PAGEBLOCK 72-00-03/101.

G. Test F - Acceptance and Performance

(1) Instrumentation Required

  (a) N_1 - cockpit

  (b) N_2 - cockpit

  (c) EGT - cockpit

  (d) EPR - cockpit

  (e) Fuel Flow - cockpit

  (f) Oil pressure - cockpit

  (g) Oil temperature - cockpit

  (h) PCP - external instrumentation - 0 - 200 psi (0.0 - 1379.0 kPa) range, measured at PCP fitting located on left side of engine diffuser case high pressure service bleed port near PS3 filter.

  (i) PS4 - external instrumentation - 0 - 300 psi (0.0 - 2068.4 kPa) range, measured at PS4 fitting located on right side of engine diffuser case high pressure service bleed port at upper end of bleed valve actuation pressure supply line.

  (j) P_{t7} - external instrumentation - 0 - 50 psi (0.0 - 344.7 kPa) range measured at P_{t7} line test fitting.

  (k) Breather pressure - external instrumentation - 09 - 30 psi (0.0 - 206.8 kPa) range. Refer to Paragraph 6.H. for installation.

  (l) Ambient temperature - Laboratory Quality Mercury Thermometer

  (m) Ambient pressure - Local facilities

  (n) Install vibration pickups at locations indicated in Figure 512. Connect to vibration monitoring instrumentation, including low frequency (40 cps) filter.

(2) To ensure accuracy of P_{t7} system, pressure check system as follows:

(a) Connect PWA 46415 (formerly 45513) Adapter to P_{t7} manifold outlet and attach source of dry, filtered compressed air, with PWA 21875 Regulator.

(b) Apply 35 - 45 PSIG (241.3 - 310.3 kPa) air pressure to P_{t7} system.

(c) Use soap and water solution, check each connection in manifold and at probes for leakage. No leakage is permitted.

(d) Disconnect and remove test equipment and reconnect manifold outlet.

(3) Verify proper exhaust nozzle area as specified by airframe manufacturer.

NOTE: Engine bleed and electrical loads must be minimized during test. Fuel heater, generator, air conditioning packs, anti-icing and low pressure airbleed must be off. However, generator cooling airbleed and hydraulic pumps shall be set as "low" or "no load".

(4) Inspect and clean engine test area.

(5) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(6) Operate engine at idle for two minutes until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(7) Shut down engine and conduct Part Power Trim check per GENERAL, SUBJECT 71-00-00, Page 501.

(8) Service engine oil system and record oil level.

(9) Restart engine.(GENERAL, SUBJECT 71-00-00, Page 501) Inspect engine for evidence of fuel or oil leak.

(10) Advance power lever slowly to Normal Takeoff EPR specified by airframe manufacturer for ambient conditions.

(a) During acceleration, check that operation of anti-surge bleed valves is within limits of Figure 510, or applicable limits in airframe manufacturer's maintenance manual. If bleed valve operation is not within limits of Figure 510, refer to PAGEBLOCK 72-00-03/101.

(b) During acceleration, mark point on power lever pedestal where EPR is 0.03 EPR ratios above bleed closing point and preserve this mark for deceleration bleed control system check.

(c) Monitor engine vibration during acceleration to Normal Takeoff.

(d) Stabilize for three minutes at Normal Takeoff. Record a full set of the readings in Paragraph 6.G.(1) and make a mark to record the power lever position. Calculate 95 percent of Normal Takeoff N_2 and keep this result for the acceleration check.

(e) Check operation of fuel deicing system during this Normal Takeoff running. Open deicing air valve and observe change in fuel temperature using cockpit instrumentation. Fuel temperature must increase minimum of 104°F (58°C) in less than one minute after valve is opened. Do not adjust power lever for resultant loss of EPR. Do not allow fuel temperature to exceed 176°F (80°C). Close fuel deicing air valve.

(f) During Takeoff running, actuate engine anti-icing system. EPR should decrease by 0.08 - 0.11 ratio, when engine anti-icing air is turned on. Do not adjust power lever for resultant loss of EPR. Close engine anti-icing valves.

(11) Retard power lever to Descent/Ground Idle and deenergize idle select solenoid. Stabilize for seven minutes. Adjust idle speed to limits specified by airframe manufacturer.

(12) Operate the engine at Approach Idle for five minutes. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, calculate Normal Takeoff EPR and do the procedure again from Paragraph 6.G.(13).

(13) Advance power lever slowly (in 30 seconds minimum) to Normal Takeoff EPR determined in Paragraph 6.G.(10) and stabilize for no more and no less than 60 seconds.

(14) Retard the power lever to Approach Idle, and in not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the mark made on the quadrant in Paragraph 6.G.(10)(d), in not more than one second.

(15) Record with a stop watch the time from when the power lever starts to move to when the engine gets to the 95 percent N_2 limit as calculated in Paragraph 6.G.(10)(d).

(16) Go back to Approach Idle and do Paragraph 6.G.(12) thru Paragraph 6.G.(14) two times again.

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(17) Calculate the average of all three acceleration times and compare this average to the limit curve calculated by the airframe manufacturer for this procedure.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in this maintenance procedure (in which a stop watch is used) are to make sure that the acceleration time is accurately calculated, with the same result each time. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Takeoff N_2) as calculated from test cell procedures.

(18) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

(19) Retard power lever to EPR = 1.75. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(20) Retard power lever to EPR = 1.65. During deceleration, monitor engine vibration. Stabilize for three minutes and then record full set of readings per Paragraph 6.G.(1).

(21) Advance power lever to EPR = 1.8. Stabilize for 30 seconds then snap power lever in one second or less to point on pedestal marked in Paragraph 6.G.(10)(b) just above bleed closing point. Deceleration bleed system is operating normally if bleed valve supply pressure (PS4) drops to near ambient pressure and then increases to normal PS4 pressure.

(22) Retard power lever to Idle. During deceleration, monitor engine vibration. Also check that anti-surge bleed valves open within limits of Figure 510.

(23) Conduct functional check of reverse thrust system per airframe manufacturer's maintenance manual instructions.

(24) Perform functional check of Reserve Takeoff Thrust system as specified by airframe manufacturer's instructions.

(25) Shut down engine and perform normal engine inspection procedures as specified by airframe manufacturer, including oil filter inspection. (GENERAL, SUBJECT 71-00-00, Page 501)

(26) Service engine oil tank as necessary. Record amount of oil added.

(27) Compute oil consumption for acceptance test. Oil consumption shall not exceed 0.1 gal/hr.

(28) Corrected N_1 vs EPR should be checked per Figure 513. This curve is designed to verify accuracy of the EPR system. During Takeoff and part power, record N_1 speed, EPR and T_{t2} at both part power and Takeoff after engine has stabilized. Check corrected N_1 according to Figure 513.

(a) Engines which plot in band of Figure 513 are acceptable if all other operating limits are met.

(b) Engine plotting above band should be investigated for cause of high N_1. Troubleshooting must include leak check of P_{t7} indicating system. If no leaks are found, following items may also be investigated for cause of high N_1:

1) Inspect fan for FOD, blended blades.

2) Check N_1 indication system.

3) Waterwash engine per airframe manufacturer's instructions.

(c) If none of above items reduce high N_1 condition but all other operating limits are met, engine is acceptable. However, high N_1 condition may result in N_1 redline limiting situation on hot days.

(d) Engines which plot below band should be checked for N_1 indicating system problems and proper size exhaust nozzle. If N_1 indicating system is not cause of low N_1 speed, but all other engine operating limits are met, engine is acceptable.

(29) EGT shall be within recommended guidelines as specified in Figure 514. Available EGT margin at Normal Takeoff rating may be determined by calculating corrected EGT from data point observed EGT and TAMB as shown in notes on Figure 514 and computing difference relative to curve in Figure 514 at constant EPR.

(30) Oil pressure and oil temperature shall not exceed limits as specified in Table 502.

(31) Measure and record the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) and compare it to the limits in Figure 515.

FIGURE 72-00-00-990-969	NOTE
Sheet 3	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 4	A. If the turbine coolong air pressure ratio (TCAR) (Pcp/Ps4) is less than the Minimum limit, it will be necessary to remove the engine for disassembly and corrective action.
Sheet 5	A. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is in the range shown (between the Minimum limit and the lower limit), do the sub-idle leak check specified in the test.
	B. If the turbine cooling air pressure ratio (TCAR) (Pcp/Ps4) is less than the lower limit, it will be necessary to remove the engine for disassembly and corrective action.

(a) If a JT8D-217C/219 engine (which is post-SB 6128 and pre-SB 6196) has a Pcp/Ps4 ratio less than the Minimum limit in Figure 515 (Sheet 5), do a sub-idle leak test as follows:

1) Attach containers to the No. 4 bearing scupper drain and the No. 5 bearing area (combution section) drain.

NOTE: For all engines a Pcp transducer (with an accuracy of ±0.1 psig) will be necessary to measure the low Pcp values at idle and lower accurately. You must not do an engine shutdown during the test procedure.

2) Do the usual acceptance test as specified in this section (but do not do an engine shutdown when the test is completed). Adjust the idle trim N2 to 46 percent (+0, -0.2 percent) and the maximum oil pressure to 50.0 psig (344.7 kPa) (-0, +0.5 psi (3.4 kPa)). Operate the engine at Idle for 20 minutes. Increase the Idle N2 to the Figure 533 limits, then do an engine shutdown.

a) Record the Pcp on all data points at idle or lower with the transducer specified above. If it is difficult to trim to low idle, or if the idle speed does not stay stable, tell Pratt & Whitney Engineering immediately.

3) After the test, look for streaks in the tailpipe and remove the drain bottles (record what is found in them). Attach new bottles, then (after an hour) remove these bottles and record what is in them.

4) Do a borescope inspection of the 1st stage turbine vane area (through the igniter plug ports) and look for wet surfaces or puddles of oil. Record the inspection results.

5) If no oil leaks are found, the engine is satisfactory. If oil leaks are found, remove the engine for disassembly to correct the leaks.

(32) Breather pressure shall not exceed limit given in Paragraph 2.M.(2).

(33) Vibration shall not exceed limits given in Table 508.

NOTE: If the engine vibration is above the limits, the operator can trim balance the engine on the aircraft to decrease vibration levels. However, trim balance only those engines on which the fan is replaced. See Paragraph 7..

Table 508 Acceptance Limits Vibration Amplitudes

Pickup Location	Single Amplitude	Double Amplitude
INLET SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
REAR SECTION	0.0015 In. (0.038 mm) (1.5 mils)	0.003 In. (0.076 mm) (3.0 mils)
NOTE: The limits in this table are valid only when vibration pickups are mounted at locations specified and only when the low frequency filter (40 CPS) is selected in the vibration monitoring circuit.		

H. Test G - Breather Pressure Check (Figure 516 and Figure 517)

(1) Disconnect airframe breather duct from engine gearbox and leave gearbox port open.

(2) On engines with oil pressure transmitter vented to gearbox, disconnect airframe vent tube from gearbox LV3 fitting and remove fitting from gearbox port. On engines with oil pressure transmitter vented to ambient, remove fitting from gearbox LV3 port.

(3) Connect 0 - 10 PSIG (0.0 - 68.9 kPa) gage to LV3 port with the gage held above the LV3 port at all times (loops in the gage line can collect oil and cause false readings). Gage should be maximum-indication type with dial marker. Wire equipment securely to protect it from vibration. (Figure 516)

NOTE: If desired, PWA 33784 Cap may be used to obtain breather pressure measurement. Make sure the gage is held above the oil tank cap at all times to keep loops out of the gage line. See Figure 517. Breather pressure measured at this location will approximate breather pressure at gearbox LV3 port. If pressure reading obtained in the following procedure is close to or higher than limits given, procedure should be repeated with pressure gage connected to gearbox LV3 port.

WARNING: OBSERVE PROPER SAFETY PRECAUTIONS AROUND RUNNING ENGINE. WEAR EAR PROTECTORS AND STAY CLEAR OF ENGINE HAZARD AREAS. SEE "ENGINE GROUND SAFETY PRECAUTIONS" FOR ENGINE HAZARD DESCRIPTION.

(4) Start engine and operate at Idle for five minutes. (GENERAL, SUBJECT 71-00-00, Page 501)

(5) Slowly accelerate (60 seconds) to Normal Takeoff power (accelerate slowly to avoid possible overshoot on 0 - 10 psi (0.0 - 68.9 kPa) gage).

WARNING: OBSERVE PROPER SAFETY PRECAUTIONS AROUND RUNNING ENGINE. WEAR EAR PROTECTORS AND STAY CLEAR OF ENGINE HAZARD AREAS. SEE "ENGINE GROUND SAFETY PRECAUTIONS" FOR ENGINE HAZARD DESCRIPTION.

(6) After engine has stabilized at Normal Takeoff (two minutes minimum), retard engine power to Idle and record breather pressure.

NOTE: Breather pressure is measured at normal takeoff. Use either remote gages with which it is possible to read the pressure safely during engine operation, or use maximum indication type gages and record the pressure on the gage after the engine is shut down.

(7) Compare recorded breather pressure with maximum limit given in Paragraph 2.M.(2).

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

CAUTION: DO NOT RETURN ENGINE TO SERVICE IF IT HAS HIGH BREATHER PRESSURE. HIGH BREATHER PRESSURE IS AN INDICATION THAT HIGH TEMPERATURE, HIGH PRESSURE AIR MAY BE LEAKING INTO A BEARING COMPARTMENT, CREATING A POTENTIALLY DANGEROUS SITUATION.

(9) If observed breather pressure is not within limits, investigate and correct as necessary. Remove engine for inspection if necessary.

NOTE: If pressure reading from oil tank mounted gage fitting is close to limits, repeat engine test with gage mounted at gearbox. See Note after Paragraph 6.H.(3).

(10) Remove test equipment and reinstall engine fittings.

I. Test H - Acceleration Check

(1) Make sure the engine test area is clean.

(2) Start the engine (use the approved aircraft maintenance procedures).

(3) Set the flight deck switches in the correct positions to make sure that there is no engine air bleed or power extraction.

NOTE: Make sure that test instruments are kept sufficiently cool during the test procedure.

(4) Operate the engine at Idle until indications are stable and the oil temperature is at 100°F (38°C) minimum.

(5) With throttle in idle position open following circuit breaker:

LOWER EPC, ENGINE - LEFT DC BUS

Row	Col	Number	Name
S	40	B1-835	APPROACH IDLE CONTROL

(6) Engine N_2 should increase to Approach Idle.

(7) Operate the engine at Approach Idle for five minutes, until the N_2 is stable.

(8) Calculate the Normal Takeoff EPR limit from barometric pressure and temperature (refer to the airframe manufacturer's data).

(9) Advance the power lever slowly (in 30 seconds minimum) to the Normal Takeoff EPR limit calculated in Paragraph 6.I.(8). Keep the engine at this power level for no more and no less than 60 seconds.

(10) With the engine at Normal Takeoff EPR, make a mark to record the power lever position. Record EPR, N_1, EGT, and N_2. Calculate and record 95 percent of N_2 (as seen on the flight deck instrument).

(11) Retard the power lever to Approach Idle. In not less than 20 seconds and not more than 25 seconds, do a "snap acceleration" (fast power lever movement) to the Normal Takeoff mark made on the quadrant in Paragraph 6.I.(10) in not more than one second. If the engine stays at Approach Idle for more than 25 seconds, keep the engine at this level for five minutes, then do the procedure again from Paragraph 6.I.(8).

CAUTION: DO NOT GO ABOVE ENGINE OPERATION LIMITS DURING THIS CHECK (THIS CAN CAUSE ENGINE DAMAGE).

(12) Record with a stop watch the time from when the power lever started to move to when the engine gets to the 95 percent N_2 limit calculated in Paragraph 6.I.(10).

(13) Go back to Approach Idle and do Paragraph 6.I.(7) thru Paragraph 6.I.(12) two times again.

(14) After three accelerations are completed, retard the power lever to Idle.

(15) With throttle in idle position close following circuit breaker:

LOWER EPC, ENGINE - LEFT DC BUS

Row	Col	Number	Name
S	40	B1-835	APPROACH IDLE CONTROL

(16) Engine N $_2$ RPM should decrease to low idle (after approximately 5 secounds delay).

(17) Do the approved airframe powerplant shutdown.

(18) Calculate the average of all three acceleration times. Compare this average to the limit curve given by the airframe manufacturer.

NOTE: During manufacture of a new engine, or during overhaul test, a more accurate procedure is used to measure engine acceleration time on only one engine acceleration. The three accelerations in the maintenance procedure in this manual (in which a stop watch is used and an average is calculated) are to keep variations to a minimum in this less accurate procedure. This average time value will give results that are as much the same each time as the more accurate test cell procedure. The acceleration time limit for this aircraft maintenance procedure is different from the absolute time limits for acceleration from Approach Idle to 95 percent of Normal Takeoff thrust (99 percent Normal Takeoff N_2) as calculated from test cell procedures.

(19) If the acceleration time is not in limits, do the troubleshooting procedures recommended by the airframe manufacturer.

J. Test I - Vibration Check

(1) Install vibration pickups at locations indicated in Figure 512. Connect pickups to vibration monitoring instrumentation, including low frequency filter (40 CPS).

(2) Inspect and clean test area.

(3) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(4) Operate engine at Idle until readings have stabilized and oil temperature reaches a minimum of 100°F (38°C).

(5) Make a slow (two to three minute) acceleration from Idle to Normal Takeoff EPR as specified by airframe manufacturer for ambient conditions. Monitor inlet and rear case vibration during acceleration. Record peak observed inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

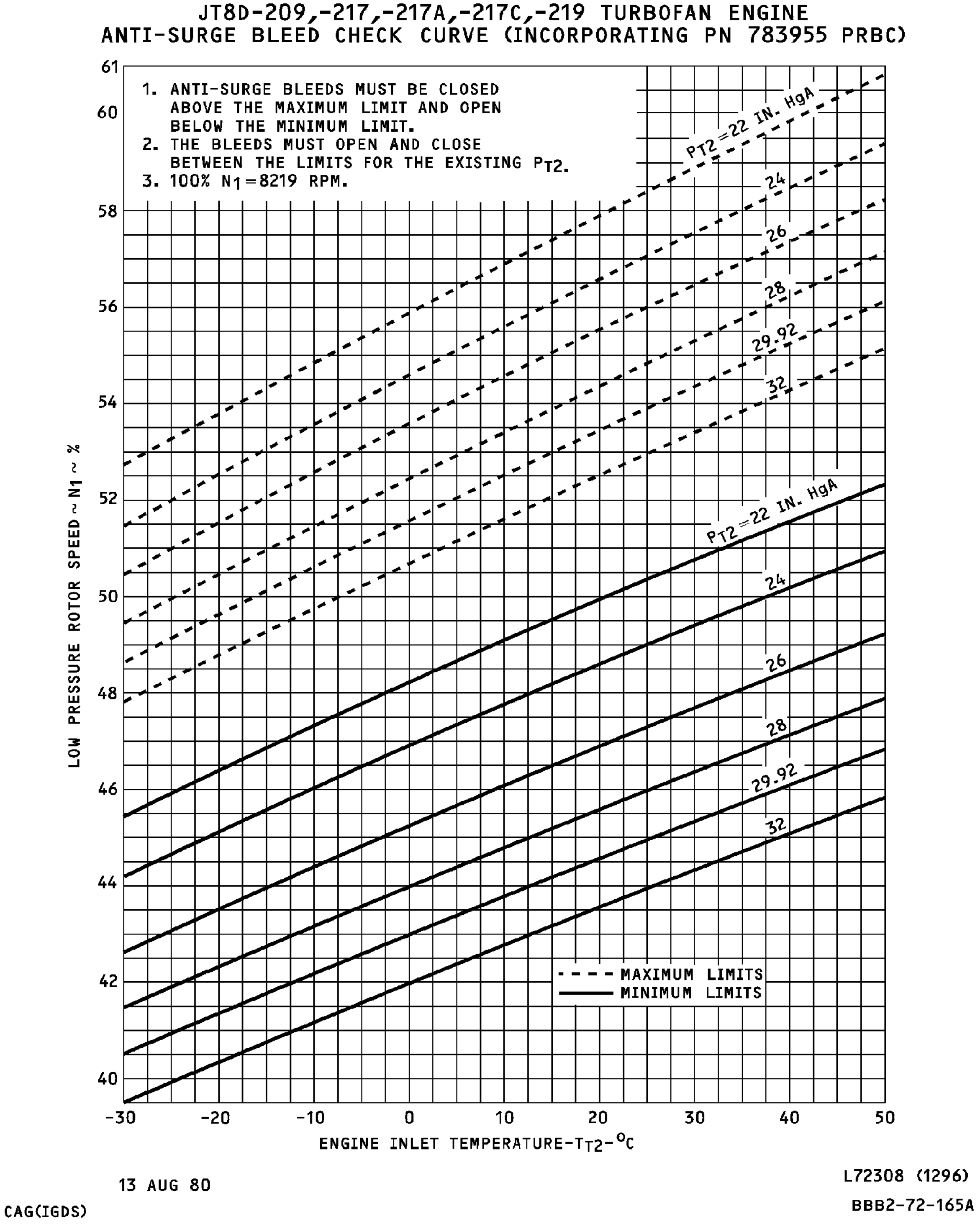
(6) Stabilize 30 seconds at Normal Takeoff EPR.

(7) Retard power lever slowly (two to three minutes) to Idle. Monitor inlet and rear case vibration during deceleration. Record Peak inlet and rear case vibration amplitudes and N_1 and N_2 RPM at which they occur.

(8) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(9) Peak vibration shall not exceed limits in Table 508.

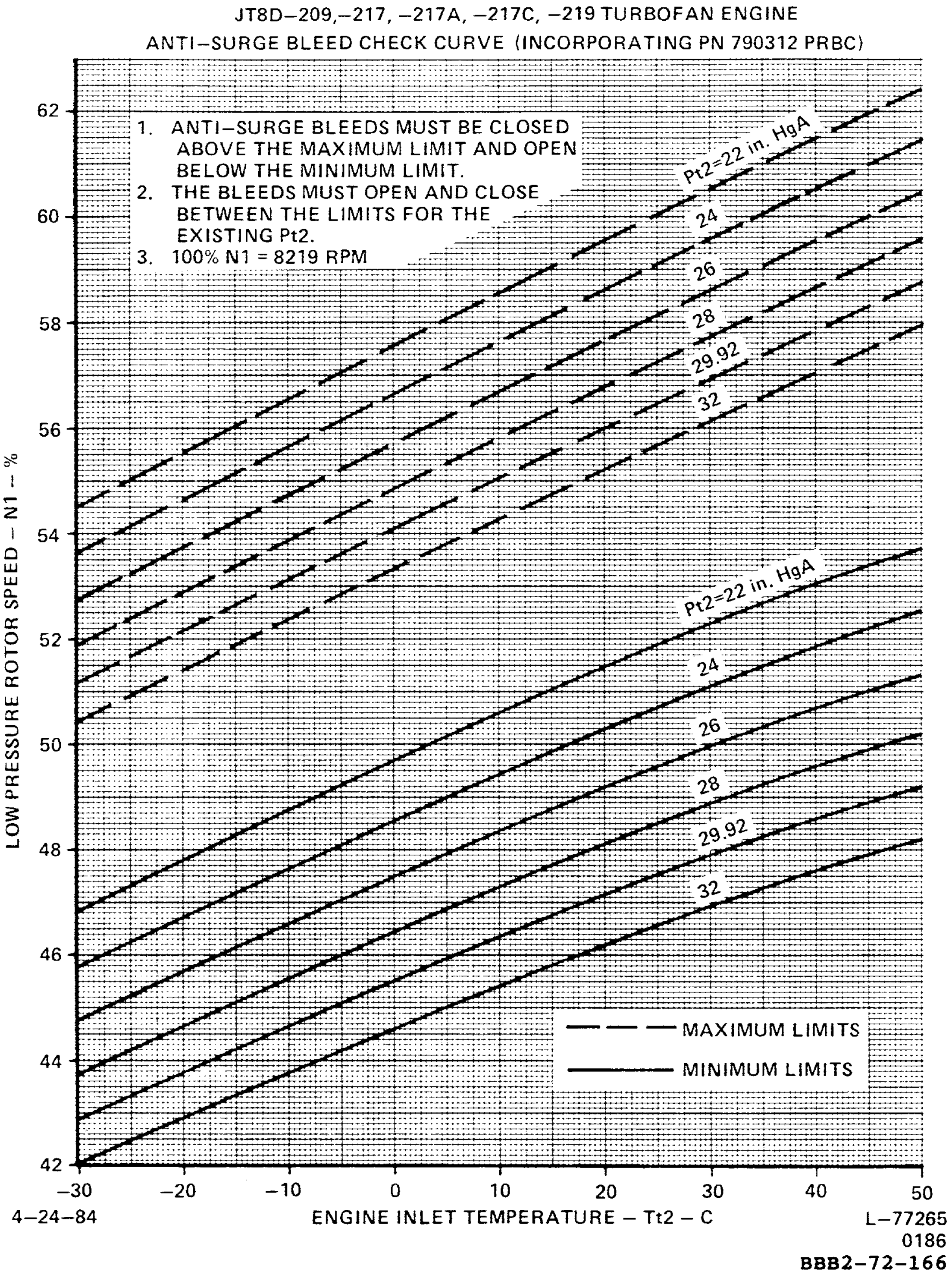
NOTE: The operator can trim balance repaired engines on the aircraft to decreased vibration levels. See Paragraph 9..



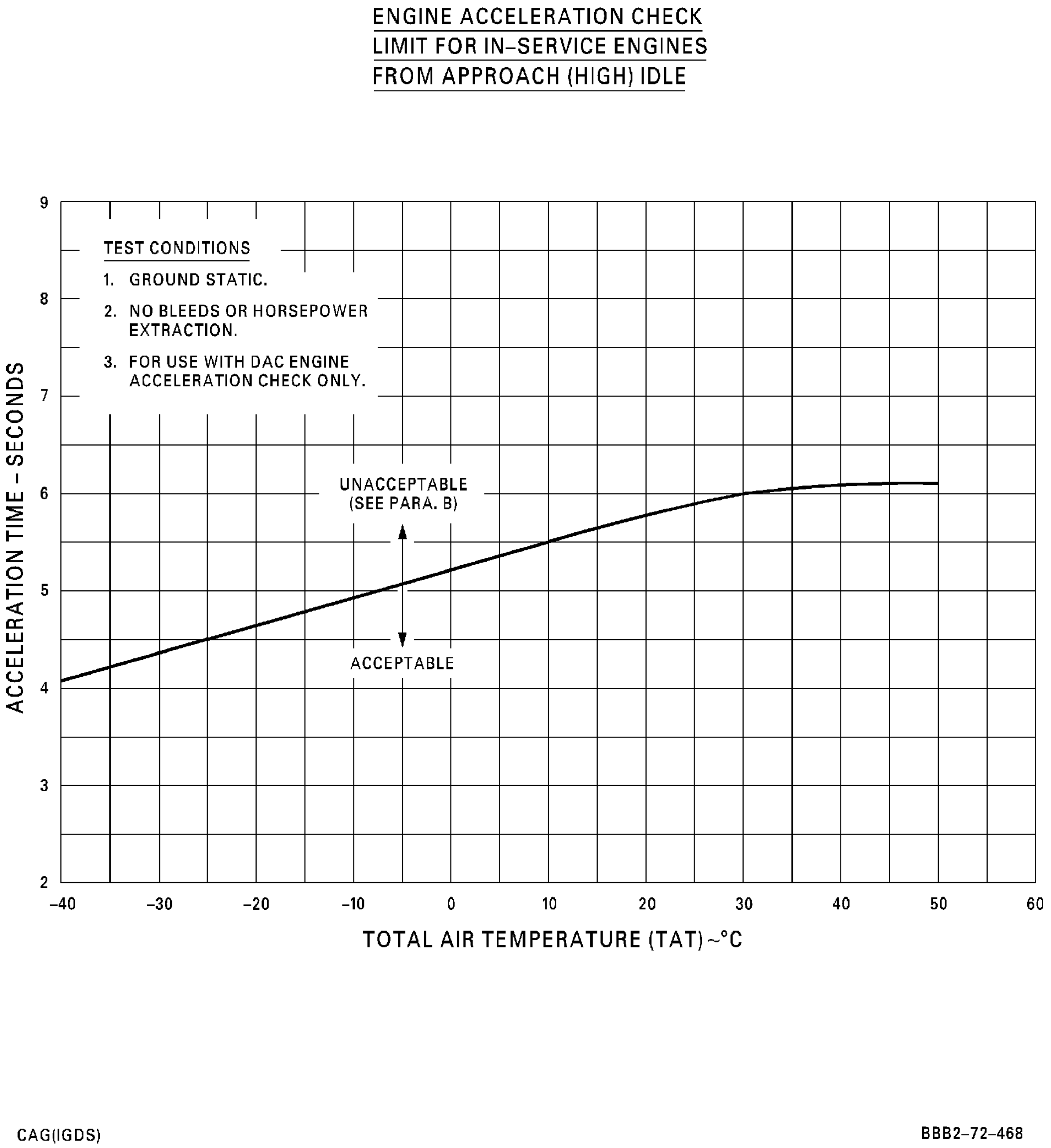
JT8D-209,-217,-217A,-217C,-219 TURBOFAN ENGINE
ANTI-SURGE BLEED CHECK CURVE (INCORPORATING PN 783955 PRBC)

1. ANTI-SURGE BLEEDS MUST BE CLOSED ABOVE THE MAXIMUM LIMIT AND OPEN BELOW THE MINIMUM LIMIT.
2. THE BLEEDS MUST OPEN AND CLOSE BETWEEN THE LIMITS FOR THE EXISTING P_{T2}.
3. 100% N_1 = 8219 RPM.

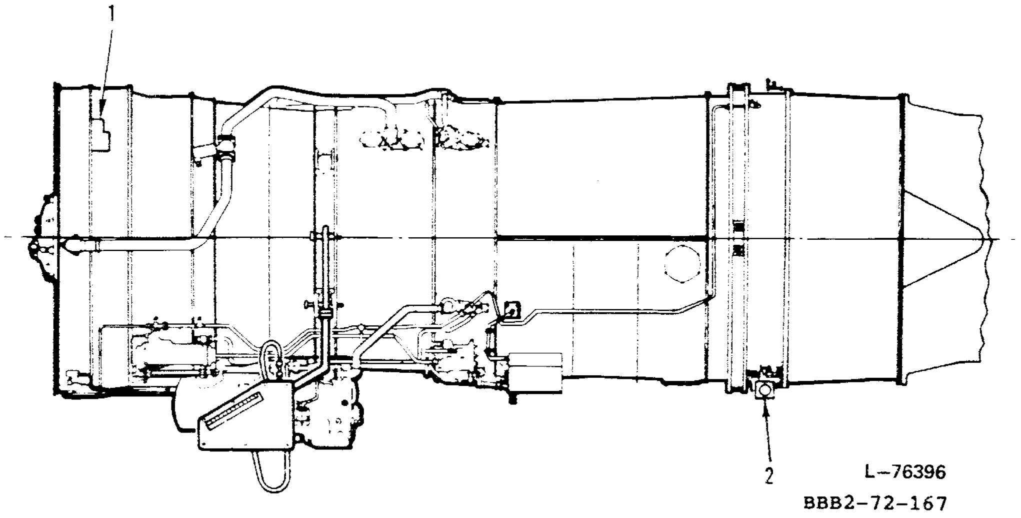
Anti-Surge Bleed Chart
Figure 510/72-00-00-990-965 (Sheet 1 of 2)



Anti-Surge Bleed Chart
Figure 510/72-00-00-990-965 (Sheet 2 of 2)



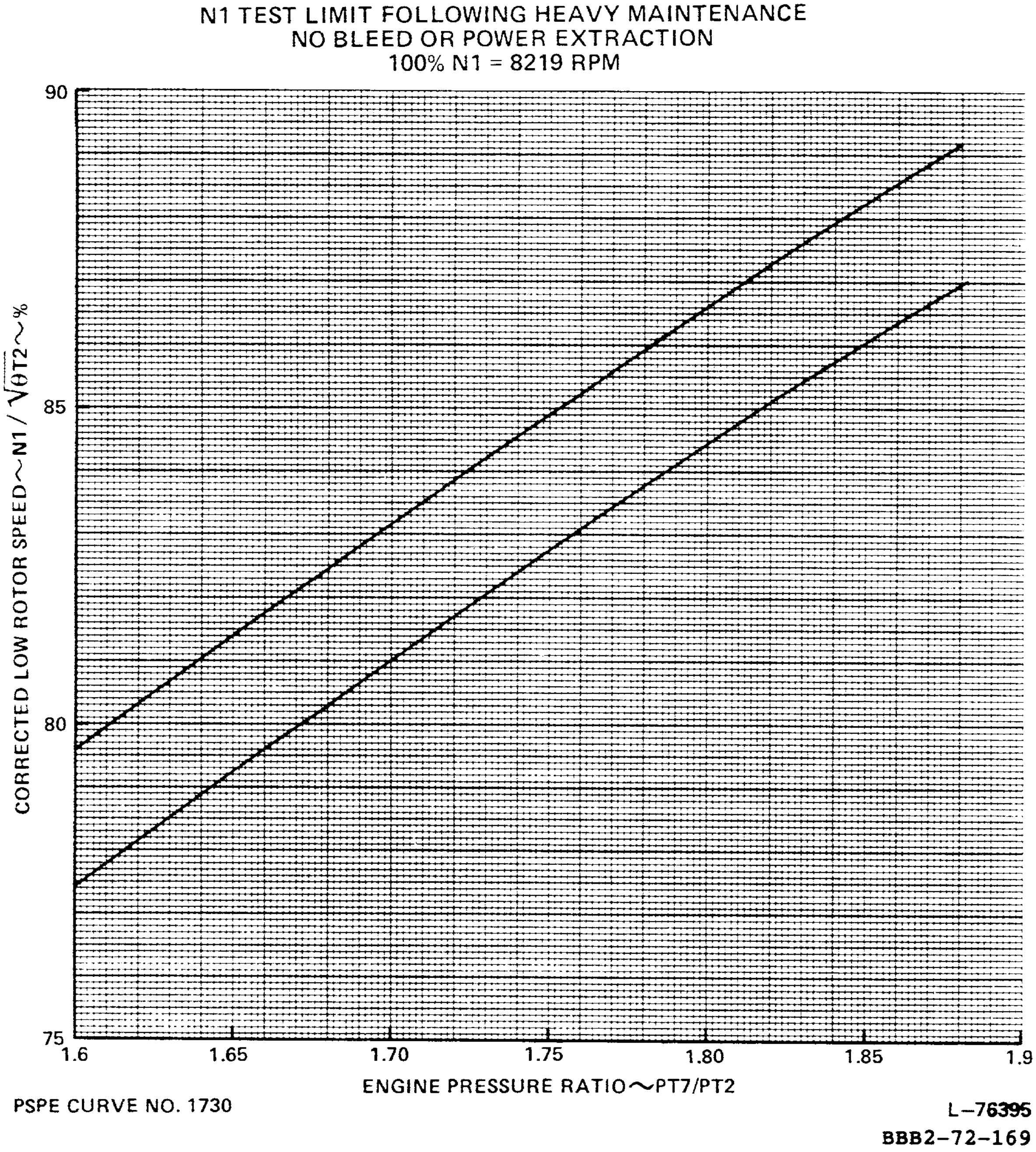
Acceleration Time Limit From Approach Idle
Figure 511/72-00-00-990-972



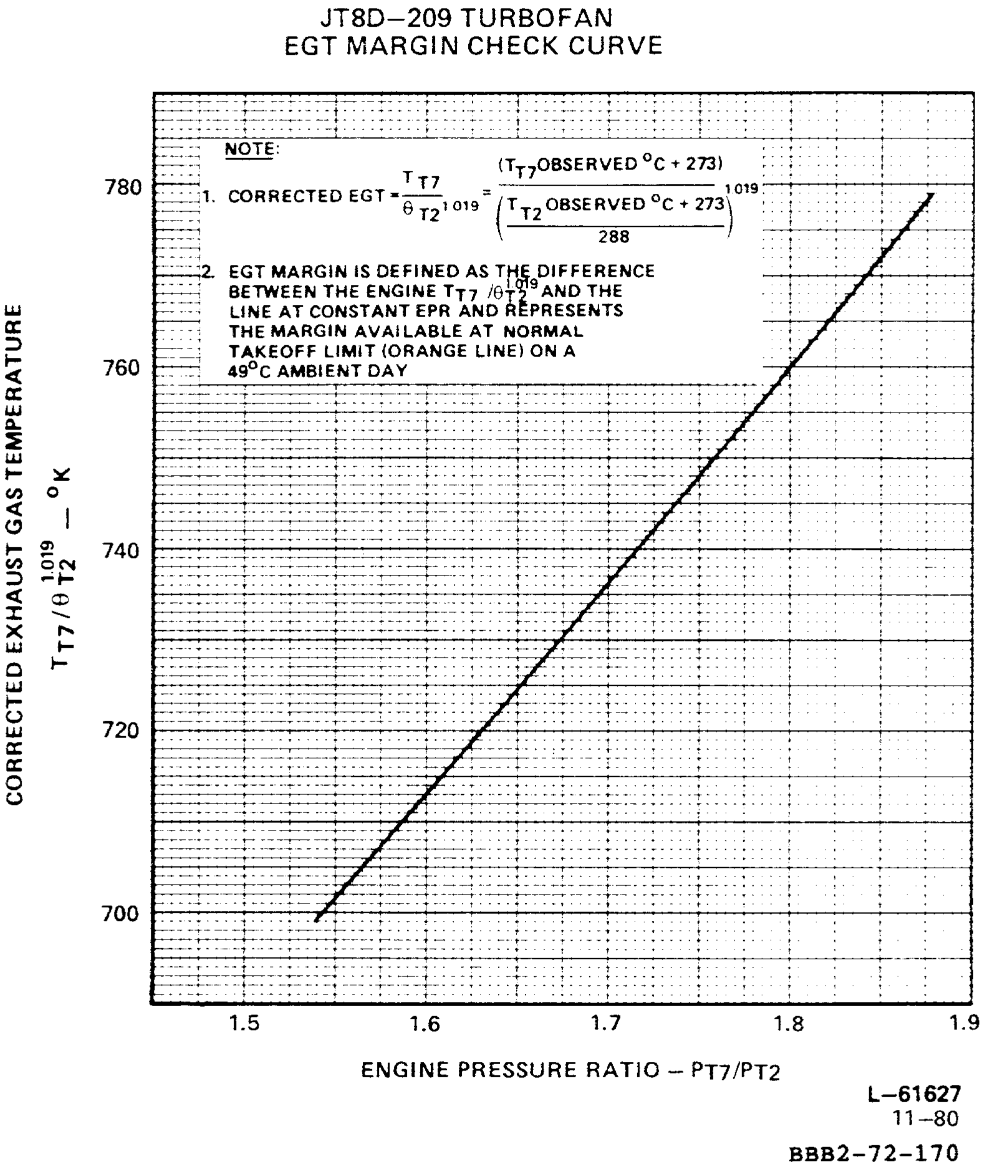
LEFT SIDE VIEW

1. Front Vibration Pickup
2. Rear Vibration Pickup

Location Of Vibration Pickups
Figure 512/72-00-00-990-966



Low Rotor Speed Limit Curve
Figure 513/72-00-00-990-967



EGT Margin Check Curve
Figure 514/72-00-00-990-968 (Sheet 1 of 3)

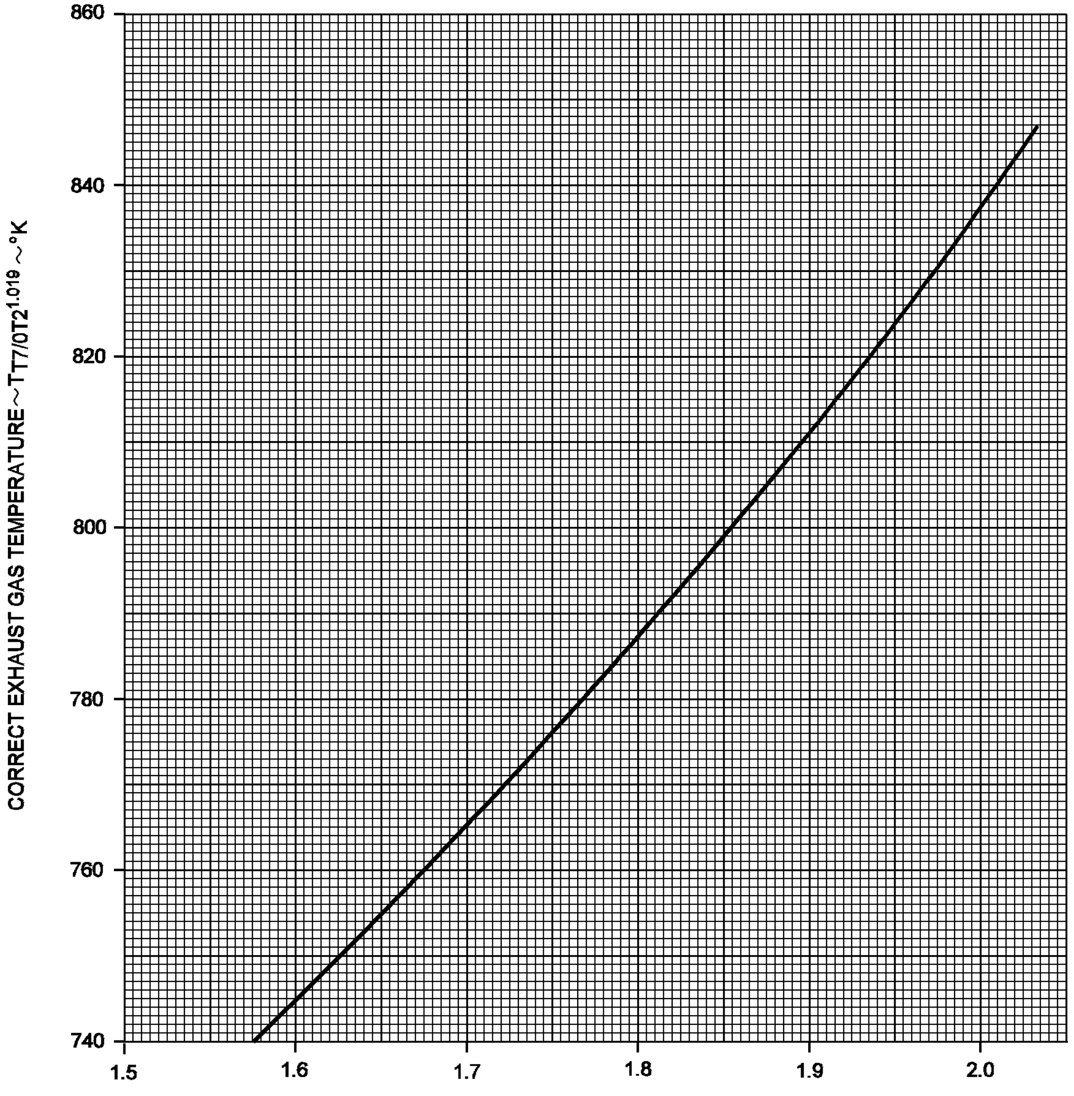
JT8D-217, -217A TURBOFAN
EGT MARGIN CHECK

NOTE:

1. CORRECTED EGT= $\dfrac{(T_{T7}\text{ OBSERVED }^{\circ}\text{C} + 273)}{\left(\dfrac{T_{T2}{}^{\circ}\text{C} + 273}{288}\right)^{1.019}}$

2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7/0T2}{}^{1.019}$ AND THE LINE AT CONSTANT EPR.

3. A COMPLETE HIGH QUALITY REFURBISHMENT OF BOTH HOT AND COLD SECTION MODULES SHOULD RESULT IN EGT MARGIN OF 15 - 20 °C.



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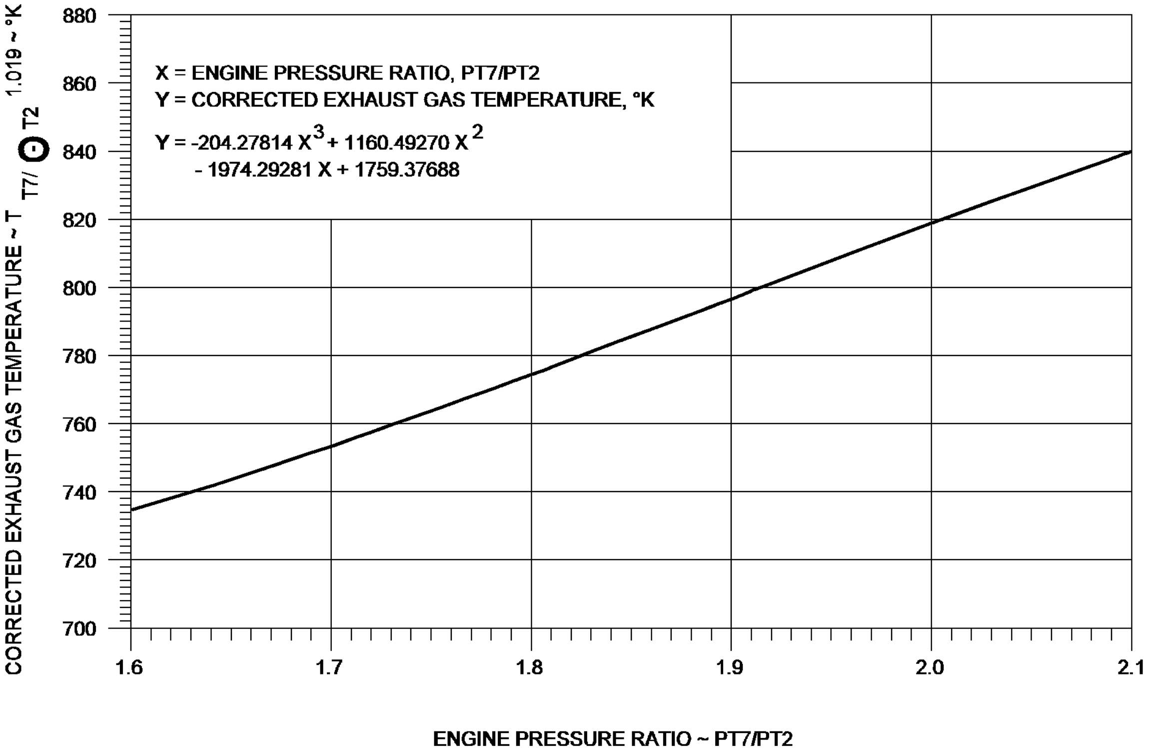
EGT Margin Check Curve
Figure 514/72-00-00-990-968 (Sheet 2 of 3)

JT8D-217C-219 TURBOFAN
EGT MARGIN CHECK

NOTES:

1. CORRECTED EGT = $$\frac{(T_{T7}\text{ OBSERVED }°C+273)}{\left(\frac{T_{T2}\,°C+273}{288}\right)^{1.019}}$$
2. EGT MARGIN IS DEFINED AS THE DIFFERENCE BETWEEN THE ENGINE $T_{T7}/\theta T2^{1.019}$ AND THE LINE AT CONSTANT EPR
3. THE EGT LIMIT REPRESENTS AN ENGINE WITH ZERO MARGIN TO THE NORMAL TAKE-OFF LIMIT (ORANGE LINE) ON A 29 °C AMBIENT DAY.



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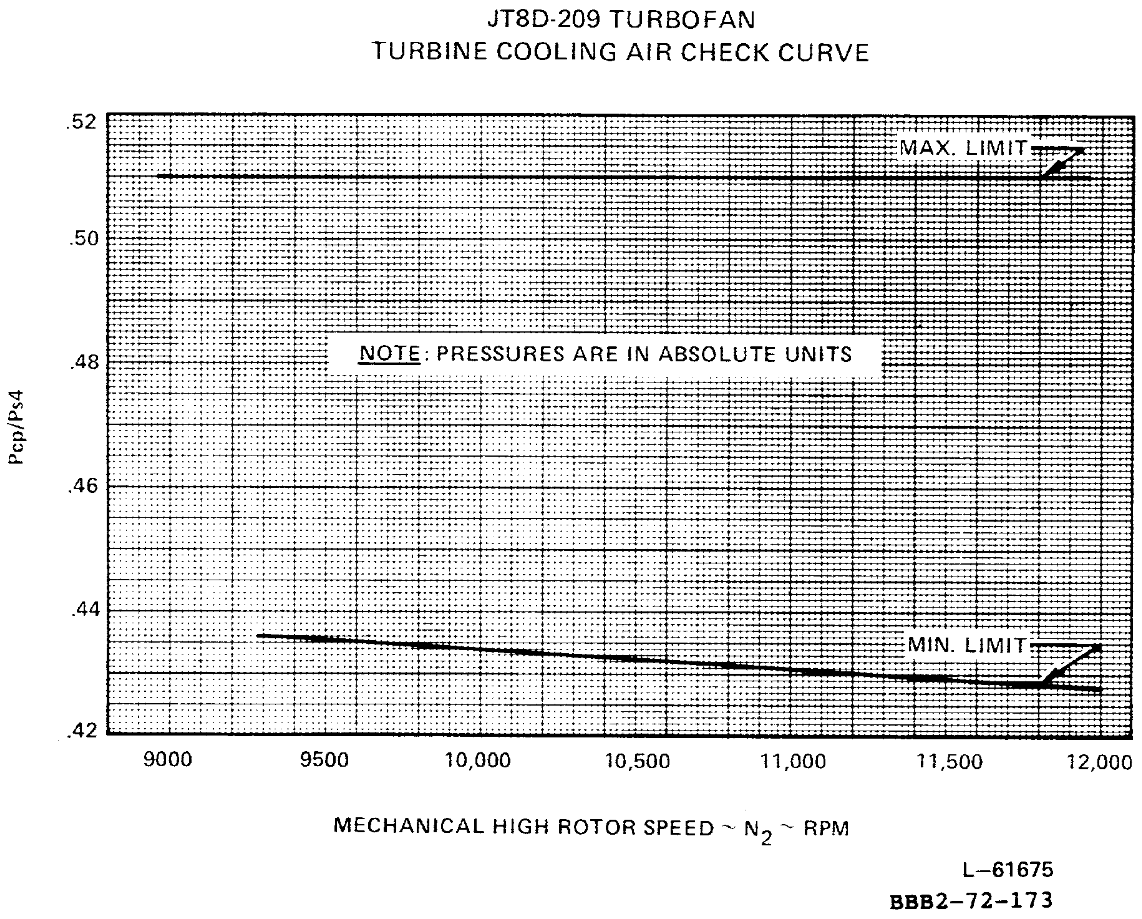
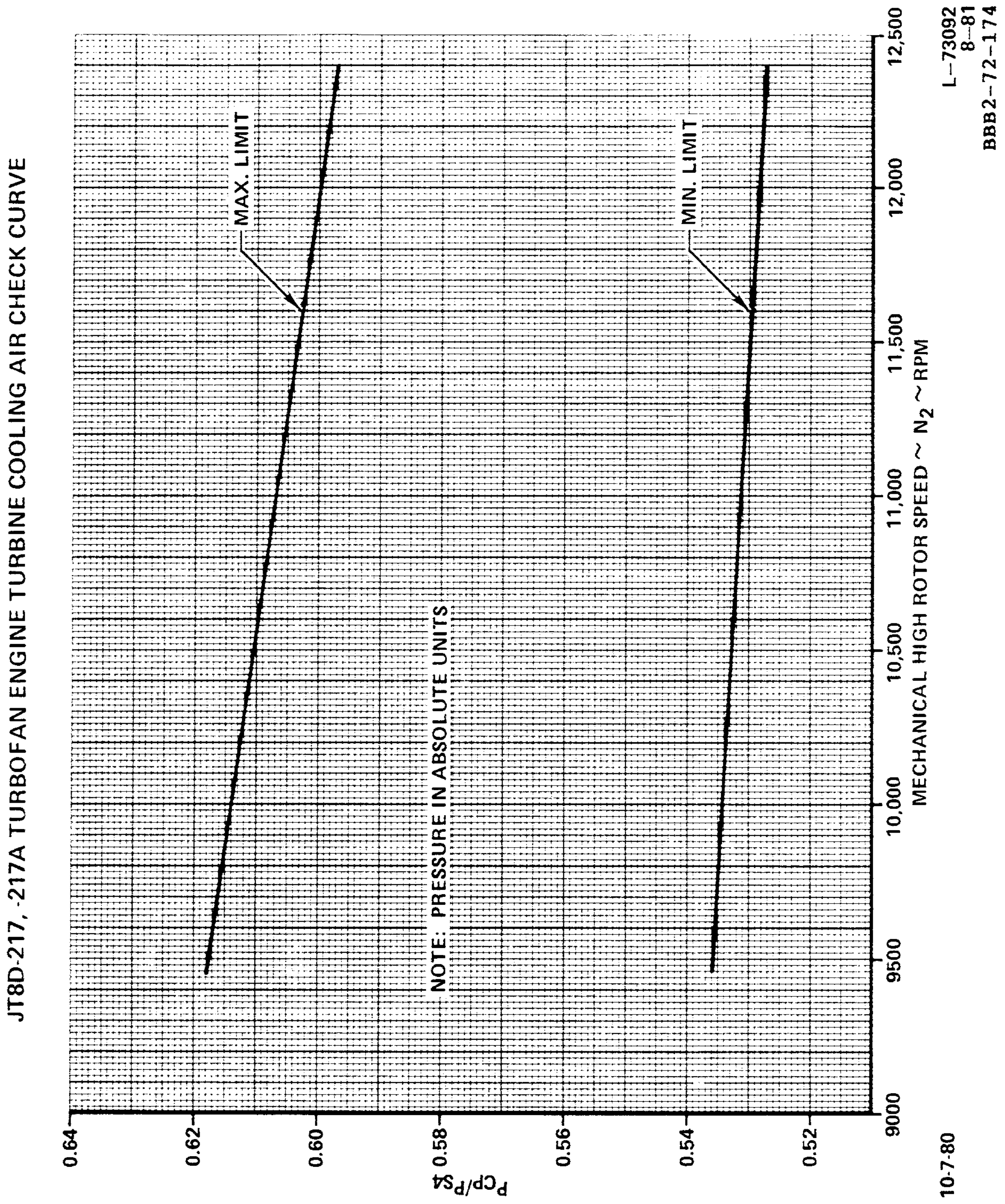
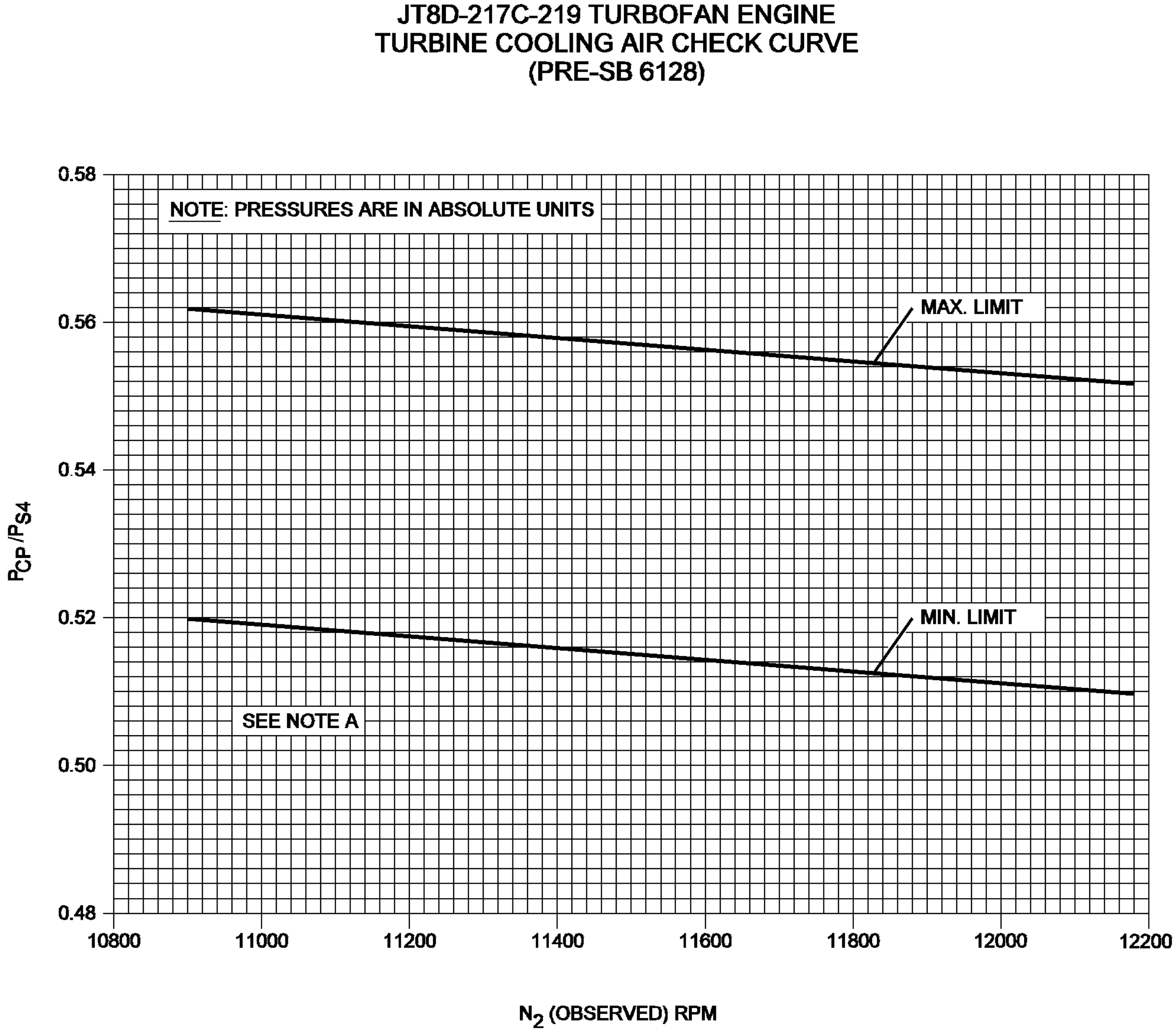
EGT Margin Check Curve
Figure 514/72-00-00-990-968 (Sheet 3 of 3)



Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-969 (Sheet 1 of 5)



Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-969 (Sheet 2 of 5)



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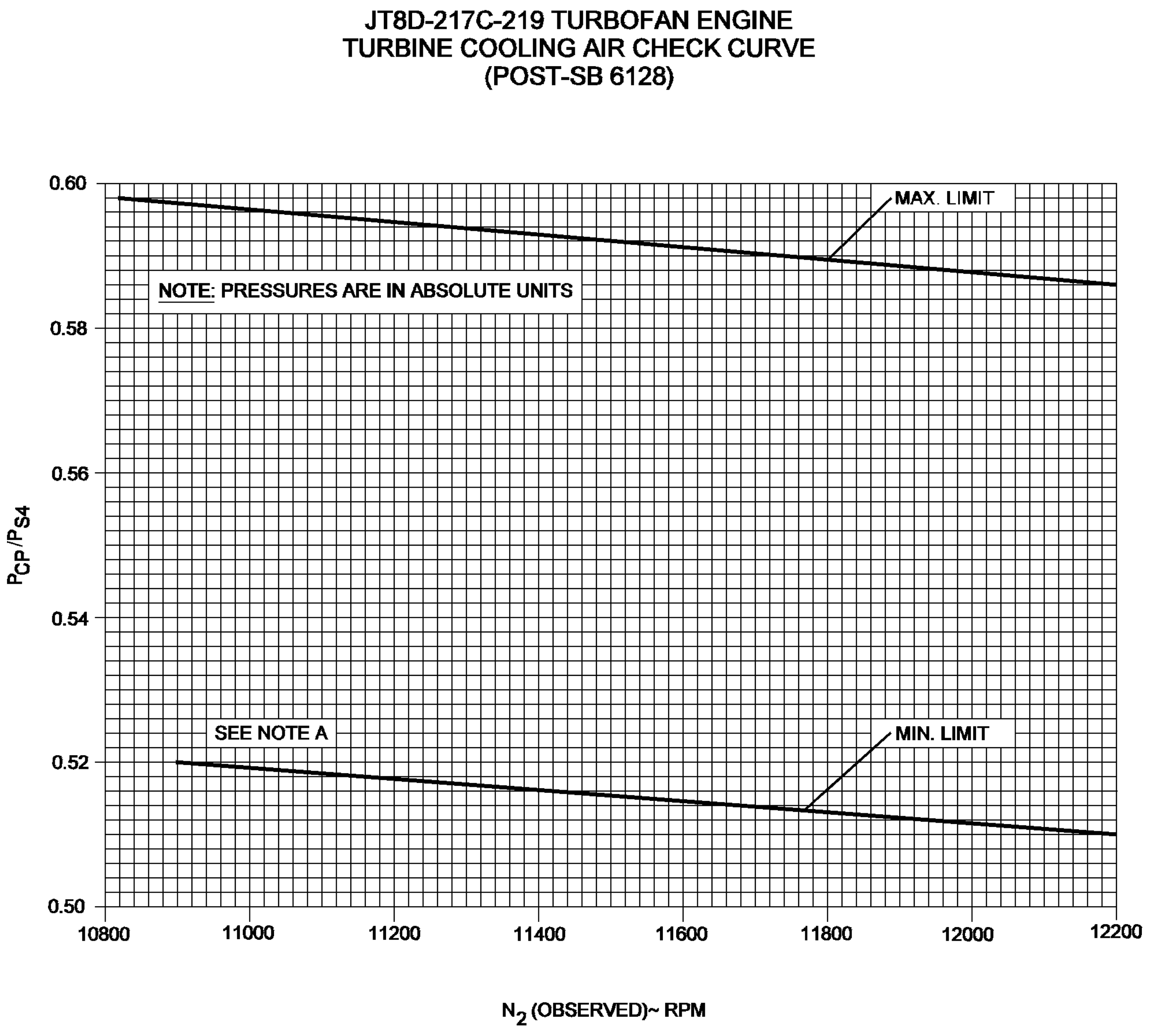
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-969 (Sheet 3 of 5)



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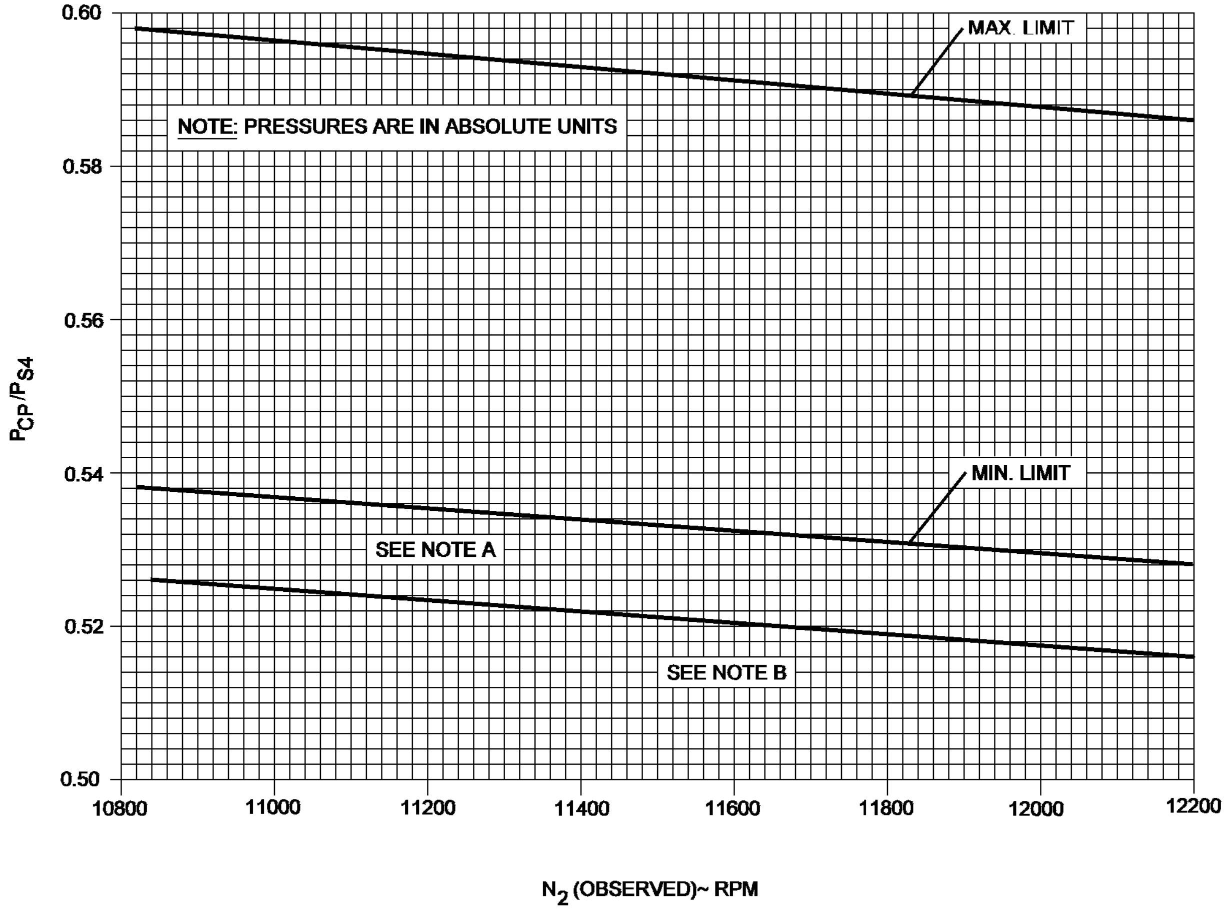
Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-969 (Sheet 4 of 5)

JT8D-217C-219 TURBOFAN ENGINE TURBINE COOLING AIR CHECK CURVE (POST-SB 6128 AND PRE-SB 6196)



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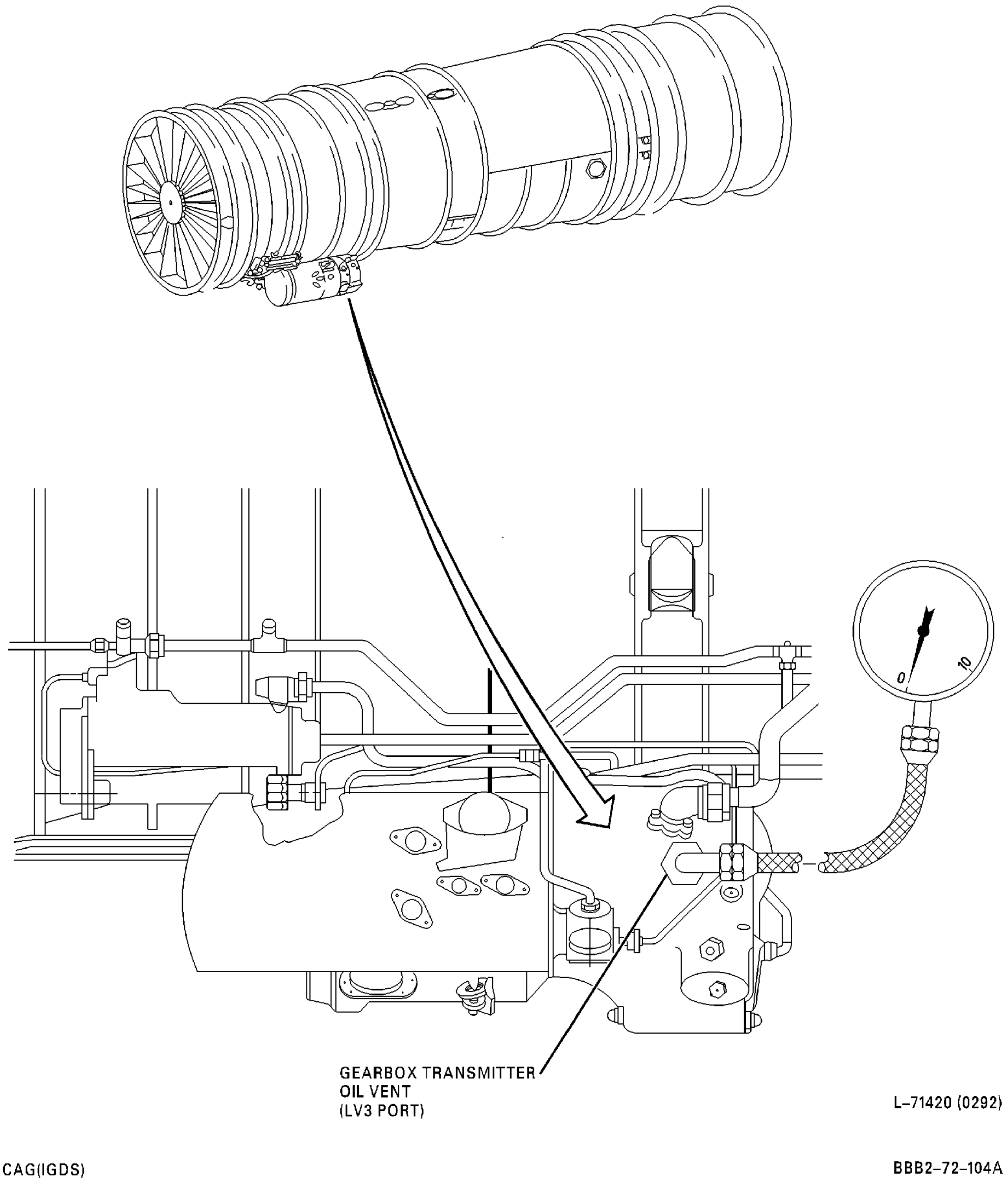
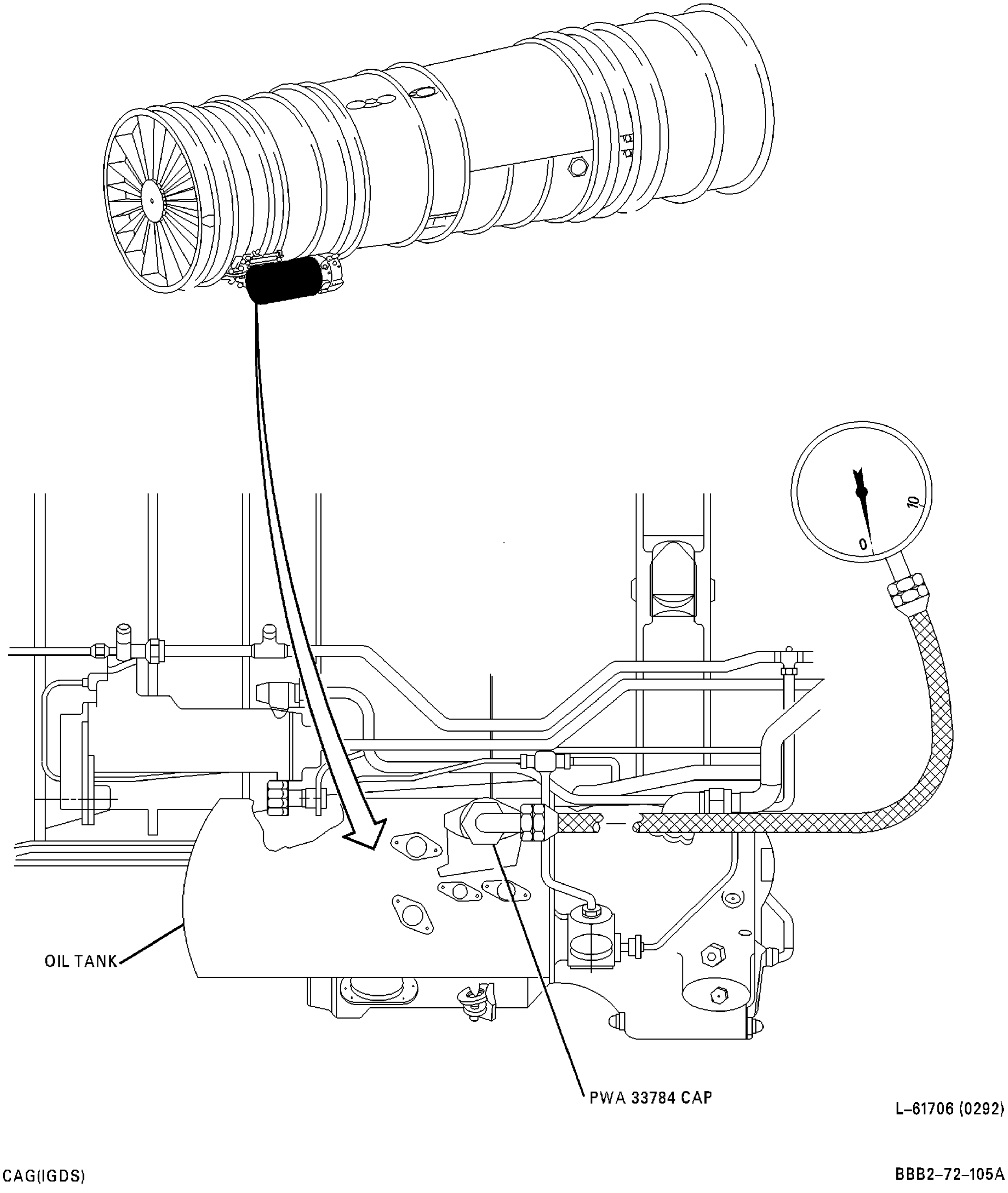
S0000306838V1

Turbine Cooling Air Check Curve
Figure 515/72-00-00-990-969 (Sheet 5 of 5)



Gearbox Housing Breather Pressure Instrumentation
Figure 516/72-00-00-990-970



Oil Tank Breather Pressure Instrumentation
Figure 517/72-00-00-990-971

7. Engine Deterioration Ground Check (For Installations Not Equipped With In-Flight Monitoring)

(Figure 518)

A. Procedure

(1) Prior to each removal for hot section inspection perform following ground check to detect engine deterioration.

(2) The following instrumentation is necessary for ground check:

(a) Absolute pressure gage to indicate 13th stage air pressure (Ps4). Special fitting is provided on right-hand side of engine at upper end of bleed valve actuation pressure supply line near high pressure (diffuser) service bleed point. Calibrated accuracy of gage should be ± 0.5 psi (25.4 mm Hg) absolute in range between 150 and 175 psi (7757 - 9050 mm HG) absolute. Maximum instrument requirement is 250 psi (12929 mm Hg) absolute.

NOTE: This measurement will indicate PS4 only when operating above bleed valve actuation point dictated by pressure ratio bleed control.

(b) Laboratory quality mercury thermometer to indicate ambient temperature.

(c) Local facilities (such as airport control tower) for indicating barometric pressure.

(d) Absolute pressure gage to indicate P_{t7}. Calibrated accuracy of gage should be ± 0.2 psi (10.3 mm Hg) absolute in range between 0 and 50 psi (2586 mm Hg) absolute.

(e) Instrumentation to check P_{t7} and EGT and provide comparison with cockpit instrumentation of EPR (P_{t7}/P_{t2}) and EGT. If cockpit EGT instrumentation and accurate null-balance test instrumentation cannot be read simultaneously, EGT may be measured at stabilized condition with test instrument and then with cockpit instrument circuit under same stabilized conditions. Respective readings should then be compared. As alternate method, cockpit instrument system may be calibrated with standard test equipment designed for this purpose.

(3) Use following test procedure:

(a) Start engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(b) With all nonessential aircraft airbleed and electrical systems shut off, set engine power to EPR (P_{t7}/P_{t2}) of 1.65.

(c) Warm up engine for five minutes and reset power to EPR of 1.65 as required.

(d) Read and record following:

1) P_{t7}

2) EPR (aircraft instrument)

3) Ps4

4) EGT (accurate null-balance instrument)

5) EGT (aircraft instrument)

6) Percent N_1 (aircraft instrument)

7) Percent N_2 (aircraft instrument)

8) Ambient temperature

9) Barometric pressure

10) Fuel Flow

(e) Shut down engine. (GENERAL, SUBJECT 71-00-00, Page 501)

(f) Use Figure 518, Figure 519 and Figure 520 to process data. Repair consisting of, replacement of 1st stage turbine vanes, combustion chambers, transition ducts, turbine outer air seals, fuel nozzles, etc. may be necessary if test reveals any of following:

1) Reduction of 3.5 percent Ps4/P_{t2} relative to new engine acceptance test, last complete overhaul, or last repair in which 1st stage turbine vane area was rebuilt within engine manual limits.
2) Corrected maximum T_{t7} more than shown in Figure 514.
3) Minus 100 RPM (minus 0.82 percent tachometer) N_2 theta T2 relative to data plate N_2 RPM.

INFORMATION	ENGINE POSITION		SOURCE
	1	2	
1. Pt7/Pt2 (EPR)	1.65	1.65	
2. Pt7/P bar	1.648	1.648	
3. P bar (psi)			
4. PT7 (psia)			(2) X (3): Set power to this value
5. EPR (Cockpit)	1.648	1.648	Set if (4) not available
6. Pt2/P bar	0.999	0.999	
7. PT2 (psia)			(3) X (6)
8. PS4 (psia)			Data
9. Ps4/Pt2			(8) / (7)
10. Ps4/Pt2 (Reference)			Latest Overhaul Calibration
11. Δ PS4/PT2			(9) - (10)
12. Percent Ps4/Pt2			[(11)/(10) X 100]
13. EGT (°C)			Data
14. Tamb (°C)			Data
15. θT2			[(14) + 273] /288 or Tables

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 518/72-00-00-990-973 (Sheet 1 of 2)

INFORMATION	ENGINE POSITION		SOURCE
	1	2	
15A. $\theta\ T2^{1.019}$			(15) to exponent 1.019 or Figure 505
16. $\sqrt{\theta\ T2}$			$\sqrt{(15)}$ or Fugure 505
17. EGT (°K)			(13) + 273
18. EGT/ $\theta\ T2^{1.019}$ (°K)			(17)/(15A)
19. EGT/ $\theta\ T2^{1.019}$ (°C)			(18) – 273
20. % N2 (Tach.)			Data
21. % N2/ $\sqrt{\theta\ T2}$			(20)/(16)
22. D.P. N2 %			Data Plate
23. % N2/ $\sqrt{\theta\ T2}$ – D.P. N2			(21) – (22)
24. % N1 (Tach.)			Data
25. % N1/ $\sqrt{\theta\ T2}$			(24)/(26)
26. Ref. N1	80.5	80.5	*or latest overhaul calibration
27. % N1/ $\sqrt{\theta\ T2}$ – Ref. N1			(25) – (26)
28. δ T2			(7)/14.70 or Figure 516
29. Fuel Flow Wf pph			Data
29A. Kc			Figure 517
30. Wf/Kc X δ T2			(29)/[Kc X (28)]
31. Ref. Wf	6980	6980	*or latest overhaul calibration
32. Δ Wf/Kc δ T2			(30) – (31)
33. % Wf/Kc δ T2			(32)/(31) X 100

*Reference Values given are from O.I. 309 and are good for all new engines. Overhauled engines should use last calibration.

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Engine Ground Check For Douglas MD-80 Aircraft
Figure 518/72-00-00-990-973 (Sheet 2 of 2)

8. Oil Pressure Adjustment

(Figure 521)

NOTE: At ground/descent Idle, oil temperature of 100°F (38°C) minimum, an oil pressure of 40 - 47 PSIG (275.8 - 324.1 kPa) is normal on cockpit gages and does not require adjustment.

A. Engine Preparation

(1) Ensure that engine has been properly serviced and is ready for operation.

(2) Install 0 - 50 PSIG (0.0 - 344.7 kPa) direct reading gage to LP2 tap on main oil pressure manifold and vent to LV3 tap on main accessory gearbox housing.

(3) Start engine and run at IDLE for two to five minutes, to stabilize power level and allow oil temperature to reach 100°F (38°C) minimum.

B. Pressure Relief Valve Adjustment

CAUTION: WHEN REMOVING OUTER PLUG, DO NOT ALLOW INNER PLUG OR VALVE HOUSING TO TURN. LOSS OF OIL AND LOSS OF VALVE SECURITY CAN RESULT FROM LOOSENING OF THESE PARTS.

(1) Hold pressure relief valve inner plug hex firmly with wrench and remove outer plug.

NOTE: Cut lockwire from outer plug only; lockwire from inner plug to valve housing and from valve housing to gearbox should be left intact.

(2) Hold adjusting screw stationary with screwdriver and loosen locknut. If desired, fabricate valve adjusting tool from 7/16 inch deep socket with angled handle welded to side to allow screwdriver to pass through center. Such a tool will allow turning locknut while holding adjusting screw stationary.

(3) Using screwdriver, adjust oil pressure to 42 - 45 PSIG (289.6 - 310.3 kPa) with engine at IDLE. Clockwise rotation will increase pressure; counterclockwise rotation will decrease pressure.

NOTE: One full turn of adjusting screw will change pressure approximately two psi (13.8 kPa).

Key To Figure 521	
1.	Pressure Relief Valve
2.	Locknut
3.	Adjusting Screw
4.	Outer Plug
5.	Packing
6.	Inner Plug
7.	Check This Screw Height After Adjustment (See Text).

CAUTION: AFTER OIL PRESSURE ADJUSTMENT IS COMPLETED, CHECK INDEX 7 DIMENSION IN FIGURE. MEASURED VALUE OF 0.280 INCH (7.112 MM) OR LESS IF NOT CONSIDERED NORMAL AND MAY INDICATE REQUIREMENT FOR OIL SYSTEM TROUBLESHOOTING.

(4) Hold adjusting screw steady and torque locknut. See tool description in Paragraph 8.B.(2).

(5) Install outer plug, with new packing, and torque to 150 - 160 in-lb. (16.948 - 18.078 N·m). Lockwire outer plug to inner plug.

RELATIVE PRESSURE

DELTA $(\delta) = \frac{P}{PO} = \frac{P}{29.92}$ INCHES HGA = PSIA (2.036)

P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ	P IN. HG. ABS	δ
40.0	1.337						
39.9	1.334	32.9	1.100	25.9	0.8656	18.9	0.6317
39.8	1.330	32.8	1.096	25.8	0.8623	18.8	0.6283
39.7	1.327	32.7	1.093	25.7	0.8586	18.7	0.6250
39.6	1.324	32.6	1.090	25.6	0.8556	18.6	0.6216
39.5	1.320	32.5	1.086	25.5	0.8523	18.5	0.6183
39.4	1.317	32.4	1.083	25.4	0.8489	18.4	0.6150
39.3	1.313	32.3	1.080	25.3	0.8456	18.3	0.6116
39.2	1.310	32.2	1.076	25.2	0.8422	18.2	0.6083
39.1	1.307	32.1	1.073	25.1	0.8389	18.1	0.6050
39.0	1.303	32.0	1.070	25.0	0.8356	18.0	0.6016
38.9	1.300	31.9	1.066	24.9	0.8322	17.9	0.5983
38.8	1.297	31.8	1.063	24.8	0.8289	17.8	0.5949
38.7	1.293	31.7	1.059	24.7	0.8255	17.7	0.5916
38.6	1.290	31.6	1.056	24.6	0.8222	17.6	0.5882
38.5	1.287	31.5	1.053	24.5	0.8188	17.5	0.5849
38.4	1.283	31.4	1.049	24.4	0.8155	17.4	0.5815
38.3	1.280	31.3	1.046	24.3	0.8122	17.3	0.5782
38.2	1.277	31.2	1.043	24.2	0.8088	17.2	0.5749
38.1	1.273	31.1	1.039	24.1	0.8055	17.1	0.5715
38.0	1.270	31.0	1.036	24.0	0.8021	17.0	0.5682
37.9	1.267	30.9	1.033	23.9	0.7988	16.9	0.5648
37.8	1.263	30.8	1.029	23.8	0.7954	16.8	0.5615
37.7	1.260	30.7	1.026	23.7	0.7921	16.7	0.5581
37.6	1.257	30.6	1.023	23.6	0.7888	16.6	0.5548
37.5	1.253	30.5	1.019	23.5	0.7854	16.5	0.5515
37.4	1.250	30.4	1.016	23.4	0.7821	16.4	0.5481
37.3	1.247	30.3	1.013	23.3	0.7787	16.3	0.5448
37.2	1.243	30.2	1.009	23.2	0.7754	16.2	0.5414
37.1	1.240	30.1	1.006	23.1	0.7720	16.1	0.5381
37.0	1.237	30.0	1.003	23.0	0.7687	16.0	0.5348
36.9	1.233	29.9	0.9993	22.9	0.7654	15.9	0.5314
36.8	1.230	29.8	0.9960	22.8	0.7620	15.8	0.5281
36.7	1.227	29.7	0.9926	22.7	0.7587	15.7	0.5247
36.6	1.223	29.6	0.9893	22.6	0.7553	15.6	0.5214
36.5	1.220	29.5	0.9859	22.5	0.7520	15.5	0.5180
36.4	1.217	29.4	0.9826	22.4	0.7487	15.4	0.5147
36.3	1.213	29.3	0.9793	22.3	0.7453	15.3	0.5224
36.2	1.210	29.2	0.9759	22.2	0.7420	15.2	0.5080
36.1	1.207	29.1	0.9726	22.1	0.7386	15.1	0.5047
36.0	1.203	29.0	0.9692	22.0	0.7353	15.0	0.5013
35.9	1.200	28.9	0.9659	21.9	0.7319	14.9	0.4980
35.8	1.196	28.8	0.9626	21.8	0.7286	14.8	0.4946
35.7	1.193	28.7	0.9592	21.7	0.7253	14.7	0.4913
35.6	1.190	28.6	0.9559	21.6	0.7219	14.6	0.4880
35.5	1.186	28.5	0.9525	21.5	0.7186	14.5	0.4846
35.4	1.183	28.4	0.9492	21.4	0.7152	14.4	0.4813
35.3	1.180	28.3	0.9458	21.3	0.7119	14.3	0.4779
35.2	1.176	28.2	0.9425	21.2	0.7085	14.2	0.4746
35.1	1.173	28.1	0.9392	21.1	0.7052	14.1	0.4713
35.0	1.170	28.0	0.9358	21.0	0.7019	14.0	0.4679
34.9	1.166	27.9	0.9325	20.9	0.6985	13.9	0.4646
34.8	1.163	27.8	0.9291	20.8	0.6952	13.8	0.4612
34.7	1.160	27.7	0.9258	20.7	0.6918	13.7	0.4579
34.6	1.156	27.6	0.9224	20.6	0.6885	13.6	0.4545
34.5	1.153	27.5	0.9191	20.5	0.6852	13.5	0.4512
34.4	1.150	27.4	0.9158	20.4	0.6818	13.4	0.4479
34.3	1.146	27.3	0.9124	20.3	0.6785	13.3	0.4445
34.2	1.143	27.2	0.9091	20.2	0.6751	13.2	0.4412
34.1	1.140	27.1	0.9057	20.1	0.6718	13.1	0.4378
34.0	1.136	27.0	0.9024	20.0	0.6684	13.0	0.4345
33.9	1.133	26.9	0.8990	19.9	0.6651	12.9	0.4311
33.8	1.130	26.8	0.8957	19.8	0.6618	12.8	0.4278
33.7	1.126	26.7	0.8924	19.7	0.6584	12.7	0.4245
33.6	1.123	26.6	0.8890	19.6	0.6551	12.6	0.4211
33.5	1.120	26.5	0.8857	19.5	0.6517	12.5	0.4178
33.4	1.116	26.4	0.8823	19.4	0.6484	12.4	0.4144
33.3	1.113	26.3	0.8790	19.3	0.6450	12.3	0.4111
33.2	1.110	26.2	0.8757	19.2	0.6417	12.2	0.4077
33.1	1.106	26.1	0.8723	19.1	0.6384	12.1	0.4044
33.0	1.103	26.0	0.8690	19.0	0.6350	12.0	0.4011

L—72747

BBB2-72-22

Relative Pressure
Figure 519/72-00-00-990-974

TEMPERATURE CORRECTION FOR FUEL FLOW

Tt2			Tt2			Tt2		
°C	°F	Kc	°C	°F	Kc	°C	°F	Kc
–40	–40.0	0.8798	–6	21.2	0.9542	28	82.4	1.0286
–39	–38.2	0.8820	–5	23.0	0.9564	29	84.2	1.0308
–38	–36.4	0.8842	–4	24.8	0.9585	30	86.0	1.0329
–37	–34.6	0.8863	–3	26.6	0.9607	31	87.8	1.0351
–36	–32.8	0.8885	–2	28.4	0.9629	32	89.6	1.0373
–35	–31.0	0.8907	–1	30.2	0.9651	33	91.4	1.0395
–34	–29.2	0.8929	0	32.0	0.9673	34	93.2	1.0417
–33	–27.4	0.8951	1	33.8	0.9695	35	95.0	1.0439
–32	–25.6	0.8973	2	35.6	0.9717	36	96.8	1.0461
–31	–23.8	0.8995	3	37.4	0.9739	37	98.6	1.0483
–30	–22.0	0.9017	4	39.2	0.9761	38	100.4	1.0504
–29	–20.2	0.9038	5	41.0	0.9782	39	102.2	1.0526
–28	–18.4	0.9060	6	42.8	0.9804	40	104.0	1.0548
–27	–16.6	0.9082	7	44.6	0.9826	41	105.8	1.0570
–26	–14.8	0.9104	8	46.4	0.9848	42	107.6	1.0592
–25	–13.0	0.9126	9	48.2	0.9870	43	109.4	1.0614
–24	–11.2	0.9148	10	50.0	0.9892	44	111.2	1.0636
–23	– 9.4	0.9170	11	51.8	0.9914	45	113.0	1.0658
–22	– 7.6	0.9192	12	53.6	0.9936	46	114.8	1.0679
–21	– 5.8	0.9214	13	55.4	0.9957	47	116.6	1.0701
–20	– 4.0	0.9235	14	57.2	0.9979	48	118.4	1.0723
–19	– 2.2	0.9257	15	59.0	1.0001	49	120.2	1.0745
–18	– 0.4	0.9279	16	60.8	1.0023	50	122.0	1.0767
–17	1.4	0.9301	17	62.6	1.0045	51	123.8	1.0789
–16	3.2	0.9323	18	64.4	1.0067	52	125.6	1.0811
–15	5.0	0.9345	19	66.2	1.0089	53	127.4	1.0833
–14	6.8	0.9367	20	68.0	1.0111	54	129.2	1.0855
–13	8.6	0.9389	21	69.8	1.0132	55	131.0	1.0876
–12	10.4	0.9410	22	71.6	1.0154	56	132.8	1.0898
–11	12.2	0.9432	23	73.4	1.0176	57	134.6	1.0920
–10	14.0	0.9454	24	75.2	1.0198	58	136.4	1.0942
–9	15.8	0.9476	25	77.0	1.0220	59	138.2	1.0964
–8	17.6	0.9498	26	78.8	1.0242	60	140.0	1.0986
–7	19.4	0.9520	27	80.6	1.0264			

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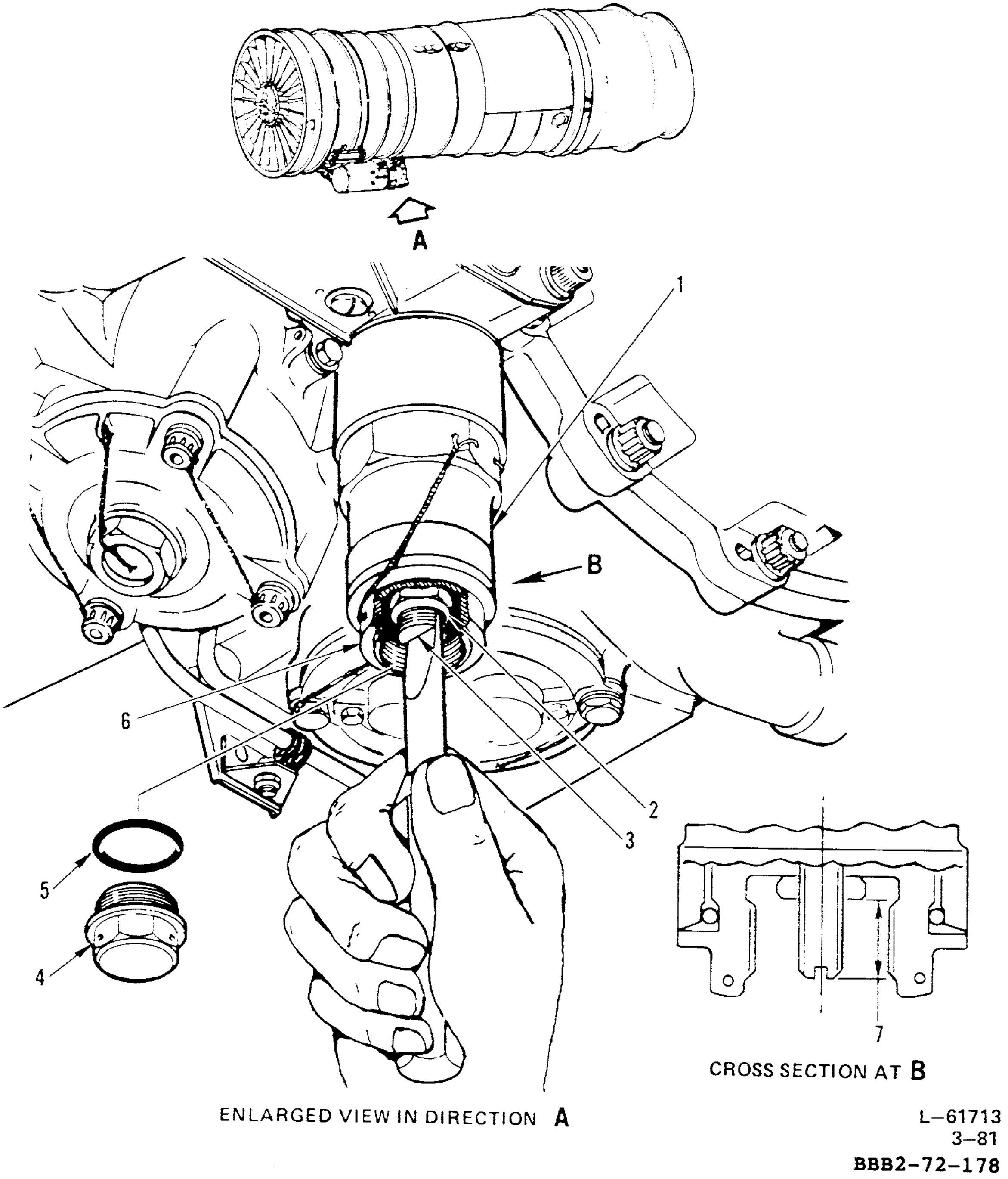
Temperature Correction For Fuel Flow
Figure 520/72-00-00-990-975



Oil Pressure Adjustment
Figure 521/72-00-00-990-976

9. Trim Balance Of Engine Installed In Aircraft

A. On-Wing Trim Balancing - General

CAUTION: APPLICATION OF TRIM BALANCING MUST MEET FOLLOWING PREREQUISITES: TRIM BALANCE IS TO BE USED ONLY ON NEW AND OVERHAULED ENGINES AND ON THOSE REPAIR ENGINES (HEAVY MAINTENANCE) WHICH HAVE HAD LOW COMPRESSOR AND LOW TURBINE ROTORS DISASSEMBLED, INSPECTED, AND REASSEMBLED ACROSS BALANCE MACHINE, EXCEPT AS NOTED BELOW. THOSE ENGINES WITH EXCESSIVE HIGH ROTOR VIBRATION OR LOW ROTOR VIBRATION WHICH EXCEED LIMITS AS SPECIFIED IN PROCEDURE MAY NOT BE TRIM BALANCED.

(1) Engine whose rotating parts are balanced will normally have some residual unbalance which will result in detectable vibration at engine operating condition. This vibration may be minimized by trim balancing, which entails addition of weight positioned to offset residual unbalance in compressor front balance plane and turbine rear balance plane.

NOTE: (Heavy Maintenance) repair engines which do not exceed normal acceptable vibration limits may be trim balanced to lower amplitude, if desired.

B. Equipment For Trim Balance

(1) Vibration Pickups: Phased velocity type, CEC 4-123A or equivalent.

(2) Speed Signal: An exact one-pulse-per revolution is required as the reference signal. Special tachometer and adapter with ratio of 24 to 47 must be mounted in place of any other tachometer or adapter on N_1 tachometer pad. Index rotor by aligning single tooth of tachometer with tip of impulse pickup. Small hole in fact of tachometer is provided for this purpose. In order to reindex rotor after running without having to make above observation, make mark with layout dye on blade and engine case.

Tach. Adapter: Model B1692-2, Ratio 24/47 (Exact)

Vendor: The Electric Tachometer Corporation 68th & Upland Streets Philadelphia, PA 19142, U.S.A.

Pulse Generator: Model HB 163212, one triangular tooth, 0.062 inch (1.588 mm) flat

Vendor: H And B Tool And Engineering Co., 481 Sullivan Ave., South Windsor, CT 06074, U.S.A.

(3) Trim Balance Analyzer: Spectral Dynamics Model SD-119-B, or equivalent.

(a) With vibration data signal (from a velocity, acceleration or non-contacting displacement pickup) and one-pulse-per-revolution reference signal, analyzer provides the following information needed for balancing an engine:

1) Amplitude of vibration

2) Phase angle between reference point and point of maximum unbalance, i.e., location of unbalance.

3) Speed in RPM of engine (N_1).

(b) To provide these operating parameters, balance analyzer accepts signal from vibration pickup and passes it through integrator for conversion to displacement signal. For signal from a displacement pickup or accelerometer, integrator is bypassed.

(c) Displacement signal is then passed through dynamic tracking filter, which is tuned by one-per-revolution signal from tachometer mounted on engine. Pulse-to-sinewave converter uses tachometer signal to provide necessary sinewave for track filter. Converter is phase-locked to tachometer signal for absolute tuning of tracking filter and absolute phase (i.e., balance location) reference. Because it is frequency tuned by speed signal, tracking filter eliminates all frequency signals other than rotor fundamental. Output of tracking filter is displayed as displacement.

(d) Difference in angular degrees between vibration signal (at one-per-revolution tuning frequency) and one-per-revolution reference frequency derived from tachometer through converter is measured by phase meter. Output of phase meter is displayed as phase. Output of pulse-to-sinewave converter is multiplied by 60 factor and displayed as speed in RPM.

C. Setup Of Equipment

(Figure 522)

(1) Install vibration pickups. (Figure 512)

(2) Check vibration pickups to ensure that they are in phase (positive outward displacement gives positive voltage output).

(3) Install special tachometer adapter and reference signal generator in place of engine adapter (if any) and N_1 tachometer.

(4) With generator in "firing position", reference front compressor (low) rotor to engine case using layout dye.

NOTE: Turn rotor in direction of engine rotation to take up backlash of tachometer drive, that is, clockwise (counterclockwise facing engine fan inlet case).

(5) Set up and operate balance analyzer per manufacturer's instructions.

D. Trim Balance Procedures

(Figure 523), (Figure 524), (Figure 525), (Figure 526)

(1) The following procedure establishes a uniform method of approaching trim balance. Phase angle lag and sensitivity data must be determined as a result of trim balance experience. No data is currently available.

(a) Definition of Terms

1) 1EL - The low speed rotor fundamental vibration amplitude.

2) 1EH - The high speed rotor fundamental vibration amplitude.

3) Cw - Calibration weight (serially numbered Cw1, Cw2, etc.) of stainless steel wire used to balance engine. Replaced by equivalent PN balance weight after trim balance.

4) Class - Category into which engine is placed based on prebalance vibration survey. (No data is currently available.)

5) Phase Angle - Phase meter reading. Phase angle by which integrated vibration signal lags reference signal.

6) Phase Angle Lag - Calculated angle indicating lag between passing of unbalance weight and response signal.

7) Assumed Phase Angle Lag - Weighted average of phase angle lags determined from previous balance attempts. Also, correction angle used in "one-shot" method.

8) VD - Vector difference from Point A to Point C.

(b) Trim Balance Sequence

1) Conduct prebalance vibration survey to determine suitability of engine for trim balance and to provide basis for classification.
2) Run "As Is" speed points as prescribed for class engine being balanced.
3) Run "As Is" data, plot A vector on polar paper, angle being laid out counter to engine rotation from 12 o'clock location. Draw R vector equal and opposite A vector. (Figure 523)
4) Apply assumed phase angle lag given for class to which engine has been assigned. Assumed phase angle lag is laid off from R in direction of rotation and indicates angular location of Cw1.
5) Apply assumed sensitivity given in respective trim balance procedures assigned engine class. Multiply amplitude of vector A and sensitivity value to give oz-in required for Cw1.
6) Install Cw1 which may be either stainless steel wire or permanent weight as described previously. See Figure 522 or Figure 525 for computation of wire necessary to correct imbalance. Wire weight is installed on nearest blade to location to that designated by steps outlined in Paragraph 9.D.(1)(b)4) above.
7) Rerun engine as in Paragraph 9.D.(1)(b)2) above repeating each speed point within ± 0.2 rev/sec on counter at time base of 10 sec. Record all data.
8) In conjunction with Paragraph 9. above observe O/A (overall) mils vibration throughout engine speed range to determine if all vibration is within acceptance limits.
9) If engine is acceptable, replace wire trial weight with equivalent weight in 1st stage compressor hub, when applicable. No changes are required if no wire weight was used.
10) If engine is unacceptable, calculate and apply Cw2 as described in specific counterweight installation procedure. All weight runs (Cw1, Cw2 ... Cwn) are calculated with respect to "As Is" data.
11) Continue to trim balance engine as required.
12) Complete trim balance report, shown in Figure 526, and file report with engine records.

(2) Hypothetical Example of Vector Balance Method

(a) Assume:

Vibration survey has shown need to trim balance (± 2.0 mils) (0.05 mm) at 6000 N_1. Engine is classified as "Class X." (Acceptance limits ± 1 mil) (0.03 mm). Procedure calls for a compressor trim at 6000 N_1 RPM, assumed phase angle lag of 130 degrees and sensitivity of 1.0 oz-in/mil (720 g.mm/0.03 mm).

(b) Record inlet pickup phase angle and amplitude at 6000 N_1 RPM. In this example let ± 2.0 mil (0.05 mm) at 300 degrees be the recorded data for run No. 1.

(c) Plot vector A (± 2.0 mil) (0.05 mm) at 300 degrees on polar paper. Lay out angle counter to engine rotation from 12 o'clock location. Draw vector R equal and opposite vector A. (See plot on Figure 523).

(d) Apply assumed phase angle lag (130 degrees) laying it off from R in direction of rotation. This indicates that Cw1 should be applied at 350 degrees as measured from 12 o'clock reference location counter to engine rotation.

(e) Apply assumed sensitivity. Multiple amplitude of A vector (± 2.0 mil) (0.05 mm) by assumed sensitivity (1.0 oz-in/mil) (720 g.mm/0.03 mm). Magnitude of Cw1 should be 2 oz-in (1440 g.mm).

(f) Install Cw1. Wire weight may be installed on nearest blade to 350 degrees. In this example let blade No. 2, shown on plot, be chosen (349 degrees).

(g) Rerun balance point and record phase angle and amplitude resulting from addition of Cw1. Run No. 2.

(h) In conjunction with previous Paragraph 9.D.(2)(g), observe O/A mils throughout engine speed range to determine if all vibration is within acceptance limits.

(i) Let data from Run No. 2 be ± 1.3 mils (0.03 mm) at 20 degrees. Plot data as vector C on polar paper. Lay out angle counter to engine rotation from 12 o'clock location.

(j) Plot Vector Difference (VD) by subtracting vector A from vector C. Draw VD from A to C, arrow pointing to C. Translate VD vector to origin of diagram. In this example VD is ± 2.2 mils (0.06 mm) at 84 degrees. VD represents effect of Cw1 alone, both in magnitude and direction. To eliminate unbalance (A vector), VD must bed rotated and adjusted in length to coincide with R vector.

(k) Calculate location and size of required balance weight, Cw2.

1) Size of correction weight = size of trial

$$\text{weight} \quad \times \quad \frac{\text{A mils}}{\text{VD mils}}$$

$$\text{Cw2} = 2 \quad \times \quad \frac{2}{2.2} = 1.82 \text{ oz-in.}$$

2) Location of correction weight: In this example, angular amount between VD (84 degrees) and R (120 degrees) is 36 degrees counter to engine rotation. Remove Cw1, move from its location 36 degrees counter to engine rotation to 25 degrees. Apply Cw2 (1.82 oz-in.) (1310 g.mm) at 25 degree (blade No. 32). This should cause VD to coincide with R.

(l) Above procedure can be repeated using second correction weight as new calibration weight. Data from new weight and "As-Is" data can be used to calculate third correction weight and thereby refine balance.

(m) Determine phase angle lag and vibration sensitivity. (Although not required for any specific engine balance, average values calculated from several engine balances are considered valuable guide for follow-on balance jobs).

1) Phase Angle Lag: Unbalance vectors are measured in terms of amplitude and phase angle (phase meter reading) and are plotted referenced to 12 o'clock location in direction counter to rotation to indicate "lag". Normal plotting procedure locates reference point at top of engine vertical centerline designated as 12 o'clock. this point is shown on the plot as 0 degrees.

Balance weights are located on rotor after rotor has been turned (indexed) to locate pulse generator tooth directly under pulse pickup. Angular location of the weight is then measured in direction counter to rotation referenced to 12 o'clock.

To determine phase angle lag, unbalance vectors and weight locations must be given common frame of reference. Angular location corresponding to 12 o'clock is taken as common reference point. Phase angle lag is angle by which response (VD) lags calibration weight. Graphically, it is angle from calibration weight to VD measured counter to engine rotation. In this example, phase lag is 96 degrees.

2) Sensitivity: Sensitivity can be calculated at any given speed point by dividing weight amplitude (Cw1 = 2.0 oz-in.) (1440 g.mm) by measured response (VD - ± 2.2 mils) (0.06 mm). In this example calculated sensitivity is 0.91 oz-in. per mil (655 g.mm per 0.03 mm).

(n) The purpose of calculating phase angle lag and sensitivity is to provide information to assist in future balances. Weighted average of these data for number of balances provide assumed phase angle lag and assumed sensitivity which, when applied to "As Is" data, established "one shot" balance method. In this example let assumed phase angle lag equal 95 degrees. After plotting information described in Paragraph 9.D.(2)(a) the 95 degree angle is now laid out from R vector in direction of engine rotation and establishes Cw1 location. Amount of weight required is established by multiplying A vector amplitude (+ mils) (+ mm) by sensitivity (oz-in./mil) (g.mm/mm) which, for this example, gives 1.82 oz-in. (1310 g.mm) required. It can now be seen that engine would be balanced by this Cw1 and no further runs are necessary.

E. Trim Balance Limits And Procedures

(1) Trim Balance Limits

(a) Engines that experience vibration at N_1 rotational frequency at inlet case and/or exhaust duct up to and including 0.002 inch single amplitude may be trim balanced to bring them within acceptable limits.

(b) Maximum correction (all trim weights) for trim balance of the front compressor at the front plane must be a vector sum of no more than 7.0 oz-in (5040. g.mm). The total number of trim weights used on the inner balance rib of the front hub must not be more than five.

(c) Maximum correction (all trim weights) for trim balancing front compressor drive turbine at rear plane shall not exceed total vector sum of 10.5 oz-in. when combined with weights previously installed while balancing turbine rotor. Previously installed weights may be moved or replaced, but total number of weights used on turbine rotor assembly shall not exceed five and total vector sum shall not exceed 10.5 oz-in. (7560 g.mm).

(d) After completing installation of final trim balance weights, conduct vibration survey to ensure that vibration levels are within acceptance limits.

(2) Trim Balance Weight Installation

(a) Front Plane

1) Remove front accessory drive group. (PAGEBLOCK 72-21-00/401)

2) Remove retaining ring holding front accessory drive gearshaft in front hub. Engage PWA 45009 Puller behind gearshaft gearteeth and remove gearshaft carefully with knocker action.

3) Find the applicable counterweight (0 - 5) as shown in Figure 527.

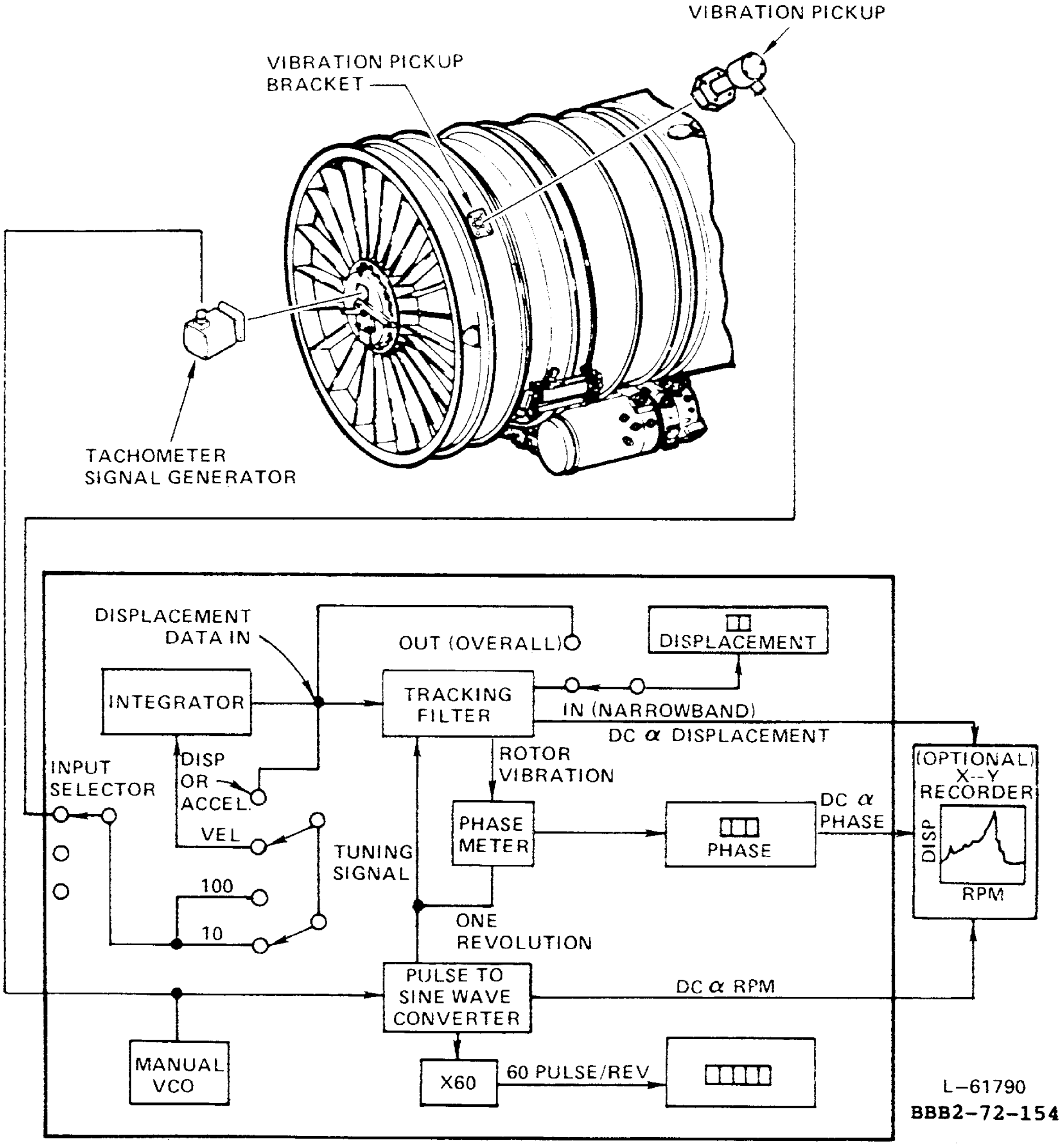
4) Install counterweight inside front hub on balancing rib as close to required angular location as possible. Compress counterweight shank against spring pressure and release shank when weight straddles balancing rib and hook section of shank is in line with hole in rib. Figure 527

5) Install a packing, lubricated with PWA 36500 Assembly Fluid, on the front accessory drive gearshaft and install the shaft on the front hub. Hold the gearshaft in position with a retaining ring.

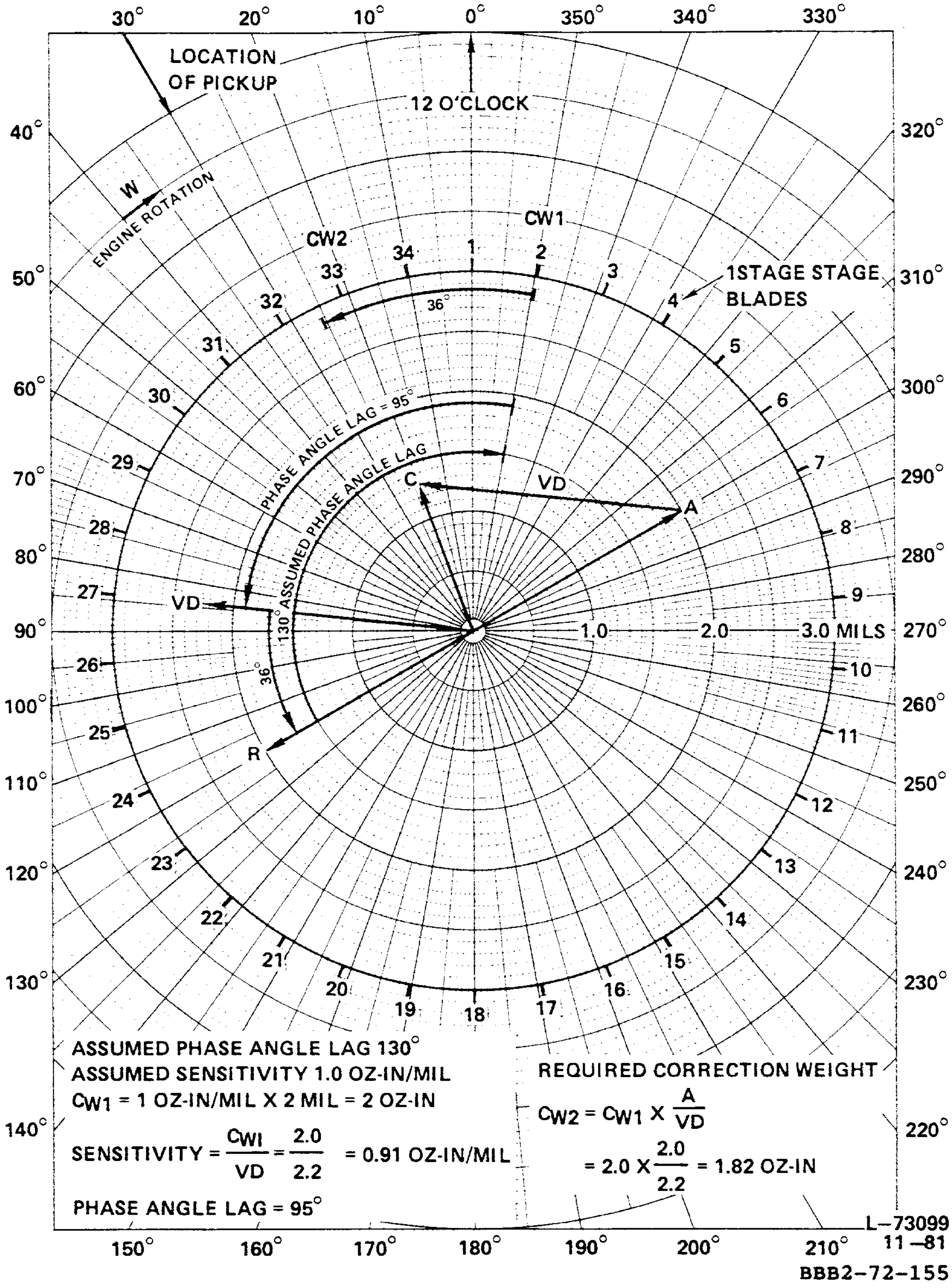
6) Install front accessory group. (PAGEBLOCK 72-21-00/401)

(b) Rear Plane

1) Remove the fan and turbine exhaust duct (mixer) for access to the rear of the turbine.
2) Add counterweights (or remove and replace counterweights found on the rear of the 4th stage turbine disk). Refer to the limits in Paragraph 9.E.(1). (Figure 528)
3) Attach counterweights with rivets (rivet heads pointed to the disk surface). Flare the rivet ends to 0.125 inch (3.175 mm) diameter minimum (PWA 46320 Riveter is available to do this).
4) Install the fan and turbine exhaust duct (mixer).



Instrumentation Block
Figure 522/72-00-00-990-977



ASSUMED PHASE ANGLE LAG 130°
ASSUMED SENSITIVITY 1.0 OZ-IN/MIL
C_{W1} = 1 OZ-IN/MIL X 2 MIL = 2 OZ-IN

$$\text{SENSITIVITY} = \frac{C_{WI}}{VD} = \frac{2.0}{2.2} = 0.91 \text{ OZ-IN/MIL}$$

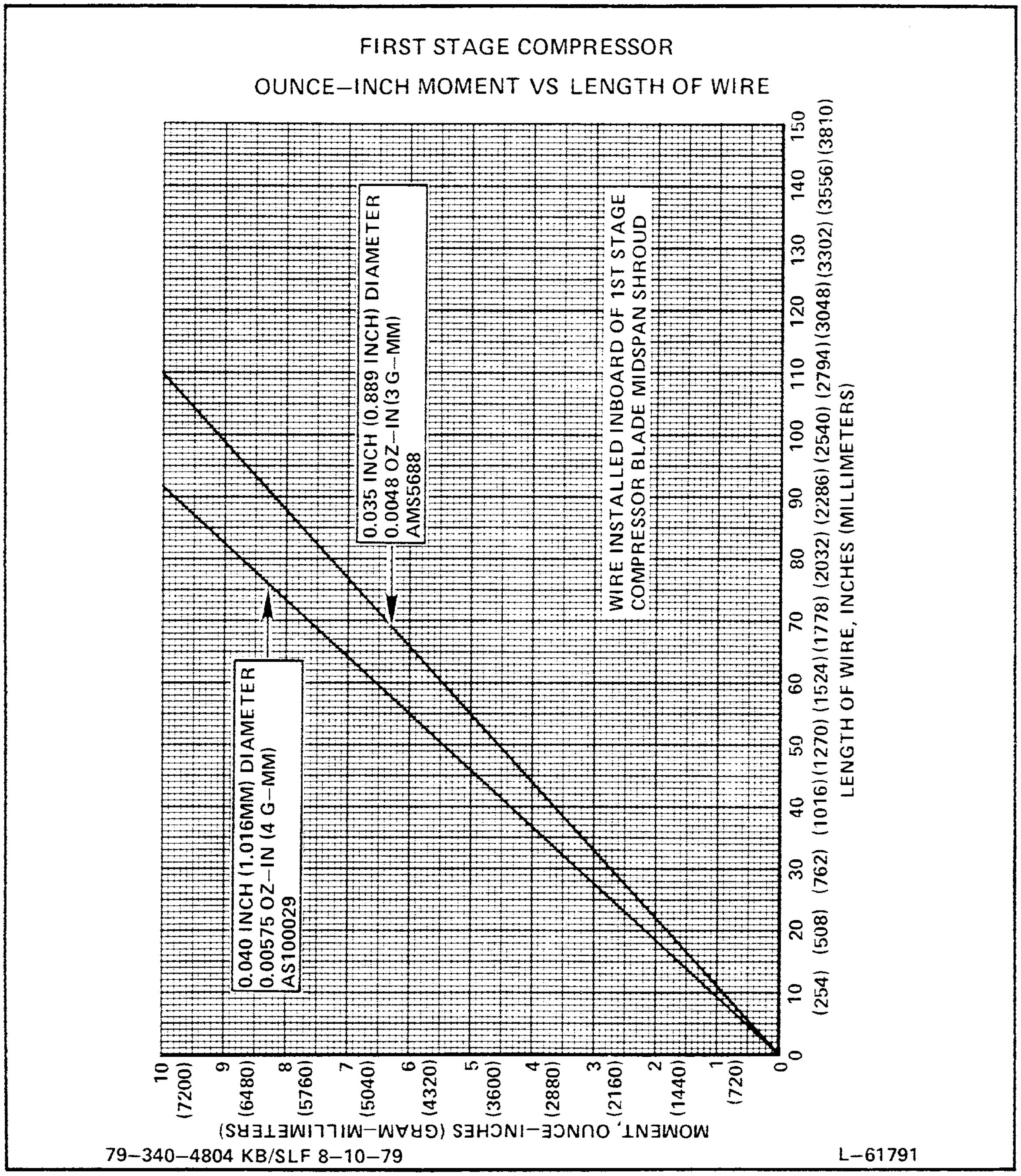
PHASE ANGLE LAG = 95°

REQUIRED CORRECTION WEIGHT

$$C_{W2} = C_{W1} \times \frac{A}{VD}$$

$$= 2.0 \times \frac{2.0}{2.2} = 1.82 \text{ OZ-IN}$$

Trim Balance Calculation Diagram
Figure 523/72-00-00-990-978



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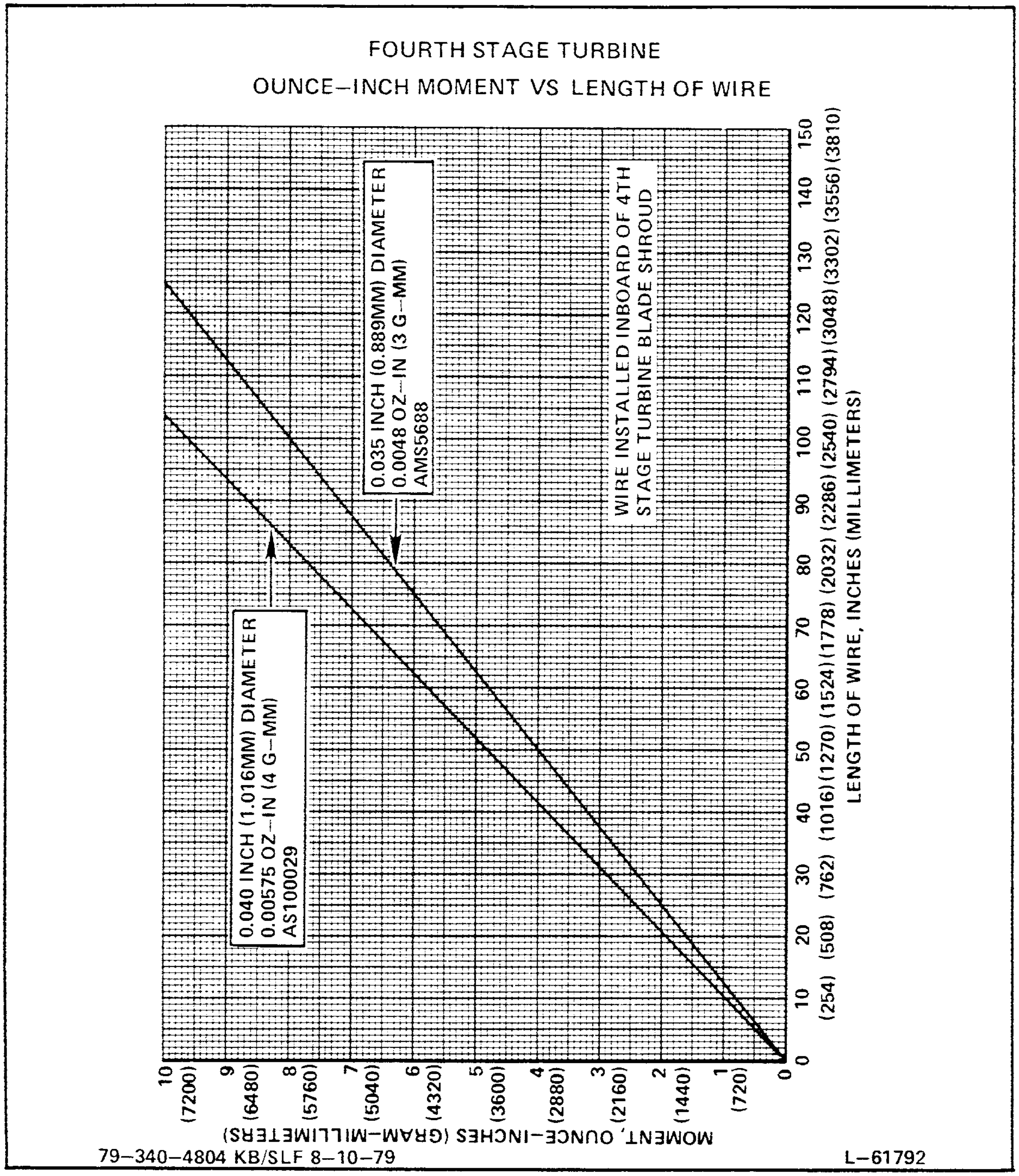
Ounce-Inch Moment Vs. Length Of Wire (First Stage Compressor)
Figure 524/72-00-00-990-979



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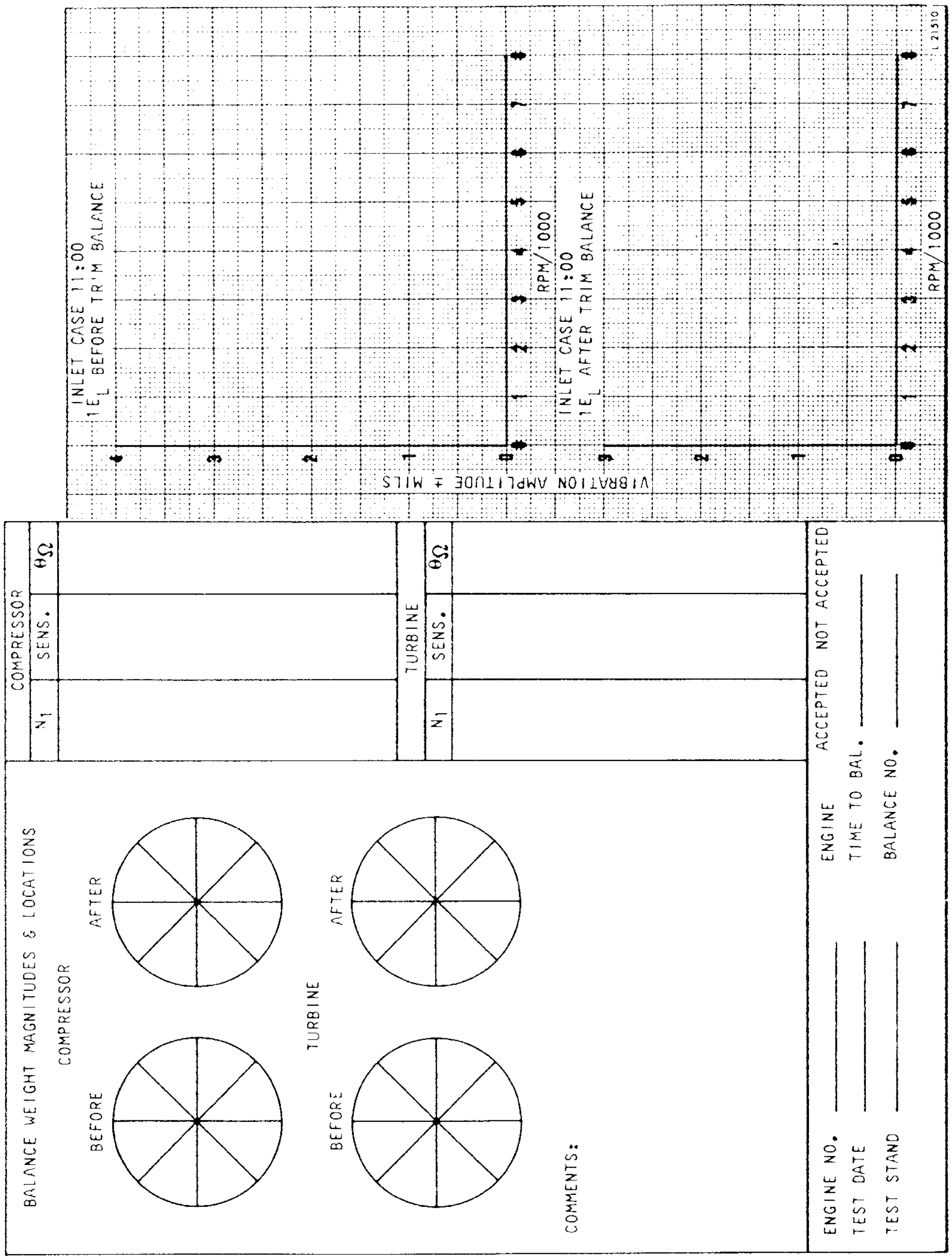
Ounce-Inch Moment Vs. Length of Wire (Fourth Stage Turbine)
Figure 525/72-00-00-990-980



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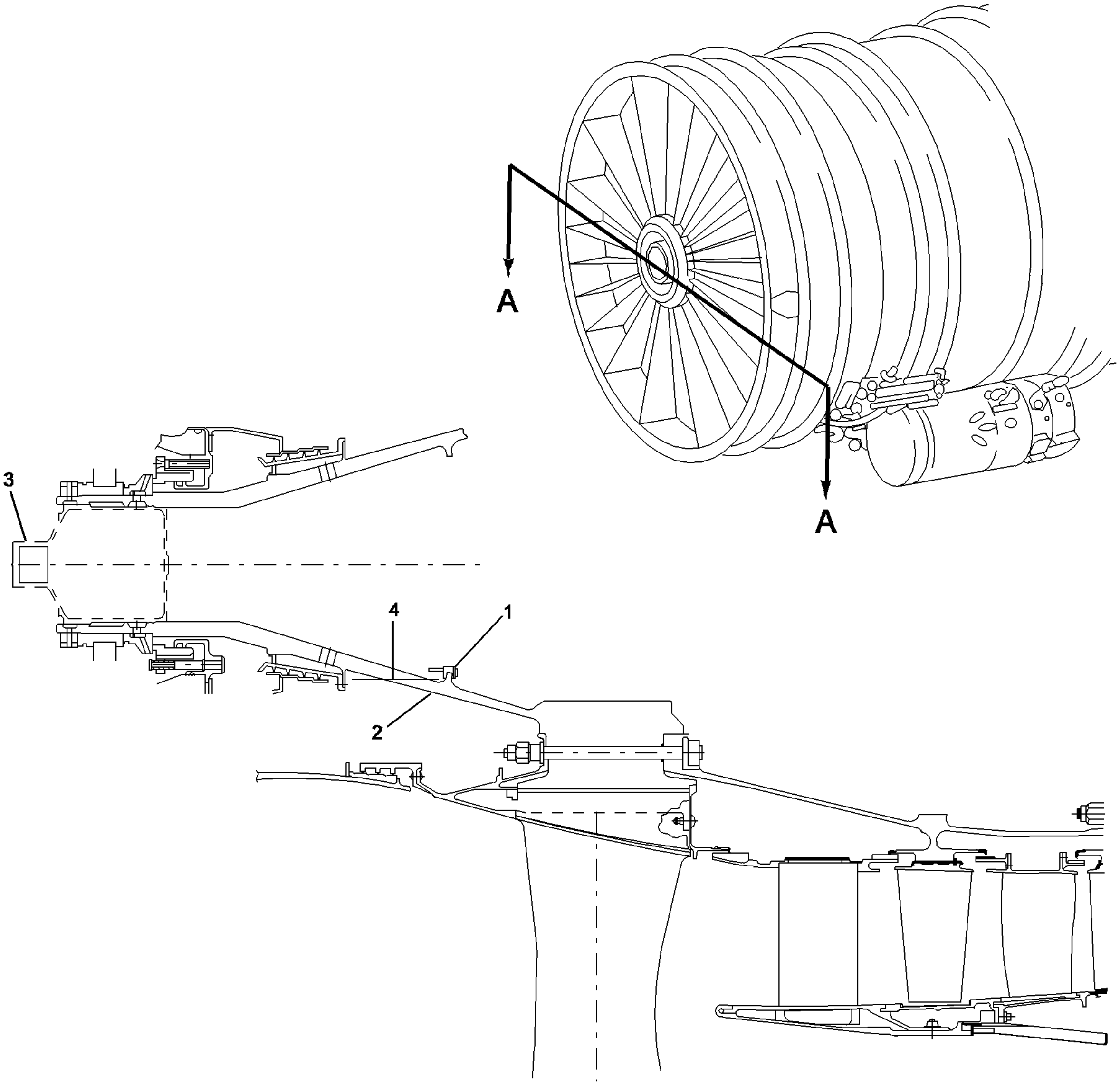
Trim Balance Report
Figure 526/72-00-00-990-981



SECTION A-A

LEGEND:

1. COUNTERWEIGHT PN 658339, 658341 (CLASS 1 OR 2) OR 761787, 0 - 5 AS REQUIRED
2. FRONT COMPRESSOR FRONT HUB
3. GEARSHAFT (REMOVED FOR ACCESS)
4. 4.000 in. (101.600 mm) BALANCING RADIUS (REFERENCE)

L-83887

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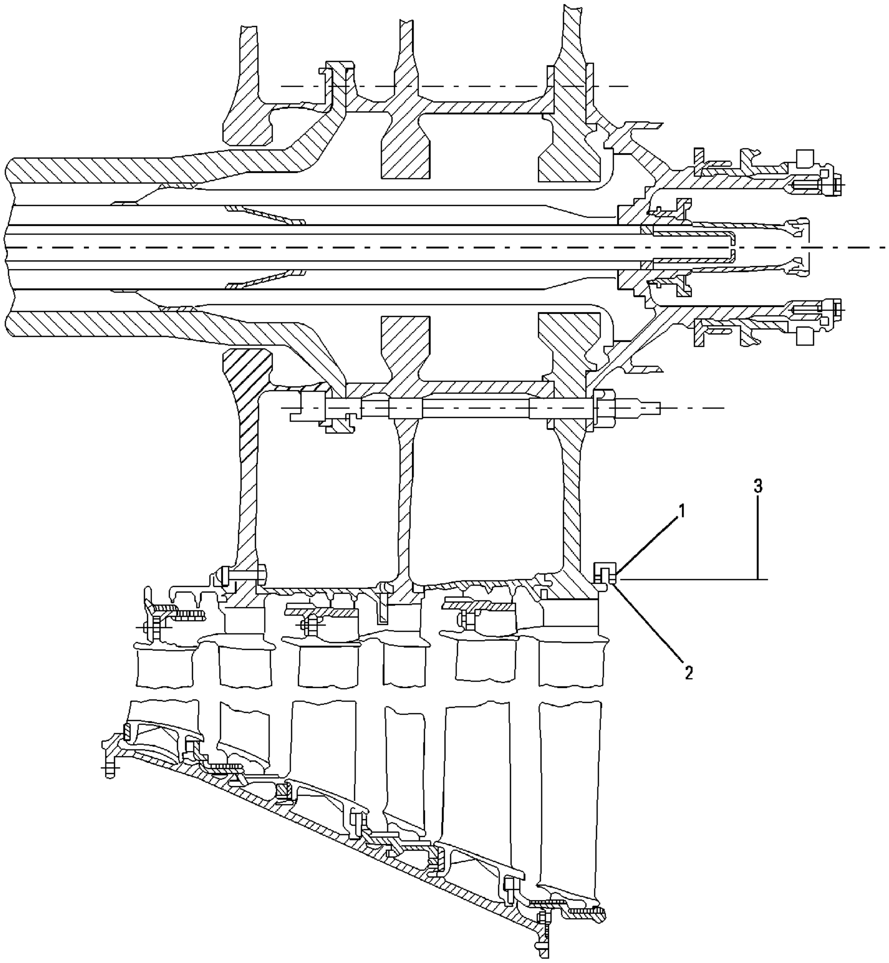
S0006554749V2

Front Compressor Trim Balancing
Figure 527/72-00-00-990-982



1. PN 534492, 584943, OR 584994 COUNTERWEIGHTS. SELECT CLASS AS NECESSARY AND INSTALL, REMOVE, OR REPLACE BY THE LIMITS IN THE TEXT. IT IS PERMITTED TO INSTALL PN 534492 EITHER SIDE OF THE DISK FLANGE.
2. RIVET (PN 4028248) (USE WITH PN 584943 OR 584944).
3. 7.715 INCHES (195.961 MM) BALANCE RADIUS (REFERENCE)

L-84125

CAG(IGDS)

BBB2-72-518

Rear Turbine Trim Balance
Figure 528/72-00-00-990-983

10. Fuel Control Starting Schedule Adjustment

A. General

(1) Fuel control removals have occurred on engines that had what could become "hot starts" and also on engines which had slow acceleration. Experience shows that fuel control linkages can have wear or part movement which can cause changes in the starting flow schedule, in either the rich or the lean direction. A rich change in fuel flow can cause hot starts. A lean change in fuel flow can cause slow acceleration. Adjustments to the fuel control to put the start schedule back in its initial calibration limits, as specified in the CMM, can decrease the number of fuel control removals which are the result of possible hot start or slow acceleration.

(2) It is possible to do this adjustment on a fuel control only two times, in the upward or downward direction. If a fuel control continues to be part of a hot start or slow acceleration problem, remove the control for approved component repair or calibration.

(3) This procedure is approved for all dash numbers of Hamilton Standard (HSD) PN 769606 fuel controls.

(4) Before fuel control adjustment, do all other applicable procedures in PAGEBLOCK 72-00-04/101 to make sure that there are no other possible causes of the hot start or slow acceleration problem.

(5) Adjustments to the fuel control other than what is specified in the procedures in this section are not permitted.

B. Procedure

(Figure 529), (Figure 530), (Figure 531), (Figure 532)

CAUTION: DO NOT USE AN ABSOLUTE PRESSURE GAGE TO MEASURE PRIMARY FUEL PRESSURES. THIS TYPE OF GAGE WILL NOT GIVE CORRECT READINGS FOR THIS PROCEDURE.

(1) Attach a gage, STD-14581 to the pressurizing and dump valve FP4 port as shown in (Figure 529).

(2) Wet motor the engine for ten (10) seconds minimum after the N_2 speed becomes stable.

(3) Measure the fuel pressure at the FP4 port.

(4) Record the engine speed and the ambient atmospheric pressure (in inches Hg).

(5) Use Figure 530 to convert the primary fuel pressure at the FP4 port to fuel flow (primary fuel pressure versus primary nozzle pressure).

(6) Find the nominal fuel flow (Wf) for the N_2 speed from the applicable starting schedule. (Figure 531, Sheets 1 thru 10)

(7) Add and subtract 30 PPH to get a plus or minus 30 PPH acceptance band.

(8) If the fuel flow (Wf) in Paragraph 10.B.(5) is in the band of fuel flow (Wf) set in Paragraph 10.B.(6), do not adjust the fuel control.

(9) If the fuel flow (Wf) in Paragraph 10.B.(5) is more than the higher fuel flow (Wf) set in Paragraph 10.B.(7), turn the throttle valve position adjustment counterclockwise to decrease the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(10) If the fuel flow (Wf) in Paragraph 10.B.(5) is less than the lower fuel flow (WF) set in Paragraph 10.B.(7), turn the throttle valve position adjustment clockwise to increase the nominal necessary fuel flow (Wf) of Paragraph 10.B.(5), plus or minus 25 PPH.

(11) Adjust the throttle valve position adjustment as follows: (Figure 508)

  (a) Remove the screw and plate from the fuel control as shown in Figure 532.

(b) Use a 3/32 inch hex wrench to turn the adjustment in the necessary direction.

NOTE: The adjustment has a limit of 230 PPH for a fuel control between bench calibrations (this will be approximately 0.3 turn). This adjustment will make a change of 800 PPH per turn. Make the last adjustment in a clockwise direction. To get a decrease in fuel flow, turn the adjustment counterclockwise one eighth (1/8) turn past the necessary position, then turn it clockwise to the necessary position.

(c) Install the plate and attach it with the screw and washer after the adjustment is completed.

(12) After all adjustments, do this procedure to make sure that the schedule mechanism is stable:

(a) Get the engine to a stable motoring speed.

(b) Set the condition lever to ON for ten (10) seconds and record the primary nozzle pressure at the P&D valve FP4 port.

(c) Set the condition lever to OFF for ten (10) seconds.

(d) Do Paragraph 10.B.(12)(b) and Paragraph 10.B.(12)(c) again.

(e) Do Paragraph 10.B.(12)(b) again.

(f) If the pressure recorded in Paragraph 10.B.(12)(e) is not plus or minus 2 psi of the pressure recorded in Paragraph 10.B.(12)(d), stop the motoring procedure and do Paragraph 10.B.(12)(a) thru Paragraph 10.B.(12)(e) again.

(g) Use Figure 530 to convert primary nozzle pressures recorded in Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) to fuel flow (Wf).

(h) The average of the fuel flow (Wf) readings from Paragraph 10.B.(12)(d) and Paragraph 10.B.(12)(e) will usually be plus or minus 25 PPH from the nominal fuel flow (Wf) in Paragraph 10.B.(6). If the average fuel flow (Wf) is more than this limit, adjust the starting fuel flow (Wf) and do all of Paragraph 10.B.(12) again.

NOTE: It is possible to do an engine run to Idle as an alternate to Paragraph 10.B.(12)(b) thru Paragraph 10.B.(12)(e), with only one pressure measured during a motoring procedure.

(13) Make sure that an increase or decrease in starting fuel flow (Wf) shows on the flight deck indicator as well as during the primary pressure flow check at the P&D valve. If the two indications are not the same, this can be a result of contamination in the primary fuel nozzles, or a problem with the flight deck instrumentation.

(14) After the adjustment, make sure that the necessary fuel control trim parameters are in limits. These parameters will include Idle and Part Power trim limits, and Takeoff, acceleration, and deceleration checks. Refer to the airframe manufacturer's trim information.

(15) Sample Calculation

(a) Sample A

1) Conditions:

a) 22 percent N_2 motoring speed

b) Fuel: Jet A

c) Pamb: 29.92 inches Hg

d) Primary fuel nozzle pressure measured at 100 PSIG

(b) Sample B

1) From Figure 531 (for -7 and -08 fuel controls) the nominal fuel flow (Wf) for 22 percent N_2 at 29.92 inches hg ambient pressure will be 730 PPH.
2) Add and subtract 30 PPH as shown in Paragraph 10.B.(7):

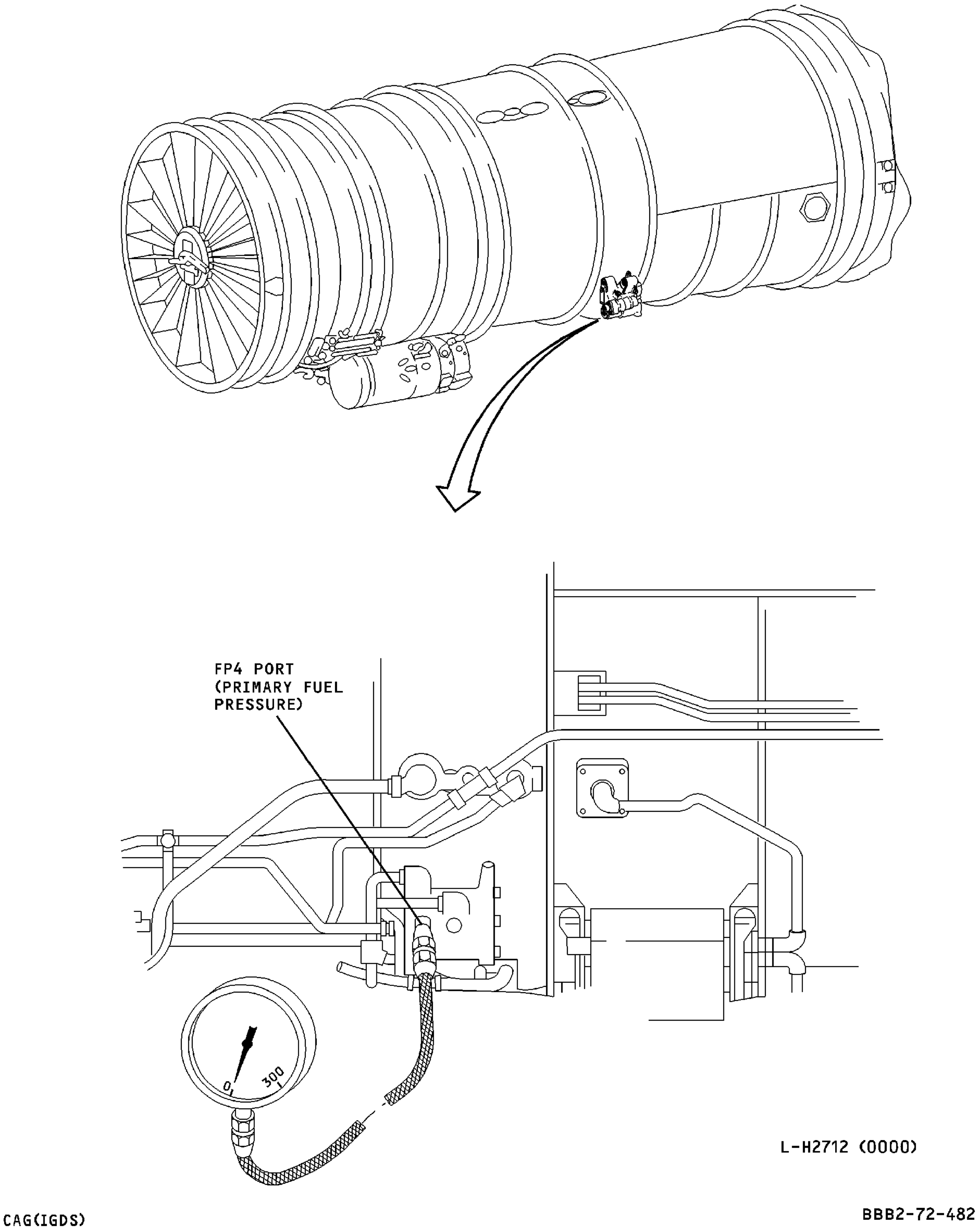
   730 + 30 = 760 pph

   730 - 30 = 700 pph

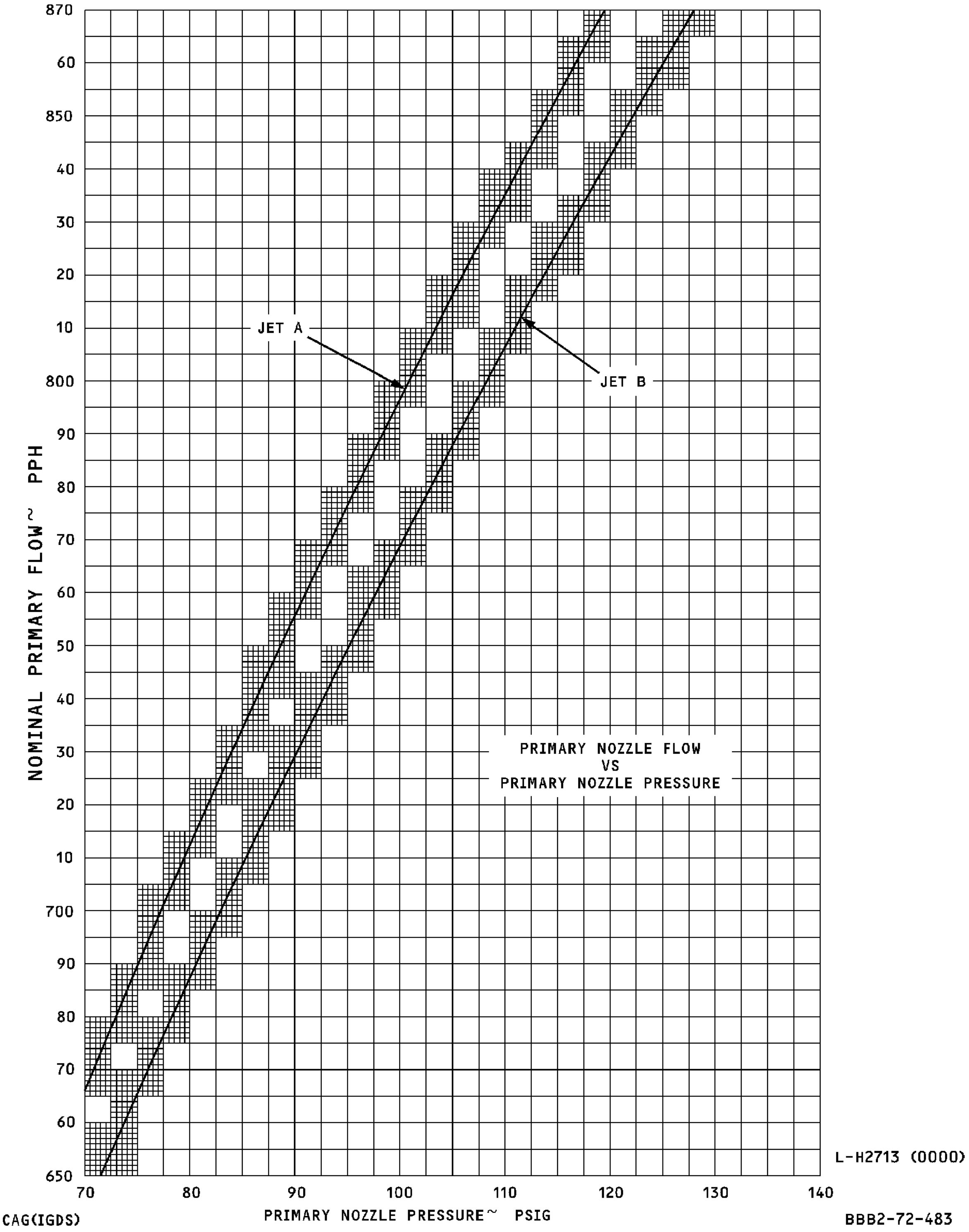
3) In this example the fuel flow (Wf) from Paragraph 10.B.(15)(a) is more than the higher fuel flow (Wf) in Paragraph 10.B.(15)(b). Therefore, it will be necessary to decrease the flow to 730 ±25 PPH. Turn the throttle valve position adjustment counterclockwise to get a primary nozzle pressure of 84 PSIG. Make the last adjustment in a clockwise direction as shown in Paragraph 10.B.(9). Refer to Table 509 for typical adjustment limits.

Table 509 Fuel Control Fuel Flow Adjustment

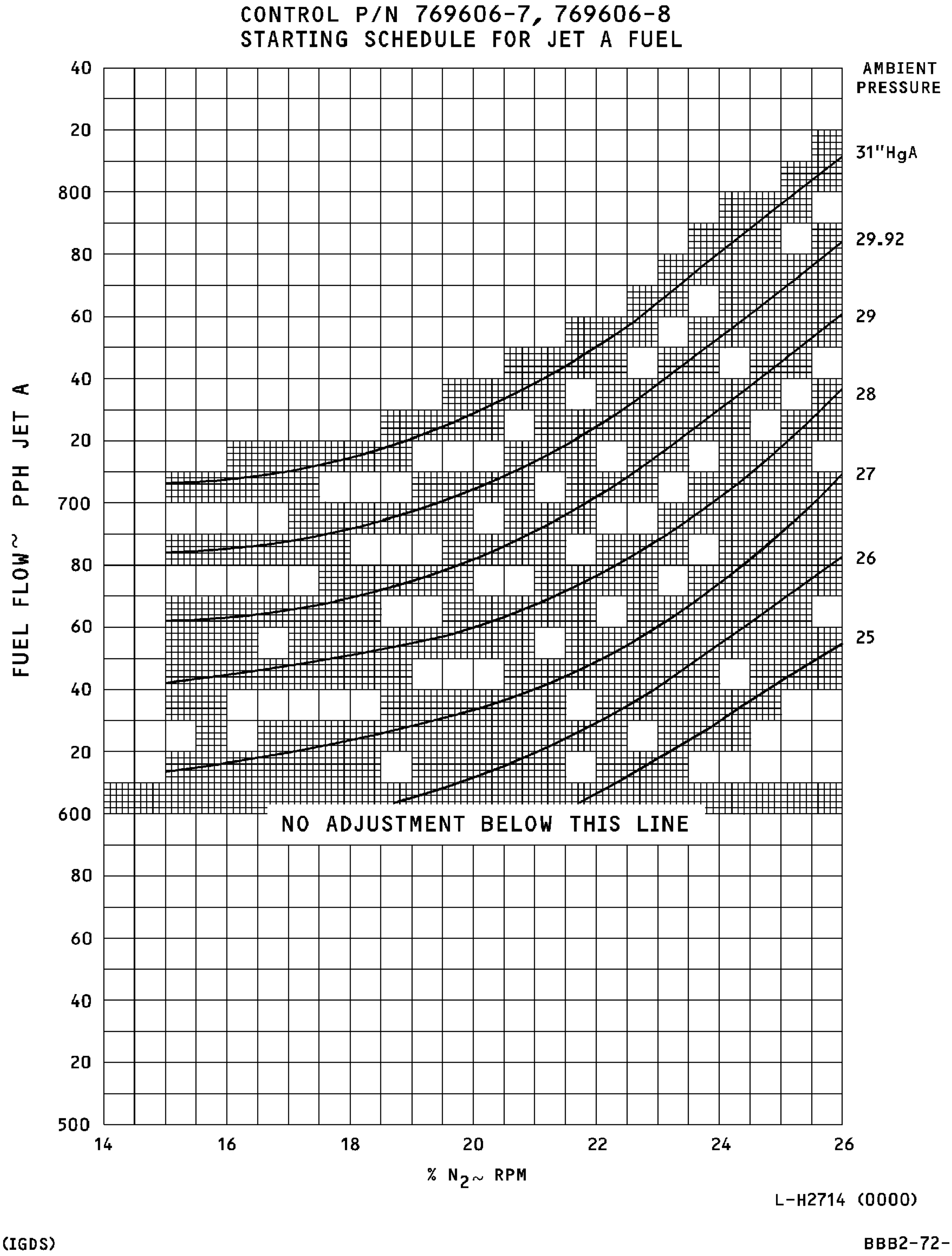
Fuel Control Throttle Valve Position Adjustment Turns	Fuel Flow (Wf) Difference (PPH)
Clockwise:	
1/16	50
1/8	100
3/16	150
1/4	200
5/16	250
3/8	300
Counterclockwise:	
1/16	-50
1/8	-100
3/16	-150
1/4	-200
5/16	-250
3/8	-300



Pressurizing and Dump Valve
Figure 529/72-00-00-990-984



Fuel Pressure to Flow Conversion
Figure 530/72-00-00-990-985



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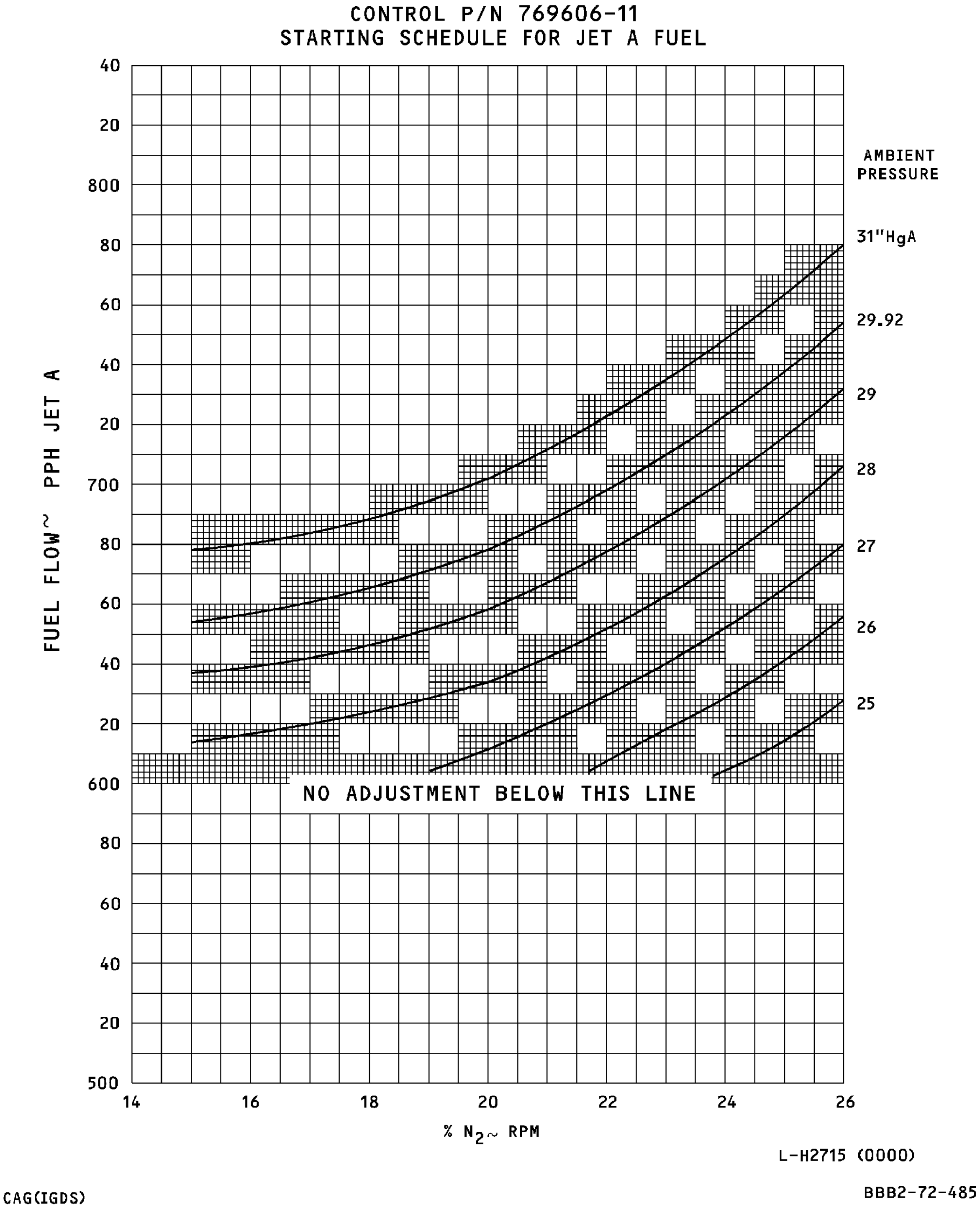
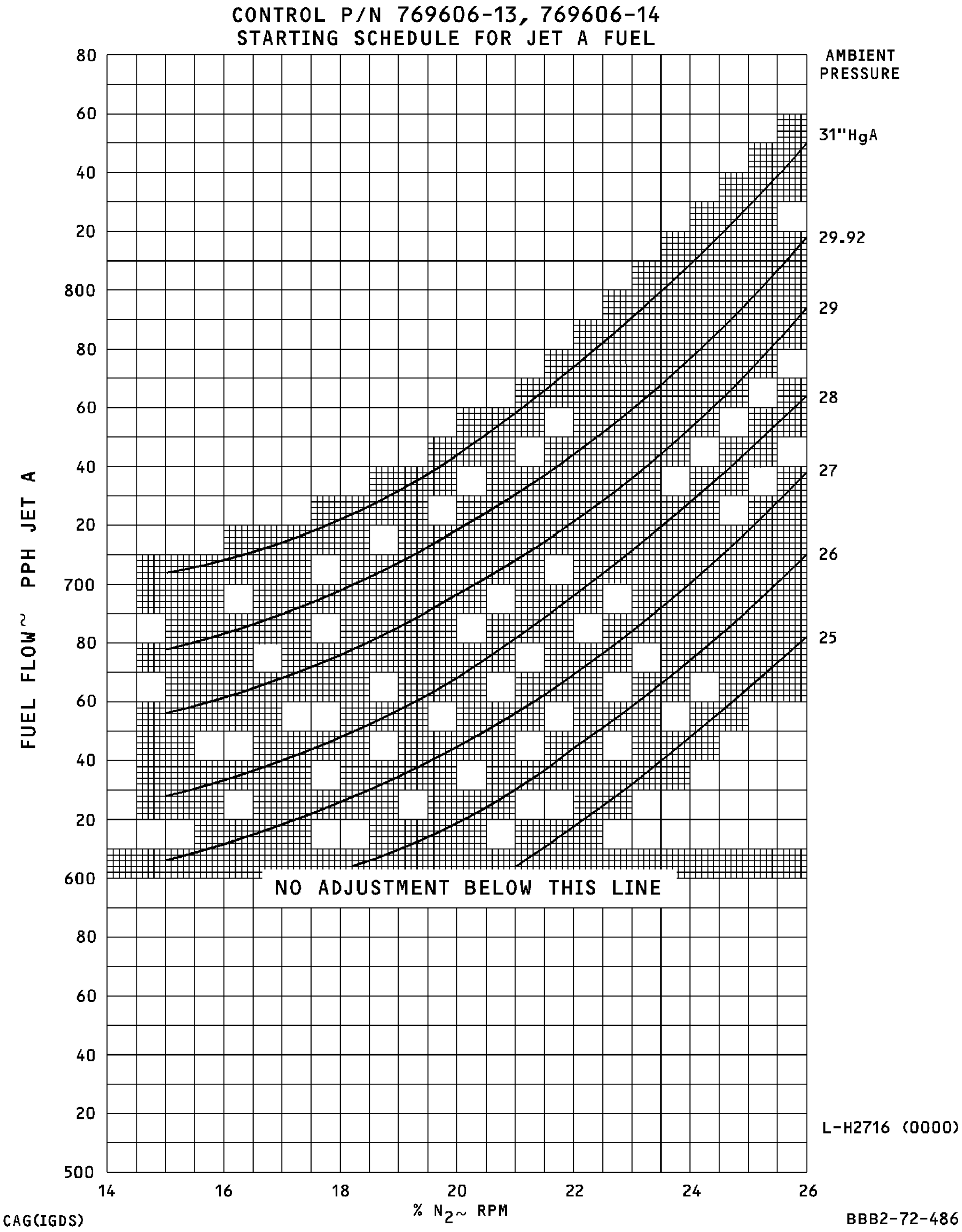
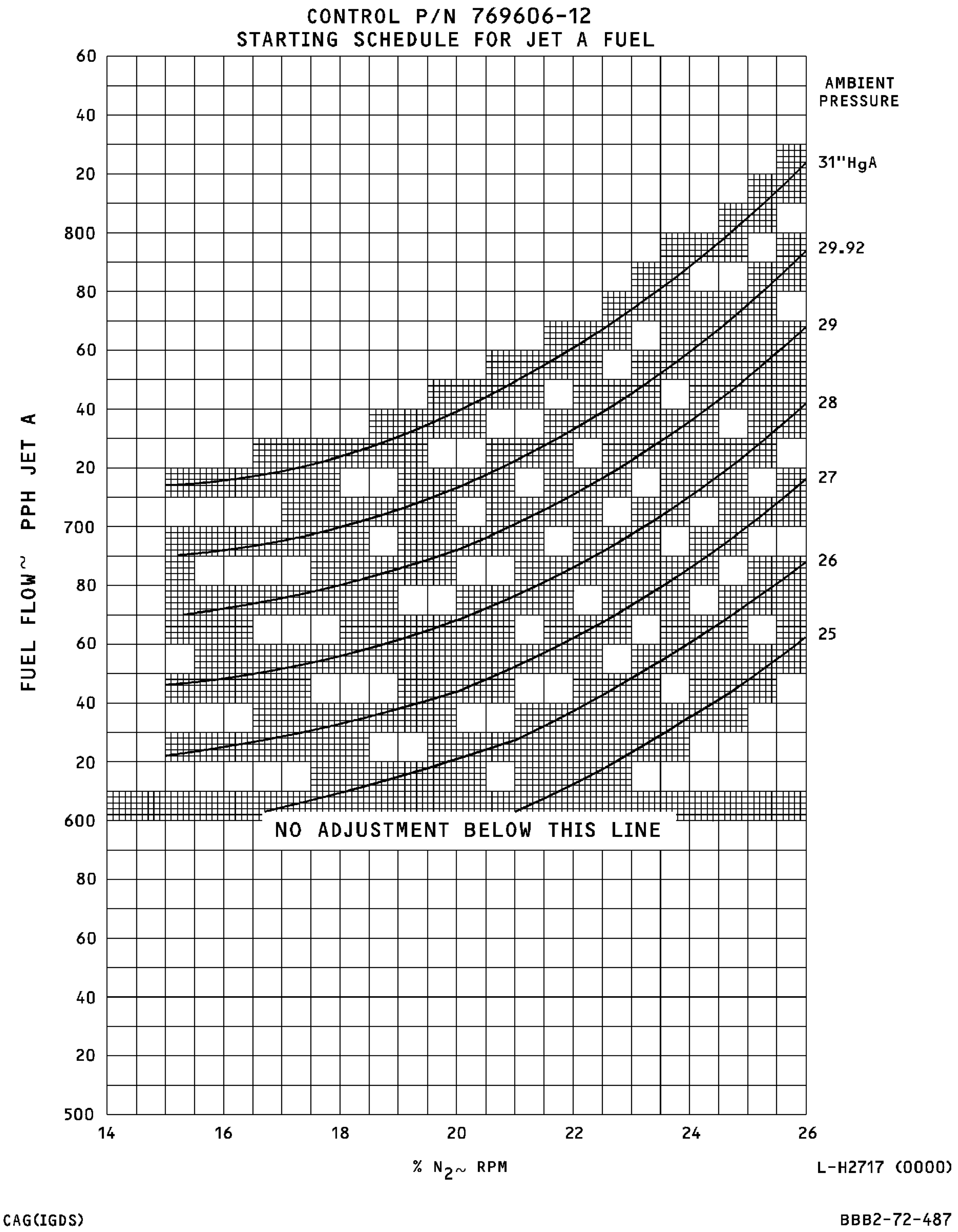
Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 1 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 2 of 10)

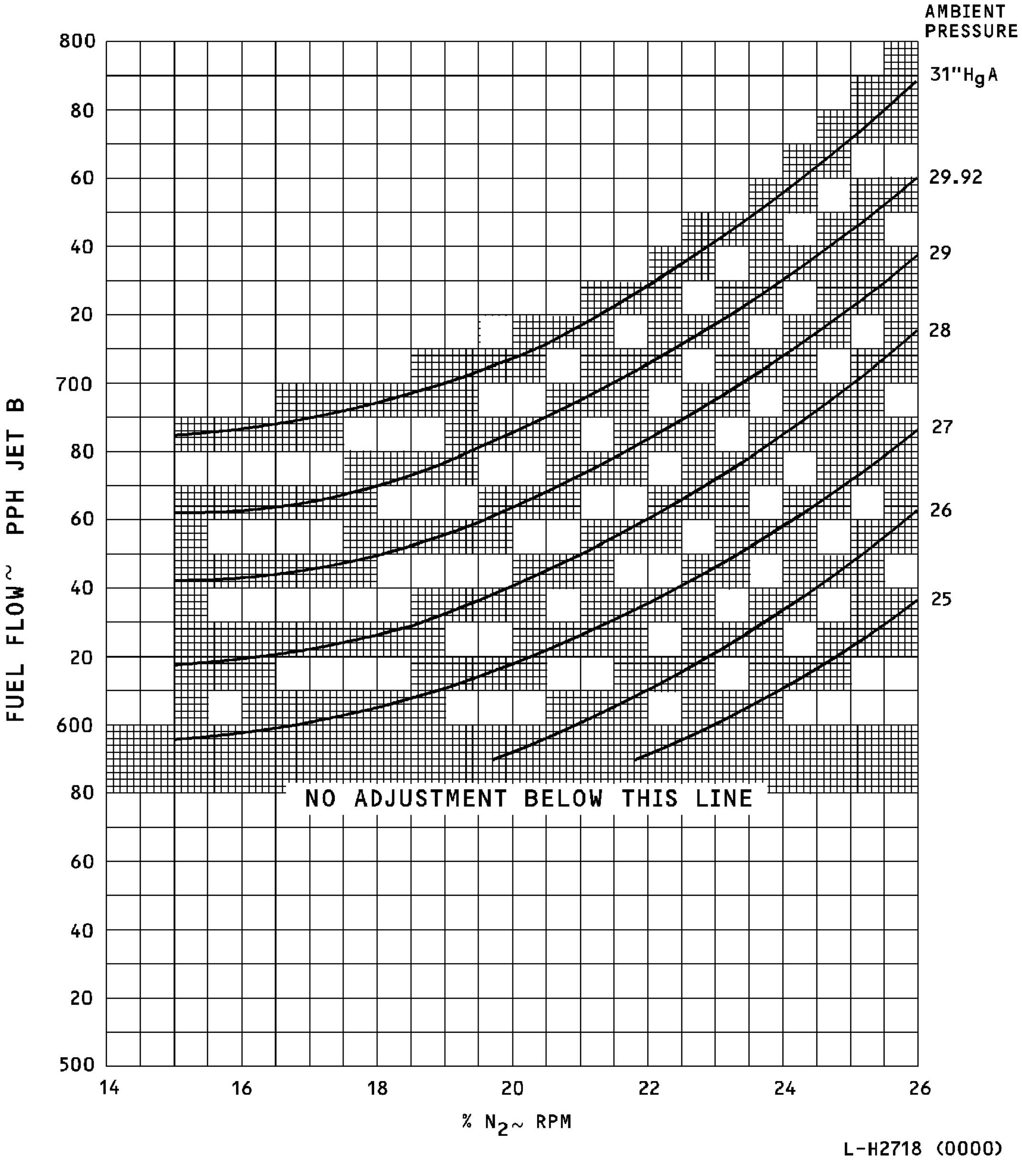


Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 3 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 4 of 10)

CONTROL P/N 769606-7, 769606-8
STARTING SCHEDULE FOR JET B FUEL



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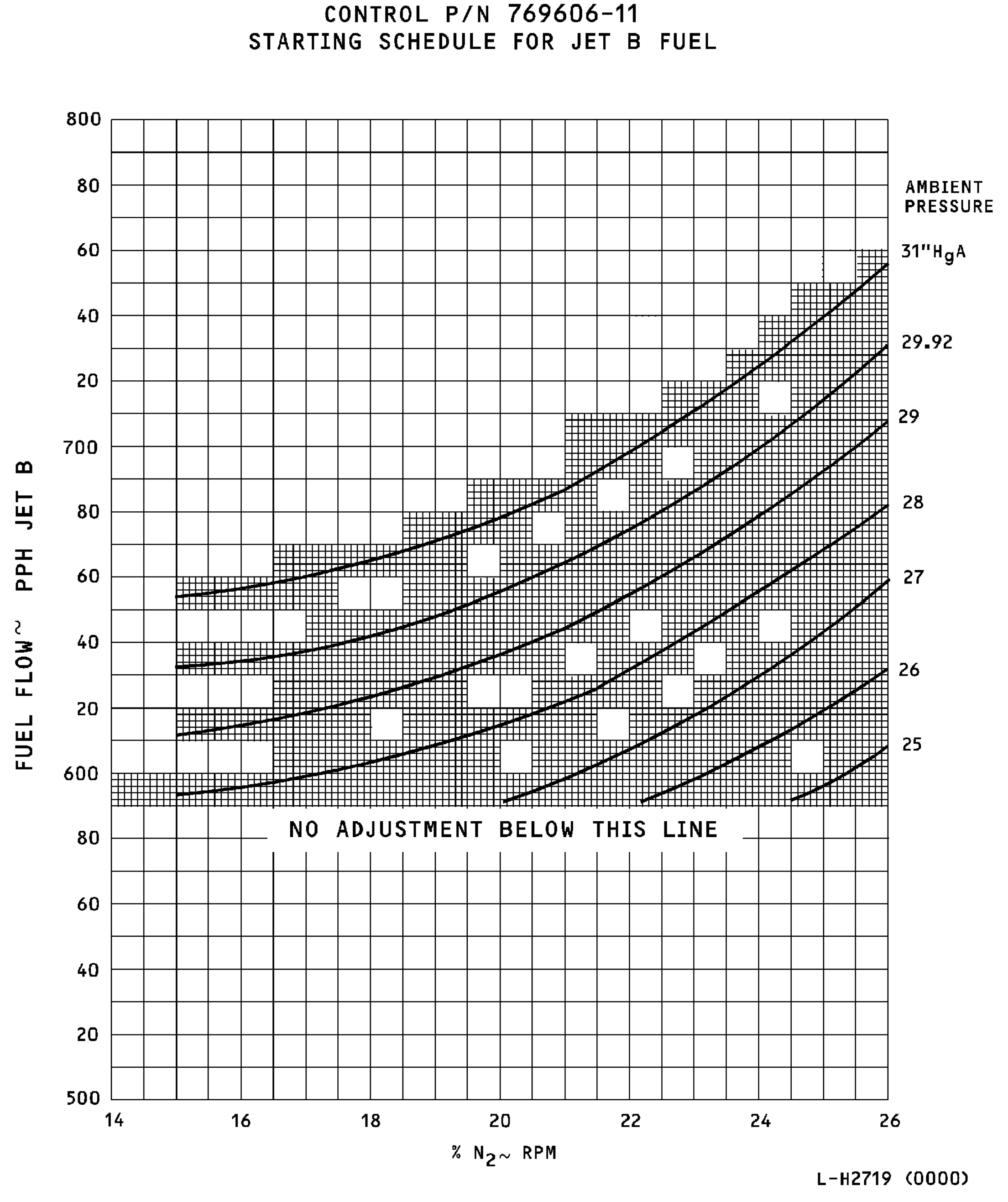
Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 5 of 10)



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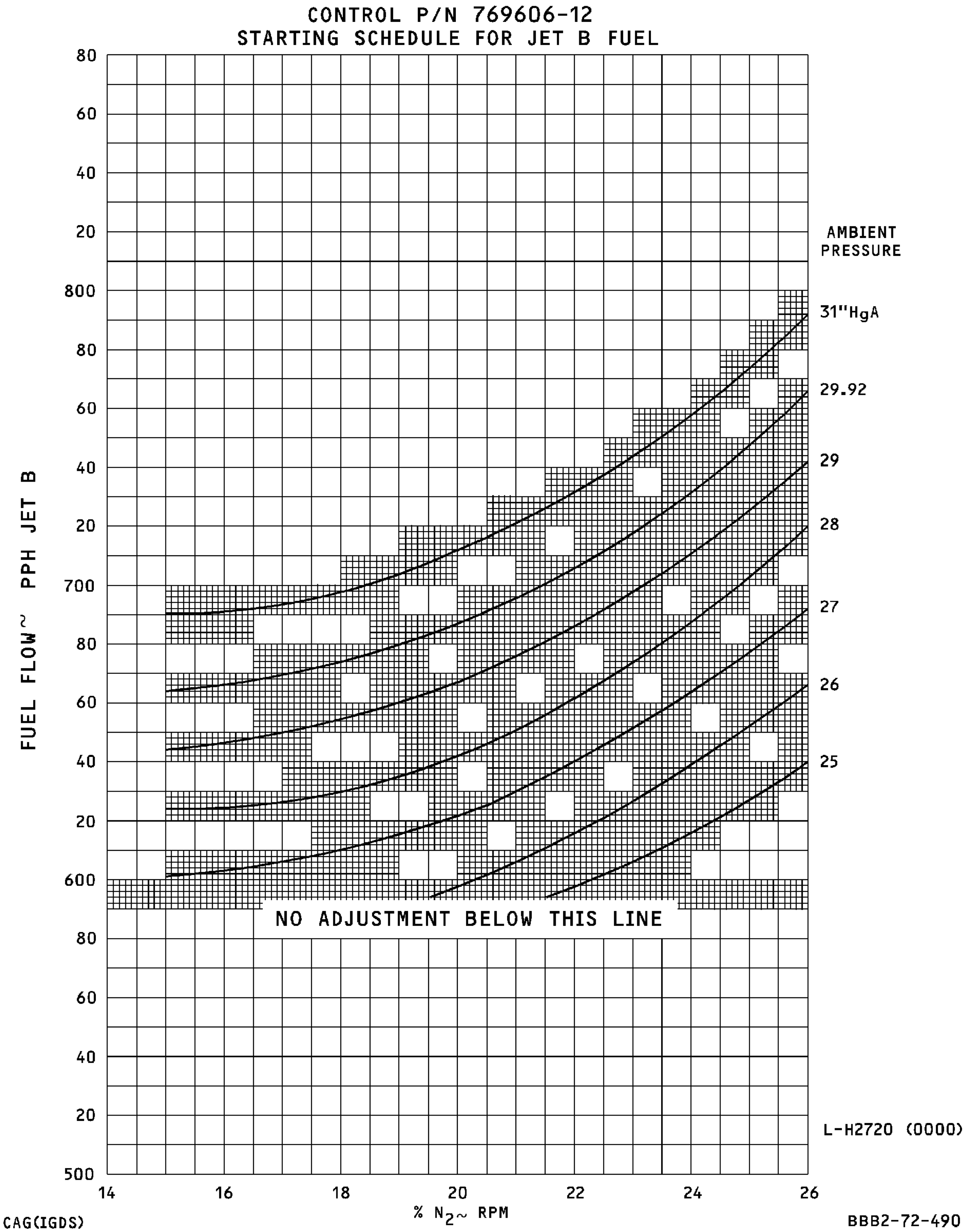
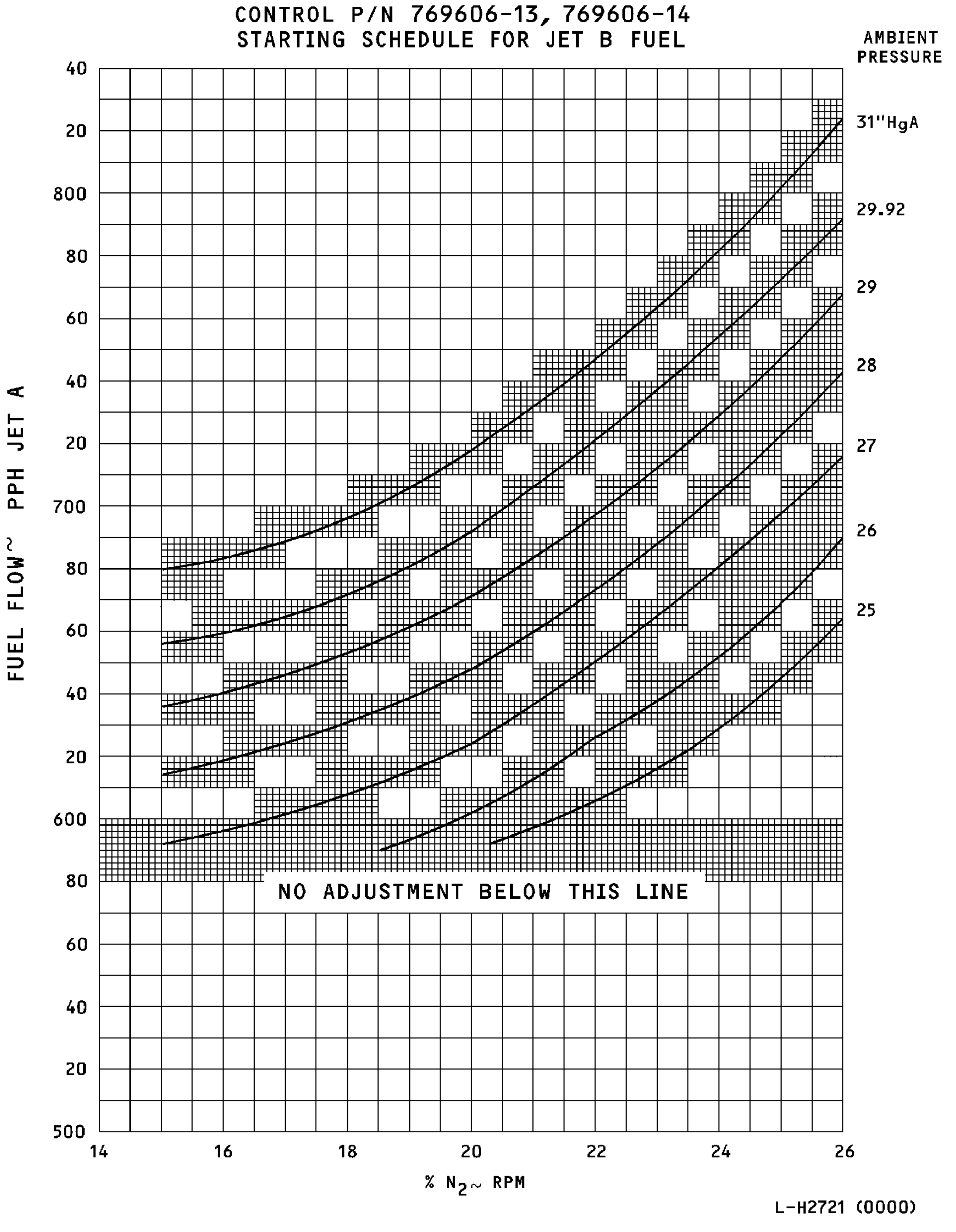
Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 6 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 7 of 10)



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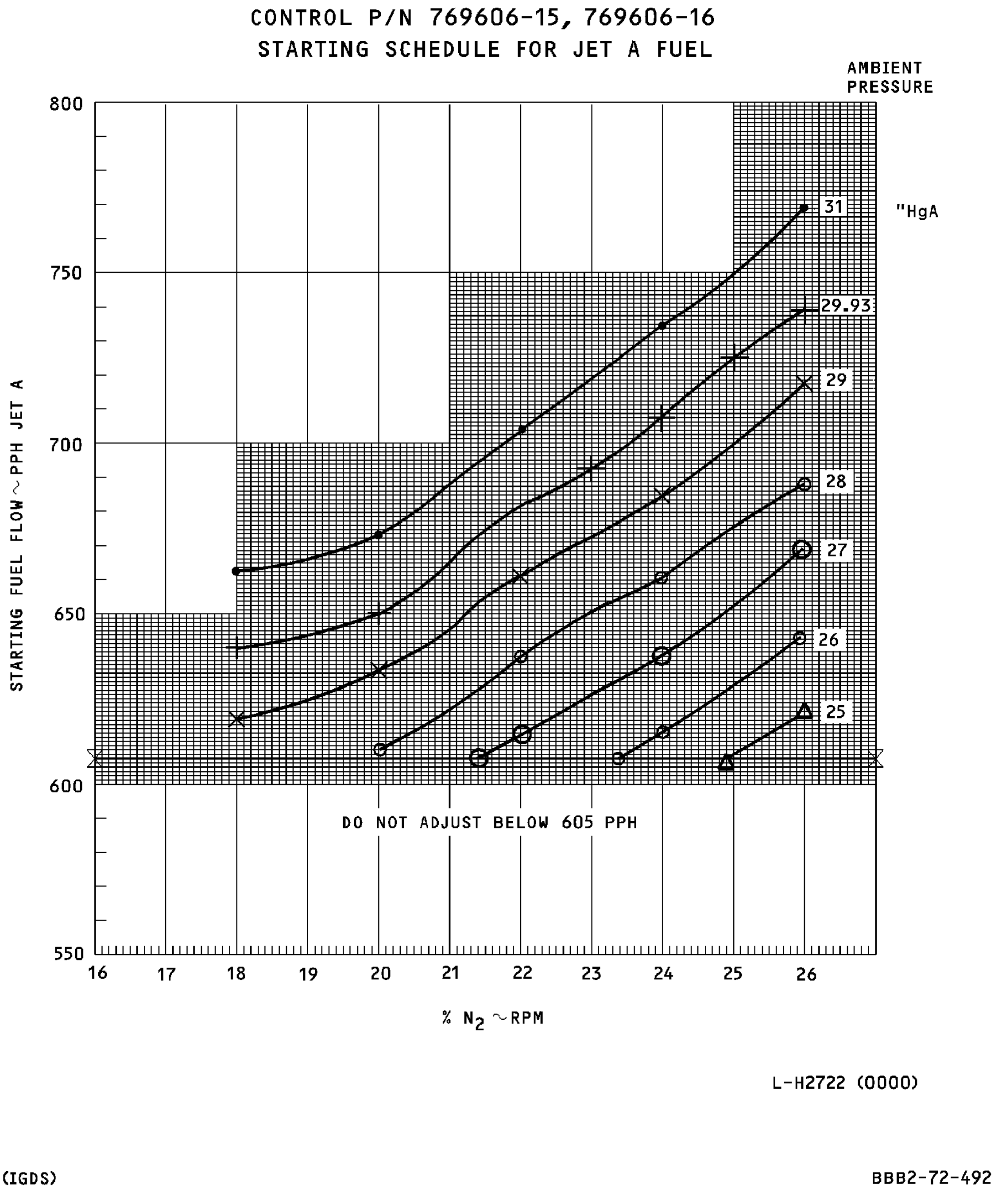
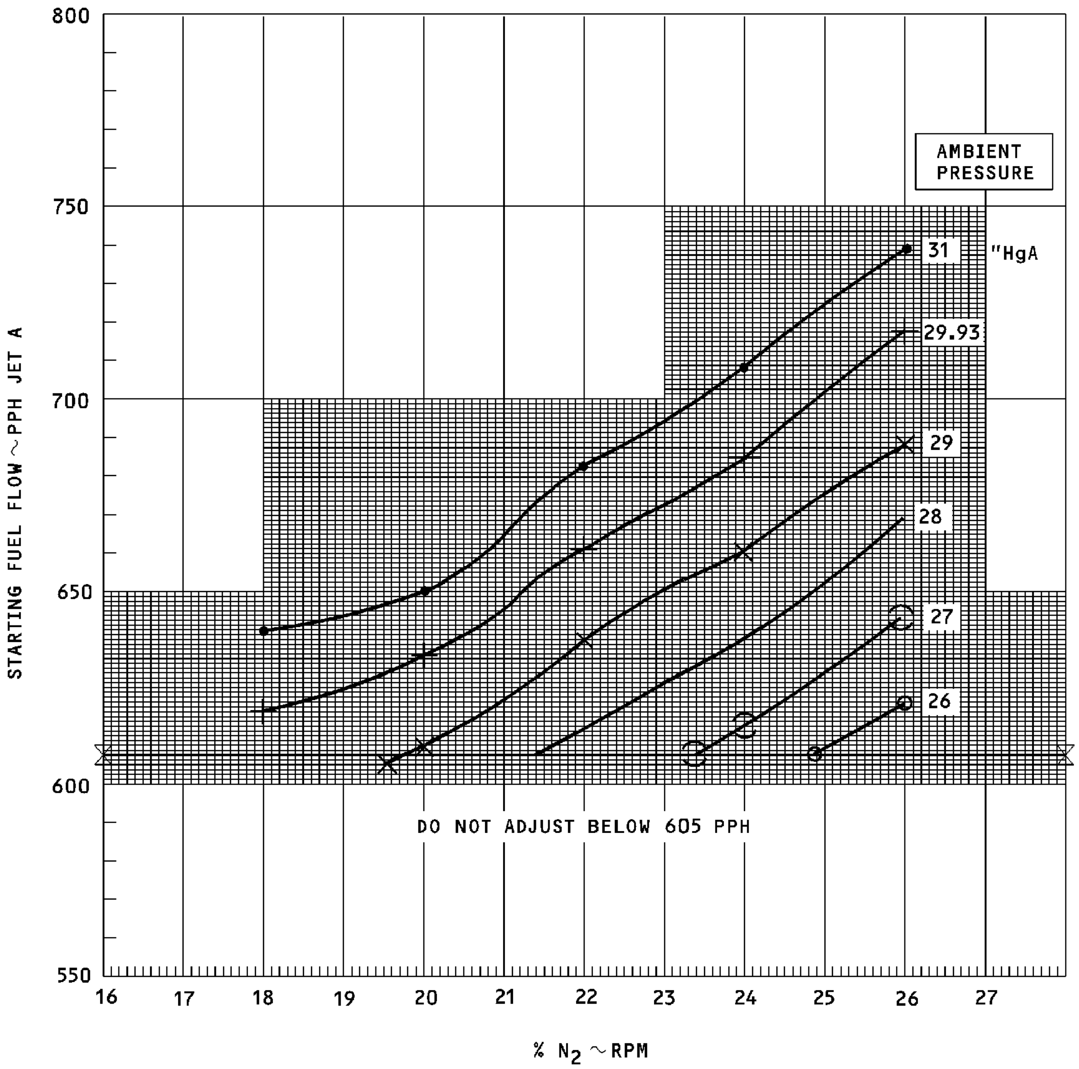
Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 8 of 10)



Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 9 of 10)

CONTROL P/N 769606-15, 769606-16
STARTING SCHEDULE FOR JET B FUEL



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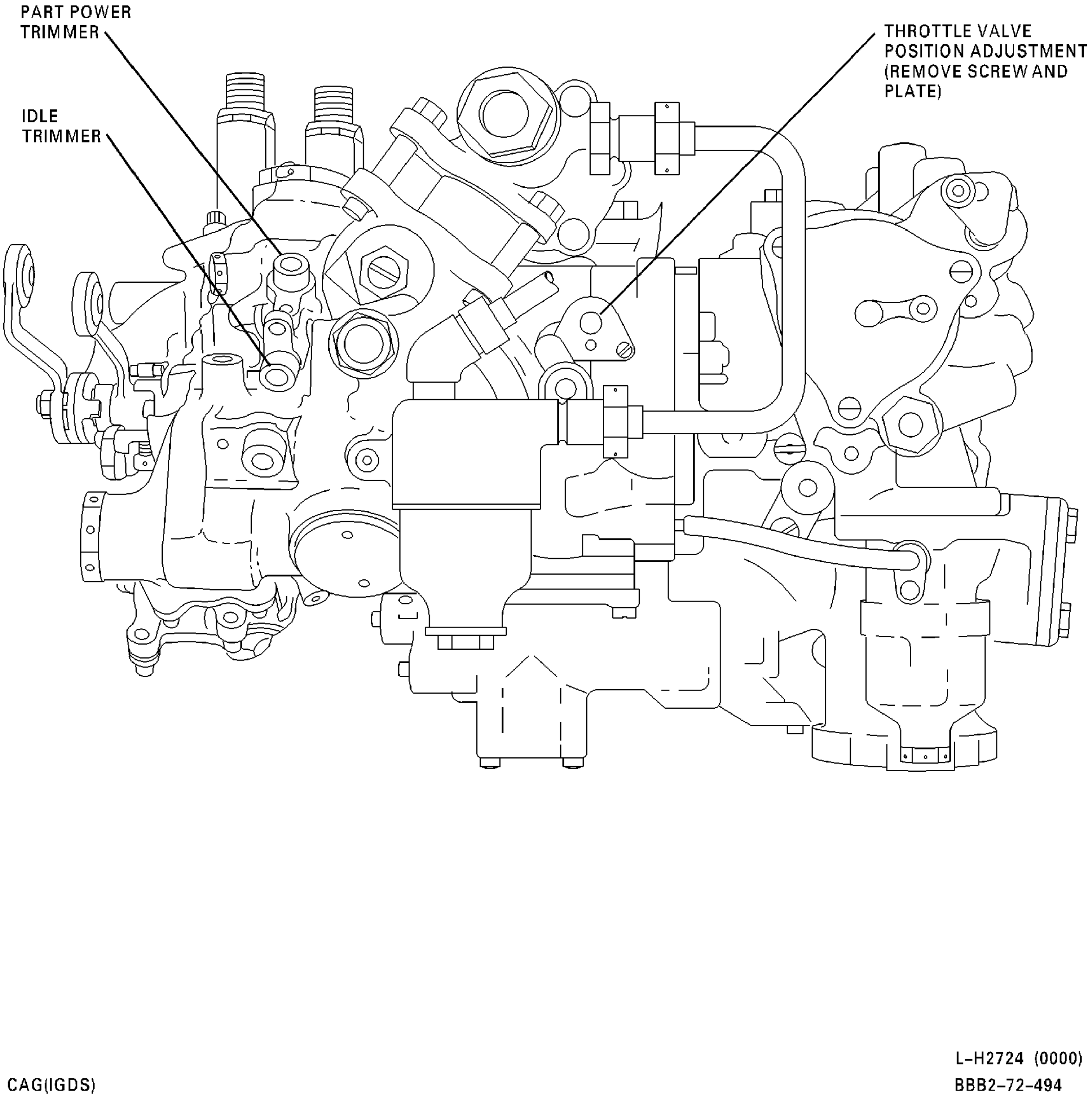
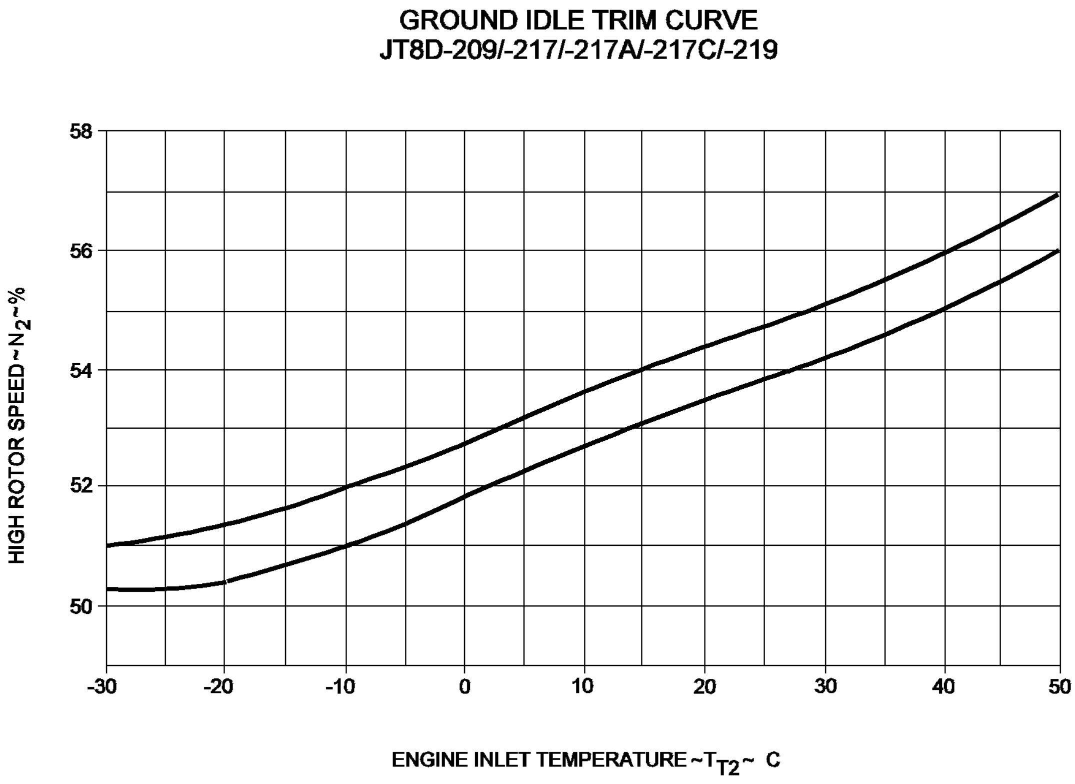
Starting Schedule Limits
Figure 531/72-00-00-990-986 (Sheet 10 of 10)



Fuel Control Adjustment
Figure 532/72-00-00-990-987



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Engine Idle Trim Curve
Figure 533/72-00-00-990-C51

ENGINE GENERAL - INSPECTION/CHECK-01

1. Periodic Inspection

A. General

(1) These inspection procedures are a normal function of operating organizations. They consist of required inspections and minor adjustments necessary on the JT8D engines. The nature and conditions of engine operation determine the time interval between required inspections. For this reason, the intervals described in the Periodic Inspection Chart in this section are labeled Routine, Minor, and Major. If experience dictates a change in these procedures or time intervals, Pratt & Whitney Technical Support Department should be contacted in order to make changes as the situation warrants.

(2) Engine compartment cleanliness is important because the intensive mass air flow tends to draw foreign objects into the engine. Thoroughly clean and inspect area after completion of any work. Keep the inlet area free of dirt, oil, and grease, and remove all unused parts, such as nuts, washers, and pieces of lockwire. Immediately cover all apertures resulting from the disconnection of parts. Use external caps on all openings not internal plugs.

(3) Suitable precautions should be taken to prevent foreign objects from coming in contact with the engine during aircraft towing and at all times when not in service. In order to prevent corrosion in the compressor stages, it is recommended that the engine inlet or tailpipe be suitably covered whenever the engine is left inoperative for more than six hours. When there is sufficient wind to rotate the engine, it is particularly important to cover the engine immediately.

B. Engine Life - Limited Parts

(1) The following definitions and regulations apply to the use of life limits:

(a) A cycle is defined as any flight (i.e. takeoff and landing) regardless of duration and whether or not reversers are used on landing. This applies to engines in normal airline usage including a moderate amount of routine pilot training. Any extended special usage such as might be incurred by assignment of one aircraft to exclusive pilot training use for several months or assignment of an engine to a flight test vehicle requires that any throttle excursion equal to or greater than idle-to-maximum continuous, in flight or on the ground, be recorded as a cycle in obtaining the total cycles on the engine life-limited parts. Touch-and-go landing and takeoff operation, is of course, included in this definition. Cyclic records must be recorded for each life-limited part for all operation.

(b) Service life of life-limited part is limited to, and must not exceed, the specified cycles. See Chapter 5-10-00 in the JT8D Engine Manual for life limits. Refer to Overhaul Standard Practices Manual for additional information on service life.

(c) Life-limited parts must be retired when cyclic limit is reached.

(2) Particular attention must be paid to inspection of rotating parts if an engine has exceeded maximum (operating) engine speed.

NOTE: Engines exceeding maximum overspeed limits must be sent to overhaul for complete inspection.

2. Inspect Inlet, Exhaust, And Exterior Of Engine

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Exterior Of Engine

(1) Carefully inspect exterior of engine without dismantling to ensure that all connections are tight and free from leaks and that lines, tubing, and controls are secure and properly locked.

(2) Check all engine controls for proper operation. Make certain that linkage from cockpit controls to engine unit is connected in a manner that permits full and free movement. See that controls are adjusted to permit overtravel of control lever to ensure full operation of engine unit.

C. Tailpipe

(1) Perform routine visual inspection of tailpipe for evidence of metallizing due to possible blade and stator interference.

(2) Enter the engine tailpipe with a portable light and visually examine the 4th stage turbine blade shrouds for fractures at convex (aft) side airfoil-to-shroud. See SB 6416 for additional instructions.

D. Inlet

(1) Perform routine visual inspection of inlet area to determine if engine has suffered damage from foreign material.

E. Fan & Turbine Exhaust Duct (Mixer)

NOTE: Bolted to the rear of the fan exhaust outer duct and turbine exhaust case is the integrated exhaust unit or mixer. Two configurations of mixers exist. One type (shim type) uses laminated shims at Outside Diameter (OD) and Inside Diameter (ID) of struts to locate mixer. The other type (saddle type) use duct covers that straddle the struts preventing lateral movement.

(1) Saddle mount type mixer (every C inspection check) (Figure 601) and (Figure 602).

(a) Visually inspect mixer struts for damage, wear or disengagement of struts at ID and OD locations.

(b) Strut disengagement limits are as follows:

1) ID strut disengagement limits (for saddle mount type mixer with ID struts) are as shown in Figure 602.

a) If disengagement is result of worn and/or broken cover, replace cover at each disengagement location.

b) If disengagement is result of mixer damage or strut wear, mixer assembly must be removed from service.

c) If disengagement has occurred without damage to strut or cover, remove cover as soon as possible and allow strut to return to normal position, then reinstall cover with strut in proper position between cover rails.

NOTE: Replace cover with new or serviceable part if deformed, broken or damaged.

2) OD strut disengagement limits are as shown in Figure 602.

a) If disengagement at any strut location is result of worn and/or damaged cover, replace cover.

b) If disengagement at any location is result of worn, damaged or mislocated strut, mixer assembly must be removed from service.

(2) Shim type mixer (Figure 601).

(a) R and A inspection check until initial C inspection check.

NOTE: If any A check occurs within a week before or after the R check, the A check takes the place of the R check. Resume subsequent R checks at the normal interval.

1) Visually inspect mixer struts for disengagement of struts at ID and OD locations due to wear (Figure 602).

(b) Initial C inspection check and subsequent A inspection checks.

1) Check mixer struts for disengagement of struts at ID and OD locations due to wear by attempting to force strut sideways as opposed to fore and aft movement. Use hand pressure.

2) Remove mixer from service if one or more OD strut disengagements are found.

3) Remove mixer from service with four adjacent ID strut disengagements.

4) A mixer which has three adjacent ID struts disengaged can be operated for a maximum of 25 hours.

5) Mixers which have ID strut disengagements and are below limits specified in steps Paragraph 2.E.(2)(b)2), Paragraph 2.E.(2)(b)3) and Paragraph 2.E.(2)(b)4) above can continue in service provided that disengagement inspection is performed on every subsequent R check.

NOTE: Time interval used in scheduling C check for mixer inspection must take into account previous accumulated time on mixer prior to current engine installation on aircraft.

F. Turbine Exhaust Cone

(1) Look in the engine exhaust to be sure that the turbine exhaust cone is in its correct position and is not damaged.

(2) If the turbine exhaust cone is not there, do as follows:

(a) Examine the turbine exhaust case for cracks (be sure to look carefully at the struts of the case).

(b) If there are no cracks in the exhaust case, it is permitted to make a ferry flight to get the engine to an approved repair facility.

G. Fan Discharge Turbine Inner Duct Segments

(1) Inspect inner duct segments from rear of engine, using light and mirror as required. Following limits apply:

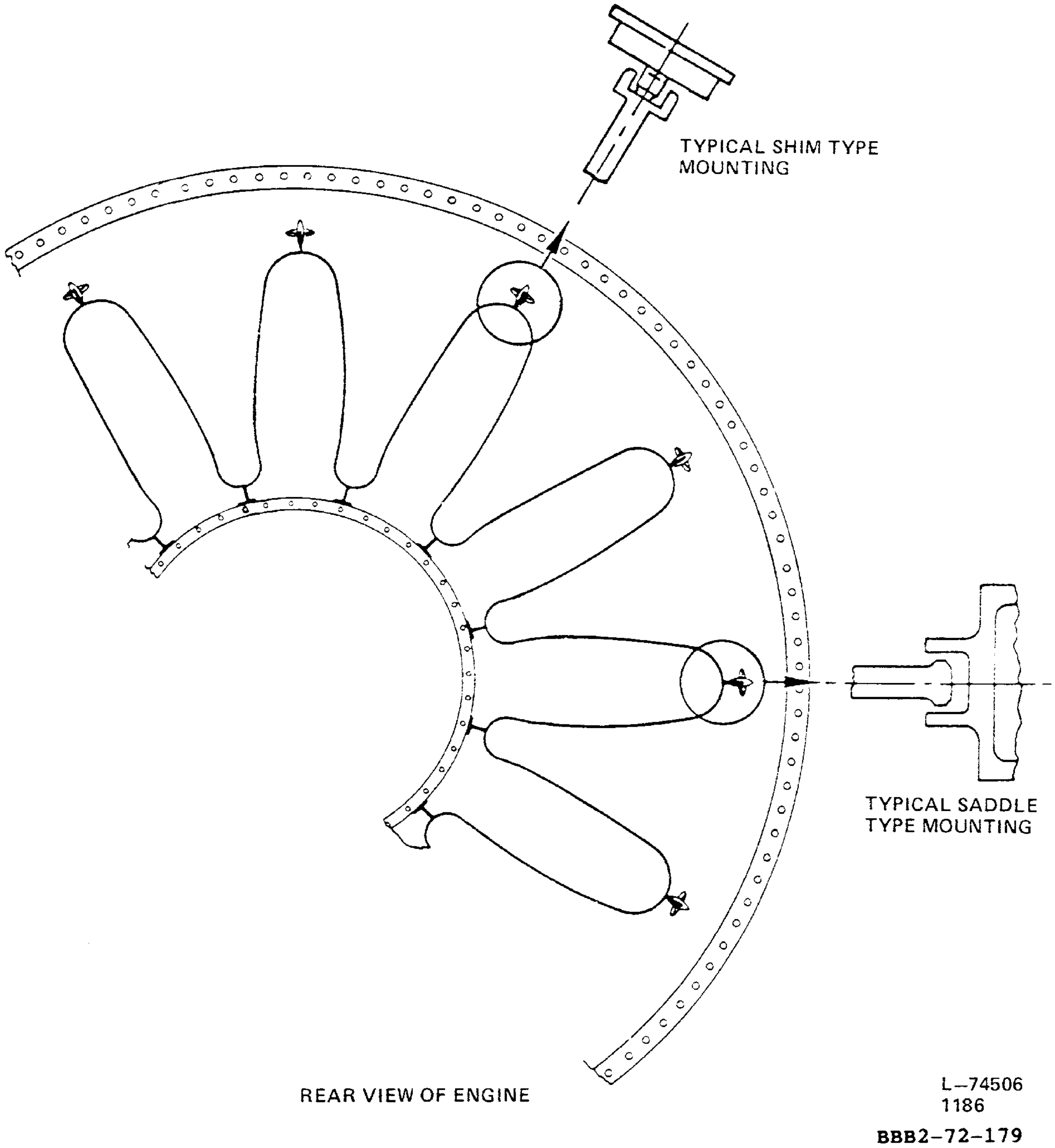
NOTE: If turbine inner fan ducts are of latest doubler-reinforced configuration (reference SB 5401) the following inspection is not required.

(a) Duct found to be cracked may be continued in service until aircraft arrives at maintenance facility. Aircraft shall be scheduled for maintenance at earliest opportunity.

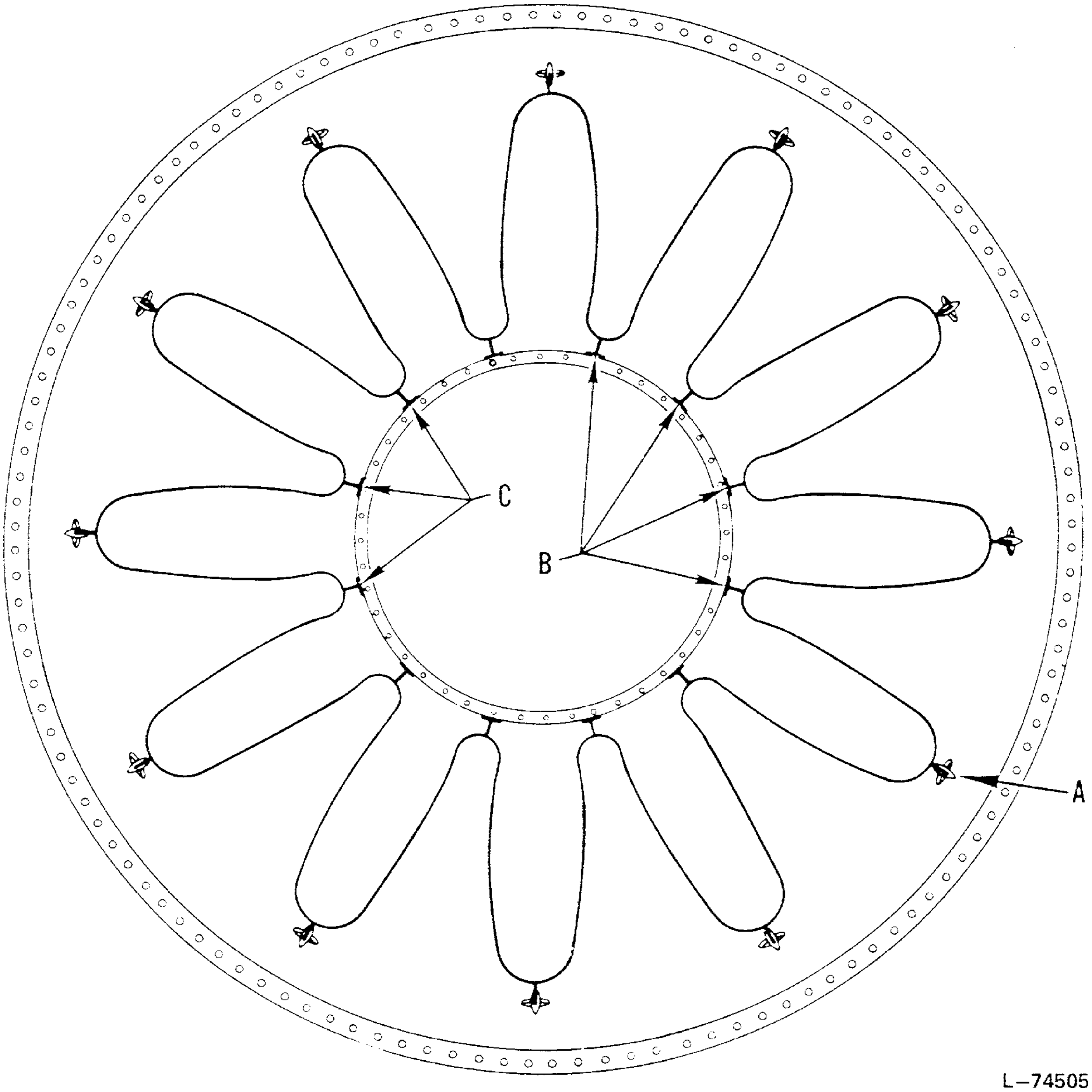
(b) Continued operation with cracked duct is limited to maximum of 20 hours or 20 cycles, whichever occurs first, and is limited to duct in which crack has not progressed entire length of duct from front to rear. Duct with holes in cracked area caused by liberated pieces may be continued in service within 20 hour/cycle limits described above.

CAUTION: CONTINUED OPERATION WITH CRACK DAMAGE MAY RESULT IN FURTHER LIBERATION OF DUCT PIECES, CAUSING SOME IMPACT DAMAGE TO ADJACENT AND DOWNSTREAM ACOUSTIC LINERS. IN ADDITION, LIBERATION OF LARGE DUCT PIECES COULD RESULT IN BLOCKAGE OF FAN STREAM, CAUSING FAN STALL; SUCH AN INCIDENT WOULD REQUIRE REDUCED ENGINE POWER OR ENGINE SHUTDOWN.

(c) No special inspection of adjacent engine cases other than visual examination will be required when engine is repaired.



Typical Examples Of Shim Type And Saddle Type Mixer Mounting
Figure 601/72-00-00-990-988



REAR VIEW OF ENGINE

A. Typical OD Strut Disengagement (Unacceptable - See Text)
B. Typical ID Strut Disengagement (Unacceptable - See Text)
C. Typical ID Strut Disengagement (Acceptable - See Text)

Mixer ID and OD Strut Disengagement Examples
Figure 602/72-00-00-990-989

3. Inspect External Tubing, Hoses, And Electrical Leads

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

Table 601

Inspect For		Inspection Time			
		Routine	Minor	Major	Remarks
1.	Security Of All Accessible Connections, Clamps, And Brackets		X	X	
2.	Evidence Of Chafing Or Wear		X	X	
3.	Evidence Of Fuel Or Oil Leakage	X	X	X	

4. Inspect Burner Pressure Sensing Line Condensation Trap

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment - None

(2) Consumables

Assembly Fluid (PWA 36500)

B. Procedure

Table 602

Nature Of Inspection		Inspection Time			
		Routine	Minor	Major	Remarks
1.	Presence Of Water (See Procedure Below)		X	X	Condensation trap should be checked and drained periodically as a precautionary measure.
2.	Icing	X			
3.	Dirt in the drain hole		X	X	

(1) Draining Condensation Trap Housing

(a) Remove drain plug and preformed packing from bottom of condensation trap (mounted on front of fuel control) and discard old packing.

(b) Drain all accumulated moisture from trap.

(c) Look to be sure there is no blockage of the drain hole.

Remove all dirt or unwanted material.

(d) Coat new packing with PWA 36500 Assembly Fluid and install packing on plug.

CAUTION: ENSURE THAT 0.020 INCH (0.508 MM) HOLE IN PLUG IS OPEN AND NOT OBSTRUCTED. DO NOT BLOCK HOLE WITH PLUG LOCKWIRE; LOCKWIRE SHOULD BE PASSED THROUGH ONLY ONE SIDE OF PLUG, NOT COMPLETELY ACROSS PLUG.

(e) Install drain plug and packing in bottom of condensation trap. Torque plug and secure with lockwire.

5. Inspect Fan Inlet Case Vanes

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

(1) Visually inspect fan inlet case vanes for nicks, dents or other evidence of foreign damage.

(2) Dents with round bottoms that do not show cracks or tears are permitted without repair 1/2 inch (12.7 mm) maximum diameter and 1/8 inch (3.175 mm) depth.

(3) Vane guidelines and continue-in-service limits for cracks (leading edge, radial cracks and vane resistance welds).

(a) When there is more than one crack per vane or three separate cracks per inlet case, remove inlet case when aircraft reaches a major maintenance base.

(b) If cracks are less than one inch long, examine the crack area by SPOP 70 portable fluorescent penetrant (high sensitivity) after 50 cycles.

NOTE: See PAGEBLOCK 70-00-00/201, for SPOP 70 fluorescent penetrant check procedures.

1) When fluorescent penetrant inspection confirms that cracks have not propagated, each successive inspection interval may be increased 50 cycles up to a maximum interval of 600 cycles.

2) When a crack has progressed, but is still less than one inch long, it may be stop-drilled per PAGEBLOCK 72-23-04/801.

NOTE: Stop-drilled holes in vanes at 5:30 and 6:00 o'clock positions (looking from front) are not permissible due to internal tubes. Perform repetitive inspections on these vanes until crack reaches one-inch limit and then remove inlet case when aircraft reaches a major maintenance base.

Do not stop drill any crack which has taken a 90 degree turn or is "U" shaped). Inlet cases with "U" shaped cracks should be inspected daily for potential material liberation and removed as soon as aircraft can be flown to major maintenance base.

(4) Guidelines and continue-in-service limits for cracking in inner and outer shrouds and vane attachment welds.

(a) When there is more than one crack in any inner or outer shroud vane attachment weld or three separate vane attachment weld cracks per inlet case, inspect daily for potential material liberation and remove case as soon as aircraft can be flown to a major maintenance base.

(b) Inner or outer shroud or vane attachment weld cracks less than two inches long may be stop-drilled per PAGEBLOCK 72-23-04/801.

(c) Cracks less than two inches long, whether stop-drilled or not, must be fluorescent penetrant inspected after 50 cycles.

(d) When fluorescent penetrant inspection confirms that cracks have not propagated, each successive inspection interval may be increased 50 cycles up to a maximum interval of 600 cycles.

(e) When any crack reaches two inch limit, or continues to have progressed after being stop-drilled, the inlet case should be inspected daily for potential material liberation and removed as soon as aircraft can be flown to a major maintenance base.

(5) Guidelines and continue-in-service limits for cracks in boss welds and case OD surface walls.

(a) When there are more than two cracks per boss or case OD surface wall remove inlet case when aircraft reaches a major maintenance base.

(b) Boss weld cracks less than two inches long and case OD surface weld cracks less than five inches long must be fluorescent penetrant inspected after 50 cycles.

(c) When fluorescent penetrant inspection confirms that boss crack and case OD surface weld crack has not propagated, each successive inspection interval may be increased 50 cycles up to a maximum interval of 600 cycles.

(d) When a boss crack has progressed, but is still less than two inches long or a case OD surface weld crack has progressed, but it still less than five inches long, they may be stop-drilled per PAGEBLOCK 72-23-04/801.

(e) When a boss or case OD wall crack reaches its respective limit or continues to have progressed after being stop-drilled, inlet case should be inspected daily for potential material liberation and removed as soon as aircraft can be flown to a major maintenance base.

(6) Any damage requires closer inspection of 1st stage compressor blades per Paragraph 9..

6. Inspect Fan Inlet Case Sleeve Strainer Element

A. Equipment and Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

(Figure 603)

NOTE: It is recommended that inlet case sleeve strainer element be removed, inspected, and cleaned at every 500 hours of engine operation.

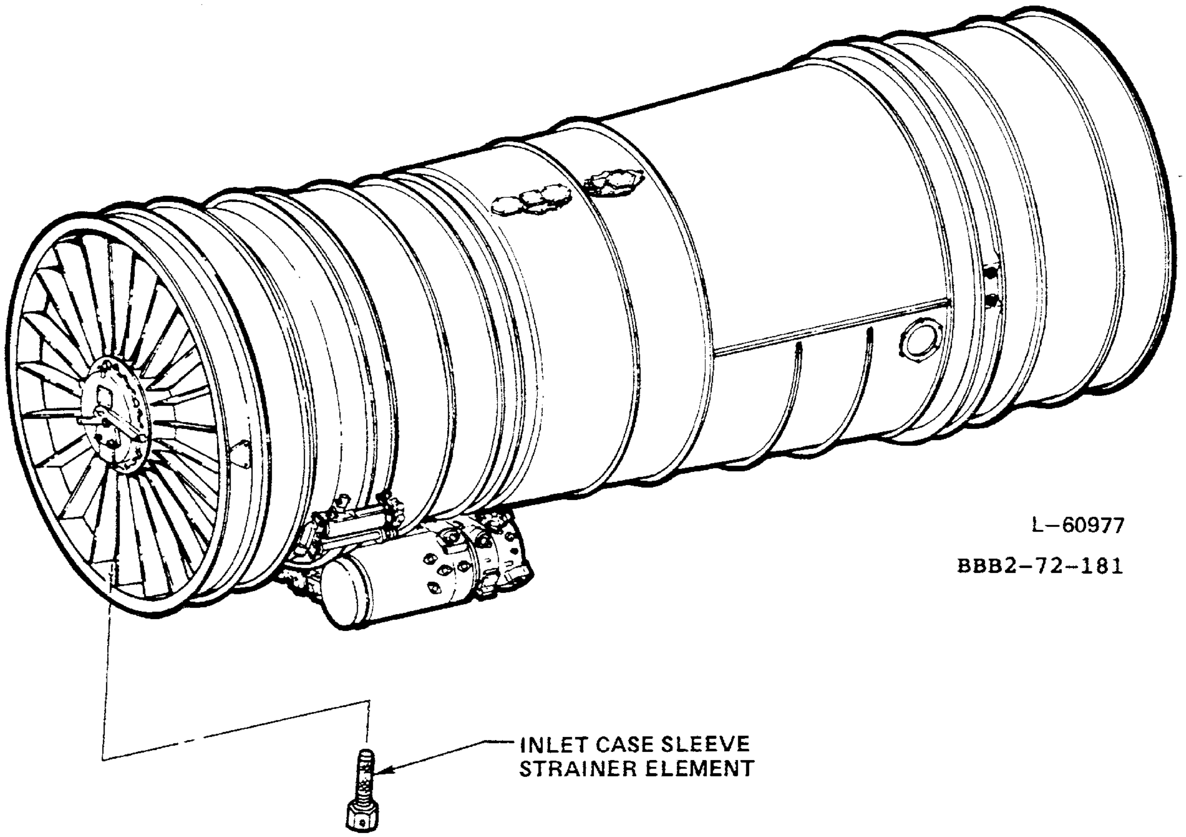
(1) Inspect vent plug area at bottom of inlet case for evidence of oil leakage through vent plug. If leakage is found, check inlet case tubing connections.

(2) Cut lockwire and remove strainer element.

(3) Check strainer for contamination and clean strainer.

NOTE: Strainer element prevents dirt particles from blocking drain hole in vent plug.

(4) After strainer element has been inspected and cleaned, reinstall in inlet case. Torque and lockwire.



Inlet Case Sleeve Strainer Element Check
Figure 603/72-00-00-990-990

7. Change Filter/Strainer

A. Oil Strainer/Filter Change

CAUTION: WHEN SMALL AMOUNT OF CONTAMINANT IS FOUND IN OIL STRAINER OR FILTER, FILTER OR STRAINER SHOULD BE CLEANED (40 MICRON) OR REPLACED (15 MICRON) AND ENGINE GROUND RUN AT PART POWER FOR SEVERAL MINUTES. ENGINE SHOULD BE ACCELERATED FROM IDLE TO PART POWER SEVERAL TIMES DURING RUN. RECHECK STRAINER OR FILTER AND, IF CLEAN, ENGINE IS READY FOR SERVICE. CHECK STRAINER OR FILTER AFTER APPROXIMATELY 50 HOURS OF OPERATION. IF STRAINER OR FILTER IS NOT CLEAN, CLEAN OR REPLACE AND REPEAT GROUND RUN AGAIN, THEN REINSPECT. IF IT IS STILL NOT CLEAN, REMOVE ENGINE FOR DETAILED INSPECTION. DETERMINE CAUSE OF CONTAMINATION AND CORRECT AS REQUIRED. 40 MICRON STRAINERS OR 15 MICRON FILTERS HAVE FINER FILTRATION THAN OTHER TYPES ANY MAY REACH DIRT HOLDING CAPACITY IN A SHORTER TIME INTERVAL, THEREFORE IT IS SUGGESTED THAT CONTAMINATION CHECK PERIODS BE ADJUSTED ACCORDINGLY.

(1) When a large amount of contamination, chips or flakes is found in an oil strainer or filter where no differential pressure (Delta P) light came on, do the troubleshooting procedure for oil filter/strainer differential pressure (Delta P) light on. (ENGINE GENERAL - TROUBLESHOOTING -02 (LUBRICATION SYSTEM), PAGEBLOCK 72-00-02/101)

(2) It is recommended that oil strainer or filter be removed for inspection at 250 - 400 hours intervals.

NOTE: New engines which have recently been put into service occasionally have metal chips reported in main oil filter or strainer or on chip detectors. This is usually caused by manufacturing machining chips. Also, oil sample S.O.A.P. (Spectrometric Oil Analysis Program) readings are sometimes higher than expected in new engines. Normally, these conditions are temporary and should be monitored to ensure that these conditions improve and return to normal with additional service time.

8. Inspect Engine After Ingestion of Sand, Dust or Volcanic Ash

CAUTION: ENGINE INGESTION OF SAND, DUST OR VOLCANIC ASH CAN CAUSE OPERATIONAL PROBLEMS INCLUDING LOSS OF POWER. EVEN IF PROBLEMS ARE NOT EXPERIENCED RIGHT AWAY, ASH CONTAMINATION OF ENGINE SYSTEMS CAN RESULT EVENTUALLY IN PERFORMANCE DETERIORATION, BLOCKED COOLING AIR PASSAGES, AND ABRASIVE DAMAGE.

A. When engine has had moderate exposure to sand, dust or volcanic ash with no subsequent operational problems, do the following inspections:

(1) Visually check engine inlet and exhaust areas for evidence of damage or excessive erosion.

(2) Borescope inspect rear compressor and 1st stage turbine for evidence of the following:

  (a) Excessive erosion.

  (b) Foreign Object Damage (FOD).

  (c) Blockage of 1st stage turbine airfoil cooling holes.

  (d) Buildup of sand, dust or ash deposits.

(3) Remove oil system chip detectors and examine for indications of engine damage.

(4) Drain, flush, and refill oil system. Retain oil sample for analysis.

(5) Remove and clean or replace all oil, fuel, and air filters/strainers. If contamination is found, retain sample for analysis.

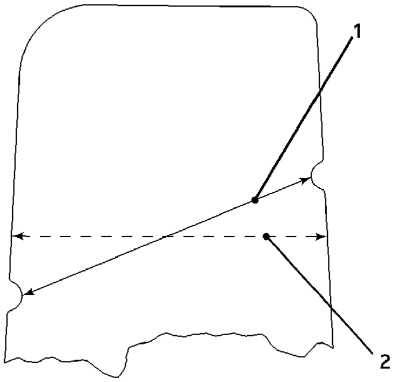
NOTE: It is strongly recommended that 15-micron main oil filter element be installed if available. If this type of filter is not used, oil change frequency should be increased.

(6) Perform engine ground run to determine if shift in performance parameters has occurred. If parameters are abnormal, engine should be replaced.

B. When engine has experienced operational problems subsequent to sand, dust or volcanic ash exposure, do the following:

(1) Remove the engine and send to a disassembly facility.

NOTE: Engine records shall direct that engine shall be disassembled, inspected, and repaired as necessary, paying particular attention to oil system, air-supplied components, and turbine cooling air passages.



1. EDGE BLEND SEPERATION TO BE EQUAL TO OR GREATER THAN MEAN CHORDAL LENGTH
2. MEAN CHORD LENGTH

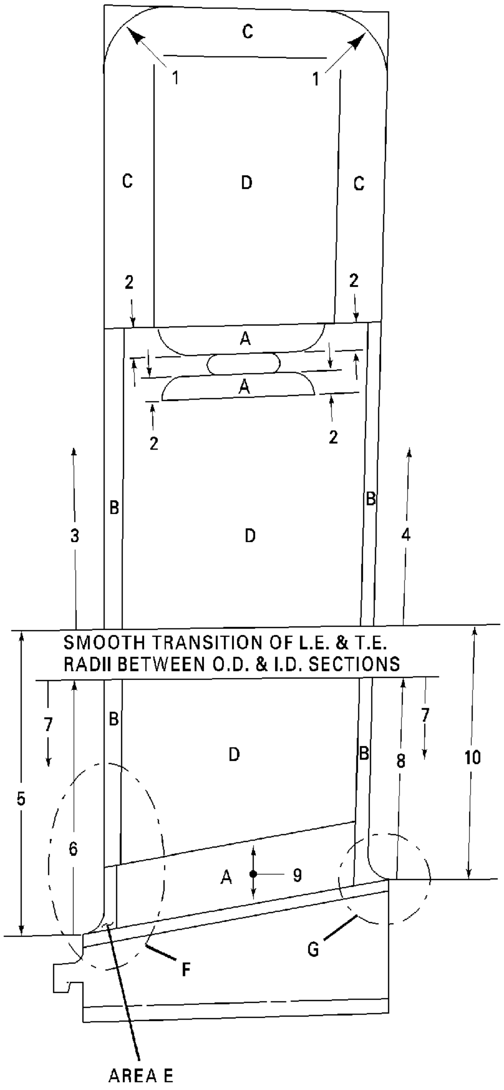
L-71641
0783

CAG(IGDS)

BBB2-72-182A

First Stage Compressor Blade Blending
Figure 604/72-00-00-990-991 (Sheet 1 of 4)

AREA	ACCEPTABLE DAMAGE LIMIT, EXCEPT NO TEARS OR CRACKS PERMISSIBLE INCHES (MILLIMETERS)	BLEND LIMITS INCHES (MILLIMETERS)	BLEND RATIO (LENGTH/DEPTH)
A	NONE		
B	0.005 (0.127)	1/8 D (3.175)	12/1
C	0.020 (0.508)	11/32 D (8.731)	6/1
D	0.010 (0.254)	0.040 RB (1.016)	6/1
E	0.003 (0.076)	0.040 D (1.016) SEE NOTES	12/1
RB– ROUND BOTTOM D – DEPTH			



NOTES:

BLADES BLENDED TO A DEPTH OF 0.020 INCH (0.508mm) OR LESS IN AREA E MAY BE CONTINUED IN SERVICE BUT MUST BE FLUORESCENT PENETRANT INSPECTED AT 500 HOUR INTERVALS.

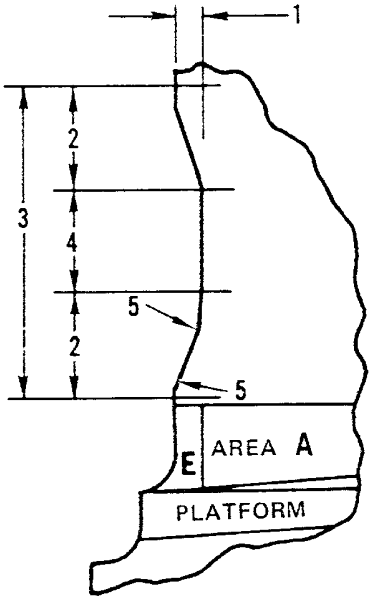
BLADES BLENDED TO A DEPTH OF MORE THAN 0.020 INCH (0.508mm) BUT LESS THAN 0.040 INCH (1.016mm) IN AREA E MAY BE CONTINUED IN SERVICE FOR A MAXIMUM OF 24 HOURS. BLENDING MUST BE PERFORMED BEFORE NEXT FLIGHT.

L–72345 (0395)

CAG(IGDS)

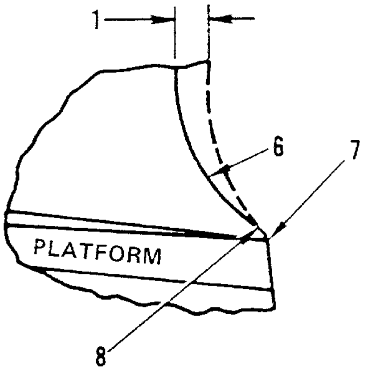
BBB2–72–183D

First Stage Compressor Blade Blending
Figure 604/72-00-00-990-991 (Sheet 2 of 4)



LEADING EDGE

VIEW F



TRAILING EDGE

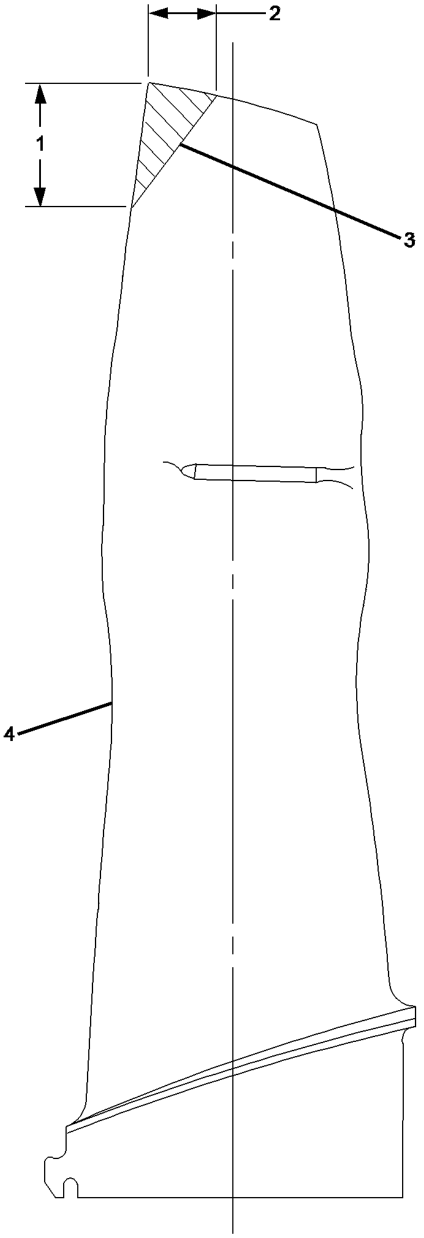
VIEW G

L-72346
0382

1. 0.125 Inch (3.175 mm)
2. Length Four (4) Times Blend Depth
3. Length Twelve (12) Times Blend Depth
4. Flat Portion Of Blend. Length Four Times Blend Depth.
5. 0.750 Inch (19.05 mm) Minimum Radius
6. 0.297 - 0.328 Inch (7.544 - 8.331 mm) Radius
7. Terminate Blend Smoothly At Platform Without Undercutting Blade-To-Platform Fillet Radius.
8. 0.030 - 0.050 Inch (0.762 - 1.270 mm) Radius Between Blend And Existing Surface.

BBB2-72-184

First Stage Compressor Blade Blending
Figure 604/72-00-00-990-991 (Sheet 3 of 4)



(TIP BEND LIMITS)

1. 2.150 in. (54.61 mm) MAXIMUM
2. 0.750 in. (19.05 mm) MAXIMUM
3. TIP BEND; NO MATERIAL REMOVED
4. LEADING EDGE (REFERENCE)

L-77936

BBB2-72-185A
S0006554782V2

First Stage Compressor Blade Blending
Figure 604/72-00-00-990-991 (Sheet 4 of 4)

9. Inspect 1st Stage Compressor Blades

A. Equipment And Materials Required

(1) Support Equipment - None

B. Procedure. (Figure 604)

(1) Inspect 1st stage compressor blades for foreign object damage. Rotate rotor as necessary to facilitate inspection.

WJE 401-412, 414, 873-881, 883, 884, 886, 887, 892, 893

NOTE: Impact damage in excess of 0.020 inch (0.51 mm) depth located between blade platform and blade part span shroud requires borescope inspection of 6th and 7th stage compressor blades per Paragraph 15..

WJE 415-427, 429

WJE (a) If impact damage in excess of 0.020 in. (0.51 mm) is found between blades platform and
WJE blade part span shroud, borescope inspection of 6th and 7th stage compressor blades
WJE per Paragraph 15. is required.

WJE 1) If damage is found beyond limits given in Paragraph 15., remove engine regardless
WJE of other damage.

WJE NOTE: This inspection need not be accomplished at line stations if borescope is
WJE not available. In such a case, perform inspection at the arrival base but not
WJE later than at the first night stop.

WJE (b) Inspect engine exhaust for metal spray.

WJE 1) If spray is found remove engine regardless of other damage.

WJE **WJE ALL**

(2) Repair of minor damage can be made per PAGEBLOCK 72-33-21/801 Config 1, provided damage can be removed without exceeding following limits:

NOTE: Make a note in engine records that blend repaired blades must be bead peened, per engine manual instructions, the next time blades are accessible in shop.

The surface damage blend limits in this procedure are also applicable to any blade that was repaired (by Engine Manual procedures) as follows:

1. The airfoil was machined to the minimum chord length or,

2. The airfoil was given a new contour or,

3. A leading edge insert was installed. It is possible for these repaired blades to show a smooth change in contour at the leading edge, from the repaired area to the area that was not repaired. This condition is satisfactory.

Key To Figure 604 (Sheet 2)	
1.	1.250 Inch (31.75 mm) Radius
2.	0.500 Inch (12.7 mm)
3.	0.010 Inch (0.254 mm) Minimum Leading Edge Radius
4.	0.008 Inch (0.203 mm) Minimum Trailing Edge Radius
5.	4.350 Inches (110.49 mm)
6.	3.750 Inches (95.25 mm)
7.	0.015 Inch (0.381 mm) Minimum Trailing Edge Radius

(Continued)

Key To Figure 604 (Sheet 2)	
8.	2.20 Inches (55.88 mm)
9.	1.000 Inch (25.400 mm)
10.	2.800 Inches (71.12 mm)

(a) Total blended length on an edge shall not be in excess of 1/3 total edge length.

(b) Blends on both edges must not be directly opposite and must be separated diagonally by minimum distance equal to mean chordal length of blade Figure 604 (Sheet 1).

(c) Blends must comply with length/depth blend ratio for that area of blade.

(d) Not more than two (2) edge blends, to maximum limit, per blade edge. Additional blends to one-half (1/2) maximum limit permitted provided two-thirds (2/3) of total edge is unblended.

(e) In Area A, no unblended damage is allowed.

(f) Midspan shroud leading edge radius.

1) Scattered pits in midspan shroud radius up to maximum depth of 0.017 inch (0.431 mm) may be removed by blending, provided airfoil thickness is not reduced. Radius of 0.422 - 0.453 inch (10.719 - 11.506 mm) and rounded edges should be maintained after blending.

(3) Repair of major FOD damage can be made per COMPRESSOR BLADES, FIRST STAGE - REPAIR-02, PAGEBLOCK 72-33-21/801 Config 2, provided damage can be removed without exceeding following limits:

(a) To continue any repaired FOD or non-repaired bent tip blades in service, all limits are valid only after engine has been run and checked for excessive vibration.

NOTE: It is permitted to operate the engine for up to 24 flight hours before the vibration check is done. This will permit the aircraft to fly to a maintenance base that can do the vibration check.

The above 24 hour flyback limit is only for aircraft that do not have engine vibration monitor equipment available (either cockpit installed or available on the ground).

(b) No more than a total of six fan blades per rotor may have non-repaired bent tips and/or repaired FOD to major FOD limits. No more than three non-repaired blades with bent tips are permitted per rotor. See Figure 604 (Sheet 4) for bend limits.

(c) Examine repaired areas by SPOP 70 portable fluorescent penetrant (ultra-high sensitivity). See PAGEBLOCK 70-00-00/201 for SPOP 70 fluorescent penetrant check procedures. No crack indications permitted after repair. Time limits for fluorescent penetrant inspection are as follows:

1) If the maintenance base at which the blend repair is done cannot do the fluorescent penetrant inspection:

a) Do the fluorescent penetrant inspection no more than 50 hours after the repair.

b) If no crack or tear was found in the blade material before blade blend repair, visual inspection is sufficient.

c) No repeated inspections are necessary.

2) If the blend repair is done at a maintenance base which can do the fluorescent penetrant inspection:

a) If a crack or tear was found in the blade material before the blade blend repair, do a SPOP 70 fluorescent penetrant inspection of the blade immediately after the repair.

b) If no crack or tear was found in the blade material before blade blend repair, visual inspection is sufficient.

c) No repeated inspections are necessary.

(d) All repairs shall have smooth, continuous contours with minimum radius of 0.625 inch (15.875 mm). All leading edge repairs shall have a length-to-depth ratio greater than six when accomplished above midspan shroud and greater than 12 when accomplished at or below midspan shroud. Restore repaired edges to original profile as closely as possible.

(e) Blades with tip bends confined by area and dimensions indicated in Figure 604 (Sheet 4) may be continued in service provided no crack indications are found by FPI or dye check inspection.

1) Do fluorescent penetrant check at 500 hour intervals. Any crack indication is cause for removal or, if possible, repair per COMPRESSOR BLADES, FIRST STAGE - REPAIR-02, PAGEBLOCK 72-33-21/801 Config 2.

(4) Shingled blades (blades whose midspan shrouds have overlapped, caused by heavy foreign object ingestion) must be unshingled and may be continued in service for 24 hours maximum if following conditions are met:

(a) Shingled blades must be unshingled without further damage.

(b) Visual inspection must confirm that midspan shroud of shingled blade has not hit airfoil of adjacent blade, or radius between airfoil and midspan shroud of adjacent blade. Blades showing evidence of having been hit in this manner must be removed from service prior to further flight.

(c) Do a fluorescent penetrant check of the midspan shrouds of shingled blades immediately and remove a blade if crack indications are found.

(d) After 24 hour limit has expired, shingled blades should be removed and scrapped, or held for possible future repair.

(e) If more than a three blade sector is shingled, blades must be removed from service immediately.

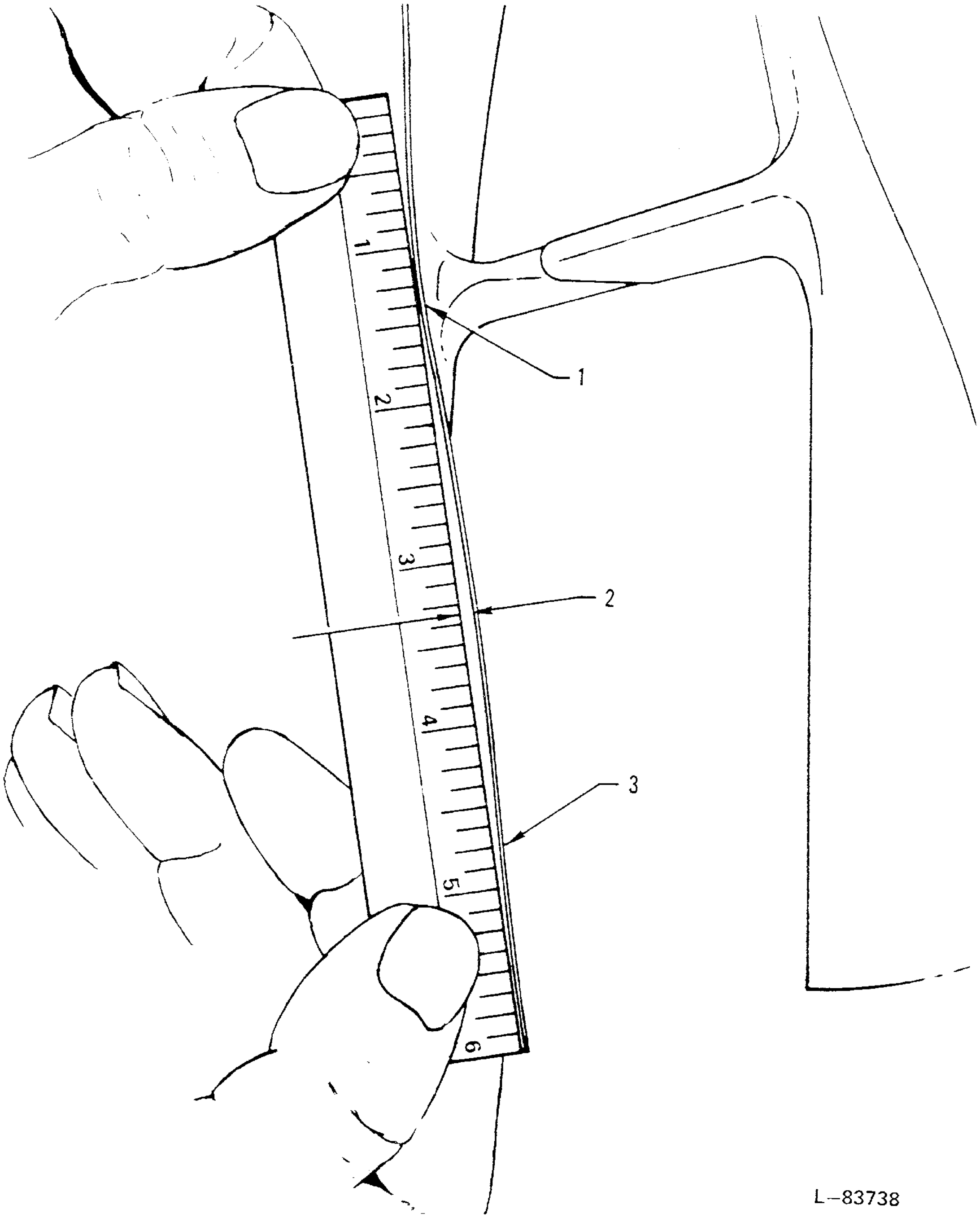
(f) Unshingled blades, continued in service, must not cause excessive unbalance and vibration during operation.

(5) Perform 1st stage compressor blade bow measurement. (Figure 605)

(a) Place one end of 4.250 inch (107.950 mm) straight edge on either side of blade leading edge, approximately perpendicular to airfoil so that end of straight edge touches blade tip.

(b) Measure gap between straight edge and airfoil surface. Reject any blade with gap (bow) in excess of 1/8 inch (3.175 mm).

NOTE: New blade will not have zero gap over 4.250 inch (107.950 mm) length.



1. Midspan Shroud
2. 1/8 Inch (3.175 mm)
3. Leading Edge

BBB2-72-186

First Stage Blade Bow Measurement
Figure 605/72-00-00-990-992

10. Inspect 1st Stage Compressor Stator And 1.5 Stage Compressor Rotor

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

NOTE: 1st stage compressor stator and 1.5 stage compressor rotor inspection is to be performed whenever 1st stage hub and blades assembly has been removed.

There are 56 vanes in the 1st stage compressor stator. In the 1.5 stage there are 48 blades in the rotor and 52 vanes in the compressor stator.

(1) Visually inspect airfoils in 1st stage compressor stator using the following limits: (Figure 606)

(a) Repair of minor injuries may be made, provided injury can be removed without exceeding repair limits. (PAGEBLOCK 72-33-51/801)

(b) Injuries to convex or concave airfoil surfaces may be blended to maximum depth of 0.020 inch (0.508 mm). Round bottom dents are acceptable without blending.

(c) Total length of combined leading edge and trailing edge or leading edge and trailing edge blends singly, must not exceed 0.500 inch (12.700 mm) per vane.

(d) Not more than two repairs to the maximum depth limit are allowed per vane.

(e) Radial length of blend must be a minimum of four times the depth of the nick (Figure 606).

(f) Blends to maximum depth on both leading and trailing edge must not be the same radial station and must be radially separated by not less than the vane mean chordal length.

(g) Blends not to maximum depth limit on leading and trailing edge and within vane chordal length radial spacing, are acceptable only if combined blended depth does not exceed single blend nick limit given above.

(h) A maximum of fifteen inches (381.000 mm) total leading edge and/or trailing edge blend length rework is allowed in vane and shroud assembly.

(i) Damage or pitting to concave and convex surfaces of vanes (Area B) must not exceed a maximum of 0.020 inch (0.508 mm) depth for total repaired area not exceeding 10 percent of vane surface.

(j) Pitting and corrosion are not considered serious provided pitting does not exceed 0.005 inch (12.700 mm) in depth.

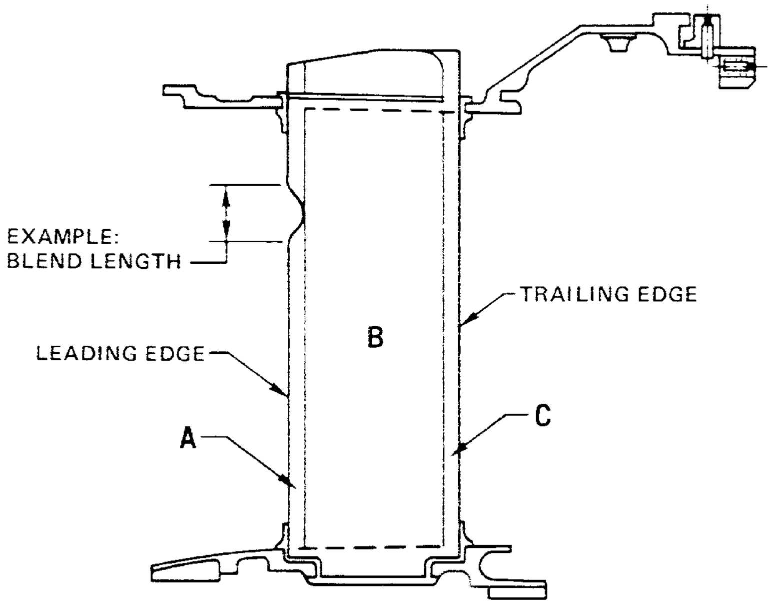
(k) Damage which can be seen on opposite side of vane is unacceptable.

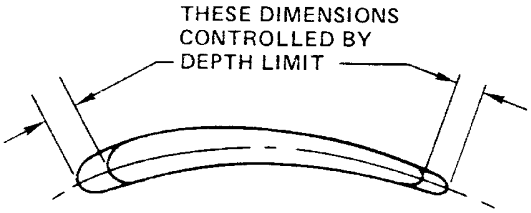
(l) Vane condition beyond limits specified is not acceptable.

(m) Examine stator vanes to be sure that they are not pulled loose from the inner shroud. Also check stator position to be sure that the stator is not turned from its initial position in the outer case.

(2) Visually check airfoils in 1.5 stage compressor rotor for nicks, dents or other evidence of foreign damage.

(3) Any damage to airfoils in 1st stage compressor stator vanes or stage 1.5 compressor blades requires borescope inspection of 6th and 7th stage compressor blades per Paragraph 12..





BLEND SMOOTHLY WITH EXISTING CONTOUR. RESTORE LEADING EDGE AND TRAILING EDGE RADII

DAMAGE DEPTH LIMITS
AFTER BLENDING

	VANE STAGE 1
A	5/64 in. D (1.981mm)
B	.020 in. D (0.508mm) SEE TEXT
C	5/64 in. D (1.981mm)

D = DEPTH

L–71870

BBB2–72–187

First Stage Compressor Stator Vane
Figure 606/72-00-00-990-993

11. Inspect Rear Fan Case Rubstrip

A. Equipment And Materials Required

(1) Support Equipment

PWA 45877 Gage (JT8D-209,-217,-217A)

PWA 46050 Gage (JT8D-217C,-219)

(2) Consumables - None

B. Procedure

(1) Inspect fan blade rubstrip for damage. Part may be continued in service provided rubstrip damage does not exceed the following limits.

(a) Up to 0.040 inch (1.016 mm) depth: No circumferential limit.

(b) In excess of 0.040 inch (1.016 mm) depth, but not exceeding 0.200 inch (5.080 mm) and including damaged or missing ribs: circumferential limit (total of all areas) 10.000 inches (254.000 mm). Axial limit each individual damaged area: 1.300 inches (33.020 mm).

(c) For engines continuing in service with damage as specified in Paragraph 11.B.(1)(b) and if said damage is in three places equally spaced around circumference (120 degrees apart), it is recommended fan blades be examined by SPOP 70 fluorescent penetrant inspection in shroud area every 500 hours. (PAGEBLOCK 70-00-00/201)

(2) Use PWA 45877 Gage (JT8D-209, -217, -217A) to make an inspection of the fan blade rubstrip for wear. (Figure 607)(Figure 608)

(a) Back off thumbscrew in gage body.

(b) Install gage body between two serviceable fan blades. Pull gage body forward so that trailing edge of blade to the right contacts innermost corner of gage body, then slide gage body to the left so that blade on left contacts side of gage body.

NOTE: Two inner gage pins behind right-hand blade rest in rear part of rubstrip trench and other, outer gage pin rests on top of rubstrip outside of trench.

(c) Gently turn thumbscrew until spherical end touches top of second rubstrip rib in from front.

(d) Being careful not to disturb thumbscrew setting, remove gage body and place it on wear gage block assembly. Align gage body pins with corresponding raised setting surfaces on block assembly. With gage body in this position, spherical end under thumbscrew should not touch block surface.

(e) If spherical end touches surface of block assembly, rubstrip wear exceeds 0.020 inch (0.508 mm). Repair rubstrip as necessary by PAGEBLOCK 72-33-67/801.

NOTE: Fan case rubstrip wear exceeding 0.020 inch (0.508 mm) in depth over 60 degree arc, coupled with bent first stage blade tips or other blade repairs, may cause engine stall margin to deteriorate during reverse thrust operation. See COMPRESSOR BLADES, FIRST STAGE - REPAIR-02, PAGEBLOCK 72-33-21/801 Config 2.

Key To Figure 607	
1.	Inner Gage Pins
2.	Rear Case Front Flange
3.	PWA 45877 Gage Body
4.	Thumbscrew

(Continued)

Key To Figure 607	
5.	Angled Locating Pin (PWA 46050 Only)
6.	Spherical End Of Thumbscrew
7.	Second Rubstrip Rib
8.	Outer Gage Pin
9.	Side Of Gage Body Contacts Blade On Left
10.	Trailing Edge Of Blade On Right; Contacts Innermost Corner Of Gage Body

(3) Use PWA 46050 Gage for (JT8D-217C and -219) to make an inspection of the fan blade rubstrip for wear. (Figure 607)(Figure 608)

(a) Back off the thumbscrew in the gage body.

(b) Install the gage body between two fan blades by hooking one fan blade around the trailing edge. Position the gage body so that the two angled locating pins are inserted into the first and last rubstrip grooves. The three spherical headed pins must make contact with the rubstrip trench.

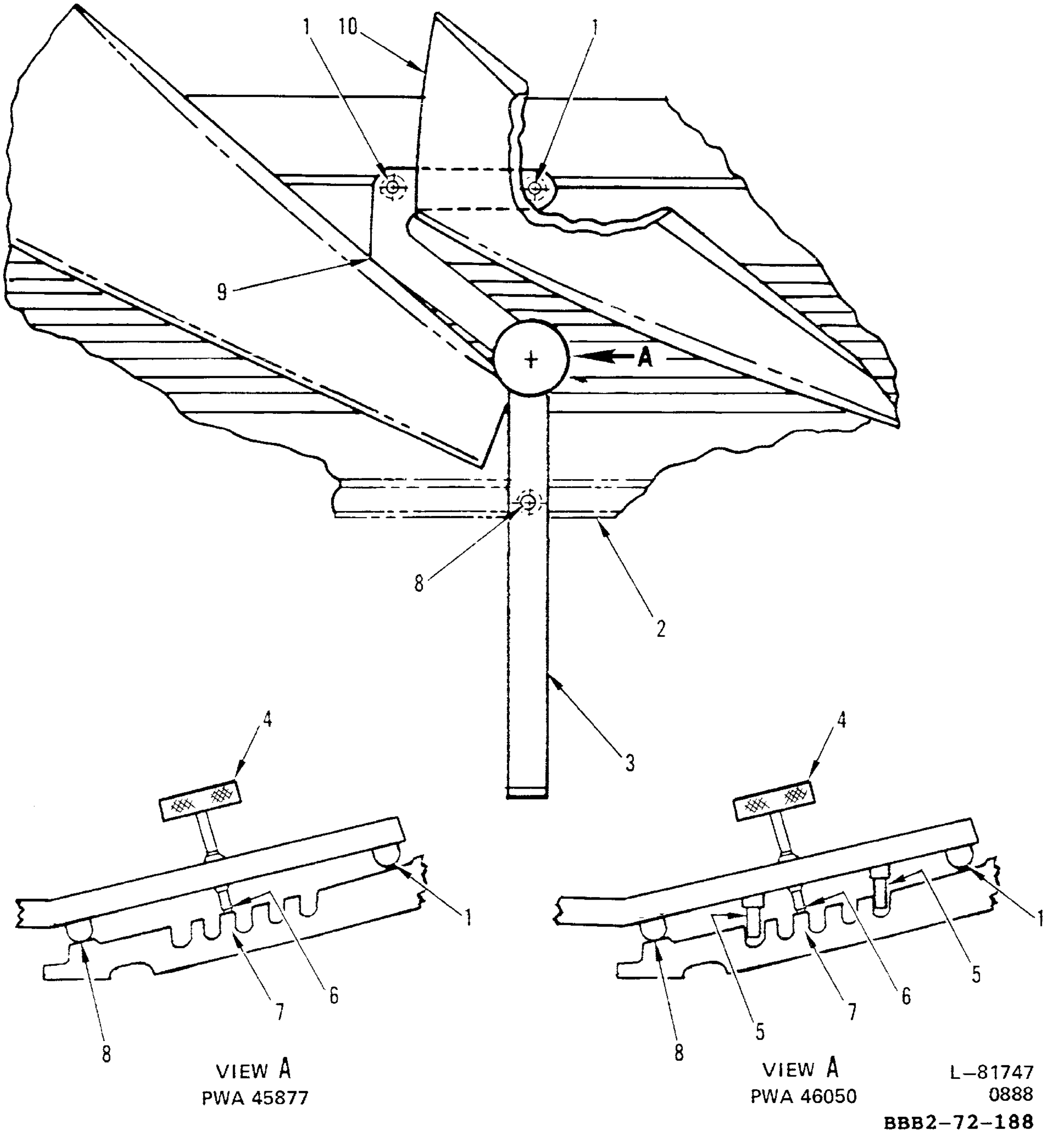
(c) Gently turn the thumbscrew until it touches the rubstrip. Make sure that the three spherical headed pins do not lift off the rubstrip trench surface.

(d) Carefully remove the gage body from the engine. Place the gage on the gaging surface plate with the three spherical headed pins on the three corresponding rest buttons.

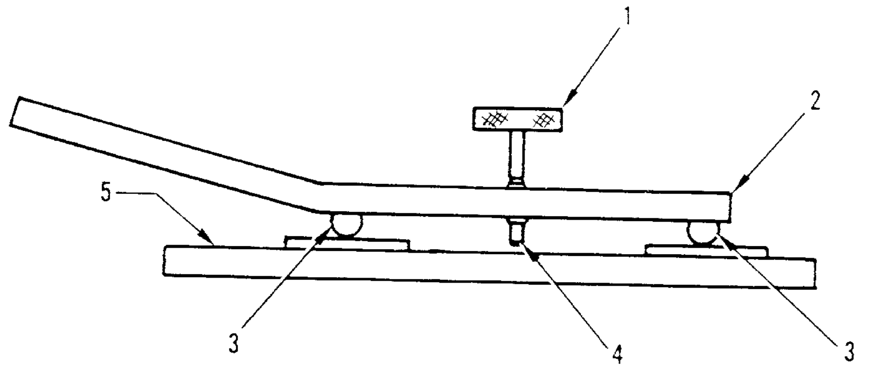
NOTE: Do not move the thumbscrew when removing the gage from the engine.

(e) With the gage body on the gaging surface plate, the spherical end of the thumbscrew must not touch the base plate of the gaging surface plate. If the spherical end touches, the deterioration is more than 0.020 inch (0.508 mm) in the rubstrip. Repair rubstrip as necessary by PAGEBLOCK 72-33-67/801.

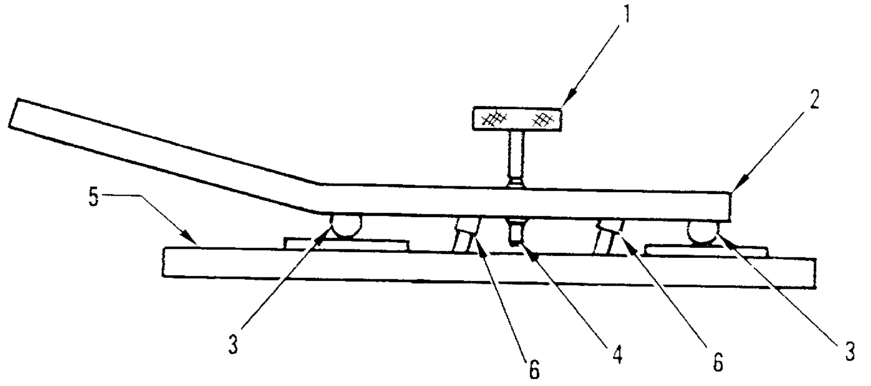
NOTE: Fan case rubstrip wear exceeding 0.020 inch (0.508 mm) in depth over 60 degree arc, coupled with bent first stage blade tips or other blade repairs, may cause engine stall margin to deteriorate during reverse thrust operation. See COMPRESSOR BLADES, FIRST STAGE - REPAIR-02, PAGEBLOCK 72-33-21/801 Config 2.



Inspecting For Fan Blade Rubstrip Wear
Figure 607/72-00-00-990-994



PWA 45877



PWA 46050

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0888

1. Thumbscrew
2. PWA 45877 Gage
3. Gage Pins
4. Spherical End Of Thumbscrew
5. Wear Gage Block Surface. If Index 4 End Touches This Surface, Rubstrip Wear Exceeds 0.020 Inch (0.508 mm).
6. Angled Location Pin

BBB2-72-189

PWA 45877 Or PWA 46050 Gage And Block Assembly
Figure 608/72-00-00-990-995

12. Inspect Front And Rear Fan Case Sound Absorbing Liners

A. Equipment And Material Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

(1) Inspect sound absorbing liners for damage.

(a) All inner perforated face sheet dents, nicks, scratches, and scrapes that do not penetrate skin are acceptable without repair provided that there are no disbonded areas exceeding one square inch at any one location.

(b) Punctures or tears in inner perforated face sheet, including collapse or removal of honeycomb cells, up to one square inch are acceptable provided that outer face sheet or duct wall are not damaged.

1) No more than one square inch of unrepaired damage is allowed per 90 degree quadrant. Remove raised material.

2) No disbonded cells are allowed adjacent to damaged area.

3) Reinspect unrepaired damage every 500 hours.

(2) Repair damage exceeding these limits per PAGEBLOCK 72-33-65/801 through PAGEBLOCK 72-33-67/801.

13. Inspect Fan Exit Fairing

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

(1) Inspect fan exit fairing for wear or damage.

(2) It is permissible to continue in service fan exit fairing having leading edge wear-through due to erosion over maximum accumulated arc of 90 degrees. Wear-through may be at one or several locations but total sum of all locations must not exceed 90 degrees.

(3) Replace unacceptable fairing per PAGEBLOCK 72-33-70/401.

14. Inspect Fan Exit Guide Vanes

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure. (Figure 609)

(1) Inspect fan exit guide vanes applying the following limits:

(a) Local isolated damage to leading and trailing edges of aluminum vanes can be repaired by blending.

(b) Blends to maximum depth on both leading and trailing edges must not be at same radial station and must be separated by minimum diagonal distance of 2.500 inches (63.500 mm). A minimum diagonal distance of 2.375 inches (60.325 mm) is permitted, if not more than three vanes (that are not adjacent) in a segment and no more than six segments in an engine are blended to this limit.

(c) Blends not to maximum depth limit on leading and trailing edges and at same radial station are acceptable provided chordal distance between blends is not less than 2.500 inches (63.500 mm). A minimum chordal distance between blends of 2.375 inches (60.325 mm) is permitted, if not more than three vanes (that are not adjacent) in a segment and no more than six segments in an engine are blended to this limit.

(d) Local isolated injuries to convex and concave surfaces can be blended out provided depth of removal does not exceed 0.020 inch (0.508 mm). Round bottom dents up to 0.020 inch (0.508 mm) deep on convex and concave surfaces are acceptable without blending. No cracks in vanes are allowed. Local blending must extend over an area at least 15 times depth of injury.

(e) Scattered pitting and corrosion are not considered serious provided pitting does not exceed 0.005 inch (0.127 mm) in depth. All evidence of corrosion products must be removed from pits.

(f) Surface finish on repaired vanes must be comparable to that of a new vane.

(g) Total length of combined leading and trailing edge blends or leading and trailing edge blends singularly must not exceed 1.500 inches (38.100 mm) per vane when blending to maximum allowed. If blend depth is less than three quarters maximum allowed, total blend length may be 2.250 inches (57.150 mm). If blend depth is less than one-half maximum allowed, total blend length may be 3.000 inches (76.200 mm).

(h) Radial length of blend must be minimum of three times depth of blend.

(2) Repair damage exceeding these limits per PAGEBLOCK 72-33-80/801.

15. Borescope Inspect Fifth (Post SB 5752 Only), Sixth and Seventh Stage Compressor Blades

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 10408 Adapter

PWA 45235 Wrench

PWA 45248 Puller

(2) Consumables

PWA 36246 Paste, Anti-Seize

B. Procedure

(Figure 610)(Figure 611)(Figure 612)(Figure 613)

WARNING: DO BORESCOPE INSPECTION IN AN AREA WHICH HAS PROTECTION FROM THE WEATHER. IF A BORESCOPE INSPECTION IS DONE IN WET CONDITIONS, USE SUFFICIENT PROTECTION TO PREVENT DAMAGE TO EQUIPMENT OR POSSIBLE ELECTRICAL SHOCK TO THE OPERATOR.

(1) Unbolt instrumentation boss cover at either 4 or 8 o'clock position on front compressor outer fan duct. Remove boss cover from duct using PWA 45248 Puller threaded into hole in cover.

(2) Thread center rod of PWA 45235 Wrench into head of instrumentation (borescope) plug and engage hex head of plug with socket portion of wrench. Unscrew and remove instrumentation plug from receptacle in inner wall of intermediate case. (Figure 610)

NOTE: Use indicated tooling and take precautions during plug removal to ensure that plug does not fall out of wrench and into fan bypass duct. Before withdrawing wrench and plug through boss in outer duct, ensure that plug is securely held by center rod of wrench.

CAUTION: ENGINE INTERNAL TEMPERATURES IN EXCESS OF 149°F (65°C) MAY DAMAGE FIBER OPTIC BORESCOPE COMPONENTS. ENGINE INTERIOR MUST BE ALLOWED TO COOL BELOW 149°F (65°C) FOLLOWING ENGINE OPERATION PRIOR TO INSERTING BORESCOPE. ALLOW COOL-DOWN PERIOD ON NEWLY SHUT-DOWN ENGINE PRIOR TO INSPECTION TO ENSURE THAT PERSONNEL ARE NOT INJURED AND EQUIPMENT IS NOT DAMAGED.

(3) Allow approximately two hours after engine shutdown before beginning borescope inspection when outside temperature is approximately 75°F (24°C); allow approximately two and a half hours if outside temperature is above 80°F (27°C), and allow approximately one hour if temperature is 30°F (-1°C) or lower. Rate of cool down can be increased by motoring engine after shutdown with starter for 30 second periods.

(4) Insert borescope through fan duct and intermediate case bosses.

(5) Inspect the compressor blades for damage.

(a) If the 6th and or 7th stage airfoils are wet with oil, this can be the result of oil leakage from the No.2 and 3 bearing compartment. If necessary, remove the engine for repair. (ENGINE GENERAL - TROUBLESHOOTING -02 (LUBRICATION SYSTEM), PAGEBLOCK 72-00-02/101)

(b) Turn rotor using PWA 10408 Adapter in gearbox starter drive to bring all 7th stage blades into view. Turn front compressor rotor by means of fan blades to bring all 5th stage and 6th stage blades into view.

NOTE: There are 62 5th stage blades, 56 5th stage vanes and 60 6th stage blades in the 6th stage compressor rotor. In the 7th stage there are 60 blades in the rotor and 52 vanes in the compressor stator.

Borescope ports are also provided at 13th stage and these ports may be used to verify rear compressor integrity further. See Paragraph 17..

(c) Sixth stage blade leading and trailing edge damage must not exceed limits in Figure 612.

(d) After the 6th stage blades are examined, the 5th stage blades can also be examined as follows:

1) The 5th stage blades can be viewed forward of the 6th stage blades and 5th stage vanes. See Figure 610. Damage limits for Post SB 5752, 5th stage blades are given in Figure 611. There are no damage limits for Pre SB 5752 blades.

CAUTION: DO NOT TURN THE FRONT COMPRESSOR BY HAND OR BY THE WIND IF THE BORESCOPE IS INSTALLED BETWEEN THE 6TH STAGE BLADES. IF THE FRONT COMPRESSOR TURNS IT WILL DAMAGE THE ENGINE AND BORESCOPE EQUIPMENT. CAREFULLY REMOVE THE BORESCOPE FROM BETWEEN THE 6TH STAGE BLADES BEFORE THE COMPRESSOR IS TURNED.

2) A closer examination of a individual 5th stage blade can be done by carefully inserting the flexible borescope forward and between the 6th stage blades and 5th stage vanes.

(e) Seventh stage blade leading and trailing edge damage must not exceed limits in Figure 613.

NOTE: Post SB 5871 (anti flutter bleeds) engines have a limit for Area B, Figure 613 that is more than pre SB 5871 engines.

(f) If blade damage exceeds limits given, do one of the steps that follows:

1) The 7th stage blades can be blend repaired in the engine by PAGEBLOCK 72-36-31/801. See this repair for damage and repair limits.

2) Remove and disassemble the engine for repair of the 5th, 6th or 7th stage compressor blades.

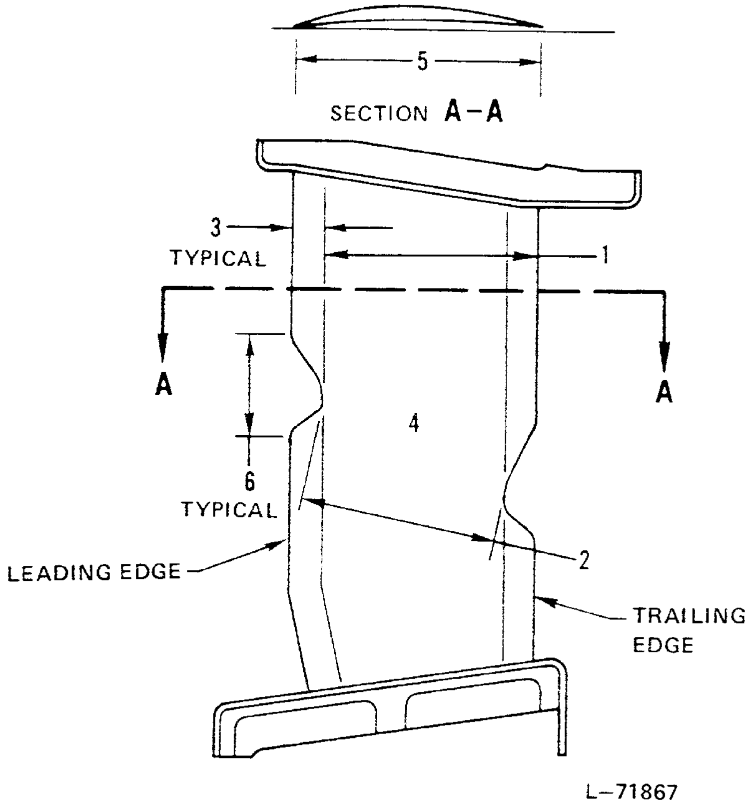
(6) Inspect intermediate case and fan duct borescope bosses for cracks.

(7) Apply wet coat of PWA 36246 anti-seize paste to threads of instrumentation (borescope) plug and remove unwanted paste. Using PWA 45235 Wrench threaded into head of borescope plug, install instrumentation boss plug through fan duct into intermediate case. Torque to 500 - 1000 in-lb. (56.492 - 112.985 N·m) with minimum run-in torque of 30 in-lb. (3.390 N·m).

NOTE: Torque limits apply with application of anti-seize paste as noted. Apply anti-seize paste to plug regardless of prior surface treatment.

If run-in torque falls below 30 in-lb. (3.390 N·m) for one plug, exchanging left and right plugs may result in run-in torque above minimum value.

(8) Install cover in fan duct boss and secure with bolts and washers. Torque to required value.



1. 2.500 Inches (63.500 mm) Minimum Allowable Chordal Length, 2.375 Inches (60.325 mm) In No More Than Three Vanes (That Are Not Adjacent) Per Segment And No More Than Six Segments Per Engine.
2. 2.500 Inches (63.500 mm) Minimum Diagonal Separation 2.375 Inches (60.325 mm) In No More Than Three Vanes (That Are Not Adjacent) Per Segment And No More Than Six Segments Per Engine.
3. 0.375 Inch (9.525 mm) Maximum Blend Depth Limit For LE and TE 0.500 Inch (12.700 mm) In No More Than Three Vanes (That Are Not Adjacent) Per Segment And No More Than Six Segments Per Engine.
4. 0.060 Inch (1.524 mm) Maximum Round Bottom Dents
5. 2.875 Inches (73.025 mm) Chordal Length Reference
6. Blend Length. Leading And Trailing Edge Radii Are To Be Restored In This Area.

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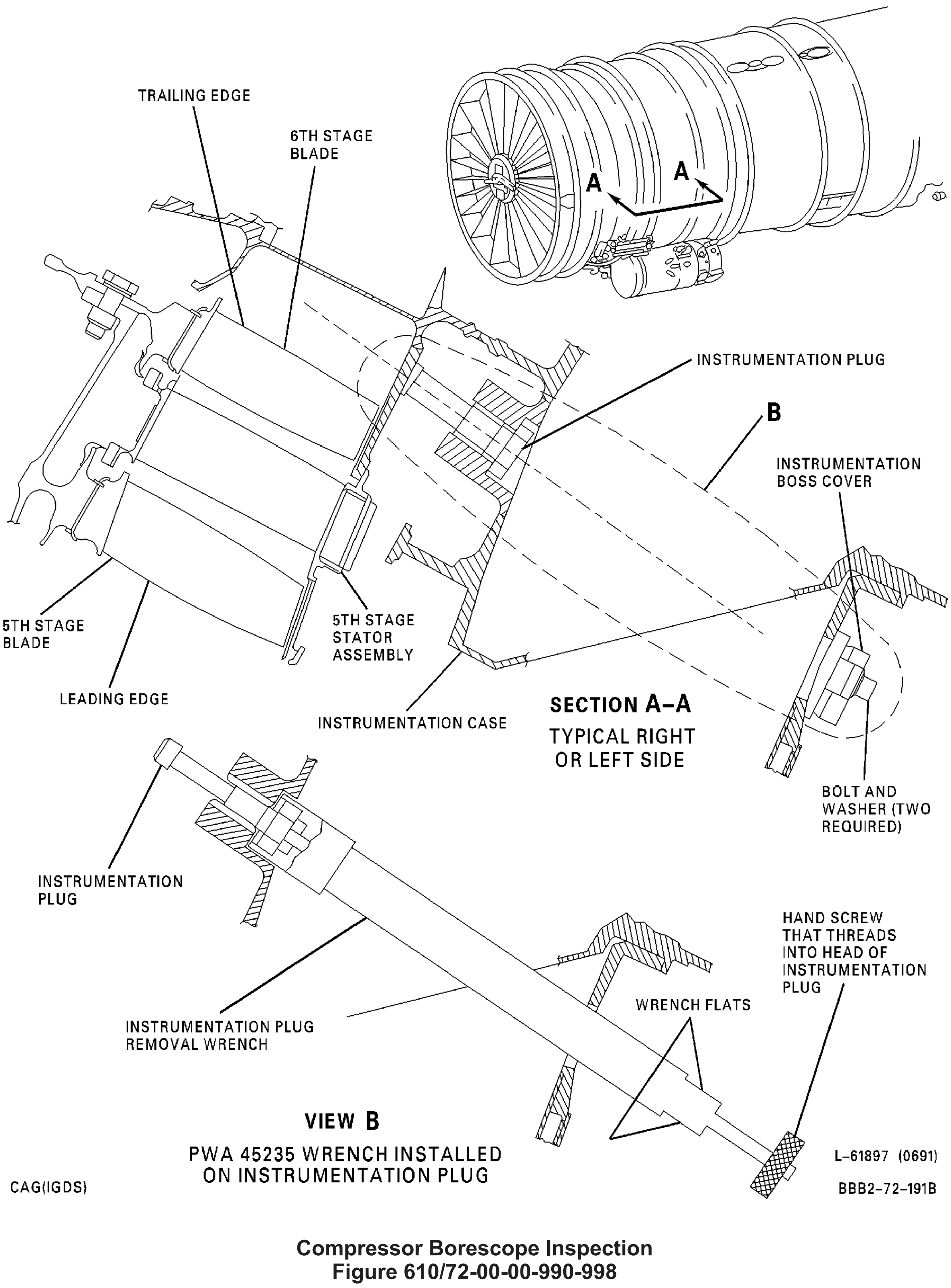
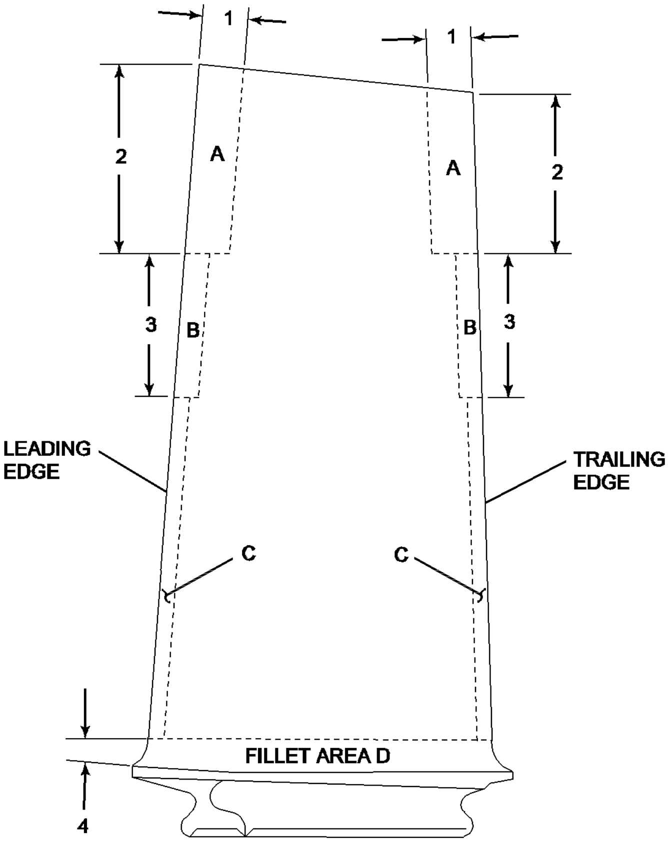
Fan Exit Vane Inspection Limits
Figure 609/72-00-00-990-997



Compressor Borescope Inspection
Figure 610/72-00-00-990-998

AREA	ACCEPTABLE DAMAGE LIMITS
A	ANY DAMAGE UP TO 1/8 in. (3.175 mm)
B	ANY DAMAGE UP TO 1/16 in. (1.588 mm) NO TEARS OR CRACKS
C	ANY DAMAGE UP TO 0.010 in. (0.254 mm) NO TEARS OR CRACKS
D	UP TO 0.005 in. (0.127 mm) ✻

✻ THE SURFACE ANOMALIES SHOULD BE SMOOTH, ROUND BOTTOM, AND MUST NOT HAVE CRACKS, RAISED MATERIAL, OR TEARS.



1. 1/8 in. (3.175 mm)
2. 1 5/8 in. (41.275 mm)
3. 1 1/16 in. (26.987 mm)
4. 1/4 in. (6.350 mm)

NOTE: THESE LIMITS ARE NOT FOR PRE SB 5752 ENGINES.

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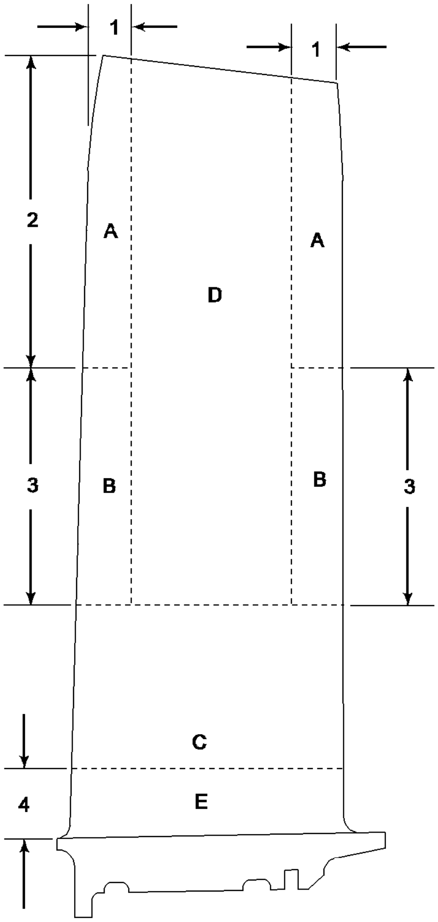
Fifth Stage Blade (Post SB 5752) Inspection Limits
Figure 611/72-00-00-990-999

AREA	ACCEPTABLE DAMAGE LIMITS
A	ANY DAMAGE UP TO 1/8 in. (3.175 mm)
B	INDENTATIONS UP TO 1/16 in. (1.588 mm) NO TEARS OR CRACKS
C	INDENTATIONS UP TO 0.010 in. (0.254 mm) NO TEARS OR CRACKS
D	ANY INDENTATIONS NO TEARS OR CRACKS
E	UP TO 0.005 in. (0.127 mm)*

* THE SURFACE ANOMALIES SHOULD BE SMOOTH, ROUND BOTTOM, AND MUST NOT HAVE CRACKS, RAISED MATERIAL, OR TEARS.



1. 1/8 in. (3.175 mm)
2. 1-1/2 in. (38.100 mm)
3. 1 in. (25.400 mm)
4. 1/4 in. (6.350 mm)

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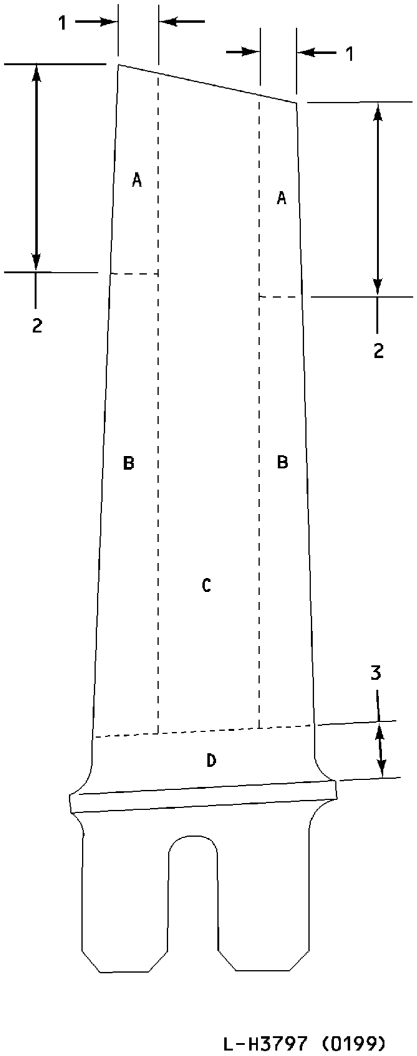
S0006554799V2

Sixth Stage Blade Inspection Limits
Figure 612/72-00-00-990-A01

	PERMITTED DAMAGE LIMITS	
BLADE AREA	PRE SB5871	POST SB5871-ANTI FLUTTER BLEEDS
A	ANY TYPE OF DAMAGE UP TO 1/8 IN. (3.175 mm) MAXIMUM	ANY TYPE OF DAMAGE UP TO 1/8 IN. (3.175 mm) MAXIMUM
B	ANY TYPE OF DAMAGE UP TO 0.020 IN. (0.508 mm) AND DENTS* UP TO 0.047 IN. (1.194 mm)	ANY TYPE OF DAMAGE UP TO 0.050 IN. (1.27 mm)
C	ANY DENT* NO TEARS OR CRACKS	ANY DENT* NO TEARS OR CRACKS
D	† DENTS * UP TO 0.005 IN. (0.127 mm)	† DENTS * UP TO 0.005 IN. (0.127 mm)

* DENTS MUST BE SMOOTH AND ROUNDED WITHOUT CRACKS, TEARS OR MATERIAL REMOVED.

† DAMAGE THAT IS MORE THAN 0.002 IN. (0.051 mm) BUT LESS THAN 0.005 IN. (0.127 mm) MUST HAVE A BORESCOPE INSPECTION EVERY 950 HOURS OR LESS.



1. 1/8 INCH (3.175 mm)
2. 3/4 INCH (19.050 mm)
3. 1/4 INCH (6.350 mm)

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Seventh Stage Blade Inspection Limits
Figure 613/72-00-00-990-A02

16. Eighth Stage Stator Shroud Crack Inspection

NOTE: Service experience has shown that cracks can develop in the 8th stage stator shroud region because of high torque loads at the interface joint with the intermediate case support flange. The shape and size of some cracks can result in pieces of the shroud to go into the gaspath. To keep this to a minimum, the on-wing inspection and crack limits are specified.

A. Inspect the 8th stage stator shroud for cracks to the limits shown. Stators with cracks that fall within the limits shown must be inspected again to the schedule shown: (Figure 614)

  (1) Stators with more than 10,000 cycles: Inspect cracks every 250 flight hours.

  (2) Stators with less than 10,000 cycles: Inspect cracks every 500 flight hours.

B. Crack Limits

  (1) The total length of any crack must not be more than 1.000 inch (25.4 mm).

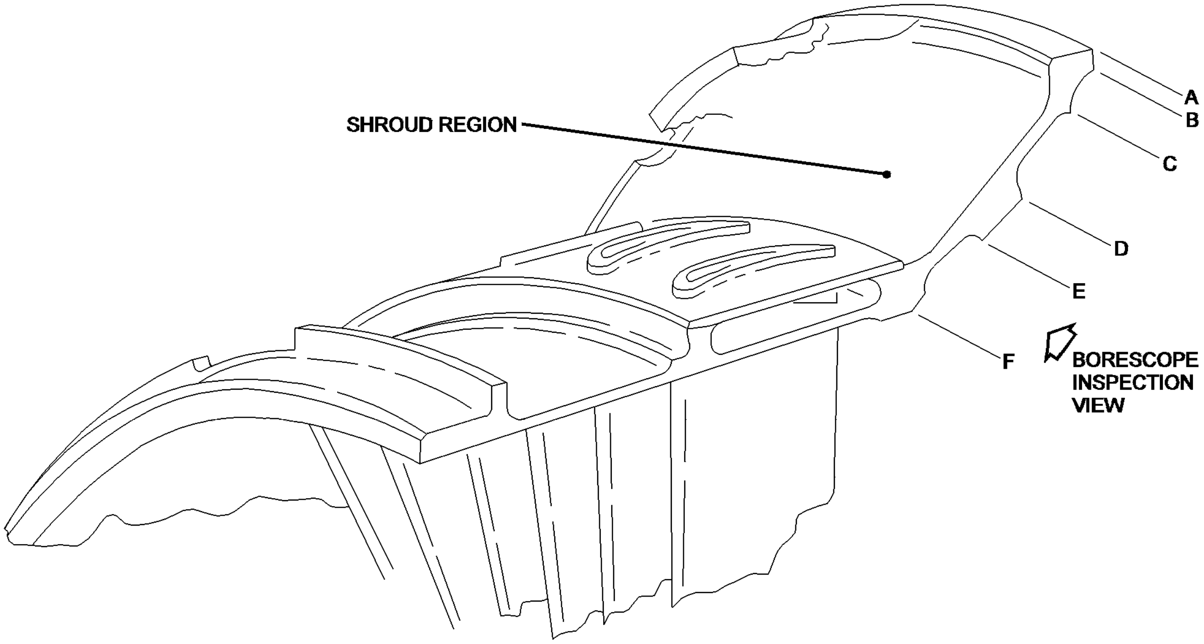
  (2) No more than two cracks are allowed.

  (3) If two cracks are identified, they must be 60 degrees apart minimum circumferentially.

  (4) No intersecting cracks are allowed.

  (5) No cracks that separate into two directions are allowed.

    NOTE: Cracks more than the limits shown is not acceptable and requires that the stator be repaired to the engine manual within 50 flight hours.



SURFACE	DISTANCE (INCHES)	DISTANCE (MILLIMETERS)
A-B	0.078 in.	1.981 mm
B-C	0.156 in.	3.962 mm
C-D	0.515 in.	13.081 mm
D-E	0.234 in.	5.943 mm
E-F	0.469 in.	11.913 mm

NOTE: THE ABOVE DISTANCES ARE STRAIGHT LINE DISTANCES FROM SURFACE TO SURFACE. USE THEM TO COMPARE WITH CRACKS TO FIND CRACK LENGTHS.

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S0000243354V1

8th Stage Stator Shroud Surface Length Comparator
Figure 614/72-00-00-990-C44

17. Borescope Inspect 12th and 13th Stage Compressor Blades

A. Equipment And Materials Required

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

(1) Support Equipment:

PWA 10408 Adapter

PWA 45248 Puller

(2) Consumables:

Assembly Fluid (PWA 36500)

B. Procedure

(Figure 615)(Figure 616)(Figure 617)

WARNING: DO BORESCOPE INSPECTION IN AN AREA WHICH HAS PROTECTION FROM THE WEATHER. IF A BORESCOPE INSPECTION IS DONE IN WET CONDITIONS, USE SUFFICIENT PROTECTION TO PREVENT DAMAGE TO EQUIPMENT OR POSSIBLE ELECTRICAL SHOCK TO THE OPERATOR.

(1) Unbolt and remove cover from 2 or 10 o'clock position on diffuser outer fan duct. Remove and discard cover packing.

(2) Remove cover in diffuser sound absorbing liner segment as follows:

(a) Thread PWA 45248 Puller into threaded hole in center of cover.

(b) Using 7/32 (5 mm) hex wrench, loosen inner liner bolts until they are free of mating boss (they will be retained by cover flange).

(c) Using knocker detail of puller, remove cover.

(3) Remove instrumentation boss cover from diffuser case as follows:

(a) Thread PWA 45248 Puller into threaded hole in cover.

(b) Loosen two 5/16 inch (8 mm) bolts securing cover until they are free of diffuser case boss (they will be retained by cover flange).

(c) Using knocker detail of Puller, remove cover.

CAUTION: ENGINE INTERNAL TEMPERATURES IN EXCESS OF 149°F (65°C) MAY DAMAGE FIBER OPTIC BORESCOPE COMPONENTS. ENGINE INTERIOR MUST BE ALLOWED TO COOL BELOW 149°F (65°C) FOLLOWING ENGINE OPERATION PRIOR TO INSERTING BORESCOPE. ALLOW COOL-DOWN PERIOD ON NEWLY SHUT-DOWN ENGINE PRIOR TO INSPECTION TO ENSURE THAT PERSONNEL ARE NOT INJURED AND EQUIPMENT IS NOT DAMAGED.

(4) Allow approximately two hours after engine shutdown before beginning borescope inspection when outside temperature is approximately 75°F (24°C); allow approximately one hour if temperature is 30°F (-1°C) or lower. Rate of cooldown can be increased by motoring engine after shutdown with starter for 30 second periods.

Key To Figure 615 (Sheet 1)	
1.	Diffuser Case Wall

(Continued)

Key To Figure 615 (Sheet 1)	
2.	Bolt (Two)
3.	Bolt Retaining Flange
4.	Threaded Hole In Cover (For Puller)
5.	Seal Ring
6.	Cover Bolt (Two)
7.	Fan Duct Cover
8.	Diffuser Inner Sound Absorbing Liner

(5) Using borescope, inspect the 12th and 13th stage blades and compressor exit stator vanes for condition.

(a) If the 12th and/or 13th stage airfoils are wet with oil, this can be the result of oil leakage from the No. 4 bearing compartment. If necessary, remove the engine for repair. (ENGINE GENERAL - TROUBLESHOOTING -02 (LUBRICATION SYSTEM), PAGEBLOCK 72-00-02/101)

(b) Turn rotor using PWA 10408 Adapter in gearbox starter drive to bring all blades into view.

NOTE: There are 80 blades in the 12th stage compressor rotor and 109 vanes in the 12th stage compressor stator. There are 74 blades in the 13th stage compressor stator and 99 vanes in the compressor exit stator.

(c) Twelfth and thirteenth stage blade leading and trailing edge damage must not exceed limits in Figure 616.

(d) If blade damage exceeds limits given, engine must be removed and disassembled for compressor repair.

(6) Using borescope, inspect all 13th stage and as much as possible of the 12th stage compressor blades for airfoil tip fractures. For this inspection an airfoil tip fracture is defined as a fracture originating at blade airfoil tip and extending to blade trailing edge. (Figure 617)

(a) Engines may continue in service provided only one compressor blade is fractured, as described above, in either 12th stage or 13th stage. These engines must be reborescope inspected at intervals not to exceed 450 hours.

(b) Engines with more than one blade tip fracture, as described above, for 12th or 13th stage compressor blades must be removed from service within 100 hours and disassembled for compressor repair.

(c) Engines with a single 12th or 13th stage blade with multiple fractures must be removed from service within 100 hours and disassembled for compressor repair. Typical multiple fractures are shown in Figure 617.

(d) Damage limits must be maintained for 13th stage compressor blade leading and trailing edges as described in Paragraph 17.B.(5).

(e) All other required operational parameters and limits must be maintained.

(7) Using borescope, inspect edges of borescope hole for cracks.

(8) Prepare instrumentation boss cover for installation as follows:

(a) Thread PWA 45248 Puller into cover to facilitate handling cover.

(b) On Part Number (P/N) 775980 Cover ensure that sealing ring is centralized so as not to jam when cover is installed.

NOTE: As shown in Figure 615 (Sheet 2), P/N 792712 centering ring may be used inside sealing ring to take up internal space in ring groove of P/N 775980 Cover, facilitating centering of outer ring. Subsequent P/N 792704 cover does not require optional use of centering ring.

(c) The large chamfer on the P/N 807417 seal ring must face towards the tip of the cover shank. See Figure 615 (Sheet 2).

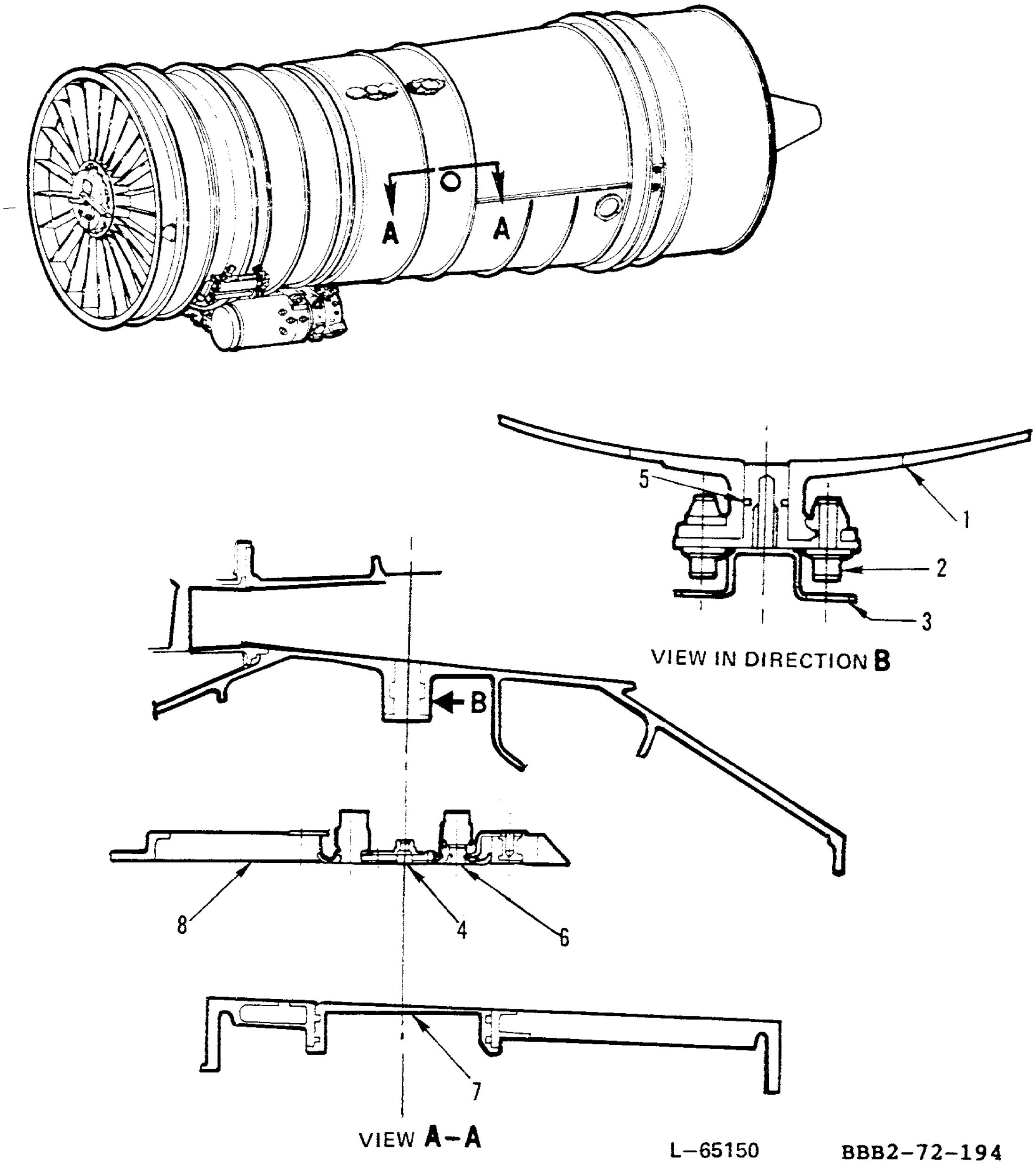
(9) Insert cover into instrumentation boss on engine case, lining up bolts with bolt holes. Secure cover with bolts.

NOTE: The self-locking nuts on the instrumentation boss covers are silver plated to prevent seizure of the bolts. However, the plating may no longer be effective after several of the bolts have been removed several times. To prevent bolt lock up, it is optional to apply wet anti-seize paste PWA 36246 to the bolt threads.

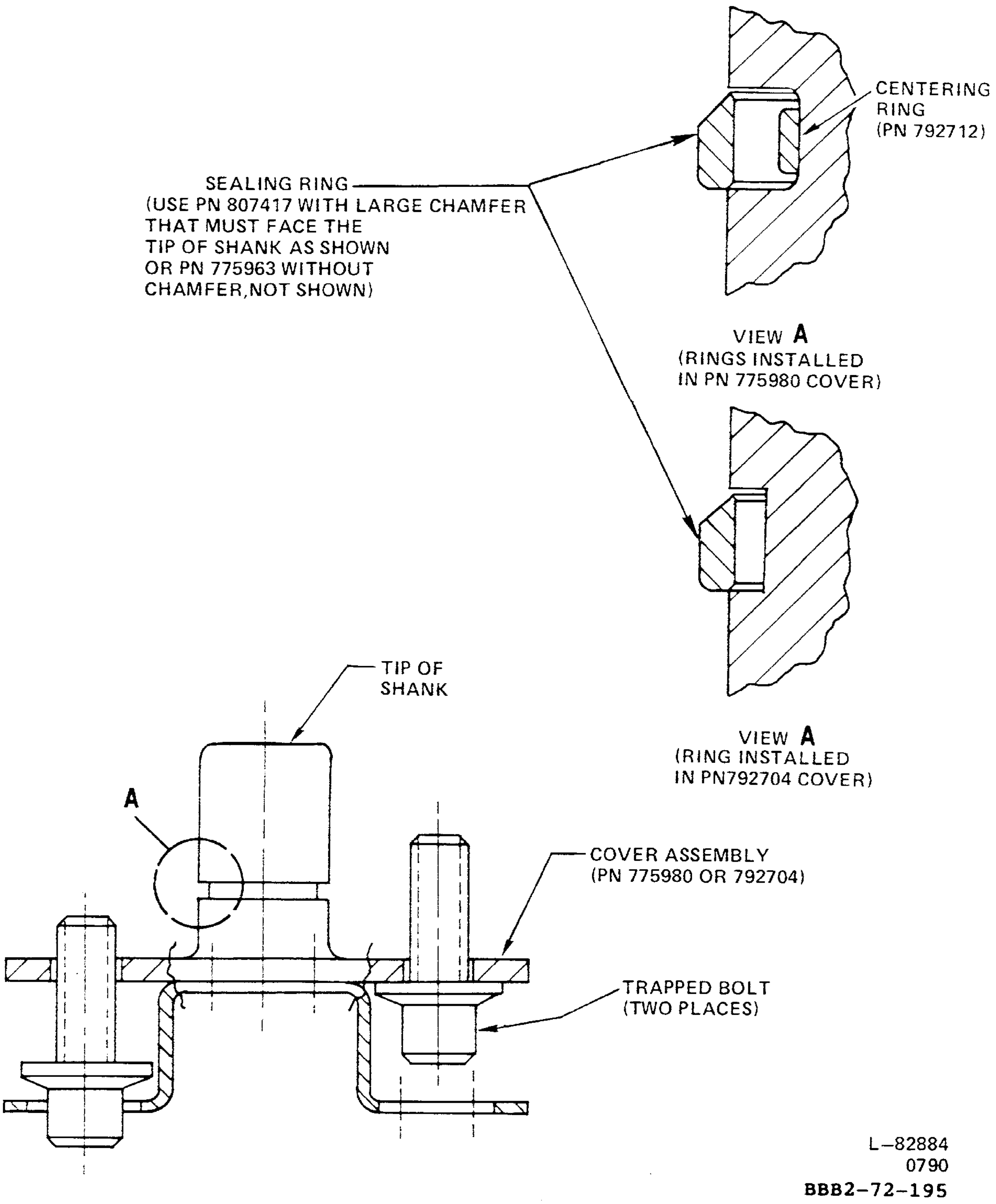
(a) Torque the bolts to 62.0 in-lb (7.0 N·m) - 72.0 in-lb (8.1 N·m).

(10) Position inner liner cover in place, using PWA 45248 Puller to hold cover. Turn fasteners to secure cover and torque fasteners to 40 - 60 in-lb. (4.519 - 6.779 N·m).

(11) Install packing, lightly coated with PWA 36500 Assembly Fluid, on fan duct cover and bolt cover in place. Torque bolts.

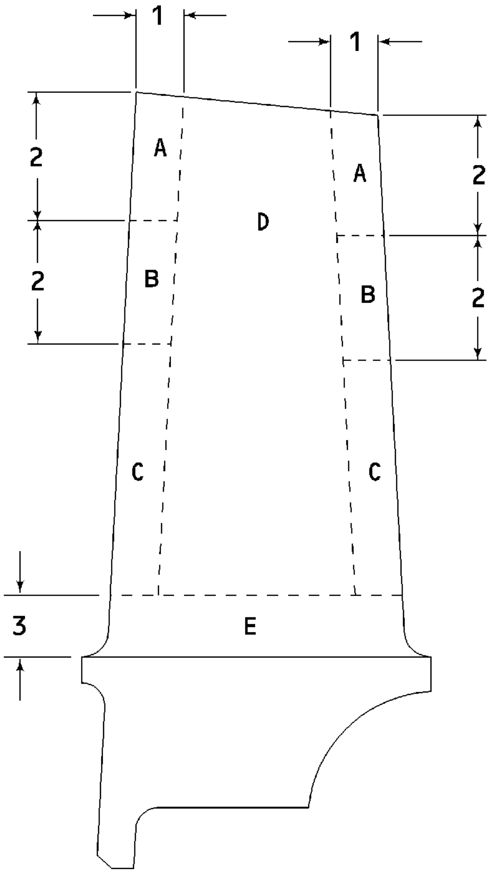


Thirteenth Stage Compressor Borescope Inspection
Figure 615/72-00-00-990-A03 (Sheet 1 of 2)



Thirteenth Stage Compressor Borescope Inspection
Figure 615/72-00-00-990-A03 (Sheet 2 of 2)

AREA	ACCEPTABLE DAMAGE LIMITS
A	ANY DAMAGE UP TO 1/16 INCH (1.588mm) ANY ROUND BOTTOMED DAMAGE UP TO .135 INCH (3.429mm) NO TEARS OR CRACKS ALLOWED BEYOND 1/16 INCH (1.588mm)
B	ANY DAMAGE UP TO 1/16 INCH (1.588mm) ANY ROUND BOTTOMED DAMAGE UP TO .135 INCH (3.429mm) NO TEARS OR CRACKS ALLOWED BEYOND 1/16 INCH (1.588mm)
C	INDENTATIONS UP TO 1/32 INCH (0.793mm) NO TEARS OR CRACKS
D	ANY INDENTATION NO TEARS OR CRACKS
E	INDENTATION UP TO 0.010 INCH (0.254mm) NO TEARS OR CRACKS



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NOTE:

DAMAGE THAT TRANSCENDS DEFINED BOUNDARIES CAN BE ADDRESSED BY ALLOWING THE GREATER DAMAGE LIMIT TO PREVAIL (NO TEARS OR CRACKS ALLOWED IN AREAS "C" OR "D". THIS NOTE DOES NOT APPLY BETWEEN BOUNDARY "C" TO "E" OR "D" TO "E".

1. 3/16 Inch (4.762 mm)
2. 1/4 Inch (6.350 mm)
3. 1/8 Inch (3.175 mm)

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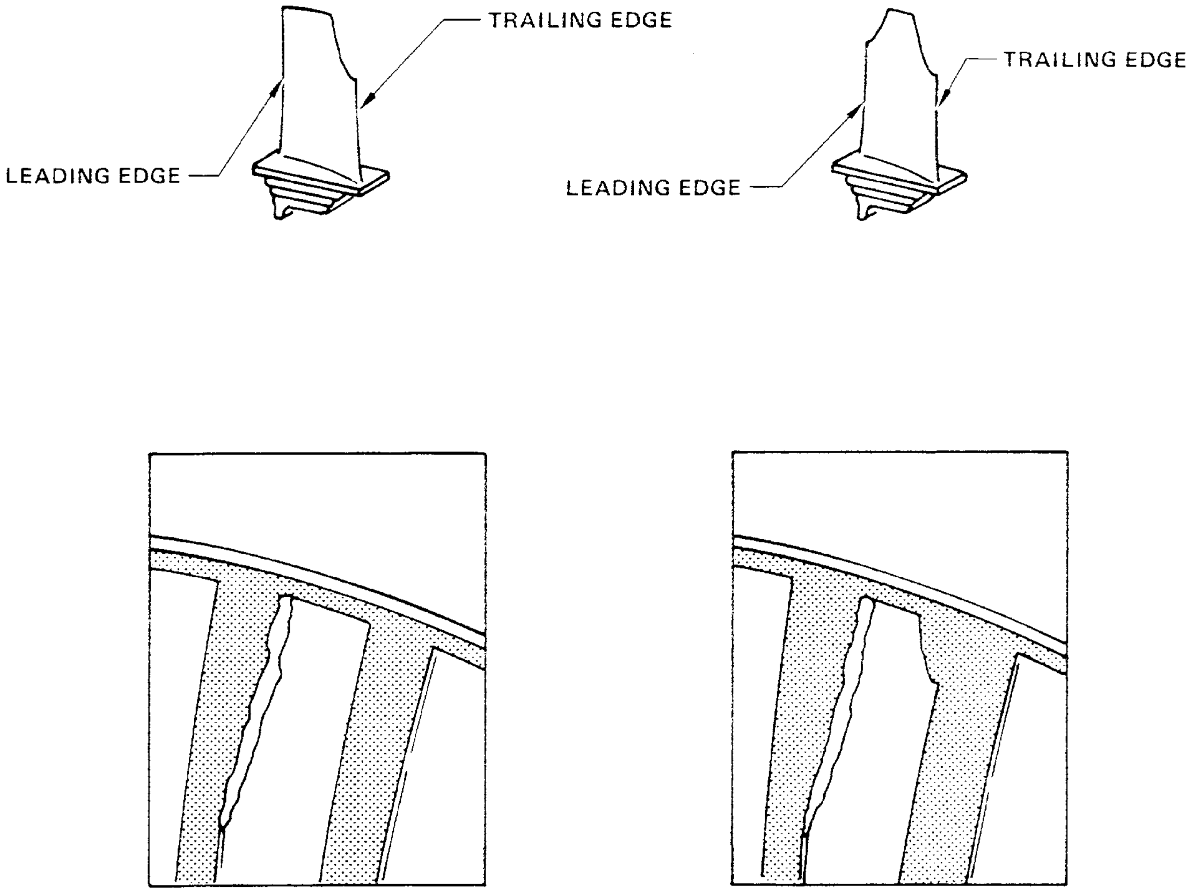
Twelfth and Thirteenth Stage Blades Inspection Limits
Figure 616/72-00-00-990-A04



TYPICAL SINGLE FRACTURE WITH TRAILING EDGE TIP LOSS

TYPICAL MULTIPLE FRACTURE WITH TRAILING EDGE AND LEADING EDGE TIP LOSS

Twelfth And Thirteenth Stage Blade Tip Fractures
Figure 617/72-00-00-990-A05

18. Examine Diffuser Fan Duct Sound Liners/Fairings

A. Equipment And Materials Required

  (1) Support Equipment - None

  (2) Consumables - None

B. Procedure

  (1) Examine diffuser fan duct sound liners for damage. If there is damage to the liners (or if parts of the liners are missing), these limits are applicable:

    (a) If the liner (top sheet) has disbonds or is missing, the honeycomb below it must be in good condition.

    (b) Damaged area up to 60 square inches (38710 square mm): Do a visual inspection at 50 hour intervals.

    (c) Damaged area more than 60 square inches (38710 square mm) but less than 82 square inches (52903 square mm): Continue in service a maximum of 50 hours. Do a visual inspection at 25 hour intervals. If more disbond damage occurs, remove the engine for repair after no more than 10 hours of operation.

    (d) Damaged area more than 82 square inches (52903 square mm): Remove the engine for repair after no more than 10 hours of operation.

  (2) Examine the fairings around the diffuser area tubes.

  NOTE: There are fairings around the bleed tubes and manifolds (10 o'clock and 2 o'clock position as seen from the rear of the engine) and around the No. 4 bearing oil tubes (8 o'clock position).

    (a) Engine operation without bleed manifold or oil tube fairings in their correct position is permitted. However, the result of engine operation without fairings can be a small decrease in engine performance as a result of high-turbulence airflow around the tubes and manifolds.

    (b) Replace the fairings when access to this part of the engine gaspath becomes possible.

19. Inspect Combustion Chambers (Borescope Method)

A. Equipment And Materials - None

B. Borescope Inspection

  (1) General

    (a) This inspection procedure is designed to detect damage or distress to combustion chambers and surrounding structures by means of flexible fiber-optic borescope. Using equipment specified in this procedure, it is possible to make thorough examination of internal surfaces of each combustion chamber. In addition, adjacent structures such as fuel nozzles, inner and outer outlet ducts, and 1st stage turbine vanes and blades may be viewed and inspected.

    (b) Inspection personnel performing borescope inspection of combustion chamber liners must have completed borescope training according to one of the following:

      1) Inspector must have completed prescribed JT8D combustion chamber liner borescope training at Pratt & Whitney Customer Training Center and must have completed training in inspection of two sets of combustion chamber installed in engines at operator or overhaul agency facility before beginning service inspections of operational engines.

      OR

2) Inspector must have completed Pratt & Whitney approved training session conducted by instructor trained at Pratt & Whitney Customer Training Center and must have completed training in inspection of two sets of combustion chambers installed in engines at operator or overhaul agency facility before beginning service inspections of operational engines.

(c) This procedure depicts the use of the following equipment:

NOTE: Equipment listed below is available as kit from Olympus Corporation IFD, 4 Nevada Drive, Lake Success, NY 11042-1179. Kit including light source is Model No. OCK-JT8D-C1 (Catalog No. 1227D). Kit without light source but with adapter allowing connection to Wolf or ACMI high-intensity light source is Model No. OCK-JT8D-C2 (Catalog No. 1227E).

1) Flexible Fiberscope Model IF6D3-20, 6mm diameter by 2 meter length.

NOTE: Side-viewing (90-degree) borescope tip, Model IF6D3-A65S is available if required and is recommended for accomplishing complete inspection of combustion chamber crossover tube areas.

2) ILV 300 watt xenon light source.

3) Articulating support arm.

4) GT-JT8D Articulating Guide Tube, 11 mm diameter by approximately 50 inch (1270 mm) length.

5) Friction plate or cup (to be attached to external fan duct ignition boss, with central hole permitting close, stabilizing fit around guide tube during borescope maneuvers).

(d) Alternate Olympus Kit is Kit No. MOD OCK-JT8D-C1/4 consisting of the following. Kit No. MOD OCK-JT8D-C2/4 contains items Paragraph 19.B.(1)(d)1) through Paragraph 19.B.(1)(d)3) but does not include light source.

1) Flexible Fiberscope Model IF8D3X2-20, 8 mm diameter by 2 meter length.

2) FT-JT8D/8x4 Articulating Guide Tube with four-way articulation and including friction plate with integral support arm mounting boss.

3) Articulating support arm.

4) Model KLS-2250 High Intensity Light Source (250 watt with improved focus feature).

NOTE: Adapters for adapting Olympus flexible fiberscope to other light sources are available on request from Olympus Corporation.

(e) Also available is similar kit from American ACMI, P.O. Box 1971, Stamford, CT 06904, U.S.A. Kit with 110V high intensity light source is Kit No. BK-JT8D-1; kit with 220V high intensity light source is Kit No. BK-JT8D-1A; kit with borescope, guide tube, friction plate and support arm but without light source is Kit No. BK-JT8D-2.

1) Flexible Borescope BFM-2270DDX

2) FGT-JT8D Four-way Flexible Guide Tube

3) SA-1 Support Arm

4) FCB-1020S (FCB-102A if 220V) High Intensity Light Source

5) Friction Plate (to be attached to external fan duct ignition boss, with central hole permitting close, stabilizing fit around guide tube during borescope maneuvers).

(f) Also available is similar kit from Machida (Machida America, 40 Ramland Road, Orangeburg, NY 10962 U.S.A.). Kit with borescope, guide tube, accessories and support arm is Kit No. MJ072000MA from Machida America; Kit with borescope, guide tube, accessories and extension arm with separate clamps for PRBC and P&D valve is Kit No. MJ072000 from Machida Japan. RG-400 high intensity light source must be ordered separately. Kit details are as follows:

1) Flexible Borescope FB7-2000A
2) GT12-1500 Guide Tube
3) SAH-1000MA Accessory Kit (FD-8D, FP-8D-200 Friction Plates, SH-8D Scope Holder)
4) MA0030 Support Arm and Clamp (Machida America Kit)
5) EA-8D Extension Arm (Machida Japan Kit)
6) CP-8D-PC PRBC Clamp (Machida Japan Kit)
7) CP-8D-DV P&D Valve Clamp (Machida Japan Kit)

NOTE: Borescope equipment other than that specified may be substituted provided no loss of effectiveness results. Operators wishing to use alternate Olympus, ACMI, or Machida products or products of other Manufacturers should request approval from the Technical Support Department, Pratt & Whitney Division of United Technologies Corporation, East Hartford, CT 06108, U.S.A.

(g) Alternate Machida Kit is Borescope Set MA11180W, consisting of 11 mm borescope with two planes of articulation on borescope sheath, allowing maneuvering of borescope without guide. Also featured is simultaneous straight ahead and 90 degree viewing. Light source RG-400 is available separately. Kit details are as follows:

1) Flexible Borescope FBA-11-180W
2) SAH-1100 Accessory Kit (MA0030 Support Arm and Clamp, MA0040 Borescope Holder, FP-8D, FP-8D-200 Friction Plates)

(h) An alternative source is the Welch Allyn Video Probe 2000 System. This equipment has a flexible borescope (Flying Probe, P/N VS2155) which uses air pressure from the distal tip to move the probe through the engine. A friction plate and support arm at the outside of the engine are not necessary with this system. Send for information to:

Welch Allyn
Inspection Systems Division
4619 Jordan Road
P. O. Box 100
Skaneateles Falls, NY 13153-0100

Welch Allyn Gmbh
Taunusstrasse 12
6238 Wallau, Germany

Welch Allyn (H.K.) Inc.

(Continued)

7/F Kam Ping Building

95 Kings Road

North Point, Hong Kong

(i) Make record of inspection findings by plotting indications and observed damage of each individual combustion chamber on individual copies of worksheet shown in Figure 618. Note that dimensions of internal features of combustion chamber are presented to aid in accurately estimating crack length and size and relative shape of damaged area. See Figure 619 for definition of internal and external features of combustion chamber.

NOTE: It is recommended that sample combustion chamber or photos of good quality be available to inspector when engine is being borescope inspected. Spare chamber or photos will assist in identifying exact position of distress, should it be present.

(j) Retain copy of individual combustion chamber liner inspection plots to aid in detecting progression of existing cracks or damage, or in evaluating appearance of new cracks or damage when feature inspection is accomplished.

(k) Compare plotted inspection findings to limits in SB 5741 to determine serviceability of combustion chambers.

WARNING: DO BORESCOPE INSPECTION IN AN AREA WHICH HAS PROTECTION FROM THE WEATHER. IF A BORESCOPE INSPECTION IS DONE IN WET CONDITIONS, USE SUFFICIENT PROTECTION TO PREVENT DAMAGE TO EQUIPMENT OR POSSIBLE ELECTRICAL SHOCK TO THE OPERATOR.

(2) Procedure

CAUTION: DO NOT ATTEMPT TO REMOVE THE FOUR NUTS (PRE-SB 6030) WHICH RETAIN THE SPARK IGNITER PACKING HOLDER ON THE RIGHT SIDE OF THE ENGINE AS THE BOLTS ARE NOT RETAINED ON THE INNER SIDE OF THE FAN DUCT (SB 6030 CHANGES THE BOLTS AND NUTS TO A RIVET PIN AND COLLAR CONFIGURATION). USE THE CAP TYPE FRICTION PLATES AT BOTH IGNITER LOCATIONS (THESE ARE RETAINED WITH SET SCREWS).

(a) Remove igniter plugs per SUBJECT 74-20-02.

(b) Attach friction plate to igniter boss on combustion chamber and turbine fan duct.

NOTE: Inspection may begin at either right or left side of engine provided all combustion receive full inspection.

(c) Set up borescope equipment as follows:

CAUTION: DO NOT ATTACH SUPPORT ARM OR OTHER HOLDING DEVICES TO TUBES OR TO OTHER THIN WALLED OR HIGHLY FINISHED STRUCTURES. SELECT ATTACHING POINT ON ENGINE WHICH WILL WITHSTAND CLAMPING FORCE AS WELL AS BENDING LOADS DURING SUBSEQUENT BORESCOPE MANEUVERS.

1) Attach support arm to secure location on engine to provide convenient mounting point for articulation control block on guide tube. Use pressure ratio bleed control housing as attachment point when using engine right side igniter boss (No. 4 combustion chamber access). Use pressurizing and dump valve housing attachment point when using engine left side igniter boss (No. 7 combustion chamber access).

2) Secure articulation control block on guide tube to support arm and position block close enough to engine to permit maximum guide tube insertion into engine.

CAUTION: ENSURE THAT SHIELD ON TIP OF DIRECT-VIEWING BORESCOPE IS SECURELY THREADED IN PLACE. DO NOT LOOP OR COIL BORESCOPE IN TIGHT BENDS WHICH MIGHT DAMAGE FIBER OPTICS. SEE MANUFACTURER'S RECOMMENDATIONS FOR SAFE HANDLING. ENGINE INTERNAL TEMPERATURES IN EXCESS OF 149°F (65°C) MAY DAMAGE FIBER OPTIC BORESCOPE COMPONENTS. ENGINE INTERIOR MUST BE ALLOWED TO COOL BELOW 149°F (65°C) FOLLOWING ENGINE OPERATION PRIOR TO INSERTING BORESCOPE. ALLOW COOL-DOWN PERIOD ON NEWLY SHUT-DOWN ENGINE PRIOR TO INSPECTION TO ENSURE THAT PERSONNEL ARE NOT INJURED AND EQUIPMENT IS NOT DAMAGED.

3) Allow approximately two hours after engine shutdown before beginning borescope inspection when outside temperature is approximately 75°F (24°C); allow approximately two and a half hours if outside temperature is above 80°F (27°C), and allow approximately one hour if temperature is 30°F (-1°C) or lower. Rate of cool-down can be increased by motoring engine after shutdown with starter for 30 second periods.

WARNING: DO NOT ATTEMPT TO PERFORM HAND CHECK OF FAN DUCT TEMPERATURE SOONER THAN ONE HOUR AFTER SHUTDOWN (TIME INTERVAL MAY VARY IF STARTER MOTORING IS USED).

4) Alternate method of determining whether or not engine has cooled sufficiently for borescope inspection of combustion area consists of placing palm of bare hand on combustion chamber and turbine fan duct; when hand can be held comfortably against duct, engine is cool enough to permit inspection.

5) Fit borescope with direct-viewing tip.

6) Insert borescope into guide tube and position eyepiece unit above guide tube control block in comfortable viewing position. (Figure 620)

NOTE: To provide maximum maneuverability, both guide tube and borescope are articulated. Position articulation controls on guide tube block and on borescope eyepiece unit in comfortable and convenient position.

7) Connect borescope to light source and turn on light source.

(d) Rotate and position guide tube and borescope with respect to operator and to each other so that UP and DOWN articulation using guide tube and borescope control knobs produces motion in same plane rather than at angle to each other. If guide tube and/or borescope features four way articulation, determine which articulation knobs produce up and down motion.

(e) Arrange borescope eyepiece unit and guide tube control block so that control knobs of each unit are positioned approximately at right angles to each other.

NOTE: Positioning of control knobs as described above (for Olympus equipment) ensures that borescope and guide tube articulation will be in same plane.

(f) For Machida and Olympus systems, look into eyepiece reticle and locate triangular mark in borescope sight picture. Ensure that this mark is at 12 o'clock position so that it will be possible to establish orientation of plane of borescope tip articulation. Reticle locates plane of articulation; reticle position at 12 or 6 o'clock position indicates vertical tip articulation, and reticle at 3 or 9 o'clock position indicates horizontal tip articulation. For ACMI system, reticle is located 90 degrees from plane of articulation.

(g) Make note of relative location at borescope tip of light and optic openings; it will be advisable during inspection procedure to position optic side of borescope tip closer than light side to combustion chamber surfaces.

NOTE: With borescope in proper up and down orientation, tip viewing lens is at upper side of tip, in line with triangular mark in eyepiece view. See Figure 621.

(h) With borescope retracted and with all articulation controls in neutral (straight) position, insert guide tube and borescope through hole in friction plate. Ensure that borescope and guide tube will respond to UP and DOWN articulation in vertical plane; articulation in vertical plane is most desirable for beginning insertion into combustion chamber.

NOTE: Friction plate is fitted with rubber seal to hold guide tube in selected position. If guide tube binds or is difficult to insert, it is permissible to lubricate guide tube lightly with petrolatum.

(i) Check progress of borescope through eyepiece while inserting borescope and guide tube; borescope should protrude from guide tube sufficiently to permit full effectiveness of viewing tip and light beam.

(j) As soon as possible after entering combustion chamber, establish orientation of borescope inside chamber. If borescope is inserted through left-side igniter plug port (No. 7 combustion chamber), fuel nozzle should be seen at left, or 9 o'clock position. View through combustion chamber toward turbine vanes should be seen at right or 3 o'clock position. For right-side igniter plug port (No. 4 combustion chamber), this orientation should be reversed. Articulate guide tube tip to align borescope with combustion chamber liner crossover tube port.

(k) If next combustion chamber to be entered is above first (No. 4 or No. 7) combustion chamber, articulate guide tube upward, verifying movement through eyepiece. If next combustion chamber is below first, articulate guide tube downward. Use articulation and twisting of guide tube to line up borescope with crossover tube.

(l) Extend borescope from guide tube while checking view through eyepiece to ensure that borescope is passing through crossover tube into next combustion chamber.

(m) Feed guide tube into engine through friction plate, simultaneously retracting borescope to prevent borescope from being extended too far into next combustion chamber.

(n) Extend guide tube and borescope through as many combustion chambers as desired before beginning detailed inspection. Borescope may be inserted through as many as four combustion chambers and permit complete chamber inspection; up to this number, borescope will have sufficient length to extend rearward through combustion chamber to view entire interior of chamber, as well as fuel nozzle, inner and outer outlet ducts and 1st stage turbine vanes and blades.

NOTE: It is recommended that borescope and guide tube be extended through maximum of four combustion chambers, with inspection beginning at farthest combustion chamber liner. Borescope should be withdrawn to next combustion chamber in sequence as inspection progresses.

(o) See Figure 622 for typical inspection sequence. Borescope may be turned and directed rearward inside combustion chamber by twisting guide tube; when borescope and guide tube are turned so that they can be articulated to point rearward, extend borescope through guide tube and inspect features shown in Figure 623.

(p) Begin inspection of interior of combustion chamber at rear liner of chamber. Articulate guide tube and borescope so that view forward toward fuel nozzle is obtained. Scan interior of combustion chamber by gently twisting guide tube (close to friction plate) so that tip of borescope moves around inner circumference of chamber. (Figure 623)

NOTE: If difficulty is experienced obtaining full, 360 degree view of chamber interior, view those areas not covered by rotating borescope from rear as in Paragraph 19.B.(2)(q) by moving borescope axially forward and back through chamber interior.

(q) Look forward toward nozzle, scan all of the liners and louvers aft of the crossover tubes to determine whether liners have cracked axially or circumferentially. Also look for indication of liner burning and cracking distress forward of resistance weld joints. If distress is noted, inspect area more closely, viewing under louvers for cracking or weld separation. (Figure 623)

NOTE: Satisfactory view of area under louvers can be obtained by articulating borescope tip so that tip curves forward against combustion chamber wall with optic side (180 degrees away from light side) toward chamber wall. (Figure 623) If light side of tip is closer to chamber wall, full view of louver will not be possible. If this occurs, articulate borescope tip in opposite direction, pull borescope holder toward operator until there is no slack in borescope between guide tube block and borescope holder, then carefully rotate entire borescope handle in holder 180 degrees repositioning tip of borescope with optic side toward combustion chamber wall.

(r) Look for axial cracking rearward and approximately in line with female crossover tube in liners 4 through 11. This is the main area of concern. If axial cracking is present, determine whether it extends from one liner to next by looking under louver lip in line with axial crack. Axial cracking may also occur in the same liners downstream of the crossover tube.

(s) Look for burning in lip of louver directly behind male and female crossover tubes. If burning is present, look for associated cracking in the liner and adjacent seam weld.

(t) Look for missing or burned material forming holes in area where axial cracking is noted. Covering axial cracks should be inspected carefully for material breakout. Louver areas forward and aft of adjacent axial cracks should be inspected for circumferential cracking. Adjoining axial and circumferential cracks can also cause material breakout.

(u) As borescope is pulled forward through combustion chamber, manipulate tip by twisting guide tube and by using articulation controls of both borescope and guide tube as necessary to view louver area where required.

(v) Ensure that louver area can be viewed through borescope all the way forward to attaching weld. If liner distortion has caused bending of inner liner outward toward outer liner so that weld cannot be seen, weld joint must be assumed to be cracked for circumferential length over which weld cannot be seen (Figure 623 (Sheet 2)).

NOTE: Inner liner lip distortion could be a result of reduction in cooling air flow or other distress in seam weld or cooling air hole area.

(w) When viewing area under louver and inspecting weld joint area, take into account that outer liner surface between weld and cooling air holes where cracks could appear will be viewed at very shallow angle. Cracking in this area may possibly appear as shiny but rough raised surface (broken edge of liner surface cracked completely through). See Figure 623 for location of liner features and depiction of liner damage as seen through borescope.

NOTE: Inspector should be alert to need for recognizing crack damage on surfaces viewed at shallow angle. Crack viewed at right angle to surface will appear as hairline or wider separation with space visible between edges but crack viewed at shallow angle in louver area will be visible as displaced surface.

(x) When inspection has proceeded as far forward as crossover tube area, inspect as follows:

1) Point borescope and guide tube radially inward toward center of combustion chamber and scan combustion chamber liner surface between crossover tubes for cracks or damage.

2) Inspect for evidence of combustion chamber shift:

a) Turn borescope toward fuel nozzle and check for excessive space between fuel and combustion chamber nozzle stator.

b) Extend borescope part way through crossover tube (preferably through female tube, looking toward male tube) and check for tube eccentricity (male tube farther to rear than female, or the opposite).

c) When checking concentricity between male and female tubes, be careful to distinguish between crossover tube and interconnector. Interconnector may be positioned closer to one tube than another at assembly and is not indicator of combustion chamber shift. (Figure 623)

(y) Prior to withdrawing borescope and guide tube from combustion chamber and proceeding to next combustion chamber, make thorough inspection of area surrounding crossover tube borescope is passing through, as follows:

1) Articulate guide tube and borescope 180 degrees around as far as possible into U-shape and inspect crossover tube base all around by twisting guide tube. See Figure 622, Sequence 4.

2) If difficulty is experienced obtaining full inspection of crossover tube area using technique in Paragraph 19.B.(2)(y)1), extend guide tube several inches (50 mm) into combustion chamber, then carefully withdraw borescope from guide tube (set articulation controls for borescope and guide tube in straight-ahead position before withdrawing borescope). Install 90 degree side-viewing tip on borescope, being careful to align installation marks on tip and borescope sleeve. Reinsert borescope through guide tube and articulate borescope only, to view directly back at crossover tube area through which borescope has passed. Pull borescope holder toward operator to remove all slack from borescope between guide tube block and borescope holder, then carefully rotate entire borescope handle in holder to obtain view of area around crossover tube.

3) When inspection of crossover tube is complete, withdraw borescope and replace side-viewing tip with direct-viewing tip, then reinsert borescope. Withdraw guide tube and borescope into next combustion chamber.

4) When view through eyepiece confirms that borescope is fully in next combustion chamber, proceed to inspect that combustion chamber in same fashion, extending borescope to rear of chamber and working forward, finishing with thorough inspection of crossover tubes where they join with combustion chamber liner.

(z) When inspection has been completed, remove borescope and guide tube from engine. Remove friction plate from ignition boss on combustion chamber and turbine fan duct.

(aa) Install igniter plugs per SUBJECT 74-20-02.

C. Combustion Chamber External Borescope Inspection

(1) General

(a) This inspection procedure finds damage or distress to external surface of combustion chambers with flexible fiber-optic borescope. It is possible (with equipment specified in this procedure) to make an inspection of part (but not all) of the external surfaces of combustion chambers.

(2) Equipment

(a) 5.5 - 7 mm diameter flexible borescope with minimum length of 1.5 meters and minimum of two-way articulation.

(b) PWA 104182 Guide Tube

(3) Engine/Equipment Preparation

(a) This inspection procedure is designed to detect damage or distress to combustion chambers and surrounding structures by means of flexible fiber-optic borescope. Using equipment specified in this procedure, it is possible to make thorough examination of internal surfaces of each combustion chamber. In addition, adjacent structures such as fuel nozzles, inner and outer outlet ducts, and 1st stage turbine vanes and blades may be viewed and inspected.

(b) Inspection personnel performing borescope inspection of combustion chamber liners must have completed borescope training according to one of the following:

1) Inspector must have completed prescribed JT8D combustion chamber liner borescope training at Pratt & Whitney Customer Training Center and must have completed training in inspection of two sets of combustion chamber installed in engines at operator or overhaul agency facility before beginning service inspections of operational engines.

OR

2) Inspector must have completed Pratt & Whitney approved training session conducted by instructor trained at Pratt & Whitney Customer Training Center and must have completed training in inspection of two sets of combustion chambers installed in engines at operator or overhaul agency facility before beginning service inspections of operational engines.

(c) This procedure depicts the use of the following equipment:

NOTE: Equipment listed below is available as kit from Olympus Corporation IFD, 4 Nevada Drive, Lake Success, NY 11042-1179. Kit including light source is Model No. OCK-JT8D-C1 (Catalog No. 1227D). Kit without light source but with adapter allowing connection to Wolf or ACMI high-intensity light source is Model No. OCK-JT8D-C2 (Catalog No. 1227E).

1) Flexible Fiberscope Model IF6D3-20, 6mm diameter by 2 meter length.

   NOTE: Side-viewing (90-degree) borescope tip, Model IF6D3-A65S is available if required and is recommended for accomplishing complete inspection of combustion chamber crossover tube areas.

2) ILV 300 watt xenon light source.

3) Articulating support arm.

4) GT-JT8D Articulating Guide Tube, 11 mm diameter by approximately 50 inch (1270 mm) length.

5) Friction plate or cup (to be attached to external fan duct ignition boss, with central hole permitting close, stabilizing fit around guide tube during borescope maneuvers).

(d) Alternate Olympus Kit is Kit No. MOD OCK-JT8D-C1/4 consisting of the following. Kit No. MOD OCK-JT8D-C2/4 contains items Paragraph 19.C.(3)(d)1) through Paragraph 19.C.(3)(d)3) but does not include light source.

1) Flexible Fiberscope Model IF8D3X2-20, 8 mm diameter by 2 meter length.

2) FT-JT8D/8x4 Articulating Guide Tube with four-way articulation and including friction plate with integral support arm mounting boss.

3) Articulating support arm.

4) Model KLS-2250 High Intensity Light Source (250 watt with improved focus feature).

   NOTE: Adapters for adapting Olympus flexible fiberscope to other light sources are available on request from Olympus Corporation.

(e) Also available is similar kit from American ACMI, P.O. Box 1971, Stamford, CT 06904, U.S.A. Kit with 110V high intensity light source is Kit No. BK-JT8D-1; kit with 220V high intensity light source is Kit No. BK-JT8D-1A; kit with borescope, guide tube, friction plate and support arm but without light source is Kit No. BK-JT8D-2.

1) Flexible Borescope BFM-2270DDX

2) FGT-JT8D Four-way Flexible Guide Tube

3) SA-1 Support Arm

4) FCB-1020S (FCB-102A if 220V) High Intensity Light Source

5) Friction Plate (to be attached to external fan duct ignition boss, with central hole permitting close, stabilizing fit around guide tube during borescope maneuvers).

(f) Also available is similar kit from Machida (Machida America, 40 Ramland Road, Orangeburg, NY 10962 U.S.A.). Kit with borescope, guide tube, accessories and support arm is Kit No. MJ072000MA from Machida America; Kit with borescope, guide tube, accessories and extension arm with separate clamps for PRBC and P&D valve is Kit No. MJ072000 from Machida Japan. RG-400 high intensity light source must be ordered separately. Kit details are as follows:

1) Flexible Borescope FB7-2000A

2) GT12-1500 Guide Tube

3) SAH-1000MA Accessory Kit (FD-8D, FP-8D-200 Friction Plates, SH-8D Scope Holder)

4) MA0030 Support Arm and Clamp (Machida America Kit)

5) EA-8D Extension Arm (Machida Japan Kit)

6) CP-8D-PC PRBC Clamp (Machida Japan Kit)

7) CP-8D-DV P&D Valve Clamp (Machida Japan Kit)

NOTE: Borescope equipment other than that specified may be substituted provided no loss of effectiveness results. Operators wishing to use alternate Olympus, ACMI, or Machida products or products of other Manufacturers should request approval from the Technical Support Department, Pratt & Whitney Division of United Technologies Corporation, East Hartford, CT 06108, U.S.A.

(g) Alternate Machida Kit is Borescope Set MA11180W, consisting of 11 mm borescope with two planes of articulation on borescope sheath, allowing maneuvering of borescope without guide. Also featured is simultaneous straight ahead and 90 degree viewing. Light source RG-400 is available separately. Kit details are as follows:

1) Flexible Borescope FBA-11-180W

2) SAH-1100 Accessory Kit (MA0030 Support Arm and Clamp, MA0040 Borescope Holder, FP-8D-200 Friction Plates)

(h) An alternative source is the Welch Allyn Video Probe 2000 System. This equipment has a flexible borescope (Flying Probe, P/N VS2155) which uses air pressure from the distal tip to move the probe through the engine. A friction plate and support arm at the outside of the engine are not necessary with this system. Send for information to:

Welch Allyn
Inspection Systems Division
4619 Jordan Road
P. O. Box 100
Skaneateles Falls, NY 13153-0100

Welch Allyn Gmbh
Taunusstrasse 12
6238 Wallau, Germany

Welch Allyn (H.K.) Inc.
7/F Kam Ping Building
95 Kings Road
North Point, Hong Kong

(4) Records of Results

(a) Make record of inspection findings by plotting indications and observed damage of each individual combustion chamber on individual copies of worksheet shown in Figure 618. Note that dimensions of internal features of combustion chamber are presented to aid in accurately estimating crack length and size and relative shape of damaged area. See Figure 619 for definition of internal and external features of combustion chamber.

NOTE: It is recommended that sample combustion chamber or photos of good quality be available to inspector when engine is being borescope inspected. Spare chamber or photos will assist in identifying exact position of distress, should it be present.

(b) Retain copy of individual combustion chamber liner inspection plots to aid in detecting progression of existing cracks or damage, or in evaluating appearance of new cracks or damage when feature inspection is accomplished.

(c) Compare plotted inspection findings to limits in SB 5741 to determine serviceability of combustion chambers.

WARNING: DO BORESCOPE INSPECTION IN AN AREA WHICH HAS PROTECTION FROM THE WEATHER. IF A BORESCOPE INSPECTION IS DONE IN WET CONDITIONS, USE SUFFICIENT PROTECTION TO PREVENT DAMAGE TO EQUIPMENT OR POSSIBLE ELECTRICAL SHOCK TO THE OPERATOR.

(5) Procedure (Figure 624)

CAUTION: DO NOT ATTEMPT TO REMOVE THE FOUR NUTS (PRE-SB 6030) WHICH RETAIN THE SPARK IGNITER PACKING HOLDER ON THE RIGHT SIDE OF THE ENGINE AS THE BOLTS ARE NOT RETAINED ON THE INNER SIDE OF THE FAN DUCT (SB 6030 CHANGES THE BOLTS AND NUTS TO A RIVET PIN AND COLLAR CONFIGURATION). USE THE CAP TYPE FRICTION PLATES AT BOTH IGNITER LOCATIONS (THESE ARE RETAINED WITH SET SCREWS).

(a) Remove igniter plugs per SUBJECT 74-20-02.

(b) Attach friction plate to igniter boss on combustion chamber and turbine fan duct.

(c) Push straightening rod detail into PWA 104182 Guide Tube to make guide tube straight.

NOTE: PWA 104182 Guide Tube has a manufactured curve at its inner end. A straightening rod detail is supplied, but do not keep the rod in the tube during storage (this will cause the tube to have an incorrect contour). Keep the rod in the slot supplied during tool storage.

(d) At left igniter boss on fan case (No. 7 combustion chamber position), start to push guide tube and rod through fan ducts and into combustion chamber outer case igniter plug boss.

(e) When guide tube is at inner edge of igniter plug boss (before it hits combustion chamber igniter plug swivel), start to pull rod out of guide tube (this will let guide tube bend upward between combustion chamber outer case inner wall and combustion chamber). (Figure 624 (Sheet 1))

NOTE: Look at the direction indicator on the base of the guide tube to be sure that it points the inner end in the up direction.

(f) Pull rod end out of guide tube.

1) Install flexible borescope tube in guide tube until it is at end of guide tube.

(g) Push flexible borescope up until it is at No. 1 combustion chamber. (Figure 624 (Sheet 3)) Sequence 1.

NOTE: For the best inspection results, it is recommended that the borescope be kept at the No. 2 and 3 liner position while it is moved up to combustion chamber No. 1.

(h) Start at combustion chamber No. 1 and do an inspection as follows:

1) Do full inspection of the outer diameter of all liners. Make sure that a detailed inspection is done of the seam that attaches each liner to the combustion chamber. See (Figure 624 (Sheet 2)) for a typical location.

NOTE: It will be necessary to push and retract the borescope to see the outer diameter of the liners. It can be necessary to adjust the guide tube from the up position to an aft position to point the flexible borescope correctly.

The outer diameter of the liners is a reference to the part of the combustion chamber from the male crossover tube to the female crossover tube adjacent to the combustion chamber outer case.

2) When inspection of surface of combustion chamber at No. 1 position is completed, pull borescope slowly back to initial inspection position on chamber.

(i) Do same inspection procedure on chambers at position 9, 8, and 7.

(j) When inspection of No. 7 combustion chamber is complete, push borescope between chambers No. 7 and 8 and push borescope up between chambers and combustion chamber inner case until it is possible to see inner surface of chamber at No. 1 position. (Figure 624 (Sheet 3)) Sequence 2.

NOTE: It will be necessary to push and retract the borescope to see the outer diameter of the No. 2 and 3 liners.

The inner surface of the liners is a reference to the part of the combustion chamber from the male crossover tube to the female crossover tube adjacent to the combustion chamber outer case.

(k) Turn borescope and articulate tip when necessary to do full inspection of No. 3 liner.

1) Make sure that inspection includes seam between No. 2 and 3 liners.

(l) When inspection of No. 1 chamber is completed, pull borescope back slowly until inner surface of No. 9 chamber is seen.

(m) Do same inspection procedures on chambers at position No. 9, 8, and 7.

(n) When inspection of No. 7 combustion chamber is completed, pull borescope back to outer case igniter plug port and turn guide tube until indicator points down.

1) Push borescope between outer case and chambers until borescope is at No. 4 chamber. (Figure 624 (Sheet 3)) Sequence 3.

(o) Do a full inspection of outer diameter of all liners for the No. 4 combustion chamber. Push and retract the borescope when necessary to see all of the outer diameter of the liners. Turn the borescope and articulate the tip when necessary to do a full inspection of this area. Make sure that this detailed inspection is done on the seam between each liner of the combustion chamber.

NOTE: It can be necessary to adjust the guide tube from the down to the aft position to make sure that the borescope is in the correct position.

The outer diameter of the liners is a reference to the part of the combustion chamber from the male crossover tube to the female crossover tube adjacent to the combustion chamber outer case.

(p) When inspection of outer surface of No. 4 chamber is complete, pull borescope back slowly to initial position on chamber.

(q) Make sure that indicator on guide tube points down and pull back borescope until No. 5 chamber is seen.

1) Do same inspection procedure on chambers No. 5 and 6.

(r) When inspection of No. 6 combustion chamber is completed, push borescope between chambers No. 6 and 7 and push borescope up between chambers and combustion chamber inner case until it is possible to see inner surface of chamber at No. 4 position. (Figure 624 (Sheet 3)) Sequence 4.

NOTE: It will be necessary to push and retract the borescope to see the outer diameter of the No. 2 and 3 liners.

The inner surface of the liners is a reference to the part of the combustion chamber from the male crossover tube to the female crossover tube adjacent to the combustion chamber outer case.

(s) Turn borescope and articulate tip when necessary to do full inspection of No. 3 liner.

  1) Make sure that inspection includes seam between No. 2 and 3 liners.

(t) When inspection of No. 4 chamber is completed, pull borescope back slowly until inner surface of No.5 chamber is seen.

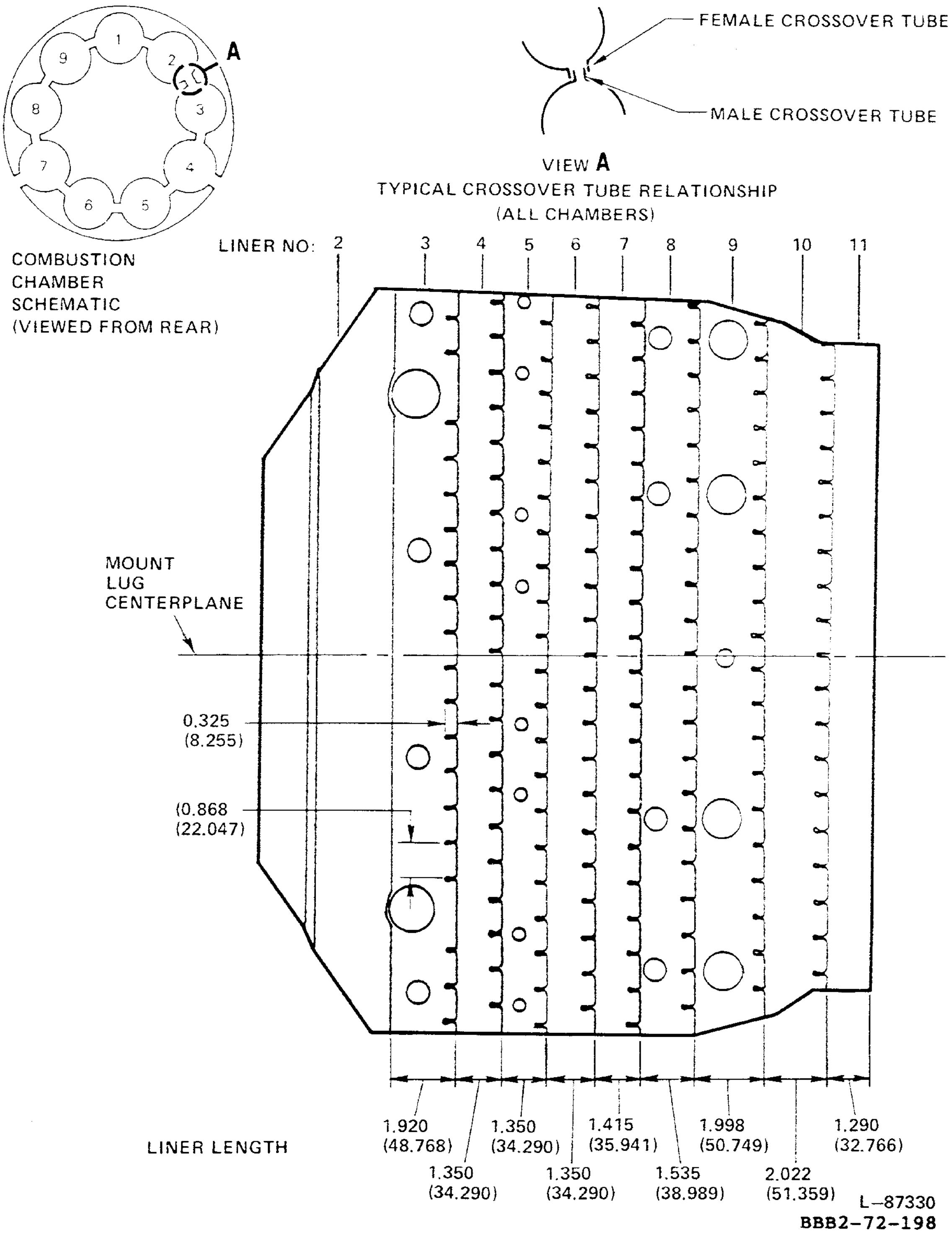
(u) Do same inspection procedure on inner surfaces of No. 5 and 6 chambers.

(v) When above inspection is completed, remove borescope and guide tube and install equipment at right-side igniter port.

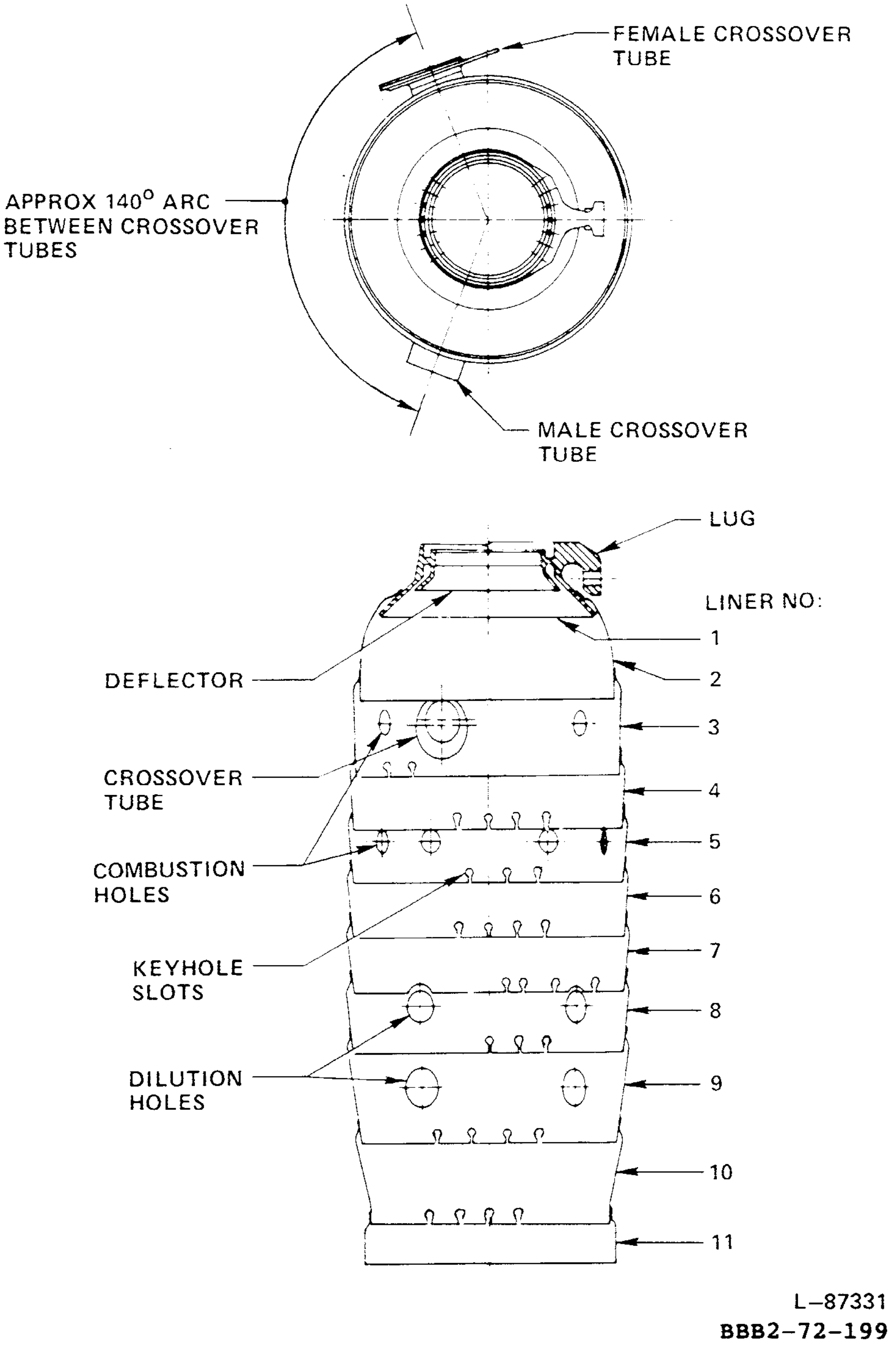
(w) Use access at No. 4 chamber position to do an inspection of the remaining No. 2 and 3 chambers. (Figure 624 (Sheet 4)) Sequence 5.

(x) When inspection has been completed, remove borescope and guide tube from engine. Remove friction plate from ignition boss on combustion chamber and turbine fan duct.

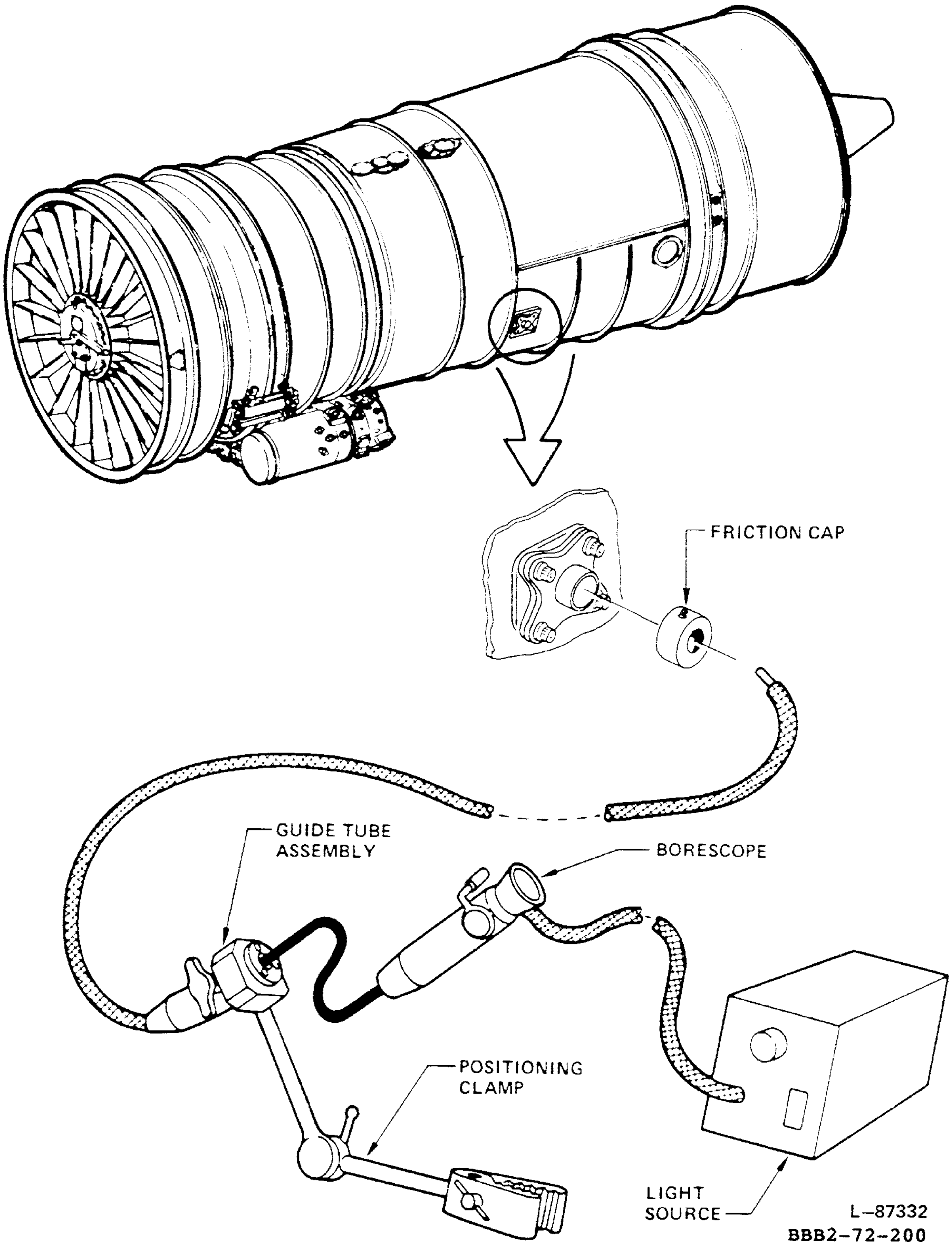
(y) Install igniter plugs per SUBJECT 74-20-02.



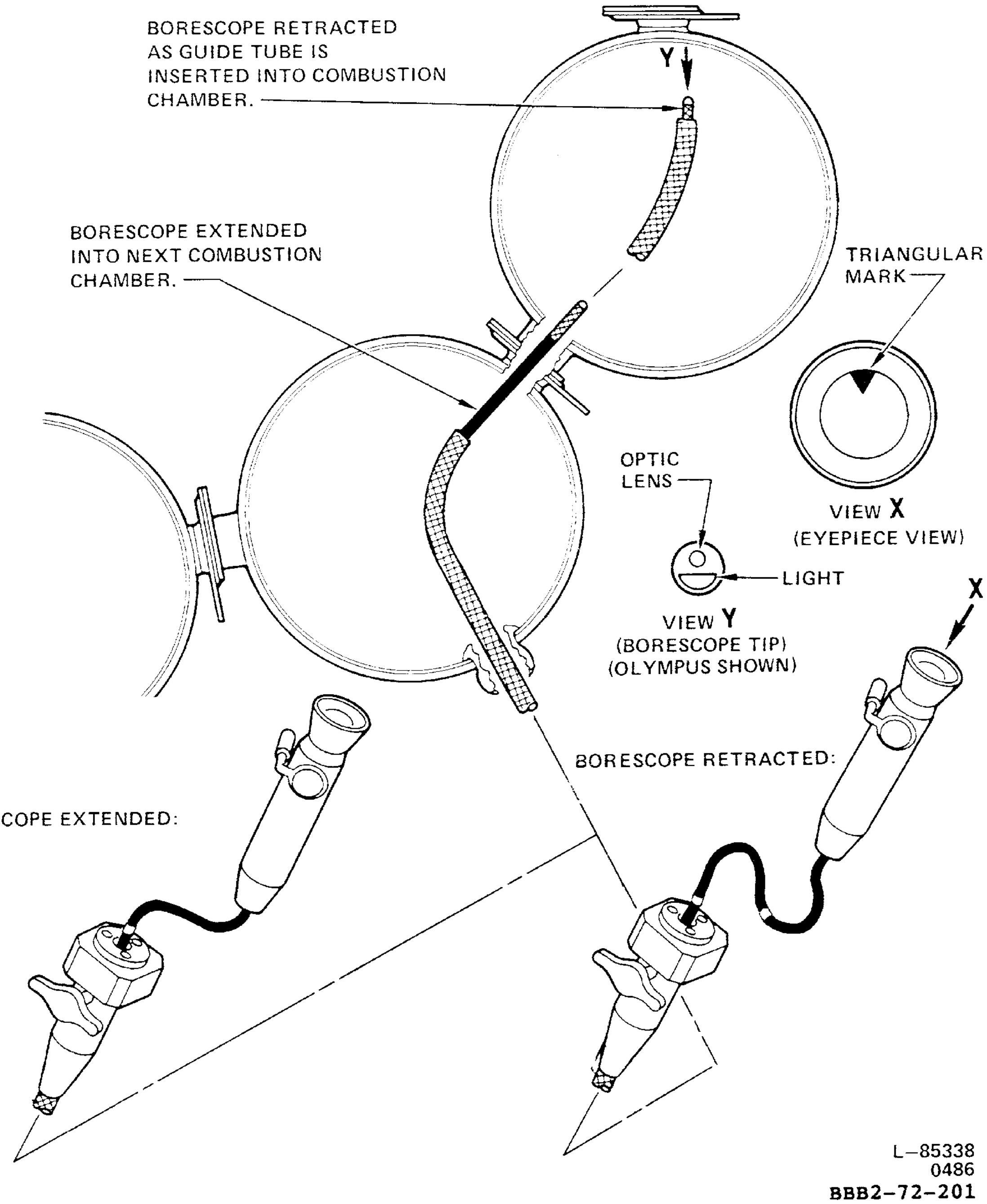
Combustion Chamber Borescope Inspection (Unwrapped Internal View)
Figure 618/72-00-00-990-A06



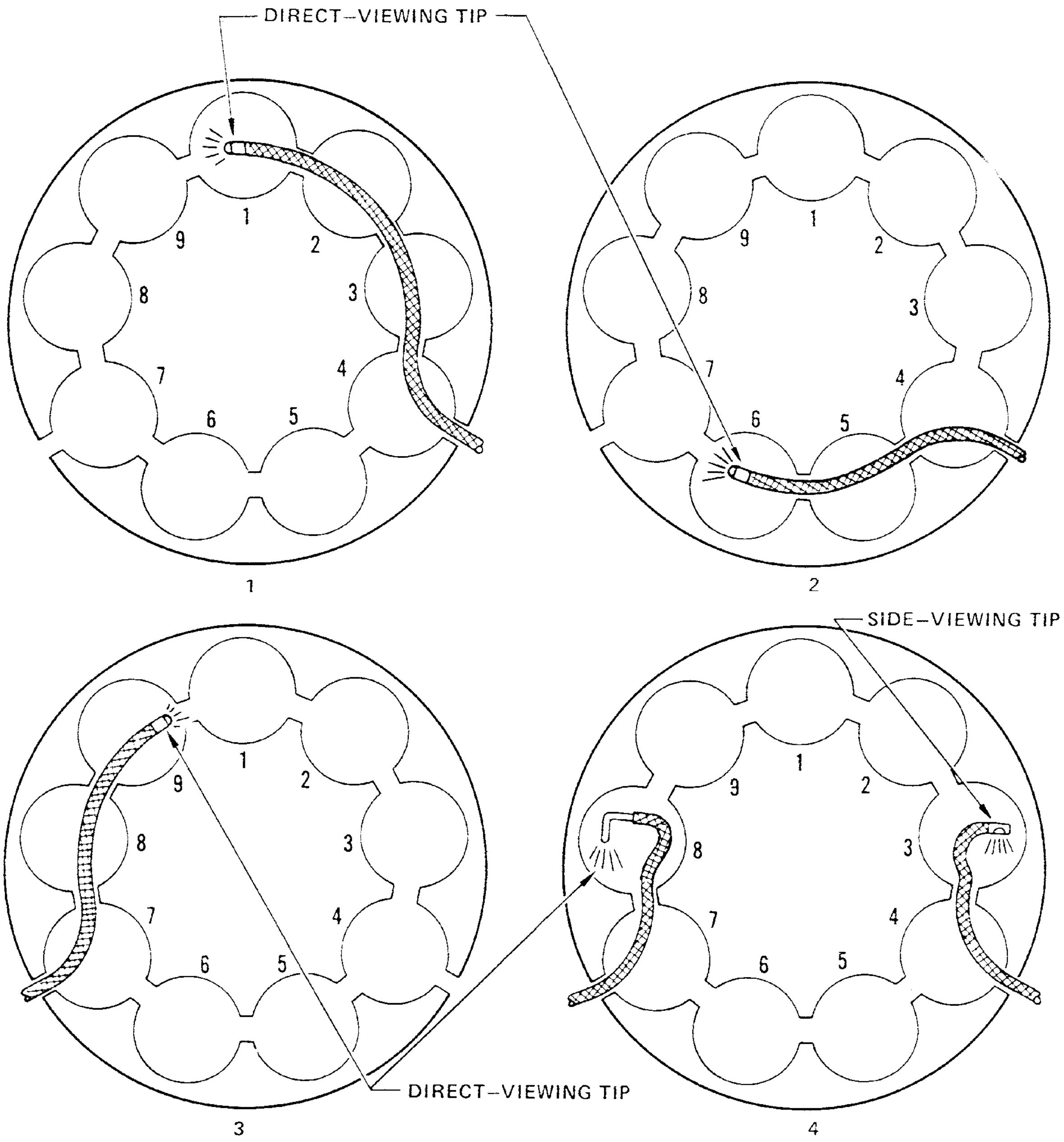
Combustion Chamber Borescope Inspection Feature Identification
Figure 619/72-00-00-990-A07



Combustion Chamber Borescope Inspection
Figure 620/72-00-00-990-A08



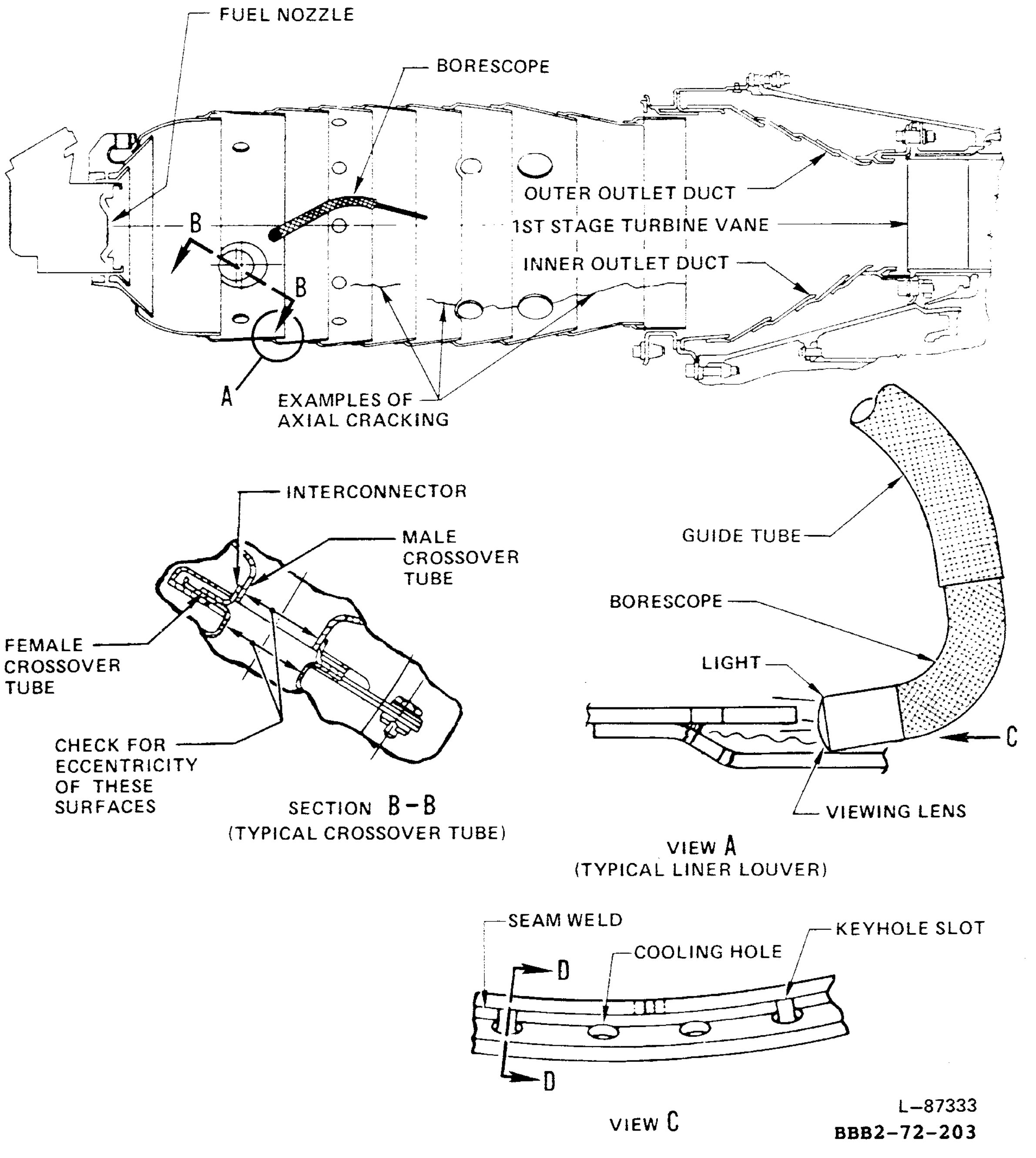
Combustion Chamber Borescope Inspection
Figure 621/72-00-00-990-A09



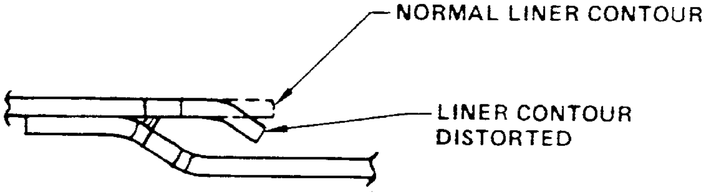
SUGGESTED BORESCOPE INSPECTION SEQUENCE
(AS VIEWED FROM REAR OF ENGINE)

L-85339
1185
BBB2-72-202

Combustion Chamber Borescope Inspection
Figure 622/72-00-00-990-A10

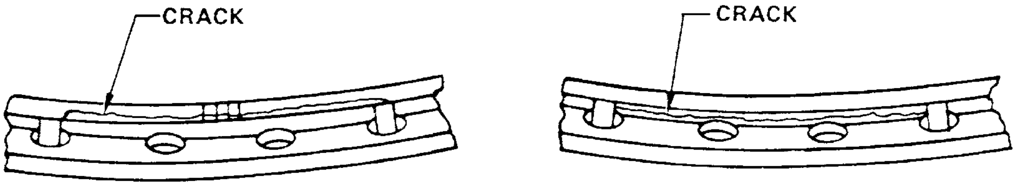


Combustion Chamber Borescope Inspection
Figure 623/72-00-00-990-A11 (Sheet 1 of 2)



SECTION D—D
(SHOWING INNER LINER DISTORTION WHICH WOULD PREVENT SEAM WELD INSPECTION)

SECTION D—D
(SHOWING OUTER LINER CRACK)

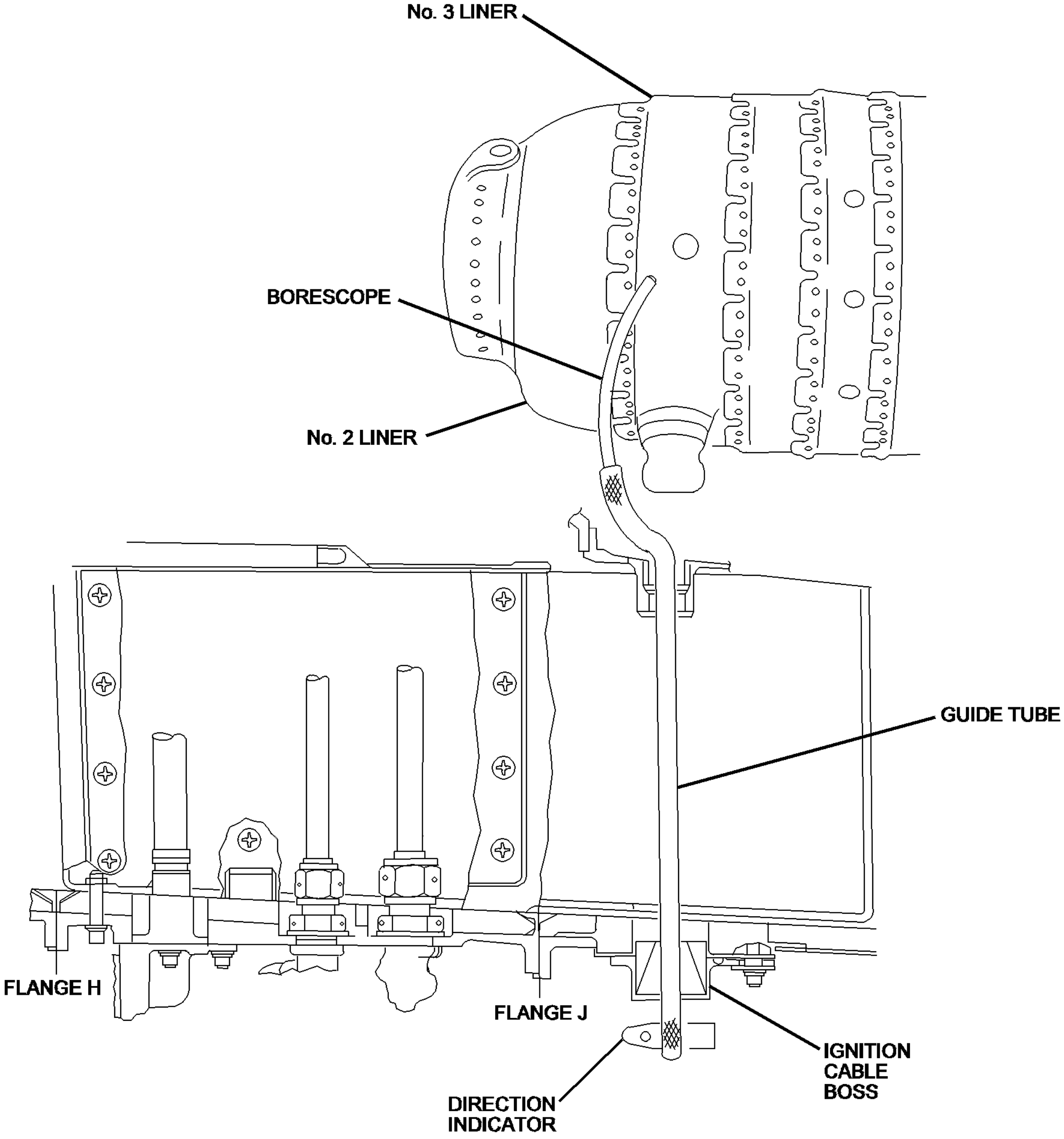


VIEW E
(CRACKED SEAM WELD)

VIEW E
(OUTER LINER CRACKED FORWARD OF COOLING HOLES)

L—86246
BBB2—72—204

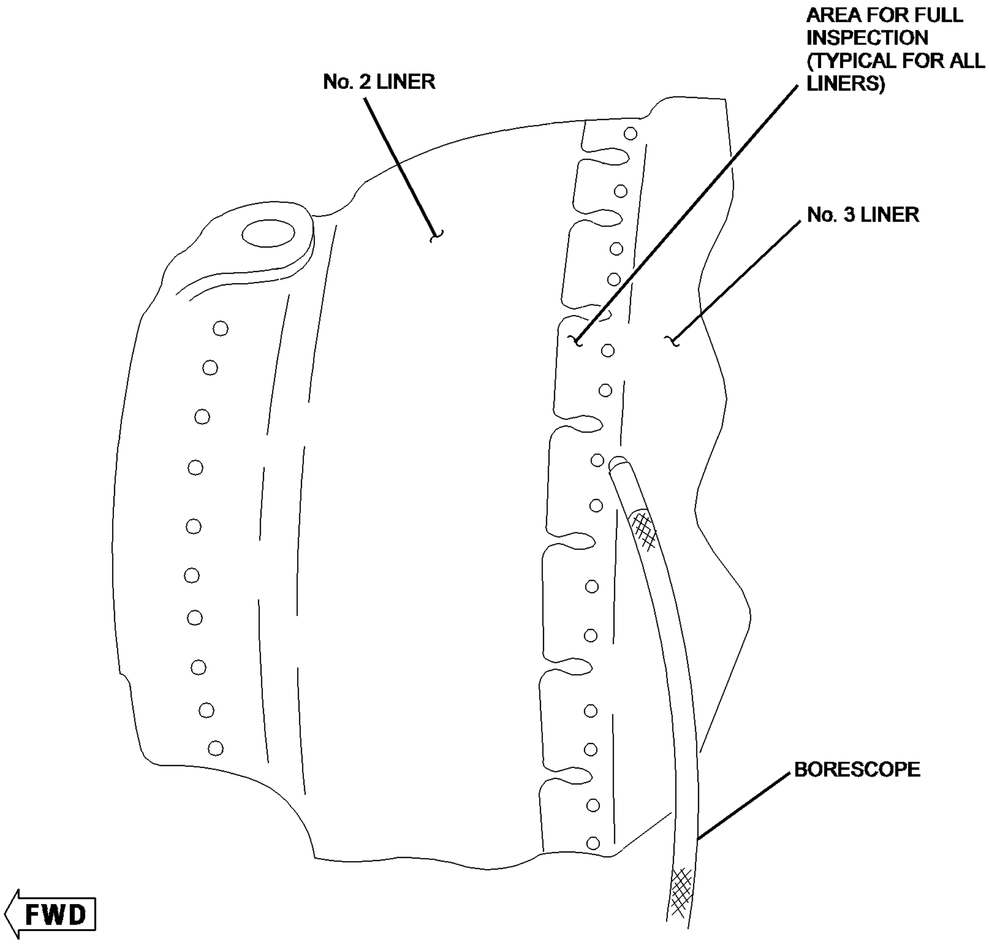
Combustion Chamber Borescope Inspection
Figure 623/72-00-00-990-A11 (Sheet 2 of 2)



CROSS SECTION THROUGH FAN DUCTS
(LEFT-HAND IGNITER POSITION)

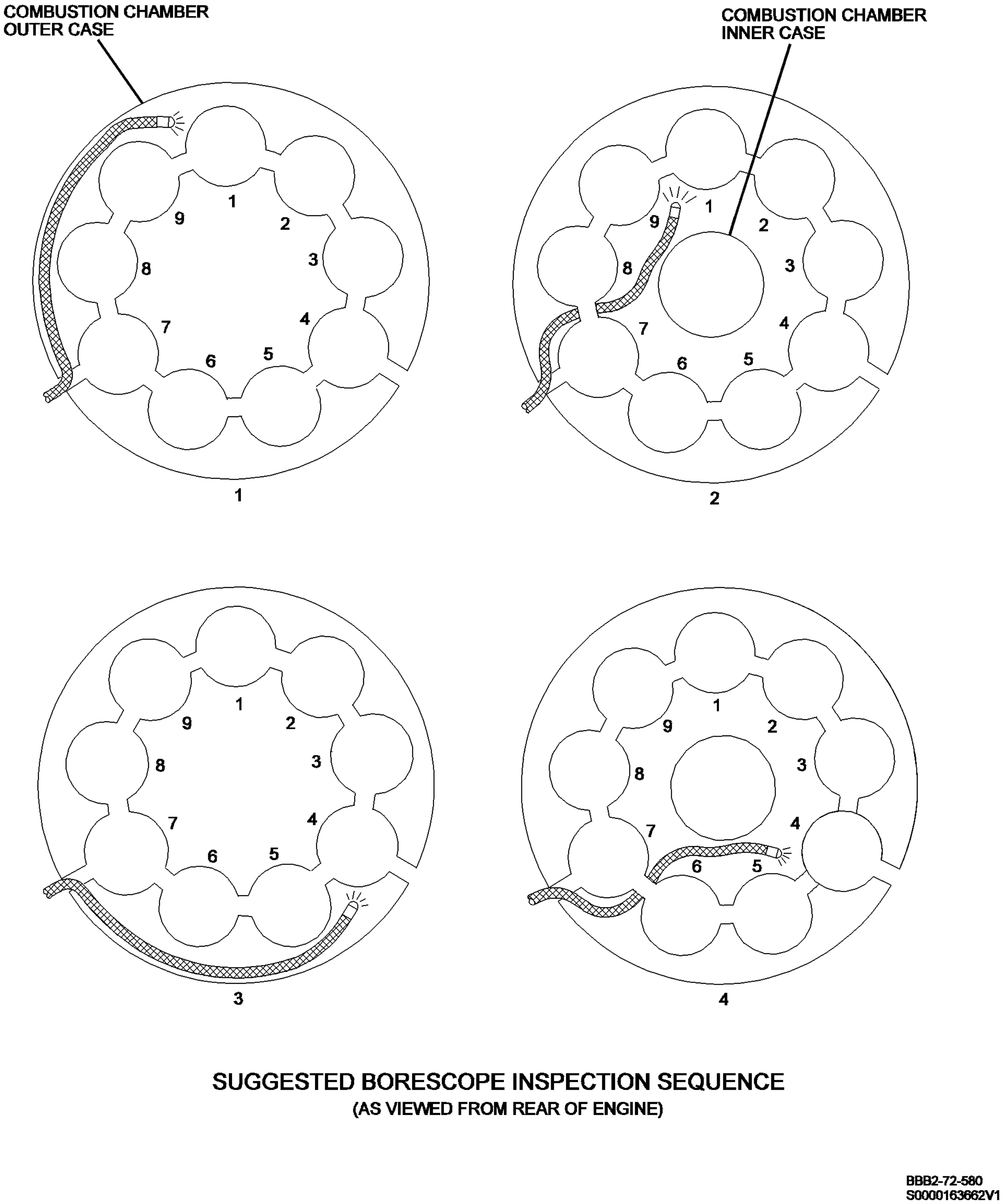
BBB2-72-578
S0000163654V1

Combustion Chamber Outer Surface
Figure 624/72-00-00-990-C33 (Sheet 1 of 4)

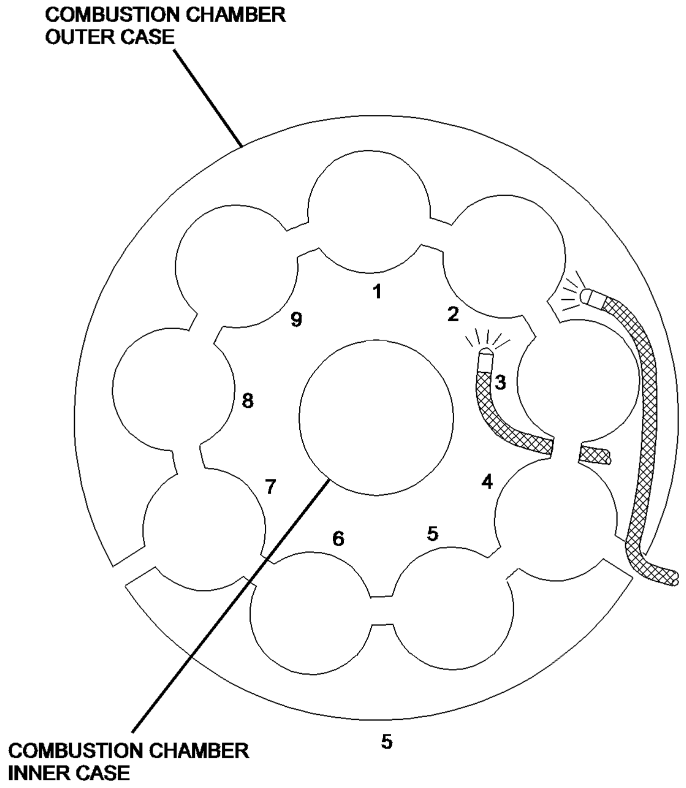


BBB2-72-579A
S0000163657V2

Combustion Chamber Outer Surface
Figure 624/72-00-00-990-C33 (Sheet 2 of 4)



Combustion Chamber Outer Surface
Figure 624/72-00-00-990-C33 (Sheet 3 of 4)



SUGGESTED BORESCOPE INSPECTION SEQUENCE
(AS VIEWED FROM REAR OF ENGINE)

BBB2-72-581
S0000163663V1

Combustion Chamber Outer Surface
Figure 624/72-00-00-990-C33 (Sheet 4 of 4)

20. Inspect Combustion Chambers (Radiographic Isotope Method)

A. Equipment And Materials Required

(1) Support Equipment

PWA 45009 Puller

PWA 46275 Support Guide Tube

PWA 46303 Film Holder Paddle (10 Required) (Paddle Method)

PWA 46304 Support (Paddle Method)

PWA 47252 Support Plate

(2) Consumables - None

B. Radiographic Isotope Inspection (Roll Film Method)

(1) General

(a) This inspection procedure is designed to detect distress to combustion chambers using radiographs produced by radiation source placed inside front compressor drive turbine shaft.

NOTE: Isotope equipment and technique other than those specified may be substituted provided no loss of effectiveness results. Operators wishing to use alternate procedures should request approval from Customer Support Department, Pratt & Whitney Division of United Technologies Corporation, East Hartford, CT 06108, U.S.A.

(2) Equipment Required

(a) Iridium 192 radiation source in Amershan Technical Operations, Inc. Model 660 Gamma Ray Projector with Model 664 Gamma Ray Control Assembly, or equivalent.

(b) Rigid source positioning rod, Amershan Technical Operations, Inc. P/N 72701, or equivalent.

(c) Flexible source tubes, Amershan Technical Operations, Inc. P/N 48907, or equivalent.

(d) PWA 47252 Support Plate, for centralizing rigid source positioning rod.

(e) PWA 46275 Support Guide Tube, for supporting and centralizing rigid source positioning rod.

(f) Film insertion poles. Locally manufactured, two required.

(g) Film, Dupont Type 55 day pack, 14 inches x 17 inches (355.6 mm x 431.8 mm) (Catalog No. 527556), or equivalent, eight required.

(3) Engine Preparation

(a) Remove front accessory drive group per PAGEBLOCK 72-21-00/401.

(b) Remove front accessory gearshaft retaining ring and remove gearshaft using PWA 45009 Puller.

(c) Remove the access plates from each side on the rear portion of the rear portion of the lower-split fan duct.

(4) Inspection Procedure

(a) Prepare film. (Figure 625) (Figure 626)

1) Tape films together and make necessary cutouts and seams as indicated.

2) Place lead identification numerals on the forward portions of films as necessary to identify combustion chambers.

3) Roll film onto insertion pole to a diameter which may be easily inserted through mixer and fan bypass duct.

(b) Install isotope equipment. (Figure 627) (Figure 628)(Figure 629)

1) Assemble PWA 47252 Support Plate and PWA 46275 Support Guide Tube to rigid source positioning rod and insert into engine central cavity. PWA 46275 Support Guide Tube will slide through turbine shaft coupling lock. Position PWA 47252 Support Place on No. 1 bearing front support so that wing nut bolts can be inserted at 10 o'clock and 4 o'clock positions. Finger tighten bolts.

2) Position and lock rigid source positioning rod so that centerline of source will be 90 3/4 inch (2305.05 mm) from aft face of PWA 47252 Support Plate.

(c) Place film in position. (Figure 630) (Figure 631)

CAUTION: ENSURE THRUST REVERSER IS INOPERABLE BEFORE ENTERING EXHAUST DUCT TO INSTALL FILM.

1) Insert rolled film through fan duct at 1 o'clock position to location just aft of fan discharge fairings.

2) Unroll film. Use remaining insertion pole inserted at 11 o'clock position to assist film placement around left side of engine to 6 o'clock position.

3) Continue unrolling film and guide film as necessary, around right side of engine.

4) Using insertion poles and reaching through outer fan split duct access panels, position film so that cutouts match corresponding engine features.

5) Tape edges of film together at 6 o'clock location.

(d) Expose films.

WARNING: EXERCISE ALL POSSIBLE SAFETY PRECAUTIONS APPROPRIATE TO HANDLING OF RADIOACTIVE MATERIAL.

1) Introduce source into rigid source positioning rod until it bottoms out.

2) Expose film for 300 curie minutes (plus or minus), to produce density between 2.0 - 3.5. Preferred range is 2.5 - 2.8 liner density.

(e) Remove isotope equipment.

(f) Remove film.

(g) Reassemble removed engine hardware and restore thrust reverser to operational condition.

Key To Figure 628	
1.	5/16 Inch (7.937 mm)
2.	1/8 Inch (3.175 mm)
3.	90 3/4 Inch (2305.050 mm)

(h) Develop film in automatic processor.

(i) Analyze film in dimly lit room using high (variable) intensity film reader.

NOTE: Cracks observed extending into areas not clearly defined on radiograph are assumed to extend through the area.

When determining lengths of cracks which intersect dilution holes, hole diameter must be added.

Broken eleventh liners manifest themselves on radiograph by indication of "metal overlap" or by 3 times normal 10th liner axial crack width.

(j) Record observed chamber distress on data sheet. (Figure 632)

(5) See SB 5741 for combustion chamber rejection criteria.

C. Radiographic Isotope Inspection (Paddle Film Method)

(1) General

(a) This inspection procedure is designed to detect distress to combustion chambers using radiographs produced by a radiation source place inside the front compressor drive turbine shaft.

NOTE: Isotope equipment and technique other than those specified may be substituted provided no loss of effectiveness results. Operators wishing to use alternate procedures should request approval from Customer Support Department, Pratt & Whitney Division of United Technologies Corporation, East Hartford, CT 06108, U.S.A.

(2) Equipment Required

(a) Iridium 192 radiation source in Amershan Technical Operations, Inc. Model 660 Gamma Ray Projector with Model 664 Gamma Ray Control Assembly, or equivalent.

(b) Rigid source positioning rod, Amershan Technical Operations, Inc. P/N 72701, or equivalent.

(c) Flexible source tubes, Amershan Technical Operations, Inc. P/N 48907, or equivalent.

(d) PWA 47252 Support Plate, for centralizing rigid source positioning rod.

(e) PWA 46275 Support Guide Tube, for supporting and centralizing rigid source positioning rod.

(f) PWA 46275 Film Holder Paddles, 10 paddles required.

(g) Film, Kodak Type M or equivalent, 7 inches x 17 inches (177.8 mm x 431.8 mm), with 0.010 inch (0.0254 mm) lead screens on both sides, 10 required.

(h) PWA 46304 Support for assisting in positioning of paddles.

(3) Engine Preparation

(a) Remove front accessory drive group per PAGEBLOCK 72-21-00/401.

(b) Remove front accessory gearshaft retaining ring and remove gearshaft using PWA 45009 Puller.

(4) Inspection Procedure

(a) Prepare film. (Figure 633)

1) Insert film into cassettes and mount cassettes onto paddles, ensuring that cassettes are inserted under front lip on front end of paddle. Use masking tape to secure cassettes to paddles.

2) Place lead identification numerals at front right edge of film, 2 inches (50 mm) from edges. Use No's 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0.

(b) Install isotope equipment. (Figure 627) (Figure 628) (Figure 629)

1) Assemble PWA 47252 Support Plate and PWA 46275 Support Guide Tube to rigid source positioning rod and insert into engine central cavity. PWA 46275 Support Guide Tube will slide through turbine shaft coupling lock. Position PWA 47252 Support Plate on No. 1 bearing front support so that wing nut bolts can be inserted at 10 o'clock and 4 o'clock positions. Finger tighten bolts.

2) Position and lock rigid source positioning rod so that centerline of source will be 90 3/4 inches (2305.050 mm) from aft face of the PWA 47252 Support Plate.

(c) Install paddles. (Figure 634) (Figure 635)

CAUTION: ENSURE THRUST REVERSER IS INOPERABLE BEFORE ENTERING EXHAUST DUCT TO INSTALL PADDLES.

1) Insert PWA 46303 Film Holder Paddles into exhaust nozzle over mixer and into fan exhaust outer duct until sleeve and clamp hook on handle slips over (nacelle) exhaust nozzle rim.

2) Locate paddles in proper circumferential location. Lock in position by pulling T handle rearward until pivot assembly on paddle is wedged between combustion chamber outer case and outer fan duct; then turn T handle clockwise.

NOTE: Paddles inserted in this manner will result in radiographs exhibiting portions of two combustion chambers with proper identification of one. The other chamber pictured will be the next in position clockwise from the rear with the exception of "0", which exhibits bottom dead center side of No. 6 combustion chamber.

Paddles used at approximate 3 and 9 o'clock positions should be used with PWA 46304 Support for ease of installation.

(d) Expose films.

WARNING: EXERCISE ALL POSSIBLE SAFETY PRECAUTIONS APPROPRIATE TO HANDLING OF RADIOACTIVE MATERIAL.

1) Introduce source into rigid source positioning rod until it bottoms out.

2) Expose film for 300 curie minutes to produce density between 2.0 - 3.5. Preferred range is 2.5 - 2.8 liner density.

(e) Remove isotope equipment.

(f) Remove film paddles.

(g) Reassemble removed engine hardware and restore thrust reverser to operational condition.

(h) Develop film in automatic processor.

(i) Analyze film in dimly lit room using high (variable) intensity film reader.

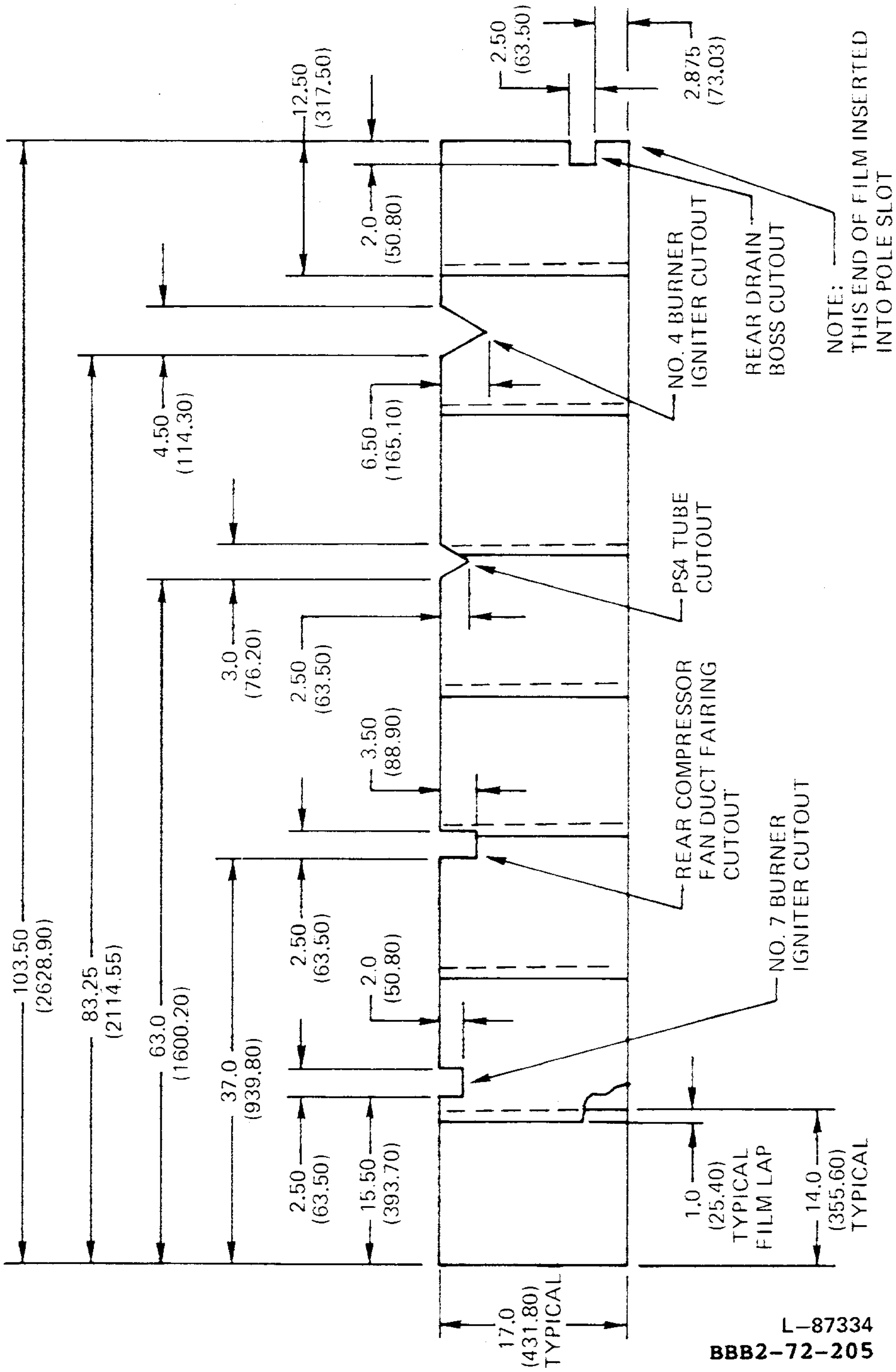
NOTE: Cracks observed extending into areas not clearly defined on radiograph are assumed to extend through area.

When determining lengths of cracks which intersect dilution holes, hole diameter must be added.

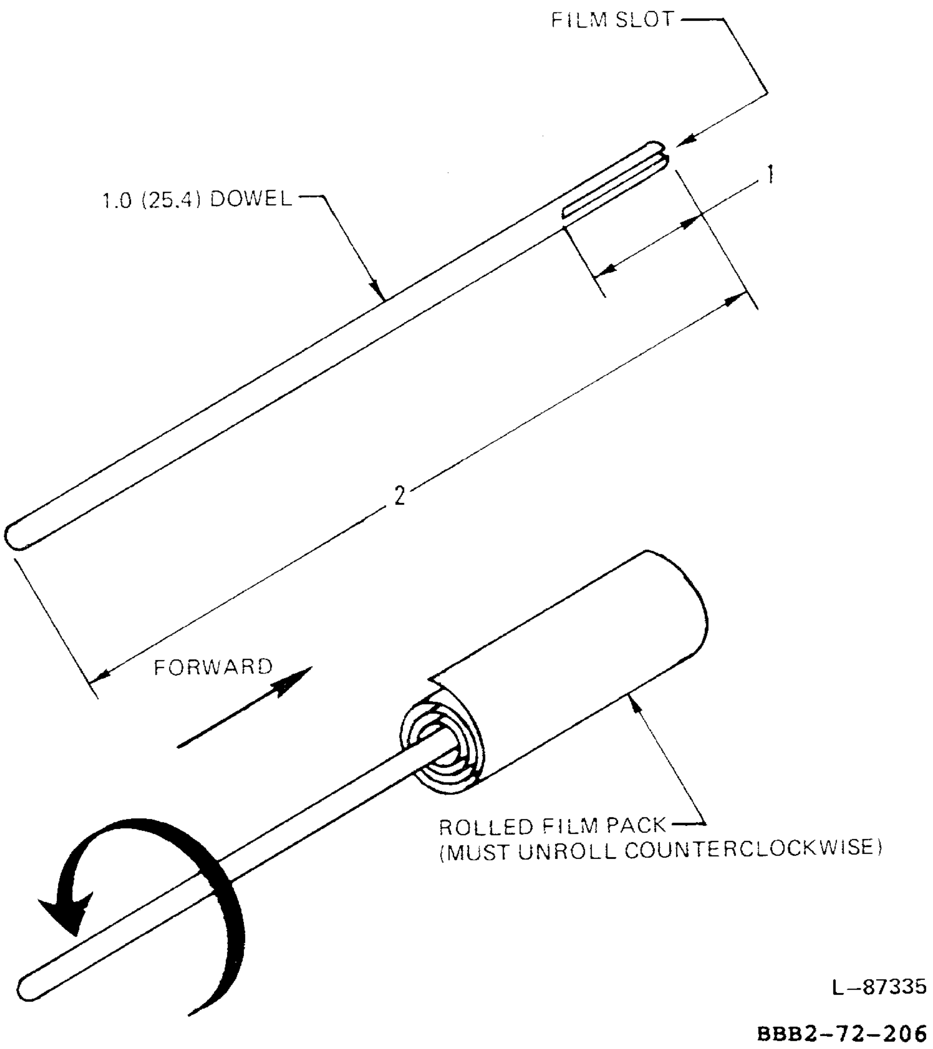
Broken eleventh liners manifest themselves on radiograph by indication of "metal overlap" or by 3 times normal 10th liner axial crack width.

(j) Record observed chamber distress on data sheet. (Figure 632)

(5) See SB 5741 for combustion chamber rejection criteria.

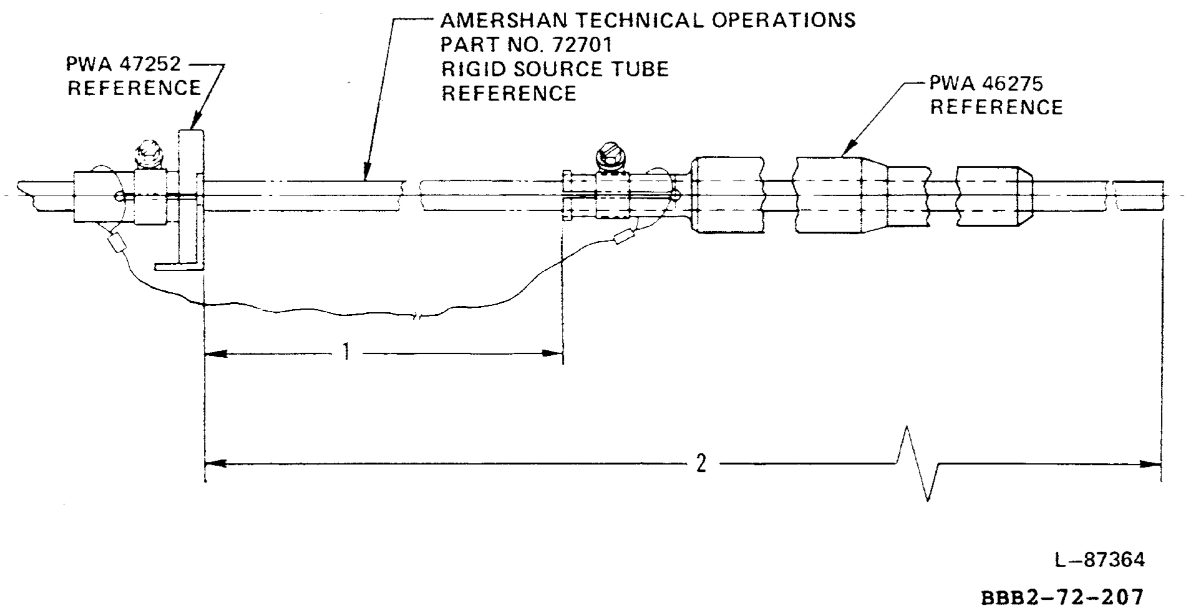


Film Pack Assembly And Cutout Specifications
Figure 625/72-00-00-990-A12



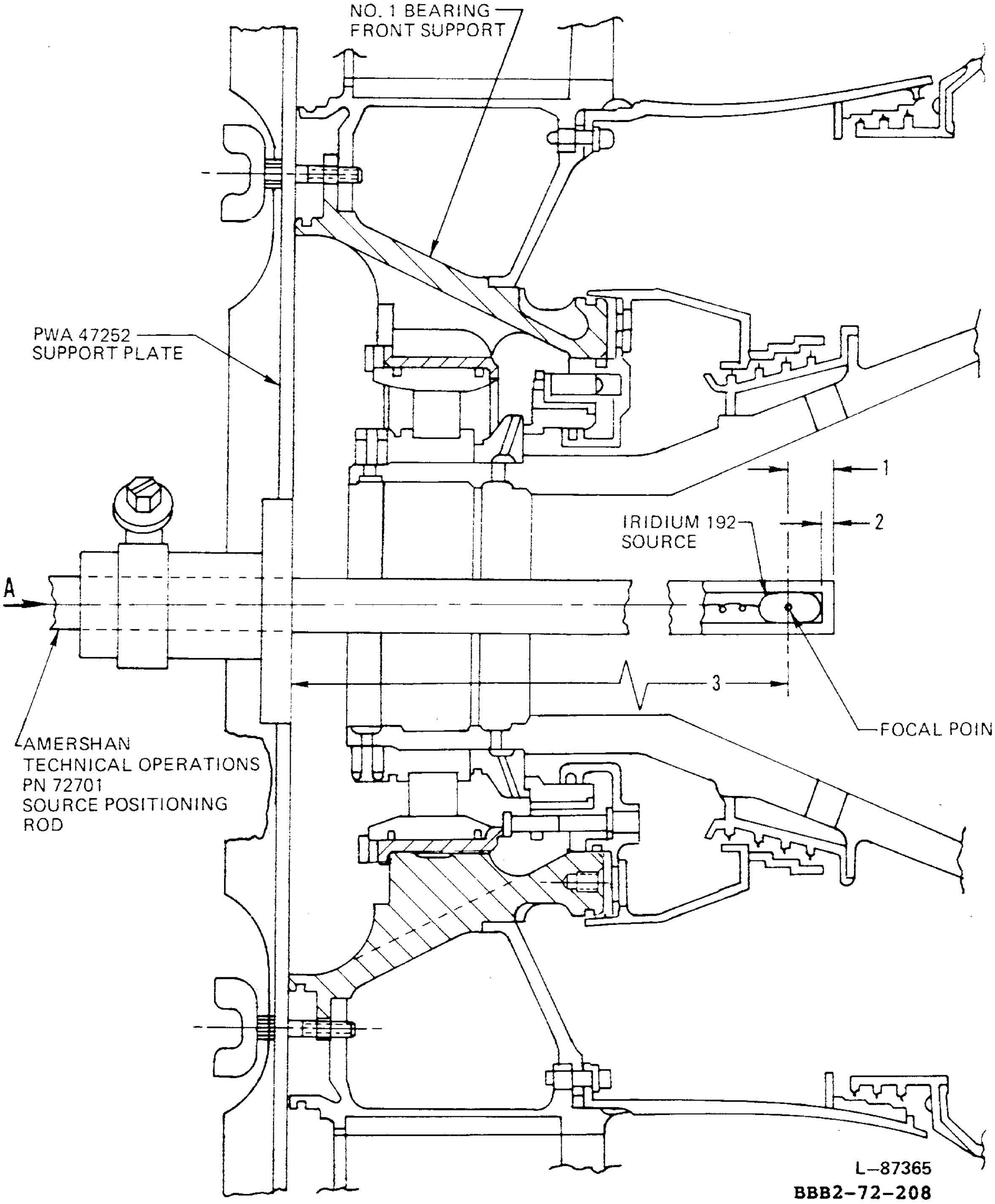
1. 14 Inches (335.60 mm)
2. 66 Inches (1676.40 mm) Minimum

Film Insertion Pole
Figure 626/72-00-00-990-A13

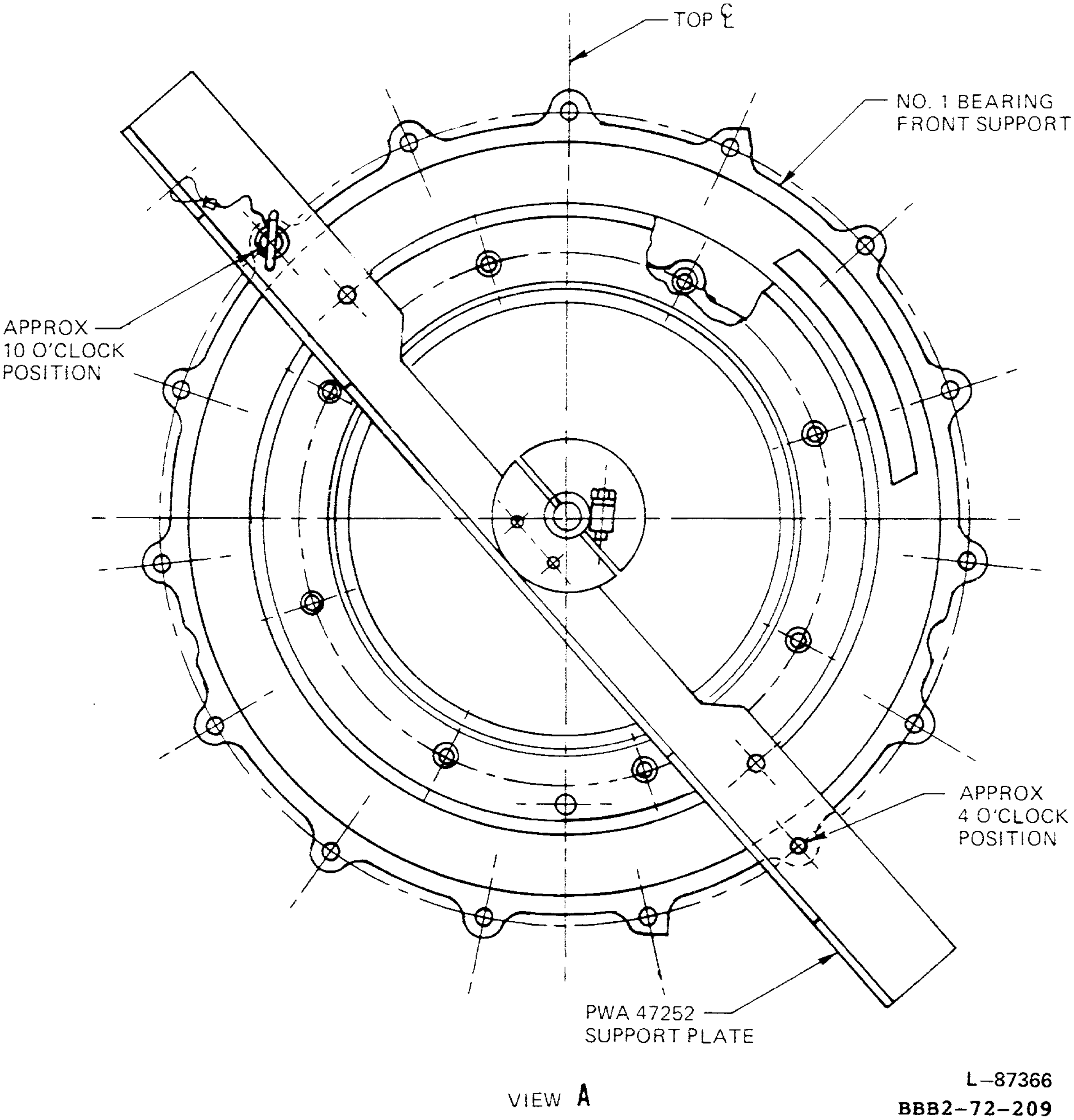


1. 35 Inches (889 mm)
2. 91 1/16 Inches (2312.988 mm)

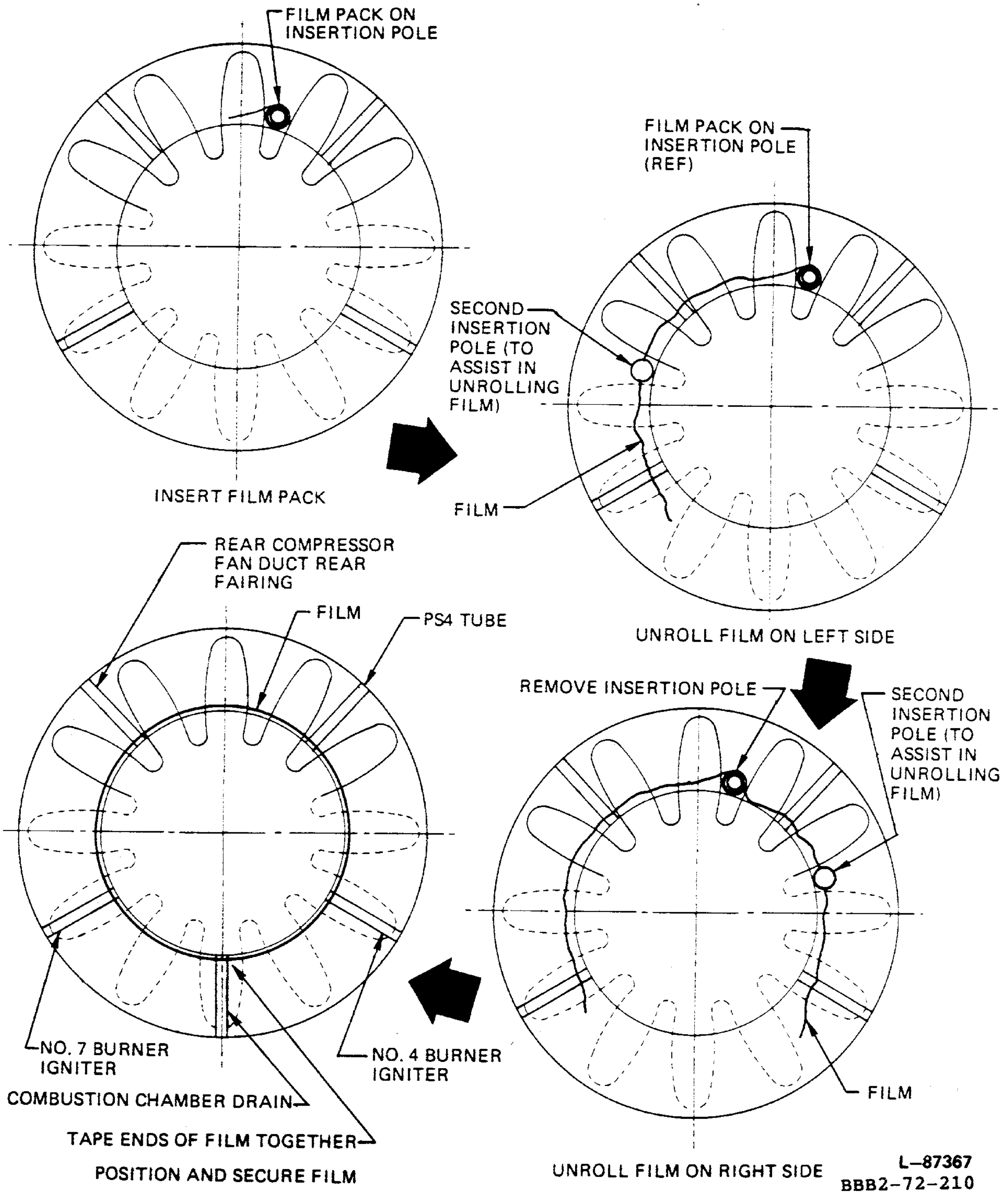
Support Plate, Support Guide Tube And Source Tube Assembly
Figure 627/72-00-00-990-A14



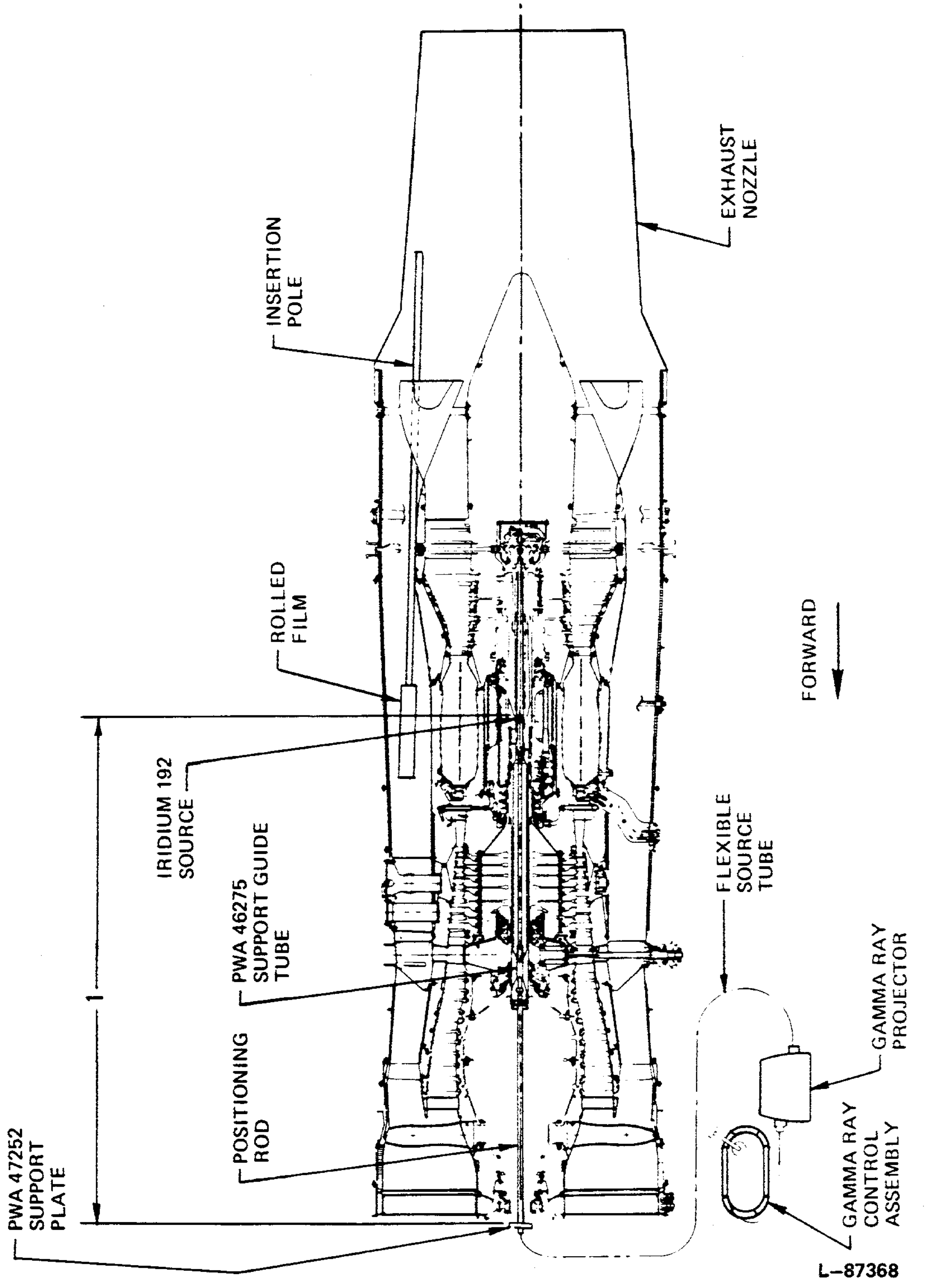
Insertion Of Rigid Source Tube And Positioning Of Iridium 192 Source
Figure 628/72-00-00-990-A15



Location Of Support Plate On No. 1 Bearing Front Support
Figure 629/72-00-00-990-A16



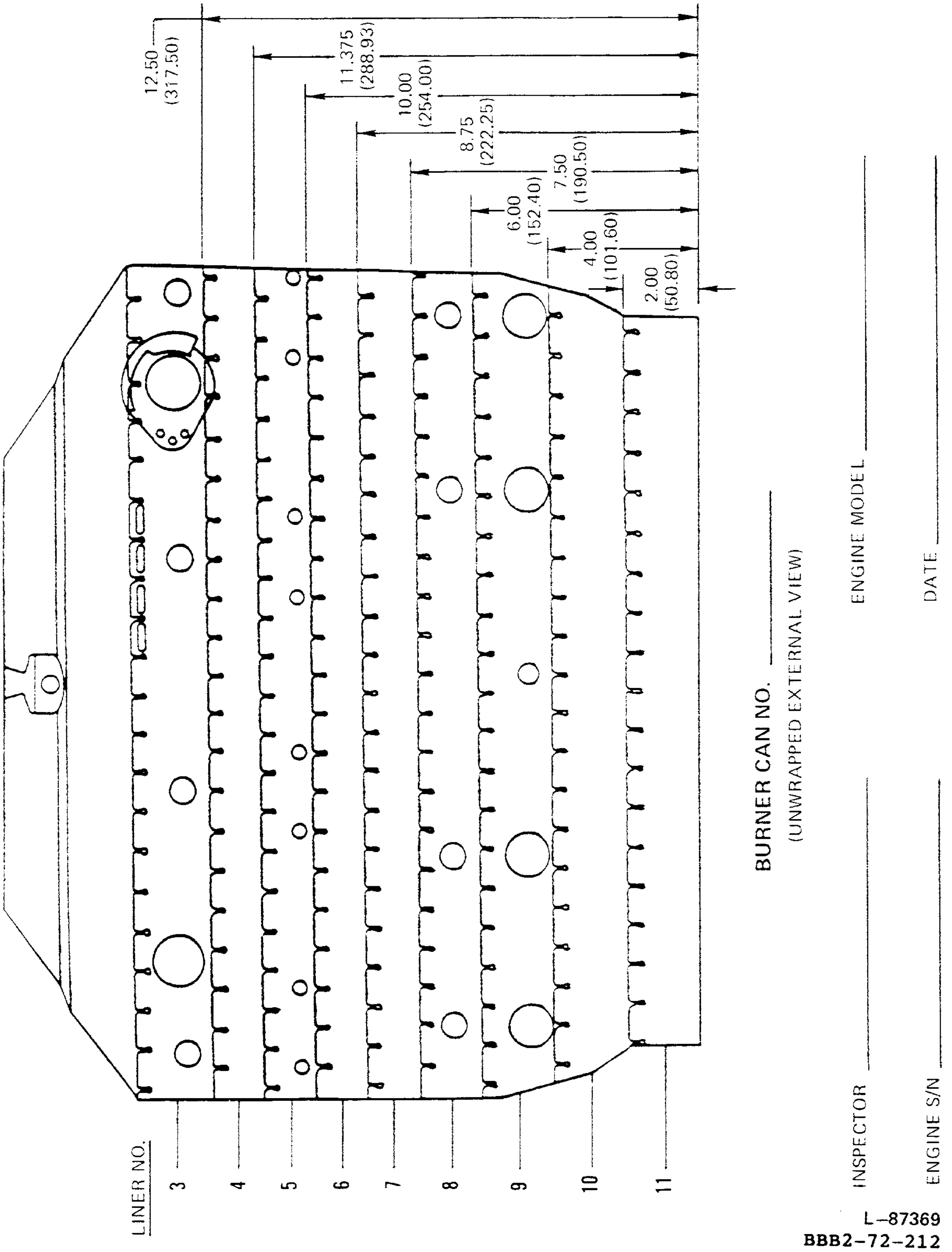
Roll Film Installation Procedure
Figure 630/72-00-00-990-A17



1. 91 1/16 Inch (2312.988 mm)

L-87368
BBB2-72-211

Equipment Position For Isotope Procedure
Figure 631/72-00-00-990-A18



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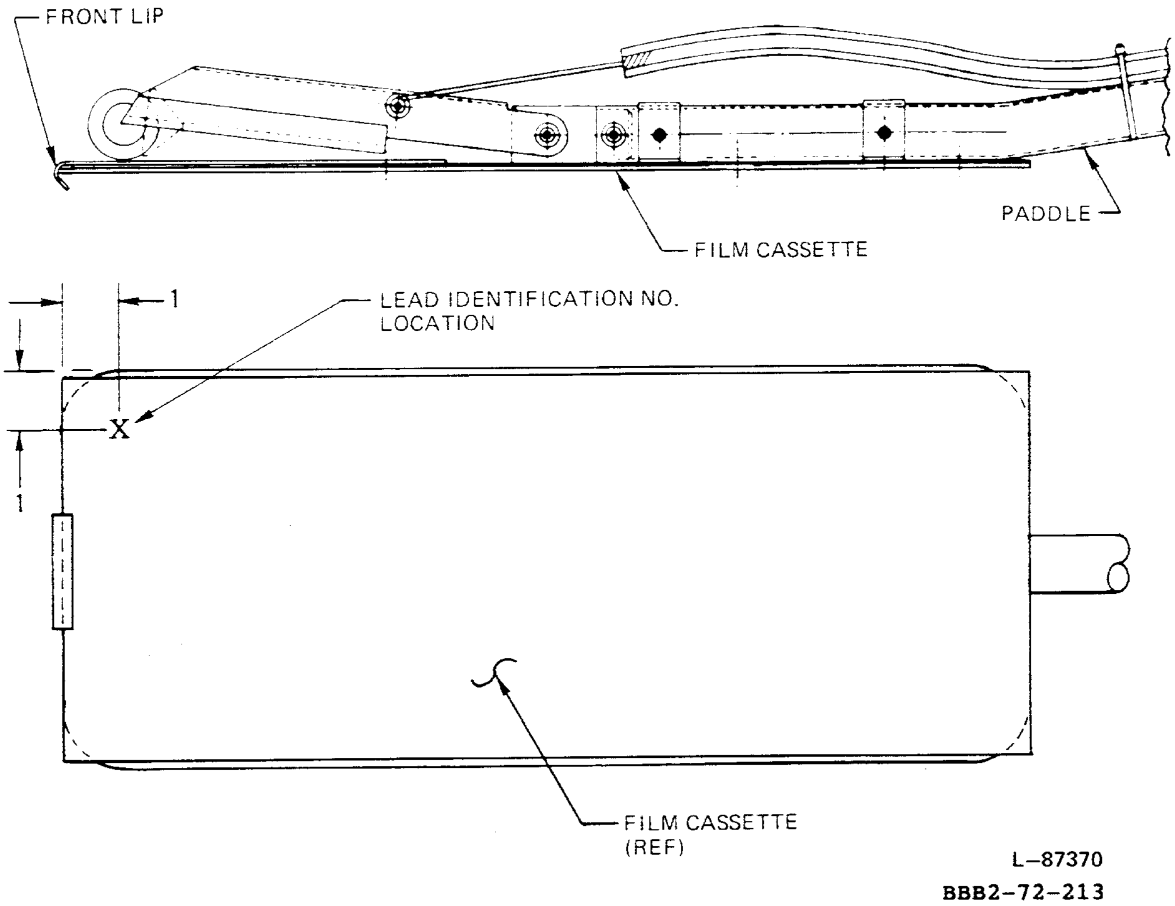
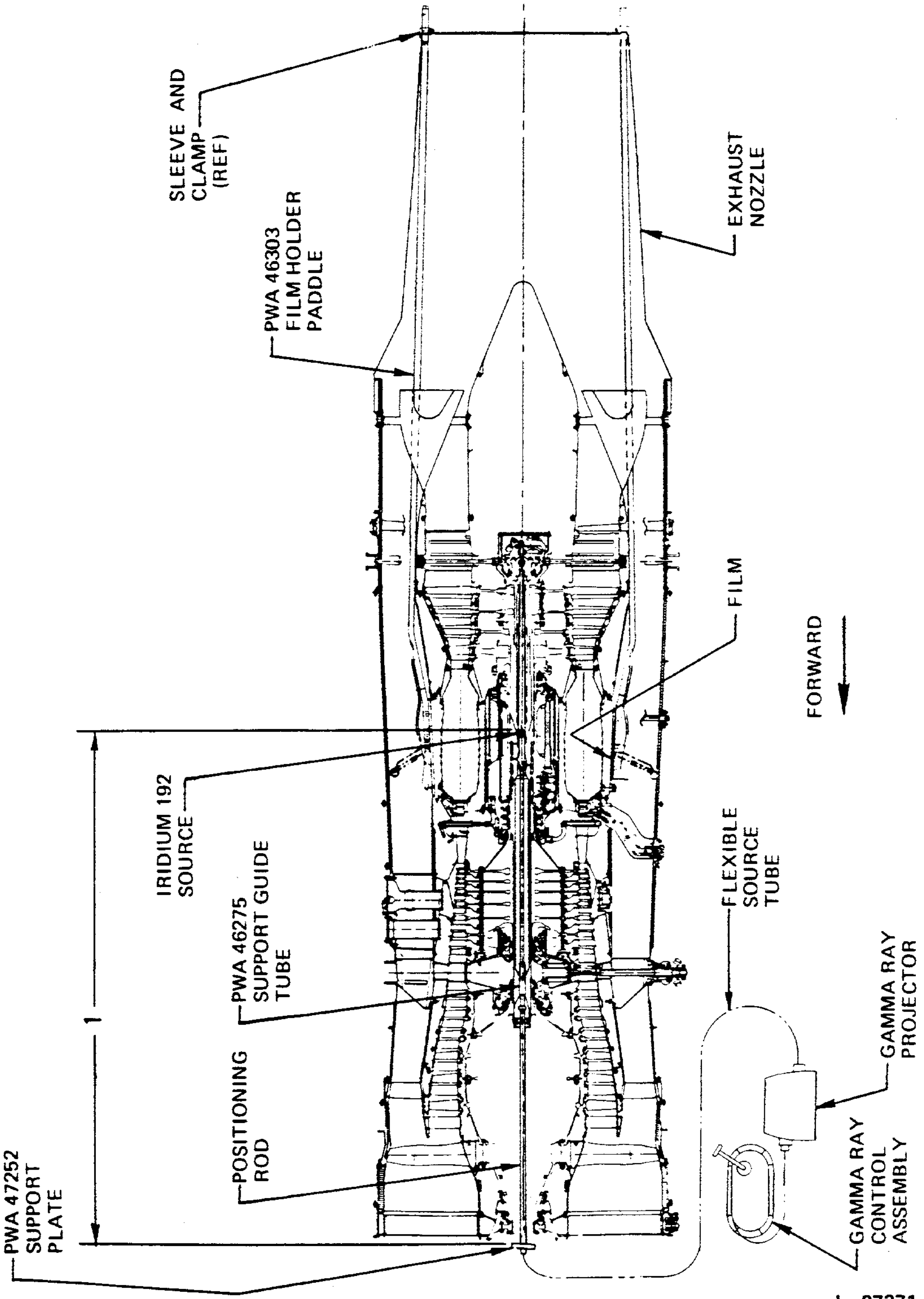
BBB2-72-212

Isotope Inspection Combustion Chamber Data Sheet
Figure 632/72-00-00-990-A19



1. 2 Inches (50.8 mm)

Film Holder Paddle With Cassette Installed
Figure 633/72-00-00-990-A20

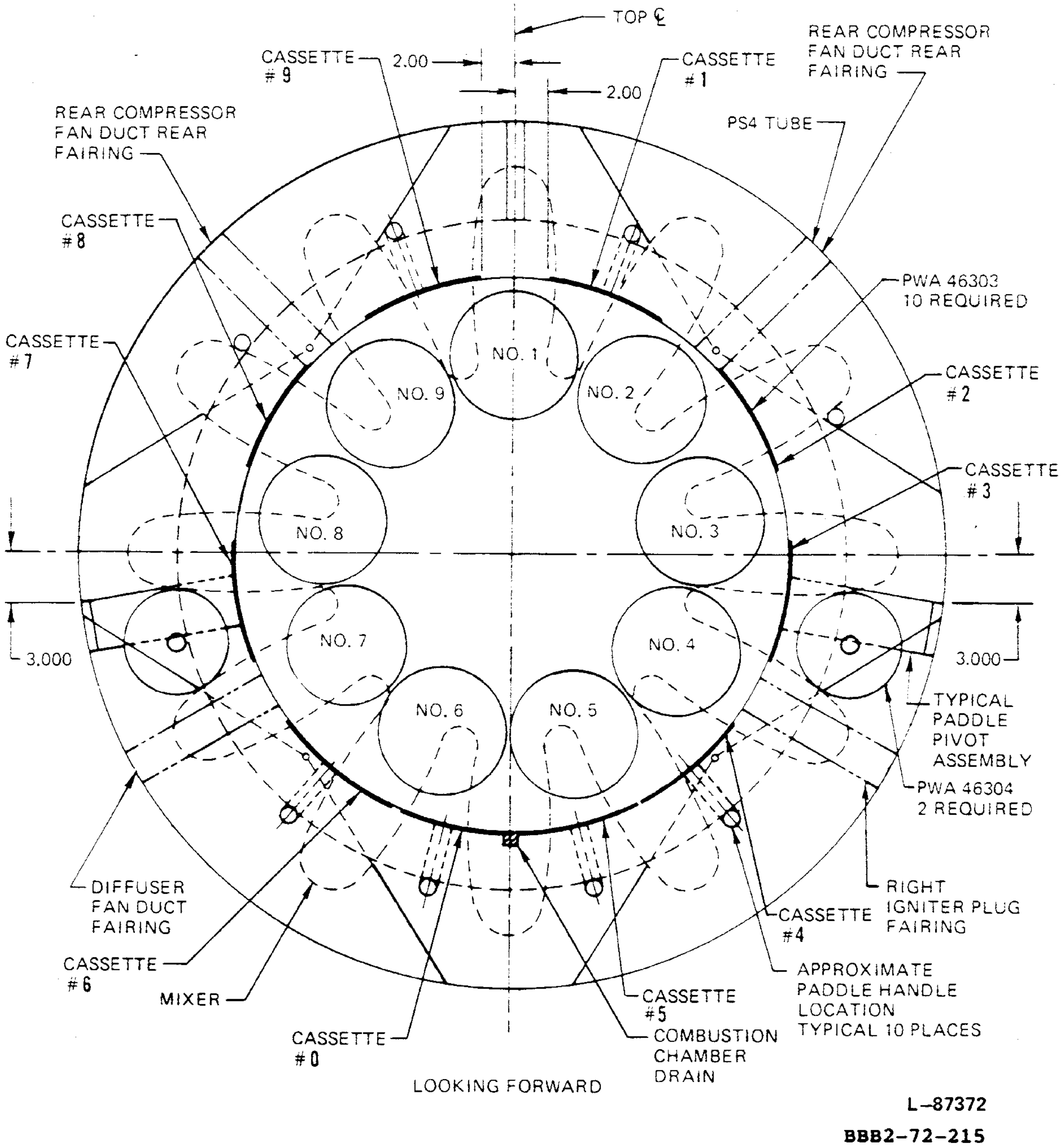


1. 91 1/16 Inches (2312.988 mm)

L-87371

BBB2-72-214

Equipment Position For Isotope Procedure
Figure 634/72-00-00-990-A21



Location Of Paddles And Film
Figure 635/72-00-00-990-A22

21. Inspect Combustion Section (Borescope)

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

Table 603

Nature Of Inspection		Inspection Time			
		Routine	Minor	Major	Remarks
1.	Combustion Chamber Borescope Inspection			X	See procedure below.

WARNING: DO BORESCOPE INSPECTION IN AN AREA WHICH HAS PROTECTION FROM THE WEATHER. IF A BORESCOPE INSPECTION IS DONE IN WET CONDITIONS, USE SUFFICIENT PROTECTION TO PREVENT DAMAGE TO EQUIPMENT OR POSSIBLE ELECTRICAL SHOCK TO THE OPERATOR.

CAUTION: ENGINE INTERNAL TEMPERATURES IN EXCESS OF 149°F (65°C) MAY DAMAGE FIBER OPTIC BORESCOPE COMPONENTS. ENGINE INTERIOR MUST BE ALLOWED TO COOL BELOW 149°F (65°C) FOLLOWING ENGINE OPERATION PRIOR TO INSERTING BORESCOPE. ALLOW COOLDOWN PERIOD ON NEWLY SHUTDOWN ENGINE PRIOR TO INSPECTION TO ENSURE THAT PERSONNEL ARE NOT INJURED AND EQUIPMENT IS NOT DAMAGED. DO NOT ATTEMPT TO REMOVE FOUR NUTS WHICH RETAIN SPARK IGNITER PACKING HOLDER ON RIGHT SIDE OF ENGINE AS BOLTS ARE NOT RETAINED ON INNER SIDE OF FAN DUCT.

(1) Allow approximately two hours after engine shutdown before beginning borescope inspection when outside temperature is approximately 75°F (24°C); allow approximately two and a half hours if outside temperature is above 80°F (27°C), and allow approximately one hour if temperature is 30°F (-1°C) or lower. Rate of cooldown can be increased by motoring engine after shutdown with starter for 30 second periods.

WARNING: DO NOT ATTEMPT TO PERFORM HAND CHECK OF FAN DUCT TEMPERATURE SOONER THAN ONE HOUR AFTER SHUTDOWN (TIME INTERVAL MAY VARY IF STARTER MOTORING IS USED).

(2) Alternate method of determining whether or not engine has cooled sufficiently for borescope inspection of combustion area consists of placing palm of bare hand on combustion chamber and turbine fan duct; when hand can be held comfortably against duct, engine is cool enough to permit inspection.

(3) Remove igniter plugs per SUBJECT 74-20-02, Page 201 and insert borescope through igniter plug ports into No. 4 and No. 7 combustion chambers.

(4) Check combustion chamber inner and outer outlet ducts for damage or distortion.

(a) Louvered inner and outer outlet duct assemblies.

NOTE: Refer to Figure 636 for the terminology of the combustion chamber outlet ducts as it is used in this check procedure. The duct "wall" as it is described in Paragraph 21.B.(4)(a)1), Paragraph 21.B.(4)(a)2), Paragraph 21.B.(4)(a)3), Paragraph 21.B.(4)(a)4), Paragraph 21.B.(4)(a)5), Paragraph 21.B.(4)(a)6) and Paragraph 21.B.(4)(a)7) is that part of a duct that isolates the area inside the ducts from the area outside the duct. The ducts are made of "liners" which are welded together. When the rear of one liner extends over the next liner, this makes a "louver" which protects the liner to the rear from heat (see Paragraph 21.B.(4)(a)4)) for limits on these louvers). The duct support is an assembly of five duct support segments.

NOTE: During initial inspections of the inner or outer duct assemblies, if there are indications of apparently missing duct material, inspection of the 1st stage turbine vanes (in the area to the rear of the missing material) and the 1st and 2nd stage turbine blades must follow as specified in this section. If subsequent duct assembly inspections do not show changes in condition, the turbine vane and blade inspections referred to as a result of initial inspection will not be necessary. In the above statement, “change in condition” has the definition of apparently new missing material (not oxidation) with an area larger than 0.078 in. (1.981 mm) by 0.078 in. (1.981 mm), or remaining surfaces with new sharp edges as a result of material fracture (not oxidation).

1) Axial cracks which go fully across the wall of a duct liner or duct support are permitted if:
    a) Material at the crack location is not badly burned.
    b) There are no more than three axial cracks at each combustion chamber outlet location (one crack in each liner), and the cracks in each liner do not connect.
    c) There is no more than one axial crack in a duct support segment.
    d) The cracks are not opened.
2) Circumferential cracks up to 2 inches (5.1 cm) in the wall of a liner at all combustion chamber positions are permitted if:
    a) Material at the crack location is not burned.
    b) There are no more than three cracks (one crack in each liner) at each combustion chamber outlet location.
3) Axial and circumferential cracks in the wall of a duct (which are less than the limits in Paragraph 21.B.(4)(a)1) and Paragraph 21.B.(4)(a)2) which go across each other are permitted if:
    a) Material at the cracks is not badly burned or oxidized.
    b) The area of material which is broken away from the duct where the cracks come together is not more than 0.1 x 0.1 inch (2.5 x 2.5 mm).
4) Louvers which are oxidized or bent are permitted. (Figure 636)
5) If the ducts have one or more of the defects that follow, examine the ducts again at 500 hours or 500 cycles (when one or the other of these occurs first):
    a) Bad distortion or oxidation in the duct wall (not in the louvers) which is badly burned. The duct can have bulges (distortion) if there are no cracks and the material is not burned.
    b) Circumferential cracks between 2 - 4 inches (51. - 102. mm) in length.

c) Material broken away from the duct, caused by cracks which go across each other, more than the limits in Paragraph 21.B.(4)(a)3) but less than 0.2 x 0.2 inch (5 x 5 mm).

6) If the duct walls have burned-through areas larger than the limits in Paragraph 21.B.(4)(a)5)c) but less 0.3 x 0.3 inch (7.62 x 7.62 mm), continue to examine the ducts again at 50 hours or 50 cycle increments, or remove the ducts from service in 50 hours or 50 cycles (when one or the other of these occurs first). If the ducts are missing material more than 0.3 x 0.3 inch (7.62 x 7.62 mm), remove them from service in 25 hours or cycles (when one or the other of these occurs first).

7) If ducts have circumferential cracks in the liner wall more than 4 inches in length as found in Paragraph 21.B.(4)(a)5)b).

a) If cracks are not more than 6 inches in length, continue to examine these ducts at 250 hour or 250 cycle increments (when one or the other of these occurs first), but only if these cracks are not at adjacent combustion chamber positions.

b) If cracks are more than 6 inches in length, or if they are 4 - 6 inches in length and are at adjacent combustion chamber positions: Remove the duct from service in 50 hours or cycles (when one or the other of these occurs first), or continue to examine the duct in 50 hour or 50 cycle increments (when one or the other of these occurs first), but remove the duct from service if the cracks increase in length between checks.

8) If the inner or outer outlet ducts have the defects that follow, do the duct inspections again in 500 hours or 500 cycles (when one of the other of these occurs first):

a) Material burned away from the end seal wall, caused by oxidation.

b) Material broken away from the end seal wall, caused by cracks which go across each other.

c) Material missing from the end seal wall and/or from the duct support wall less than or equal to 0.2 in. (5.1 mm) by 0.2 in. (5.1 mm) that opens into the cavity inside the turbine front case.

9) If the inner or outer duct support has the defects that follow, remove the engine from service in 25 hours or 25 cycles (when one or the other of these occurs first):

a) Material missing from the end seal wall and/or from the duct support wall more than 0.2 in. (5.1 mm) by 0.2 in. (5.1 mm) that opens into the cavity inside the turbine front case.

NOTE: Gaps caused by distortion can occur at the seal/duct support interface. This condition is permitted if no material is missing from the end seal wall or duct support. If material is missing from the end seal wall or duct support, refer to the limits of the steps 8)c) and 9)a) above.

(5) Check all 1st stage turbine vanes that is possible to see for airfoil damage, cracks and burning.

(a) If the turbine airfoils are wet with oil, this can be a result of oil leakage from the No. 4 bearing compartment. If necessary, remove the engine for repair. (ENGINE GENERAL - TROUBLESHOOTING -02 (LUBRICATION SYSTEM), PAGEBLOCK 72-00-02/101)

(b) Vane leading edge and convex wall oxidation and burning, which appears as black/brown residue, is acceptable providing burning does not cover more than 50 percent of the span or has not progressed through vane wall into internal cavity. Vanes which exhibit leading edge burning/oxidation in excess of 50 percent of span or appear to have reduced vane chord noticeably should be repeat borescope checked in 500 hours or 400 cycles, whichever comes first. (Figure 637)

(c) Vane leading edge cracks which have not opened are acceptable. These cracks normally appear as black spots at leading edge of vane and may exhibit black streaking on airfoil.

(d) Tight cracks on the vane airfoil are permitted if there are no burns or oxidation. The cracks are permitted to extend from the platform or the trailing edge cooling holes/slots of the vane and in any direction but cannot connect with the trailing edge. It is permitted for cracks to extend around the leading edge and connect with leading edge cooling holes, but cracks are not permitted to extend beyond the holes on the convex side.

(e) Schedule an engine for borescope inspection at increments of 700 hours or 500 cycles (whichever occurs first) when:

- Leading edge cracks extend to make "V"-shape holes not larger than 0.050 inch (1.270 mm) in width (in burned or not burned areas)
- Trailing edge cracks extend along the airfoil axis into the cooling holes or slots at the trailing edge
- Trailing edge material is burned away (with material missing) up to one-half inch (12.7 mm) along the airfoil axis and up to one and one-half inch (38.1 mm) along the span (length) of the trailing edge.

(f) If any vane exhibits burn through, engine should be scheduled for removal within 50 hours or 50 cycles, whichever comes first.

(g) The mating surfaces of vane buttresses are permitted to be not aligned (vane mismatch) if this does not cause an opening of the cooling air cavity at the outer platforms. If there is an opening, examine the area again at increments of 2000 hours or 1500 cycles (when the first of these occurs). If there is evidence of vane burning at the gap or escaping hot gases during vane inspection, you must remove the vane within 50 hours. (Figure 638)

NOTE: Vane platform mismatch of adjacent vanes aft of the cooling cavity is permitted up to 0.3125 inch (7.938 mm). Vanes in performance-improvement engines have extended rear outer vane platforms.

(6) Check fuel nozzle nuts for signs of burning and cracking. Nuts with damage exceeding limiting conditions defined below may be continued in service for a maximum of 50 hours, providing limits for combustion chambers and 1st stage turbine vanes are not exceeded. (Table 604) (Figure 640)

Table 604 Fuel Nozzle Rear Face Inspection Fuel Nozzles Before "Low NOx" Or "E-Kit" Configuration

CONDITION		LIMIT	
(1)	Cracks across fuel nozzle nut face up to air cooling holes. (Figure 640)	(a)	Maximum of one radial crack across lip face to each lip cooling hole. See Area A.
		(b)	No circumferential cracks between cooling holes. See Area B.
(2)	Cracks of fuel nozzle nut deflector. (Figure 640)	(a)	Maximum of one crack between any one key hole slot and any one deflector air cooling hole (8 cracks maximum). See Areas C, D and E.
		(b)	Maximum of one radial crack in deflector between each key hole slot (8 cracks maximum).

Table 604 Fuel Nozzle Rear Face Inspection Fuel Nozzles Before "Low NOx" Or "E-Kit" Configuration (Continued)

CONDITION		LIMIT	
		(c)	No circumferential cracks in deflector between key hole slots. See Areas D and E.
(3)	Erosion of nozzle nut lip face and lip OD. (Figure 640)	(a)	Depth of eroded area shall not exceed bottoms of lip cooling holes. See Area A. Total arc of eroded area shall not exceed 180 degrees. If arc of eroded area is 90 to 180 degrees, engine should be scheduled for repetitive borescope inspection of 1st stage turbine vanes, combustion chambers, and fuel nozzles. Use intervals of approximately 750 hours or 600 cycles, whichever comes first.
(4)	Erosion of nozzle nut deflector key hole slot and deflector ID. (Figure 640)	(a)	Slot width may be in creased by erosion to maximum of 0.08 inch (2.023 mm). New, uneroded slot has width of 0.025 inch (0.625 mm). See Areas D and E.
(5)	Burning, erosion or cracking of nut inner lip. (Figure 640)	(a)	Not acceptable. See Area F.
(6)	Burning, erosion or cracking of fuel nozzle. (Figure 640)	(a)	Not acceptable. See Areas G, H and I.

Table 605 Air Scoop Penetration Inspection Based On Observation Of Air Scoop Corner Radius

INSPECTION RESULTS		NECESSARY ACTION	
(1)	Corner radius of the air scoop is NOT contacting the fuel nozzle support fairing. (Figure 641, Sheet 1)	(a)	Do the inspection again at next convenient maintenance interval.
(2)	Corner radius of the air scoop IS contacting the fairing, but the radius is still visible.	(a)	Do the inspection again in 500 hours or use Table 606 or Table 607 for evaluation.
(3)	Corner radius of the air scoop is worn completely in the fairing, and the radius is NOT visible. (Figure 641, Sheet 2)	(a)	Remove in 50 hours or use Table 606 or Table 607 for evaluation.

Table 606 Air Scoop Penetration Inspection Based On Measured Depth Of Air Scoop Penetration

INSPECTION RESULTS		NECESSARY ACTION	
(1)	Corner radius of the air scoop is NOT contacting the fuel nozzle support fairing. (Figure 641Sheet 1)	(a)	Do the inspection again at next convenient maintenance interval.
(2)	Measured depth of air scoop penetration is less than 0.140 inch (3.556 mm). (Figure 642)	(a)	Do the inspection again in 500 hours or less.
(3)	Measured depth of air scoop penetration is less than 0.160 inch (4.064 mm). (Figure 642)	(a)	Do the inspection again in 250 hours or less.
(4)	Measured depth of air scoop penetration is less than 0.180 inch (4.572 mm). (Figure 642)	(a)	Do the inspection in 100 hours or less.

Table 606 Air Scoop Penetration Inspection Based On Measured Depth Of Air Scoop Penetration (Continued)

INSPECTION RESULTS		NECESSARY ACTION	
(5)	Measured depth of air scoop penetration is 0.180 inch (4.572 mm) or more. (Figure 642)	(a)	Remove the nozzle in 50 hours or less.

Table 607 Air Scoop Penetration Inspection Based On Measured Gap Between Air Scoop And Fairing On Opposite Side Of Nozzle

INSPECTION RESULTS		NECESSARY ACTION	
(1)	Corner radius of the air scoop is NOT contacting the fuel nozzle support fairing. (Figure 641, Sheet 1)	(a)	Do the inspection again at next convenient maintenance interval.
(2)	Measured gap between air scoop and fairing, on side of nozzle opposite contact between scoop and fairing, is less than 0.220 inch (5.588 mm). (Figure 643)	(a)	Do the inspection again in 500 hours or less.
(3)	Measured gap between air scoop and fairing, on side of nozzle opposite contact between scoop and fairing, is less than 0.360 inch (9.144 mm). (Figure 643)	(a)	Do the inspection again in 250 hours or less.
(4)	Measured gap between air scoop and fairing, on side of nozzle opposite contact between scoop and fairing, is less than 0.470 inch (11.938 mm). (Figure 643)	(a)	Do the inspection again in 100 hours or less.
(5)	Measured gap between air scoop and fairing, on side of nozzle opposite contact between scoop and fairing, is 0.470 inch (11.938 mm) or more. (Figure 643)	(a)	Remove the nozzle in 50 hours or less.

Key To Figure 640	
1.	Area D - Keyhole Slots (8)
2.	Area E - Deflector
3.	Area C - Deflector Cooling Air Holes (30)
4.	Area A - Lip Face
5.	Area H
6.	Area G
7.	Area I
8.	Area F - Nut Inner Lip
9.	0.159 Inch (4.039 mm), Reference.
10.	Area B - Lip Cooling Holes (36)

(7) Cracks in the combustion chamber dome deflector are permitted if they are in the limits specified: (Figure 639)

(a) Cracks in the deflector are permitted if they do not go into the 0.100 inch (2.540 mm) area, as shown in the figure.

(b) Each chamber can have no more than 25 cracks in the deflector. There is no limit on the distance the cracks must be apart.

(c) Cracks in the dome deflector that have no broken material are permitted.

NOTE: Tell the Manager of Technical Support Group, Pratt & Whitney, 400 Main Street, East Hartford, CT 06108-0969 if the chambers are rejected for damage more than the limits specified above.

(8) Examine the rear face of the fuel nozzles for burning, erosion, and cracking.

NOTE: This inspection is done using a borescope inserted through the igniter ports into the combustion chambers, as described in Paragraph 21.B.(3).

(a) For fuel nozzles before the "Low NOx" or "E-Kit" configuration (Reference SB 6363):

1) Examine the rear face of the fuel nozzles and fuel nozzle nuts for signs of burning, erosion, and cracking. Fuel nozzles with damage that is more than the limits specified in Table 604 can be continued in service for a maximum of 50 hours, if the combustion chambers and the 1st stage vanes are in limits. (Figure 640)

(b) For fuel nozzles of "Low NOx" or "E-Kit" configuration (Reference SB 6363):

1) Examine the rear face of the fuel nozzles for signs of burning, erosion and cracking. Burning, erosion and cracking are not permitted. Contact the Manager of Technical Support Group, Pratt & Whitney, 400 Main Street, East Hartford, CT 06108-0969 with details of distress for further recommendations.

2) Loss of thermal barrier (ceramic) coating on the rear face of the fuel nozzle is acceptable.

(9) Examine the fuel nozzle and support assemblies for penetration of the air scoop into the support fairing (or heatshield), and examine the fairings for cracks, broken welds, or burning.

NOTE: This inspection is accomplished using a borescope inserted through the 13th stage borescope inspection port in the diffuser case, as described in Paragraph 19.. Point the borescope rearward to view the fuel nozzle and support assemblies. Articulate the borescope to view all fuel nozzle positions.

This inspection does not apply to fuel nozzles that have incorporated the welded scoop by SB 6405, and it does not apply to the "Low NOx" or "E-Kit" fuel nozzles (Reference SB 6363).

(a) Examine fuel nozzle and support assemblies for penetration of the air scoop into the support fairing, using one of the three procedures listed below. (Figure 641) (Figure 642) (Figure 643)

1) Examine air scoop and support fairing to determine if the corner radius of the air scoop is visible, as shown in Figure 641. Remove or reinspect the fuel nozzle and support assemblies as necessary. (Table 605)

2) Examine the air scoop to measure the actual depth of penetration of the air scoop in the support fairing, as shown in Figure 642. Remove or reinspect the fuel nozzle and support assemblies as necessary. (Table 606)

NOTE: To use this procedure, you must make the necessary on-wing measurements to a precision of ±0.020 inch (0.508 mm).

3) Examine the air scoop and support fairing to measure the gap between the air scoop and the fairing on the side of the nozzle opposite to the contact between the air scoop and the fairing, as shown in Figure 643. Remove or reinspect fuel nozzle and support assemblies as necessary. (Table 607)

NOTE: To use this procedure, you must make the necessary on-wing measurements to a precision of ±0.020 inch (0.508 mm).

(b) Examine the fuel nozzle support fairings for evidence of burning or melting. See Figure 644. Fuel nozzles that exhibit burning or melting must be removed in 25 hours.

NOTE: This inspection is not necessary for fuel nozzle and support assemblies that have incorporated ASB A6169.

(c) Examine fuel nozzle support fairings for cracks and broken welds. Figure 645

1) Examine the support fairing for cracks along seam weld on aft (downstream) surface of the fairing. Examine the tack welds which attach fairing to support at forward (upstream) surface and at inboard surface for cracks. Cracks in or around the tabs, seam weld, or tack welds are acceptable for continued service as follows:

a) Support fairings that have cracks at one or more of the weld locations can be continued in service with an inspection every 500 hours to look for fairing liberation or wear into the support.

b) Support fairings that are detached and at an angle, but not liberated, can be continued in service with an inspection every 500 hours to look for fairing liberation or wear into the support.

c) Support fairings that have a radial crack the entire length of forward edge of fairing must be removed from service in 25 hours.

2) If the fuel nozzle air scoop has contacted the fuel nozzle support fairing (See Figure 641, Sheet 2), examine support fairing for cracks at the location of contact between the support fairing and air scoop.

a) Support fairings that have cracks can be continued in service with an inspection every 150 hours. If the crack grew longer since the previous inspection, reduce the inspection interval to every 50 hours.

b) Support fairings that have cracks which can cause a piece of fairing to break off must be removed from service in 25 hours.

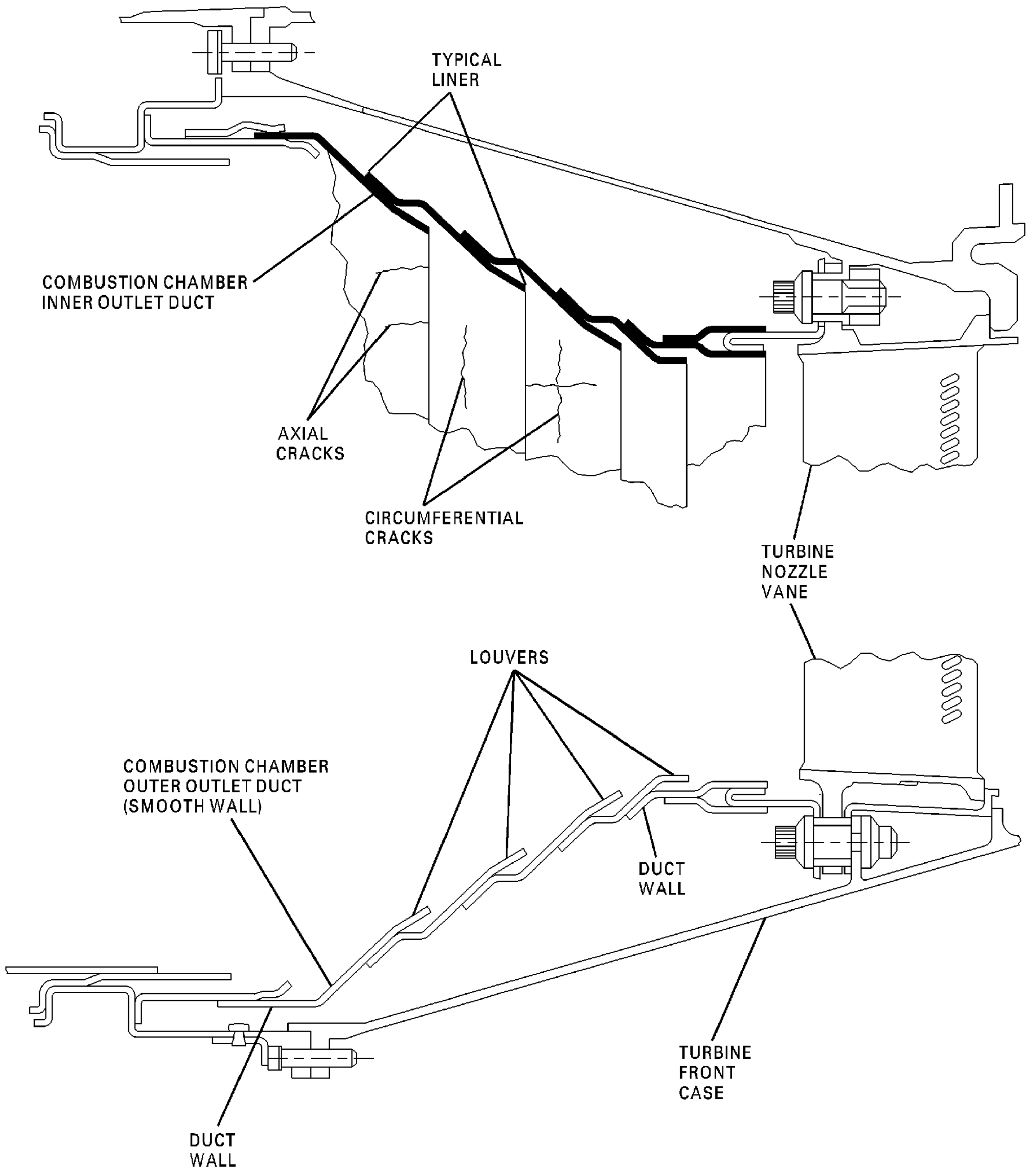
3) If a fuel nozzle is detected with the support fairing missing, examine the combustion chamber and 2nd stage turbine vanes downstream of that nozzle (accounting for gaspath swirl) for distress indicative of a "streaking" fuel nozzle.

a) Reinspect the combustion chamber and 2nd stage turbine vanes at 500 hour intervals.

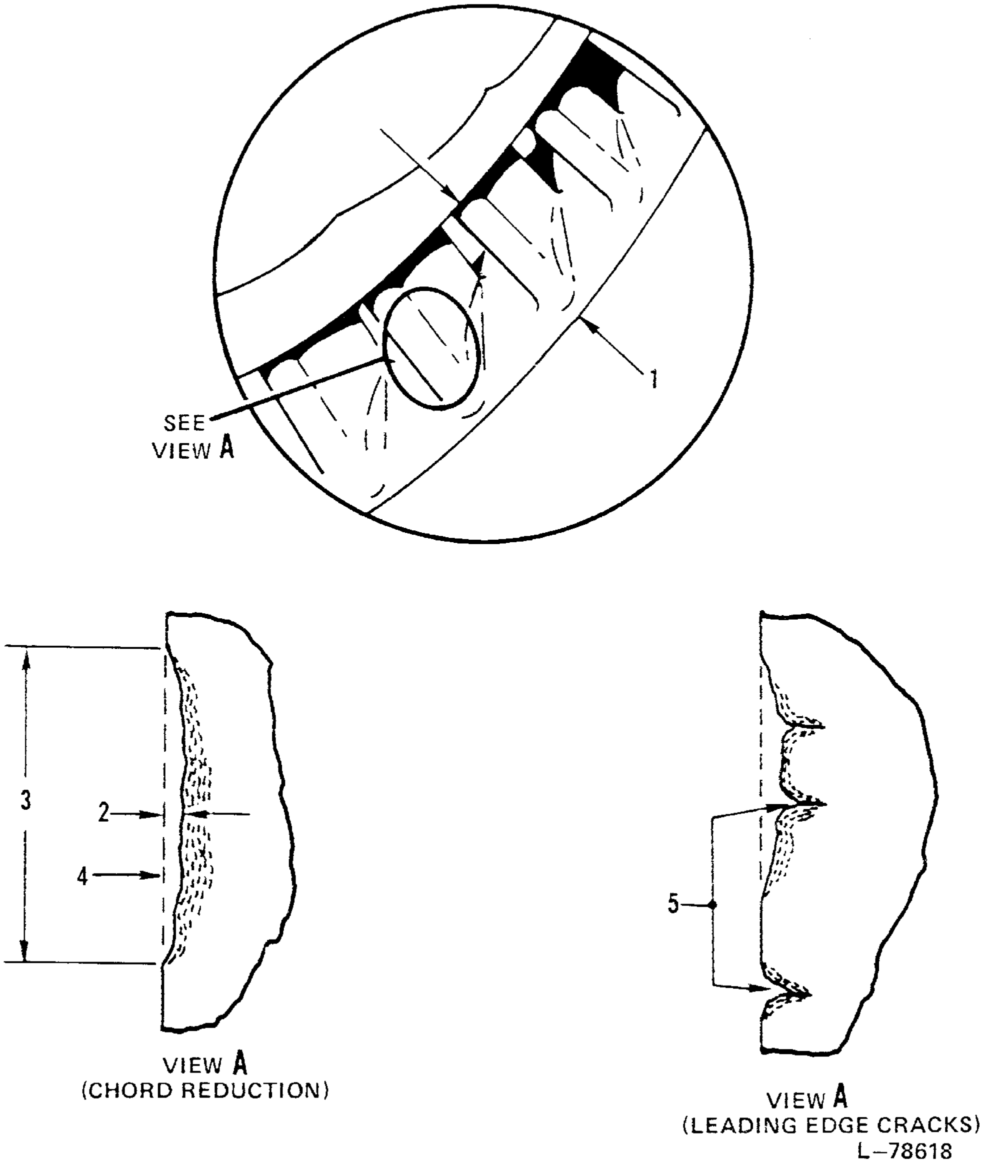
b) Reduce this interval or remove the engine in accordance with applicable Maintenance Manual and/or Service Bulletin Limits for combustion chamber and turbine distress.

4) If a fuel nozzle is detected with the support fairing loose, but in place and wearing into support, contact Manager of Technical Support Group, Pratt & Whitney, 400 Main Street, East Hartford, CT 06108-0969 with a detailed description for the wear, including photos, if possible, for further recommendations.

(10) Install igniter plugs per SUBJECT 74-20-02, Page 201.



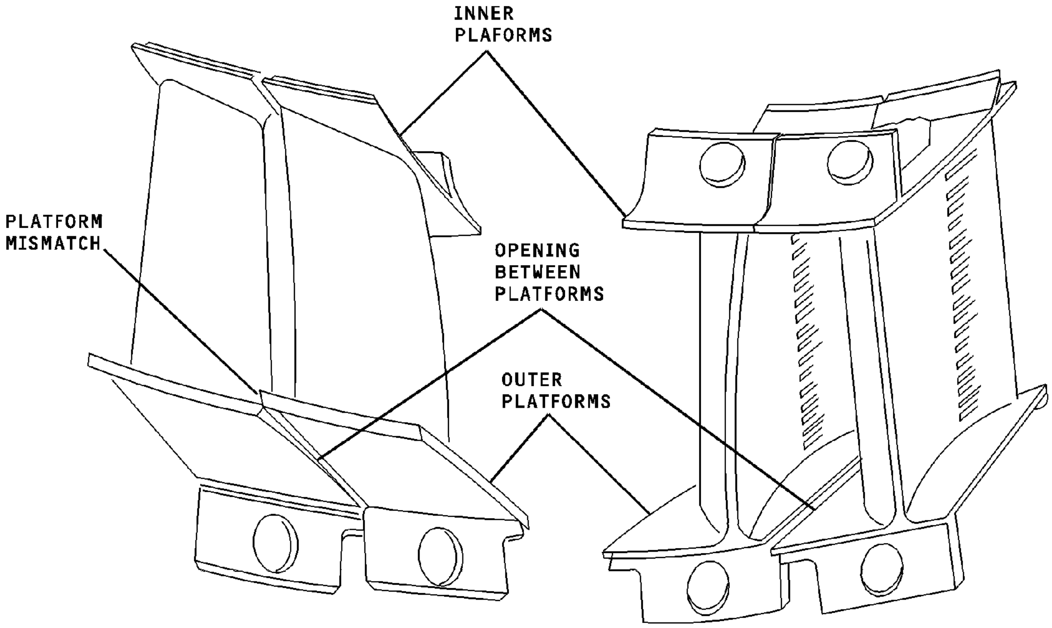
Inner and Outer Outlet Ducts Check
Figure 636/72-00-00-990-A23



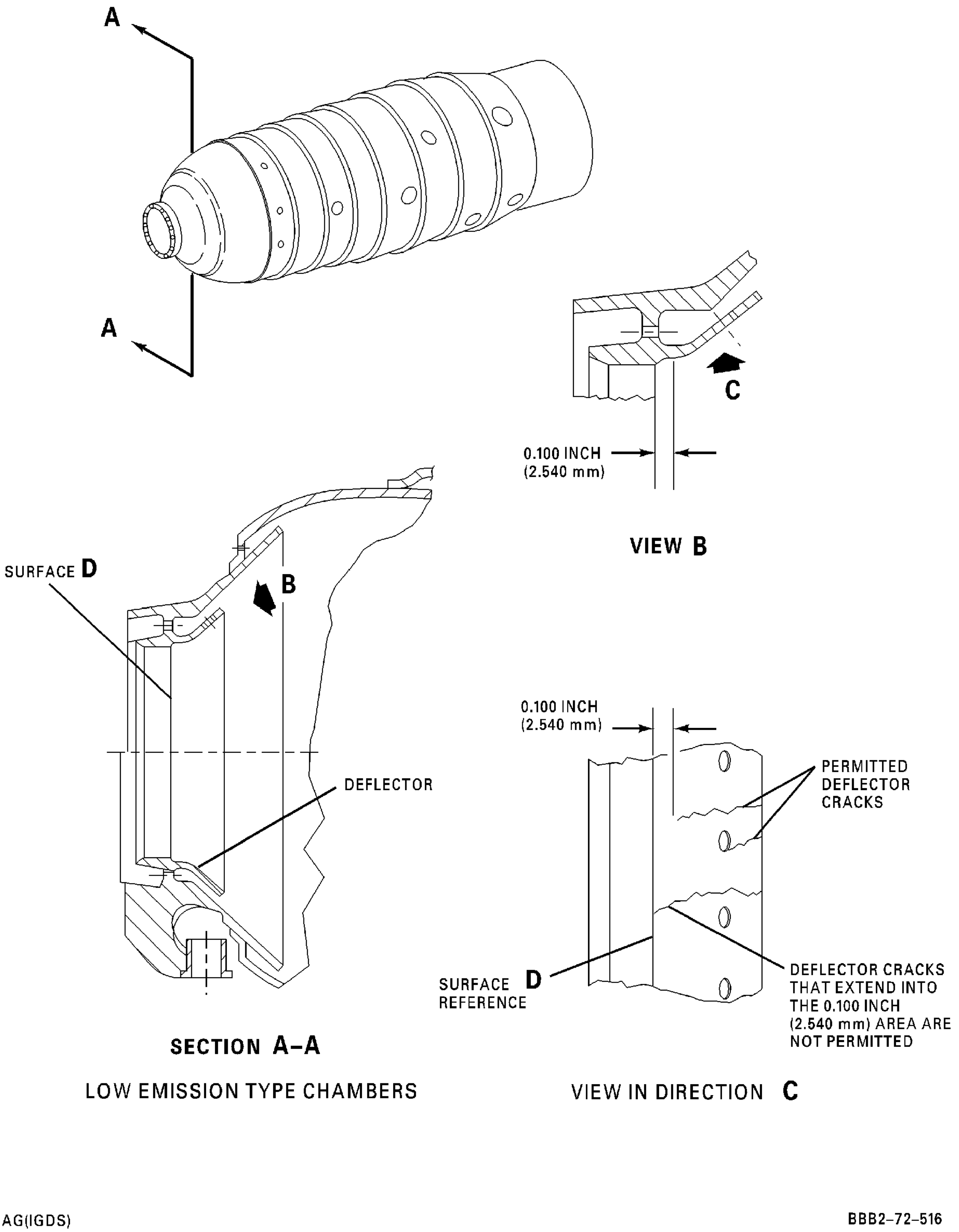
1. Span
2. Reduction In Chord
3. One Half Span Maximum
4. Original Contour
5. Vee Shaped Cracks

BBB2-72-216

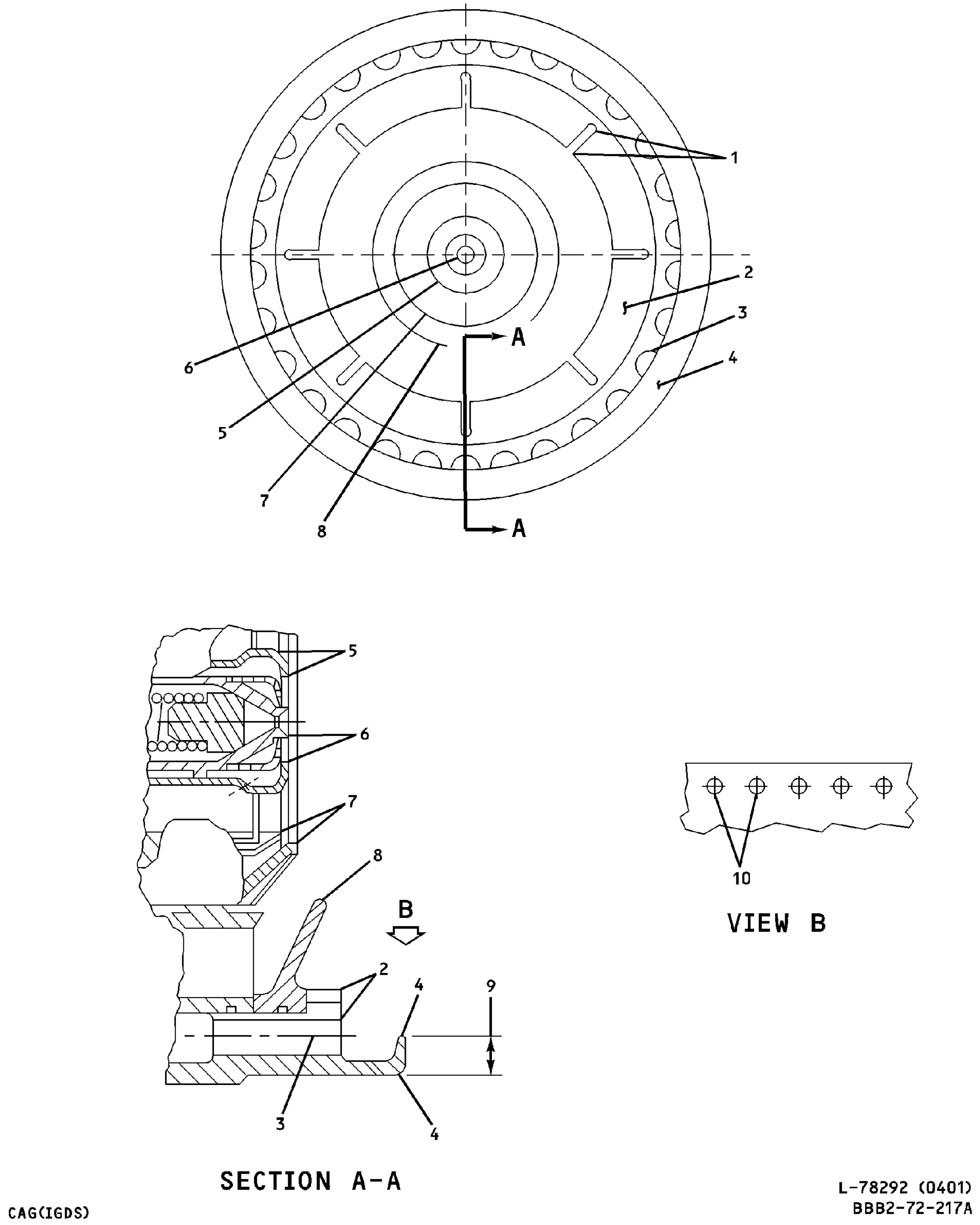
First Stage Vane Borescope Inspection
Figure 637/72-00-00-990-A24



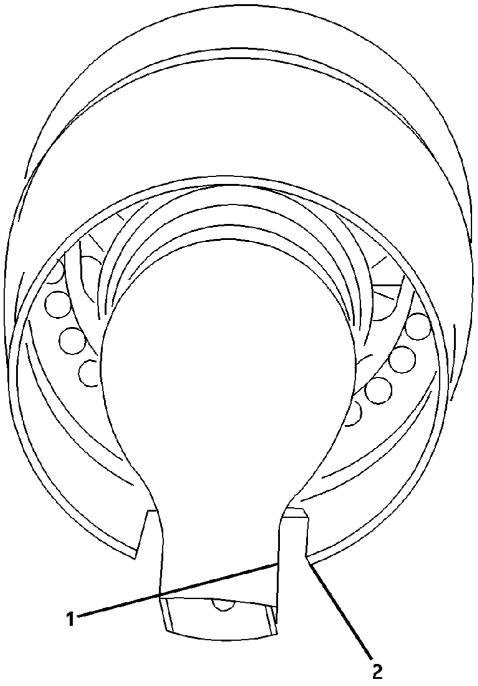
First Stage Turbine Vane Platform Mismatch
Figure 638/72-00-00-990-A25



Combustion Chamber Dome Deflector Crack Limits
Figure 639/72-00-00-990-A26



Fuel Nozzle Rear Face Inspection (Fuel Nozzle Before "Low NOx" Or "E-Kit" Configuration)
Figure 640/72-00-00-990-A27



1. SUPPORT FAIRING (HEAT SHIELD)
2. CORNER RADIUS OF AIR SCOOP

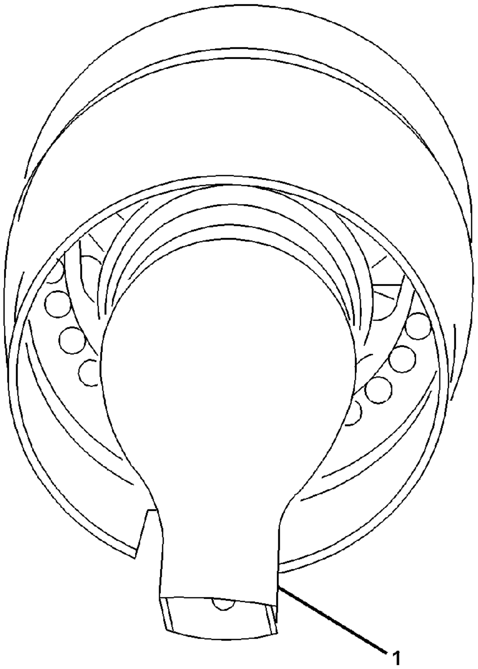
INSPECTION FOR PENETRATION OF AIR SCOOP INTO FAIRING, SHOWS NO CONTACT BETWEEN AIR SCOOP AND FAIRING.

L-H4758 (0401)

CAG(IGDS)

BBB2-72-570

Air Scoop Penetration
Figure 641/72-00-00-990-A28 (Sheet 1 of 2)



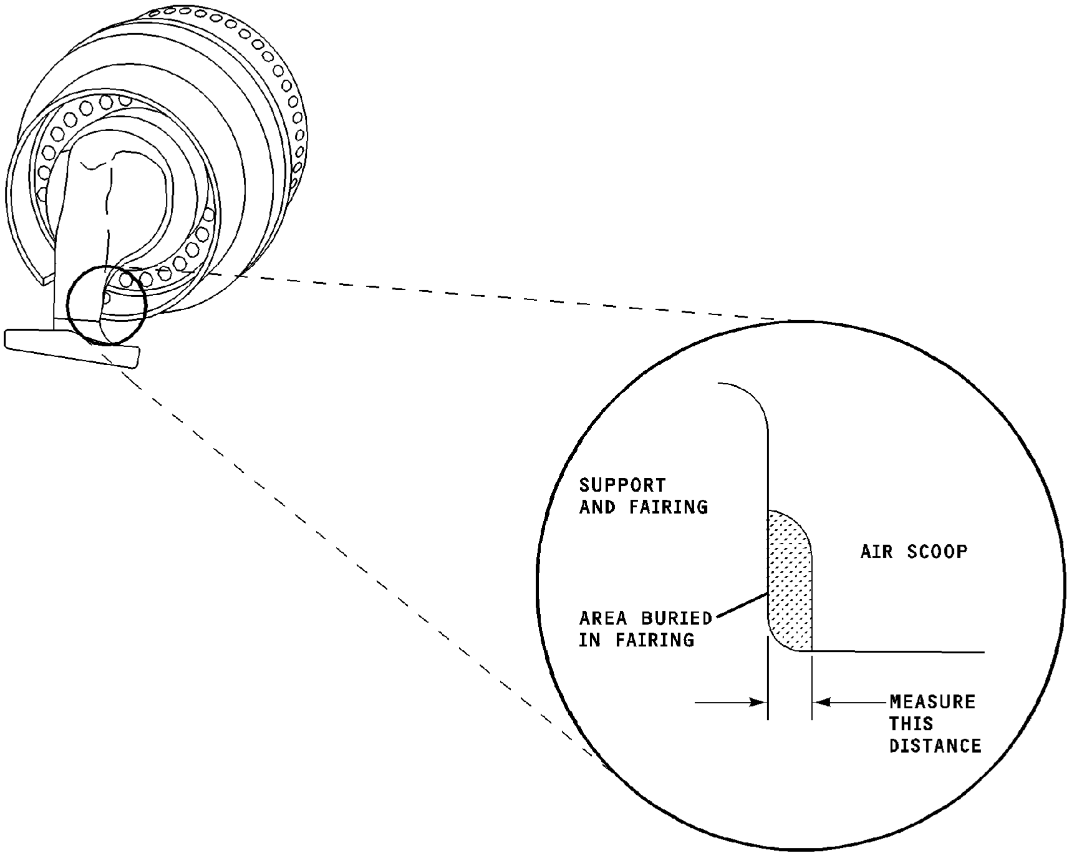
1. RADIUS COMPLETELY BURIED IN FAIRING.

INSPECTION FOR PENETRATION OF AIR SCOOP INTO FAIRING, SHOWS CONTACT BETWEEN AIR SCOOP AND FAIRING.

CAG(IGDS)

L-H4759 (0401)
BBB2-72-571

Air Scoop Penetration
Figure 641/72-00-00-990-A28 (Sheet 2 of 2)

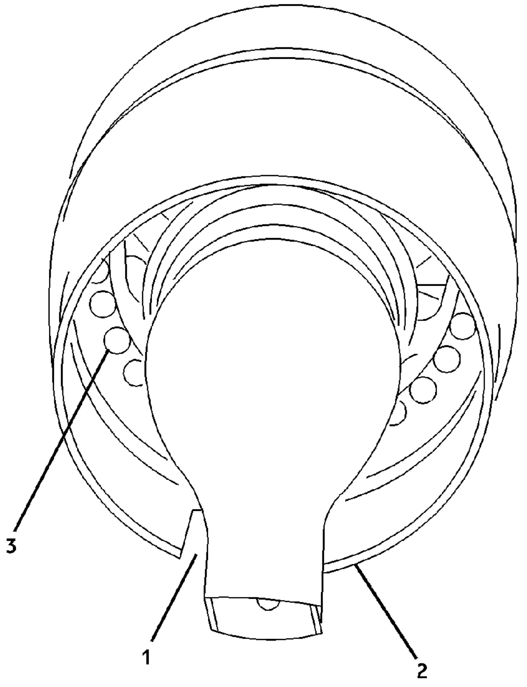


INSPECTION FOR PENETRATION OF AIR SCOOP INTO FAIRING, SHOWS ACTUAL MEASURED DEPTH OF AIR SCOOP PENETRATION.

CAG(IGDS)

L-H4760 (0401)
BBB2-72-572

Air Scoop Penetration
Figure 642/72-00-00-990-A29



1. MEASURE GAP BETWEEN THE AIR SCOOP AND FAIRING.
2. 0.060 INCH (1.524 mm) , REFERENCE. THICKNESS OF AIR SCOOP.
3. 0.160 INCH (4.064 mm) DIAMETER, REFERENCE. DIAMETER OF FUEL NOZZLE NUT DEFLECTOR COOLING AIR HOLES.

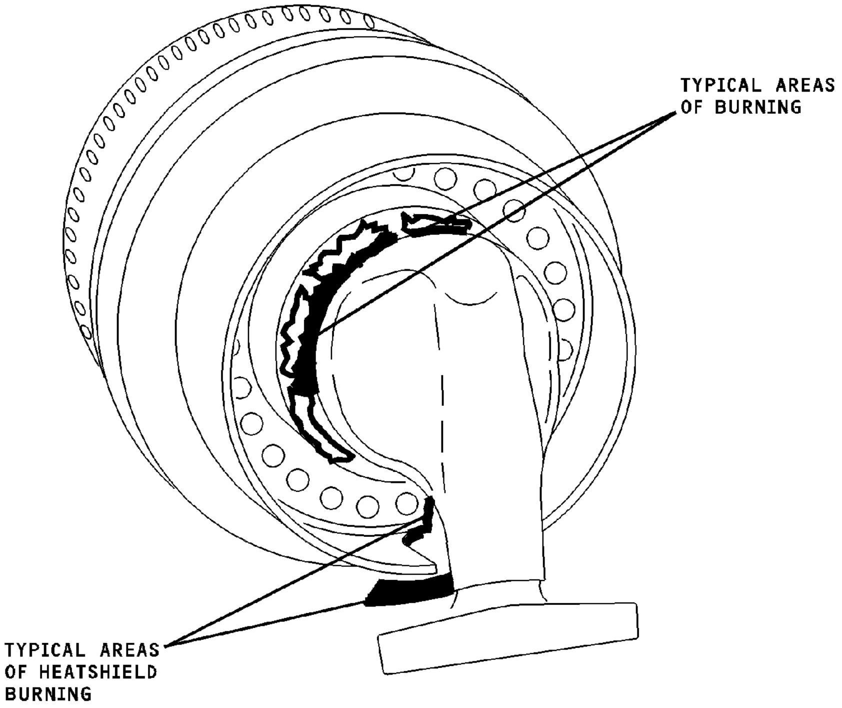
INSPECTION FOR PENETRATION OF AIR SCOOP INTO FAIRING, SHOWS MEASUREMENT OF GAP BETWEEN AIR SCOOP AND FAIRING ON OPPOSITE SIDE OF NOZZLE.

L-H4771 (0401)

CAG(IGDS)

BBB2-72-573

Air Scoop Penetration
Figure 643/72-00-00-990-A30



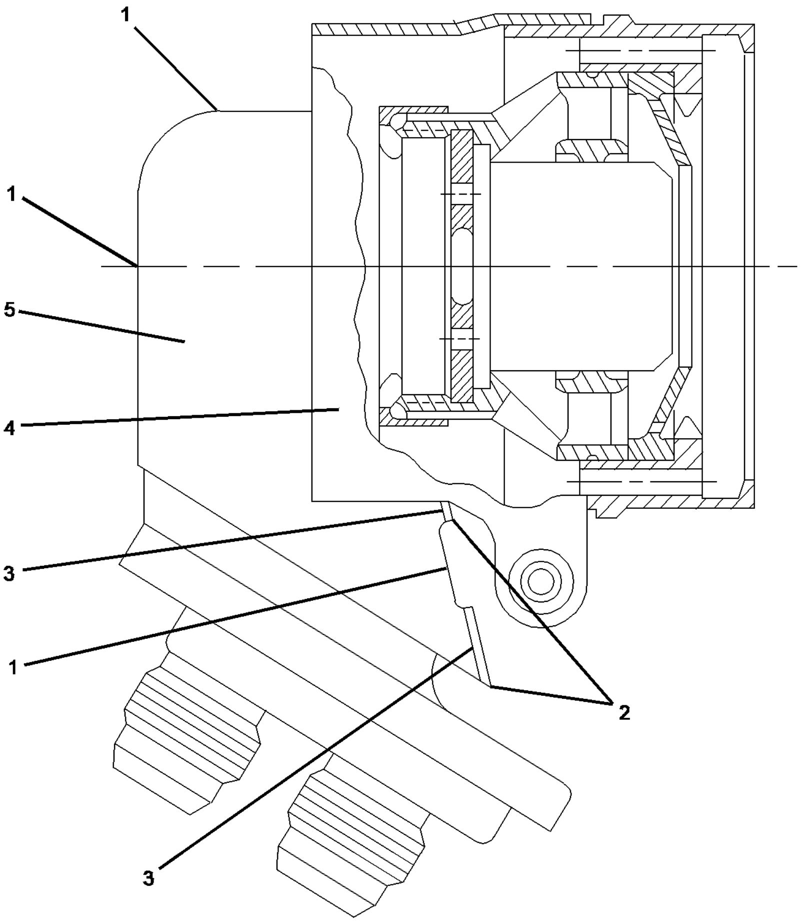
INSPECTION OF SUPPORT FAIRING FOR BURNING OR MELTING.

L-H4772 (0401)

CAG(IGDS)

BBB2-72-574

Inspection For Burning Or Melting
Figure 644/72-00-00-990-A31



LEGEND:
1. TACK WELD LOCATIONS
2. SEAM WELD LOCATION
3. TABS
4. AIRSCOOP
5. SUPPORT FAIRING

BBB2-72-552A
S0006554860V2

Fuel Nozzle Support Fairing
Figure 645/72-00-00-990-C31

22. Borescope Inspect 1st And 2nd Stage Turbine Blades And 2nd Stage Turbine Vanes

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 10408 Adapter

PWA 45248 Puller

PWA 46018 Puller/Driver

(2) Consumables

Assembly Fluid (PWA 36500)

B. Procedure

(Figure 646)

(Figure 647)

(Figure 648)

(Figure 649)

(Figure 650)

(Figure 651)

(Figure 652)

(Figure 653)

(Figure 654)

Key To Figure 646	
1.	First Stage Turbine Blade
2.	Second Stage Turbine Vane
3.	Second Stage Turbine Blade
4.	Instrumentation Boss Cover Assembly
5.	Turbine Rear Case
6.	Bolt Retaining Bracket
7.	Threaded Hole (Install Puller In This Hole)
8.	Turbine Inner Duct Borescope Port Cover
9.	Combustion Chamber And Turbine Fan Duct Borescope Port
10.	Bolt (Two)
11.	Turbine Front Case

WARNING: DO BORESCOPE INSPECTION IN AN AREA WHICH HAS PROTECTION FROM THE WEATHER. IF A BORESCOPE INSPECTION IS DONE IN WET CONDITIONS, USE SUFFICIENT PROTECTION TO PREVENT DAMAGE TO EQUIPMENT OR POSSIBLE ELECTRICAL SHOCK TO THE OPERATOR.

(1) Remove covers from borescope port at either 5 or 7 o'clock position on combustion chamber and turbine fan duct as follows:

(a) Remove outer cover from combustion chamber and turbine fan duct. Remove and Discard packing.

(b) Using 7.32 inch (5 mm) hex wrench, loosen inner fan duct cover fasteners and remove cover.

(c) Post SB 6053: Engines with this modification have a turbine containment shield around the turbine case in the plane of the 2nd stage turbine vanes. At either the 5 or 7 o'clock position, remove the corner bolts and move the containment shield cover in the clamp to permit access to the turbine case instrumentation boss. (Figure 648)

NOTE: Do not remove the six-point bolts at the center of each clamp (see Figure 650). These bolts attach the clamps to the shield.

Figure 653 shows the position of the cover and its upper and lower clamps. It is possible to find the cover (right or left side) in one of two positions, with the threaded boss at the lower side (with the result that the cover must move up), and with the boss at the upper side (with the result that the cover moves down). The location of this boss is optional. The threaded boss has a 0.250 -28 thread. It is permitted to use a threaded rod in this hole if this will make it easier to push the cover up or down in the shield opening.

(d) Post SB A6346: Engines with this modification have a turbine containment shield around the turbine case in the plane of the 2nd stage turbine vanes. At either the 5 or 7 o'clock position, remove the inner shield cover as follows:

CAUTION: IT IS NECESSARY TO REMOVE THE SIX BOLTS THAT ATTACH THE COVER TO THE SHIELD. BE CAREFUL NOT TO LET THE BOLTS OR THE COVER FALL INTO THE ENGINE WHEN THE BOLTS ARE REMOVED.

1) Remove the six bolts that hold the cover. Before the sixth bolt is removed, install a 0.250-28 threaded rod into the boss on the cover to hold the cover in position.

NOTE: Figure 649 shows the position of the cover. The threaded boss will be at the lower side of the cover on the right side of the engine and on the upper side of the cover on the left side of the engine. The threaded boss has a 0.250-28 thread. It is permitted to use a threaded rod in this hole if this will make it easier to hold the cover to remove it or to make sure that it does not fall into the engine.

2) When all bolts are removed, either remove the cover through the inner and outer fan duct ports, or let the cover stay against the lower edge of the shield opening while the turbine case borescope plug is removed.

(e) Thread PWA 45248 Puller into threads of instrumentation boss cover on turbine case and remove two 5/16 (8 mm) bolt, securing cover to case, until they are free of boss in turbine case.

NOTE: Bolts will be retained by flange on base of cover assembly.

(f) Using knocker detail of puller, remove borescope cover.

(g) On JT8D-217C or -219 engine pre-SB 6045, remove instrumentation plug from base of 2nd stage turbine vane as follows:

NOTE: JT8D-217C, -219 engines Post SB 6045 have the same type of one-piece instrumentation plug as the current JT8D-209, -217, -217A.

On Pre SB 6045 engines a field modification is permitted which puts a rivet through the cover and instrumentation. This is to let the plug and cover go into position as one assembly if there is no damage to the 2nd stage vane flange which holds the plug. See Figure 651 for a view of this modification.

1) Thread center rod of PWA 46018 Puller/Driver into instrumentation plug and extend outer tube inward until it engages slot of plug.

2) Turn plug 90 degrees clockwise to release locking lugs from base to vane.

3) Remove plug on end of puller/driver and remove plug from tool.

NOTE: To bring all 1st stage blades into view, rotate rotor through starter drive pad on gearbox using PWA 10408 Adapter.

There are 46 vanes and 80 (JT8D-209, -217, -217A) or 64 (JT8D-217C, -219) blades in the 1st stage turbine. There are 78 blades and 69 vanes in the 2nd stage turbine.

CAUTION: ENGINE INTERNAL TEMPERATURES IN EXCESS OF 149°F (65°C) MAY DAMAGE FIBER OPTIC BORESCOPE COMPONENTS. ENGINE INTERIOR MUST BE ALLOWED TO COOL BELOW 149°F (65°C) FOLLOWING ENGINE OPERATION PRIOR TO INSERTING BORESCOPE. ALLOW COOL-DOWN PERIOD ON NEWLY SHUT-DOWN ENGINE PRIOR TO INSPECTION TO ENSURE THAT PERSONNEL ARE NOT INJURED AND EQUIPMENT IS NOT DAMAGED.

(h) Allow approximately two hours after engine shutdown before beginning borescope inspection when outside temperature is approximately 75°F (24°C); allow approximately two and a half hours if outside temperature is above 80°F (27°C), and allow approximately one hour if temperature is 30°F (-1°C) or lower. Rate of cool-down can be increased by motoring engine after shutdown with starter for 30 second period.

(i) Insert borescope.

(2) Aim borescope forward and examine 1st stage turbine blades for dents, nicks, cracks, warpage, or other evidence indicating passage of foreign material, leading edge erosion, or sulfidation.

(a) If the turbine airfoils are wet with oil, this can be the result of oil leakage from the No. 4 and 5 bearing compartment. If necessary, remove the engine for repair. (ENGINE GENERAL - TROUBLESHOOTING -02 (LUBRICATION SYSTEM), PAGEBLOCK 72-00-02/101)

(b) Rotate rear compressor drive turbine rotor as necessary to bring all blades into view. Remove starter and connect PWA 10408 Adapter to gearbox starter drive to provide means of turning rotor.

(c) All blades with cracks in airfoil shall be removed from service.

(d) Blades with nicks or dents limited in depth to 0.010 in. (0.254 mm) on the leading and trailing edges and 0.005 in. (0.127 mm) for all other airfoil areas are suitable for continued service providing coating has remained intact.

(e) Loss of coating on blades is not by itself a reason for engine removal. However, sulfidation is a serious problem, follow guidelines in steps (3) and (4) below.

(f) Shroud notch areas are not permitted to be missing.

CAUTION: BLADES WHICH EXHIBIT SULFIDATION WILL DETERIORATE AT A FASTER RATE THAN THEY DID PREVIOUSLY. IT IS RECOMMENDED THAT THESE BE INSPECTED, EITHER BY BORESCOPE OR BY HOT SECTION, WITHIN THE NEXT 2000 HOURS OR 2000 CYCLES, WHICHEVER OCCURS FIRST. SUBSEQUENT INSPECTION INTERVALS SHOULD BE BASED ON INDIVIDUAL OPERATOR EXPERIENCE, DEPENDING ON RATE OF SULFIDATION. ALSO BLADES WHICH EXHIBIT SULFIDATION AND ARE CONTINUED IN SERVICE WITHOUT REPAIR MAY BE BEYOND REPAIRABLE LIMITS AT NEXT OVERHAUL.

(3) Non-aircooled (JT8D-209) 1st stage turbine blades which exhibit sulfidation may be continued in service provided the following conditions are met:

  (a) No more than 25 percent of observable blade concave airfoil surface (including underside of shroud) exhibits sulfidation blistering. Sulfidation spotting (coating degradation as opposed to actual blistering) is acceptable over entire blade.

  (b) Sulfidation on airfoil leading edge radius has not noticeably reduced blade chord.

  (c) No blade internal slots are broken through to airfoil surface on those blades that have two lightening slots in airfoil.

CAUTION: BLADES WHICH EXHIBIT SULFIDATION WILL DETERIORATE AT A FASTER RATE THAN THEY DID PREVIOUSLY. IT IS RECOMMENDED THAT THESE BE INSPECTED, EITHER BY BORESCOPE OR BY HOT SECTION, WITHIN THE NEXT 2000 HOURS OR 2000 CYCLES, WHICHEVER OCCURS FIRST. SUBSEQUENT INSPECTION INTERVALS SHOULD BE BASED ON INDIVIDUAL OPERATOR EXPERIENCE, DEPENDING ON RATE OF SULFIDATION. ALSO BLADES WHICH EXHIBIT SULFIDATION AND ARE CONTINUED IN SERVICE WITHOUT REPAIR MAY BE BEYOND REPAIRABLE LIMITS AT NEXT OVERHAUL.

(4) Air-cooled (JT8D-217, -217A, -217C, -219) 1st stage turbine blades are permitted to continue-in-service with sulfidation if:

  (a) No more than 25 percent of blade concave airfoil surface (that it is possible to see) shows sulfidation blisters. Sulfidation spots (coating deterioration, not blisters) are permitted on all of the blade.

  (b) No airfoil surface is broken through to the internal cooling cavity.

  NOTE: Current JT8D-217, -217A, -217C, -219 blades have small holes on either side of the leading and trailing edges near the shroud. These holes, either open or closed, are not important in the inspection of blade sulfidation damage.

  (c) Schedule the engine for removal after 250 hours or 200 cycles (when one of these occurs first) if:

    1) More than 75 percent of the blade airfoil leading edge has sulfidation

    or

    2) There is leading edge sulfidation which is continuous with wide areas of sulfidation on the concave airfoil surface.

  (d) If blades are not to the limits in Paragraph 22.B.(4)(a), send the engine to overhaul for repair of the rear compressor drive turbine rotor.

(5) Aim borescope rearward and examine 2nd stage turbine blades for dents, nicks, cracks, warpage, or other evidence indicating passage of foreign material, leading edge erosion or sulfidation. Rotate front compressor drive turbine rotor as necessary to bring all blades into view.

(6) Inspect all 2nd stage turbine blades for evidence that the 2nd stage turbine vane platform rubbed against the blade leading edges. With this type of damage, the rubbed areas will have sharp edges of a regular contour as shown in Figure 652. If damage is found consult ASB 5782 to determine serviceability of engine.

NOTE: ASB 5782 has information on the turbine blade airfoil leading edge rub limits. The limits on blade rub are the same for all engine models (JT8D-209, -217, -217A, -217C, -219); if there is rub on all 2nd stage blades, do not continue the engine in service.

ASB 5782 does not have platform flow guide rub limits because this type of rub is superficial and does not have an effect on the structural quality of the blade. If you find rub only on the platform flow guide, do not reject engine. Platform flow guide rub can also be the result of tolerance controls between the blade and vane and will not be found on all engines. Platform flow guide rub is usually found on the ramp area of the flow guide approximately 0.100 inch (2.540 mm) forward of the airfoil leading edge. (Figure 652) (Figure 654)

(7) Examine all 2nd stage turbine blades for leading edge areas rubbed by a 2nd stage Low Pressure Turbine (LPT) seal which moved rearward out of its slot in the vane platform. With this type of damage, the seal touches the blade without very much force. The edges of the rubbed area are rounded and without sharp edges. This type of damage is permitted if the depth of the damage is less than 0.040 inch (1.016 mm). As with vane areas, because of vane contact (see above), rubbed areas on the upper surface of the blade root platform ("flowguide") contact with a vane seal is very minor. If rub is found on the platform flow guide, do not reject the engine. (Figure 654)

(8) If a turbine blade shows damage which is more than is permitted for continued service, remove the engine to make a careful inspection of the blades as possible.

NOTE: Blades are permitted to continue-in-service if they are in the limits for inspection specified in the JT8D-200 Engine Manual (PN 773128). Blend repairs done to blades during a shop visit and part disassembly/overhaul will be apparent during subsequent gaspath inspection. It can be necessary to refer to the Engine Manual to identify blade areas repaired and accepted during part overhaul done before. These areas will have smooth contours and the length-to-depth ratio of these areas will be approximately six to one. Blades with these engine manual repairs are serviceable.

(9) Using borescope, inspect 2nd stage turbine vanes for loss of coating, leading or trailing edge cracks, and/or melting.

(10) If vanes are not acceptable, they shall be removed for further inspection and repair.

(11) Remove borescope and inspect edges of borescope access ports in fan ducts for cracks.

(12) Prepare instrumentation boss cover for installation as follows:

(a) Thread PWA 45248 Puller into cover to facilitate handling cover.

(b) On P/N 775961 Cover ensure that sealing ring is centralized so as not to jam when cover is installed.

NOTE: As shown in Figure 650, P/N 792712 centering ring may be used inside sealing ring to take up internal space in ring groove of P/N 775961 cover, facilitating centering of outer ring. Subsequent P/N 792710 cover does not require optional use of centering ring.

(c) The large chamfer on the P/N 807417 seal ring must face towards the tip of the cover shank. (Figure 650)

(13) On JT8D-217C or -219 engine Pre SB 6045 position instrumentation plug on end of PWA 46018 Puller/Driver and insert plug into borescope port so that 90 degree counterclockwise turn will bring larger locking lug to point rearward and inner tip of plug will incline to rear, matching contour of gaspath. Turn plug 90 degrees counterclockwise to lock plug into base of turbine vane. Unthread and remove puller/driver.

CAUTION: ON JT8D-217C OR -219 ENGINE PRE-SB 6045, IF COVER MEETS RESISTANCE DURING INSTALLATION, INSPECT INSTRUMENTATION PLUG FOR PROPER POSITIONING. WHEN YOU INSTALL A CURRENT (ONE-PIECE) COVER ASSEMBLY (ANY PART NUMBER) BE SURE TO ALIGN THE ANGULAR TIP AND BOLTS CORRECTLY. THE TIP MUST MAKE A SMOOTH AND CONTINUOUS SURFACE WITH THE GAS PATH AS SHOWN IN THE ILLUSTRATION. THE COVER BOLTS CAN ONLY BE INSTALLED IN ONE DIRECTION IN THE CASE BOSS.

(14) Install the cover assembly as follows:

(a) As an optional procedure, apply PWA 36246 anti-seize paste to the threads of the instrumentation boss bolts. Refer to 70-00-00, Page 201.

NOTE: The self-locking bolts on the instrumentation boss are silver-plated to prevent thread seizure, but it is possible after more than on removal and installation that this plate may no longer have this effect. To prevent thread seizure, it is optional to apply anti-seize paste to the bolt threads. Torque the bolts to the correct torque for the anti-seize-coated 0.250-28 thread. Refer to 70-00-00, Page 201.

(b) JT8D-209, -217, -217A engines with the small 0.562 - 0.563 inch (14.275 - 14.300 mm) diameter instrumentation boss on the engine: Use P/N 775961 or 792710 cover assembly.

(c) All engines with the large 0.720 - 0.721 inch (18.288 - 18.313 mm) diameter instrumentation boss on the engine: Use P/N 808160 cover assembly.

(d) All JT8D-217C, -219 engines must use P/N 800534 cover assembly.

NOTE: On Pre SB 6045 engines a modification is permitted which assembles the inner plug to the cover with a rivet (this can be necessary when there is damage to the 2nd stage vane flange which holds the plug). See Figure 651for a view of this modification. With this type of plug and cover, install the plug and cover assembly with the same procedure and tool as used for a cover only. Be sure to point the arrow on the cover outer surface in the forward direction (this will align the inner surface of the plug with the gaspath).

(e) Align the bolts with the boss bolt holes.

(f) Remove the installation tool.

(g) Tighten and torque the bolts. Be sure to use the correct torque if the bolts got anti-seize paste (see the Note above). 62-72 in-lb (7.01 - 8.14 N.m).

(15) Post SB 6053: Move the containment shield cover into position and install the corner clamp bolts. Torque the bolts to the standard torque.

CAUTION: BE CAREFUL NOT TO LET THE BOLTS OR THE COVER FALL INTO THE ENGINE WHEN THE COVER AND BOLTS ARE INSTALLED.

(16) Post SB A6346: Install containment shield cover as follows:

(a) Move cover into position with threaded rod used for removal.

WARNING: USE THE HAZARDOUS MATERIAL WARNINGS GIVEN BELOW FOR THE STEPS THAT FOLLOW.

THE HAZARDOUS MATERIAL WARNINGS ARE LISTED AFTER THE INTRODUCTION SECTION IN THE FRONT OF THE AMM.

Hazardous Material Warnings

HAZMAT 1080, LUBRICANT/MOLYBDENUM DISULFIDE DISPERSION (DPM 5309)

HAZMAT 1000, REFER TO MSDS

(b) Apply PWA 36246 anti-seize compound to the threads and remove the unwanted paste.

(c) Install six bolts to attach cover to containment shield.

(d) Torque bolts to 515 in-lb (58.187 N·m) - 575 in-lb (64.966 N·m).

(17) Position inner fan duct cover in place and turn fasteners to secure cover. Torque fasteners to 40 - 60 in-lb. (4.519 - 6.779 N·m).

(18) Install cover in fan duct, using new packing coated with PWA 36500 Assembly Fluid. Bolt cover in place and torque bolts.

NOTE: PWA 36500 Assembly Fluid is available as:

Ultrachem Assembly Fluid #1 from Ultrachem Inc.

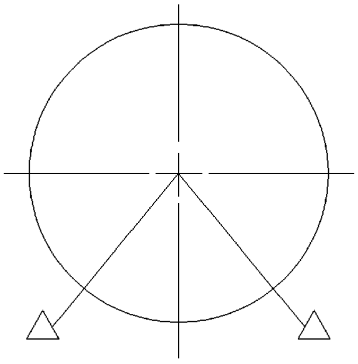
Wilmington, DE 19899

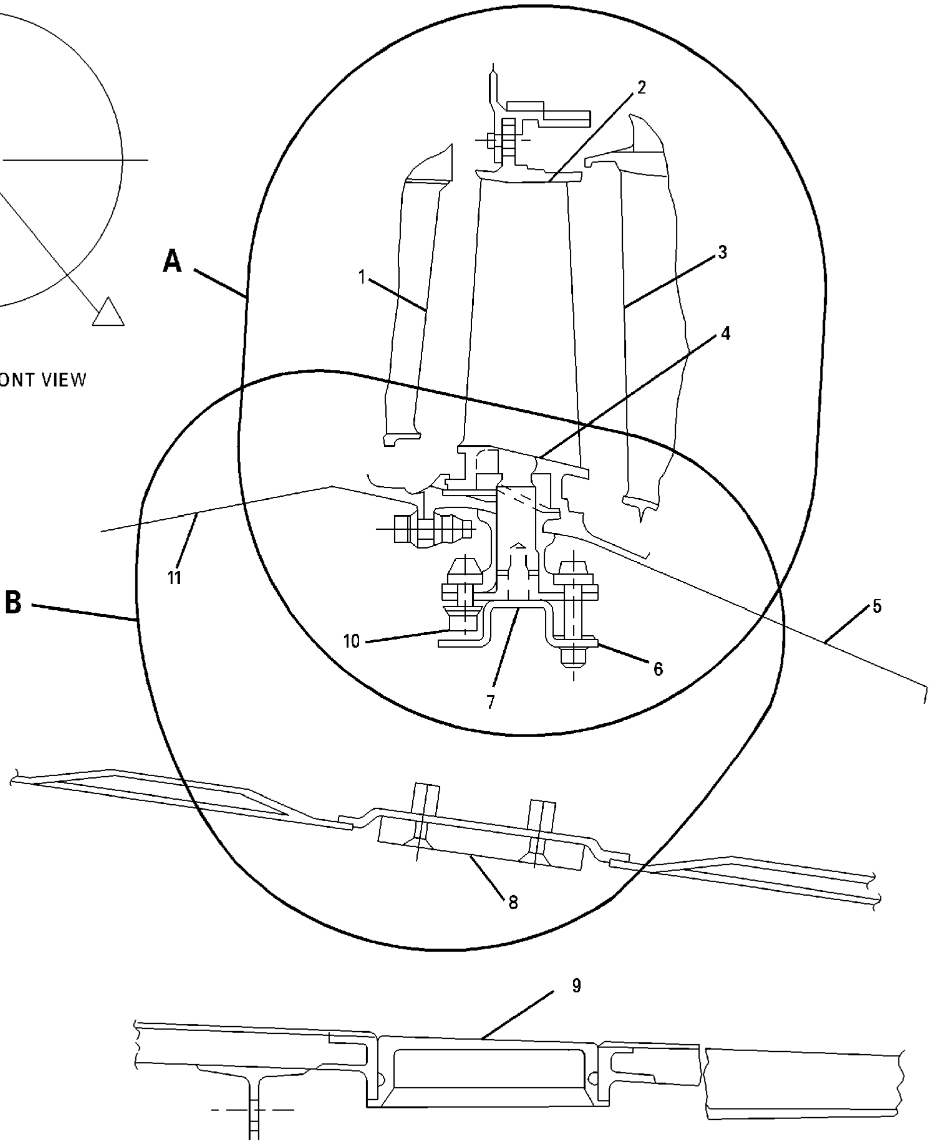
or

Royco HC825 from

Royal Lubricants Co., Inc.

East Hanover, NJ 07936

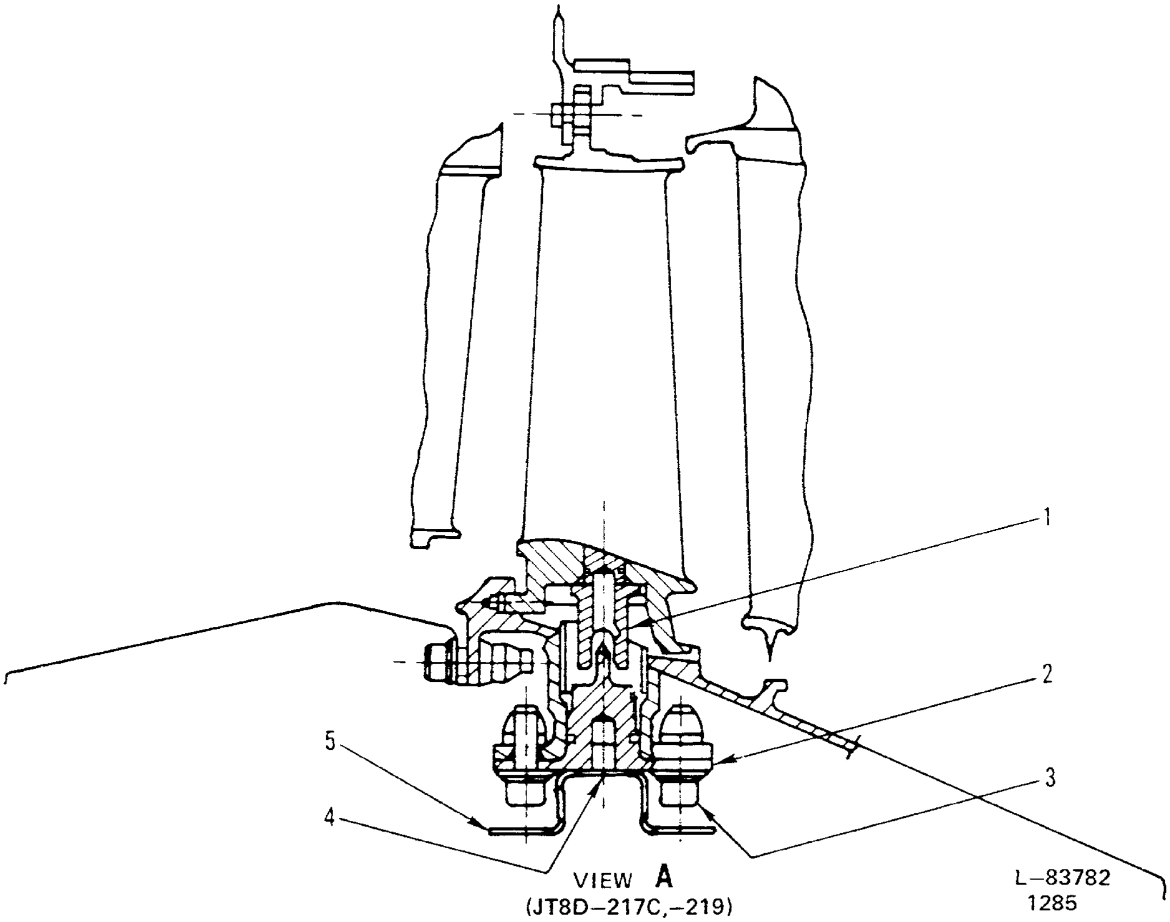




CAG(IGDS)

BBB2-72-218A

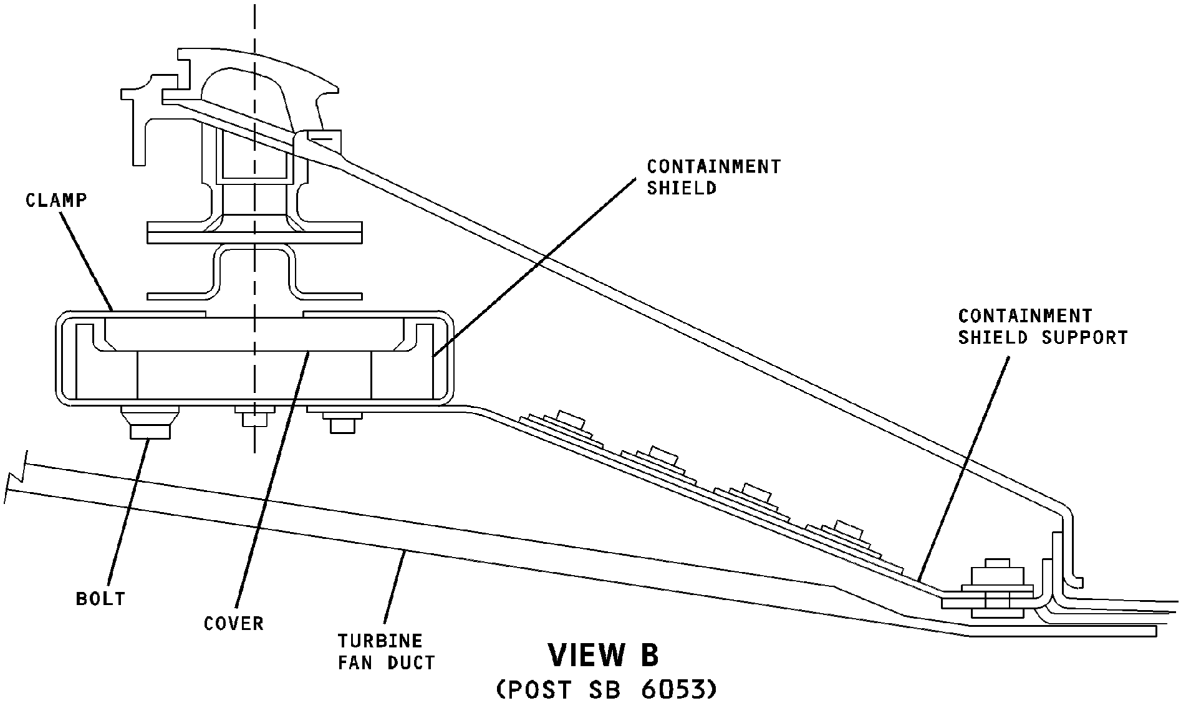
Turbine Blade And Second Stage Vane Borescope Check
Figure 646/72-00-00-990-A32

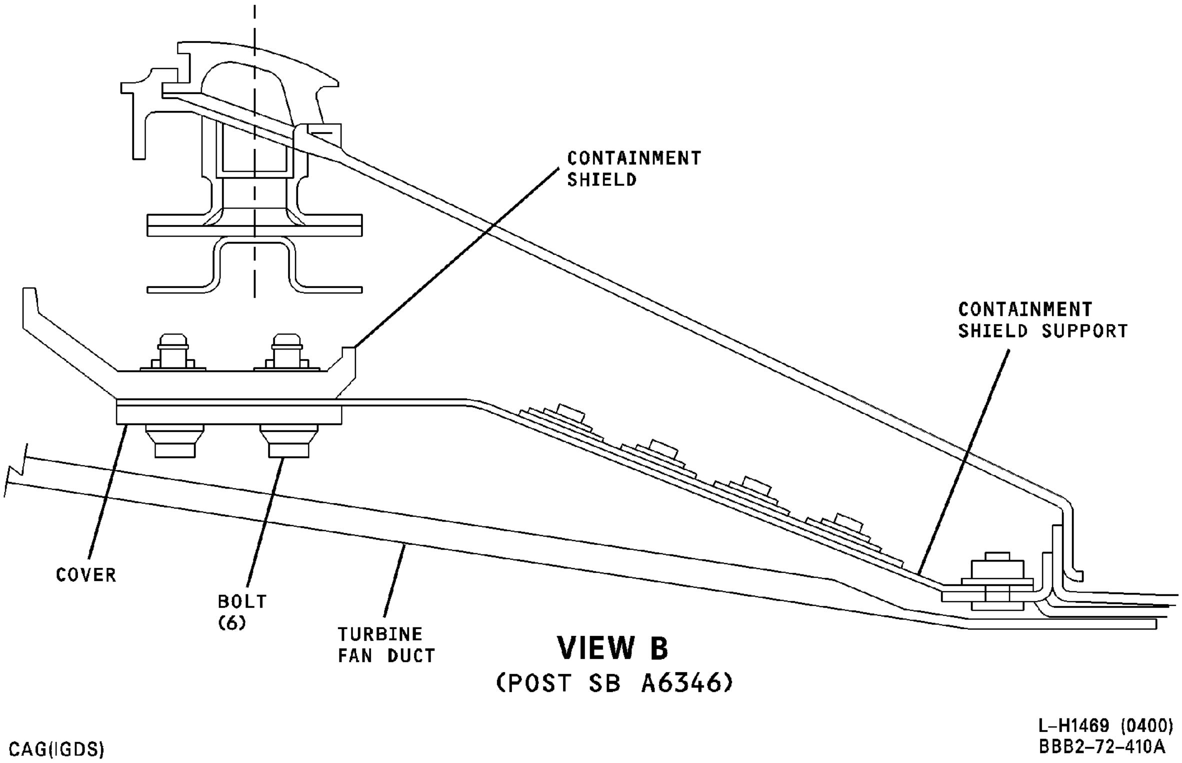


1. Instrumentation Plug
2. Instrumentation Cover
3. Bolt (Two)
4. Threaded Hole (Install Puller In This Hole)
5. Bolt Retaining Bracket

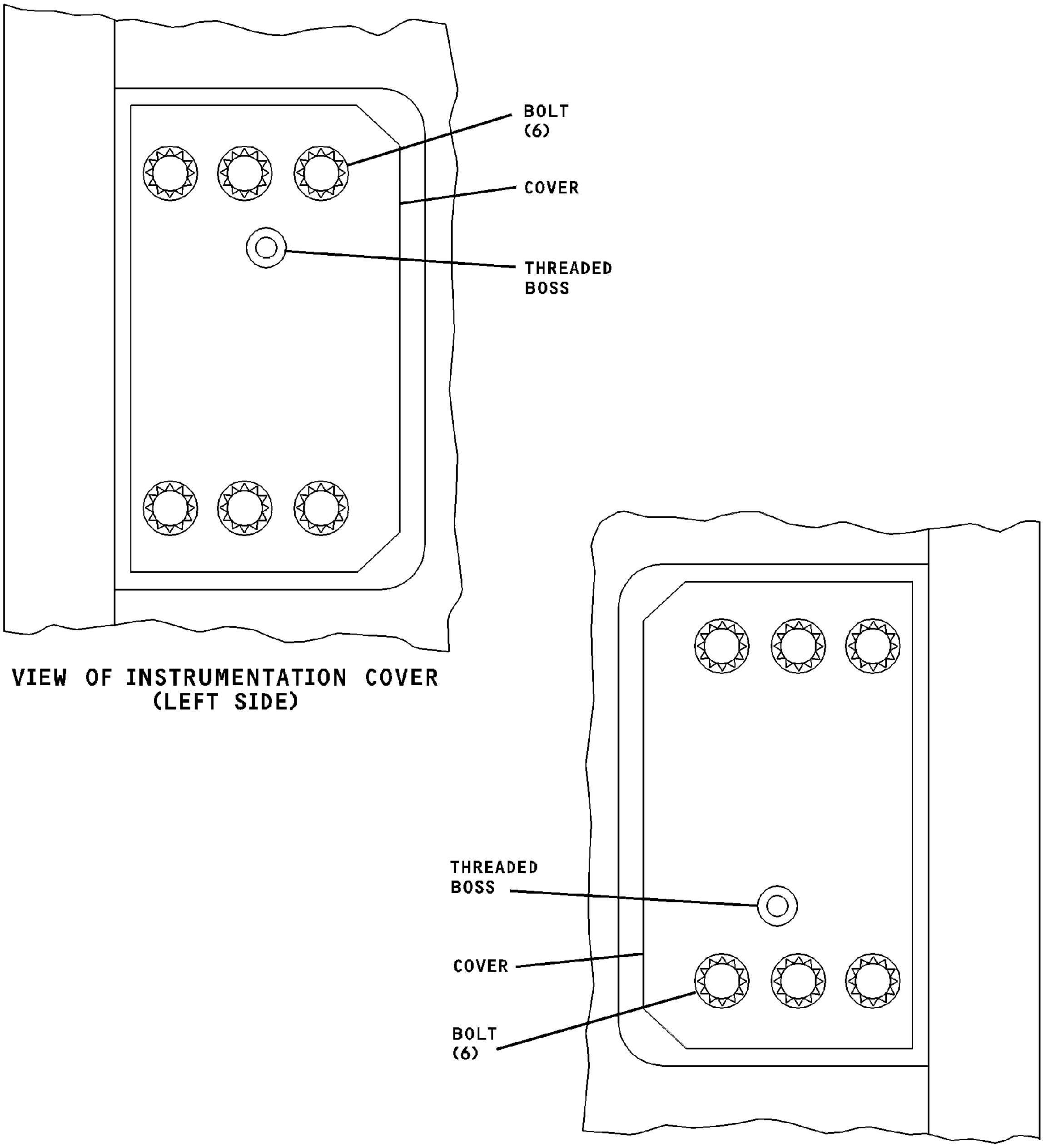
BBB2-72-219

Turbine Blade And Second Stage Vane Borescope Inspection (Pre SB 6045)
Figure 647/72-00-00-990-A33





Turbine Blade And Second Stage Vane Borescope Inspection (Post SB 6053)
Figure 648/72-00-00-990-A34



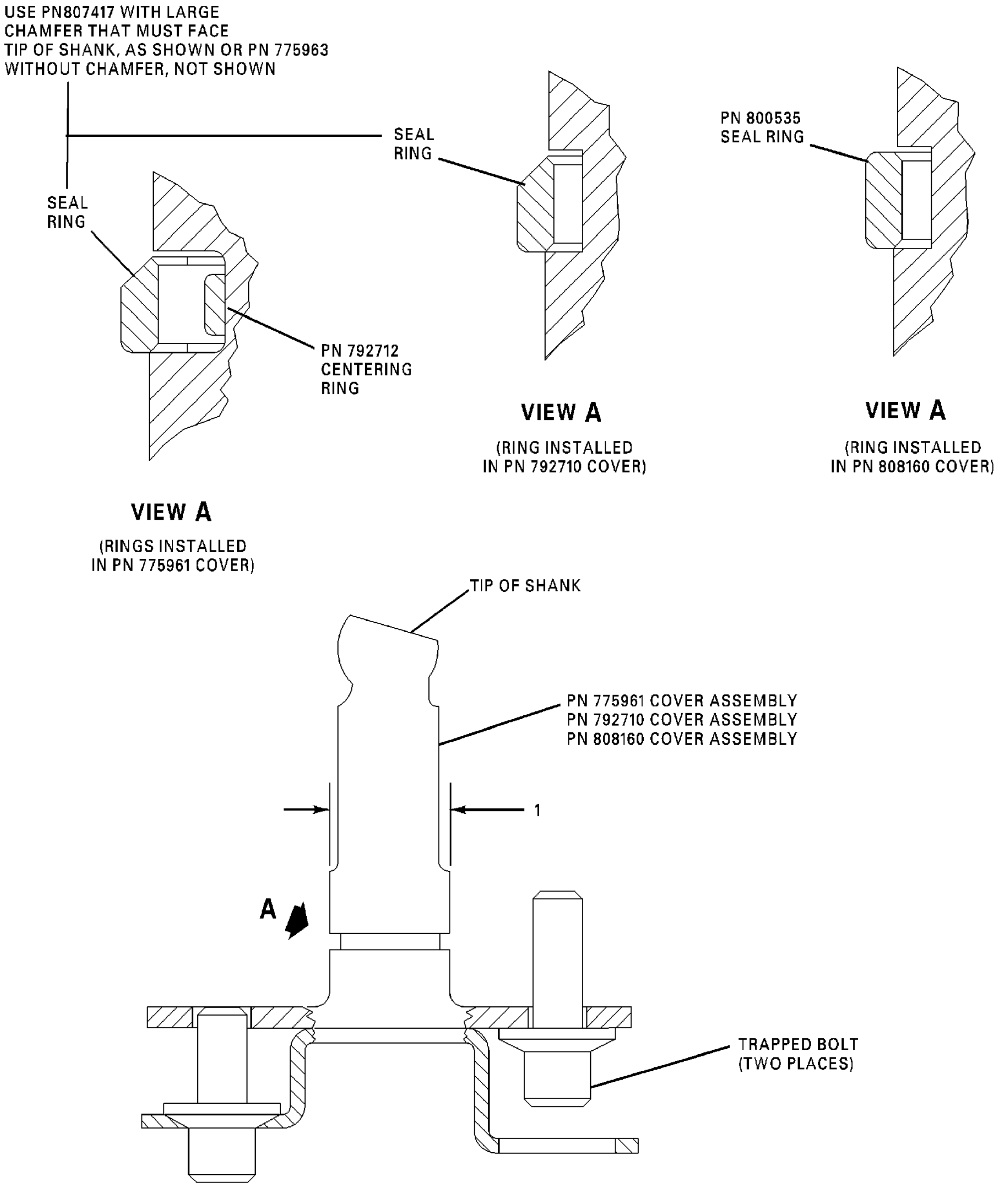
VIEW OF INSTRUMENTATION COVER
(LEFT SIDE)

VIEW OF INSTRUMENTATION COVER
(RIGHT SIDE)

CAG(IGDS)

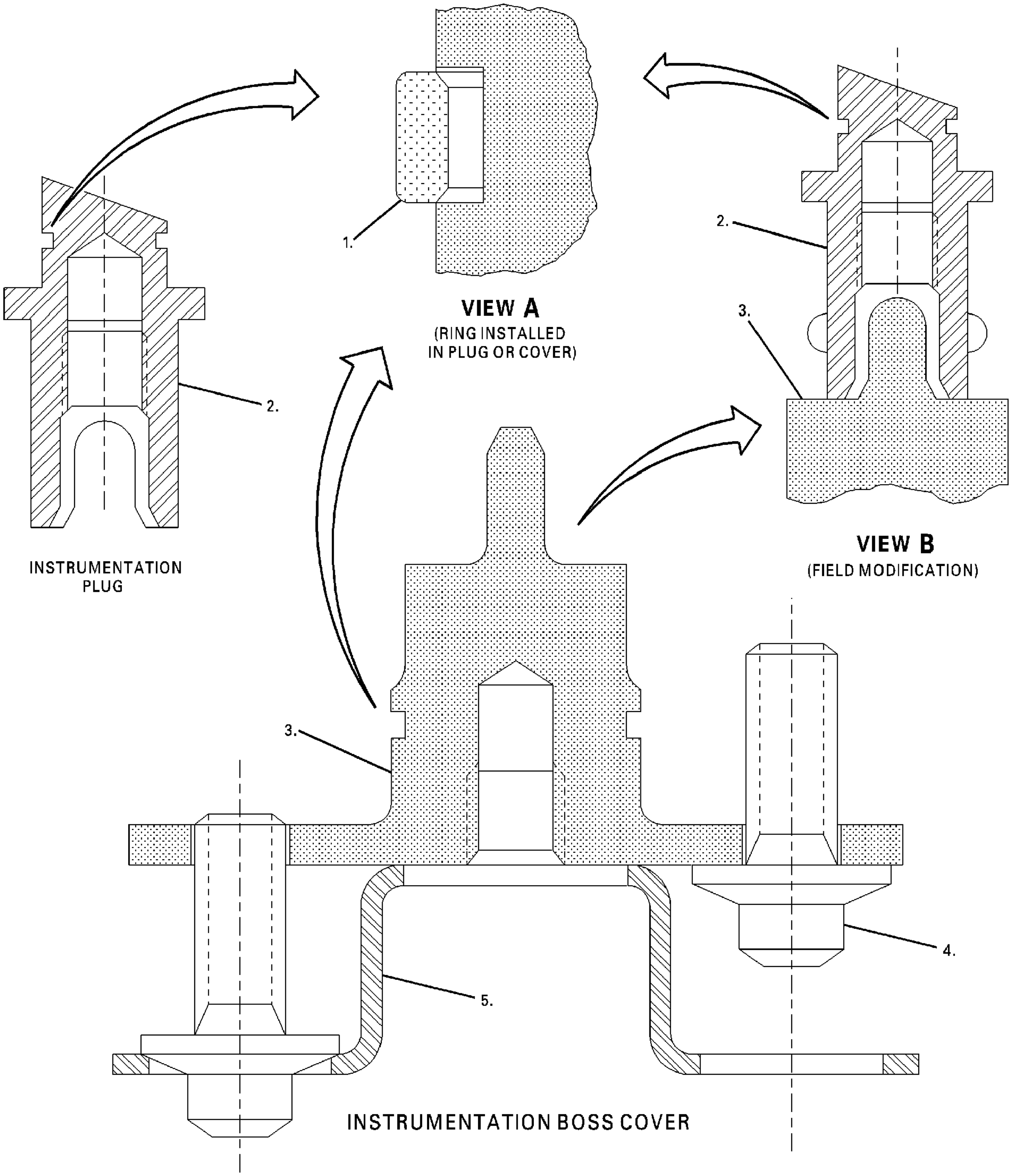
L-H4172 (0400)
PW V
BBB2-72-562

Turbine Blade And Second Stage Vane Borescope Inspection (Post SB A6346)
Figure 649/72-00-00-990-A35



1. 0.562 – 0.563 inch (14.275 – 14.300 mm) FOR PN 775961 OR 792710 COVER ASSEMBLY.
0.720 – 0.721 inch (18.288 – 18.313 mm) FOR PN 808160 COVER ASSEMBLY.

Turbine Blade and Second Stage Vane Borescope Inspection
Figure 650/72-00-00-990-A36



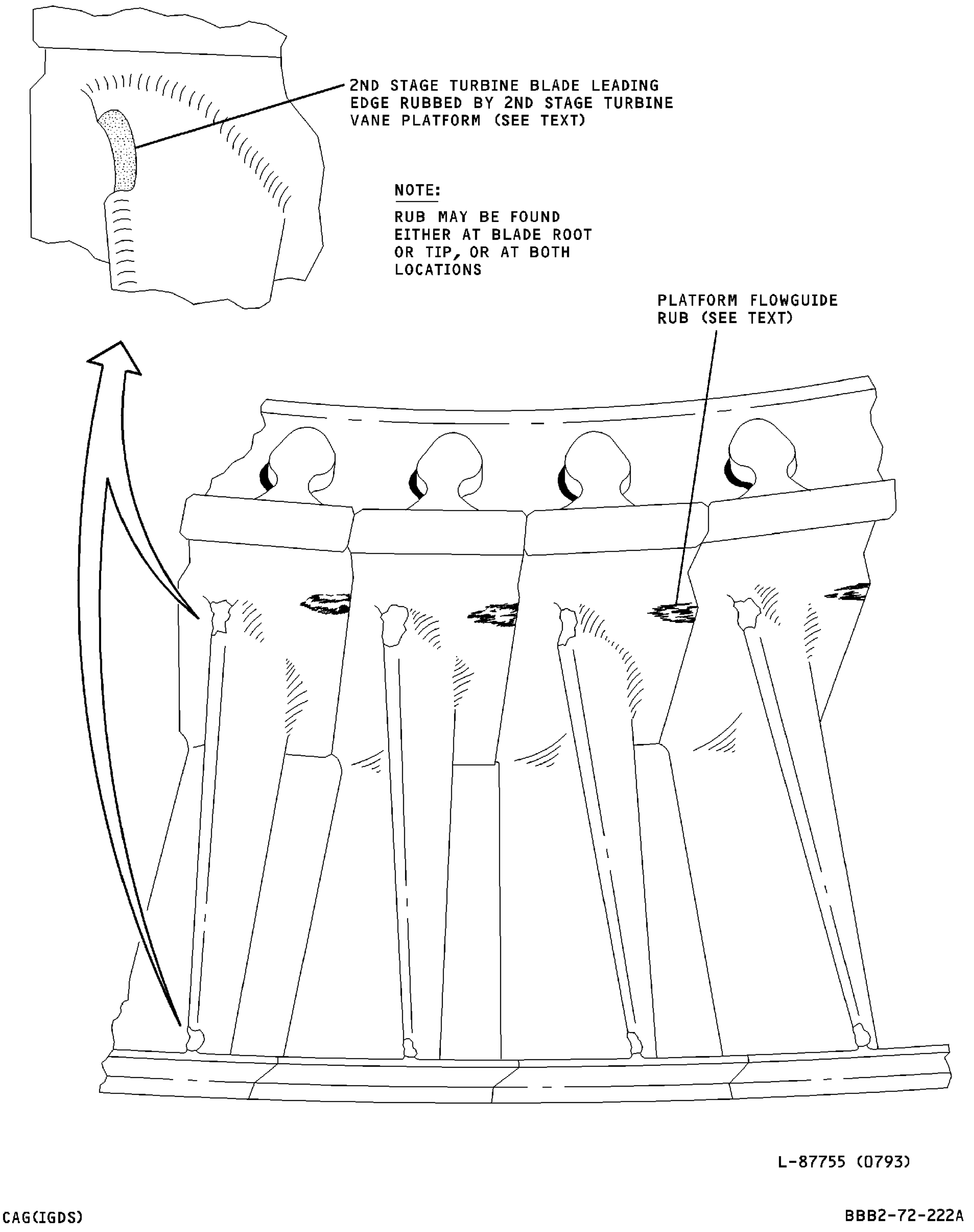
1. SEAL RING (PN 800543 FOR THE PLUG, PN 800535 FOR THE COVER)
2. PLUG
3. COVER ASSEMBLY (PN 800534)
4. BOLT (TWO)
5. BRACKET

L-H1870

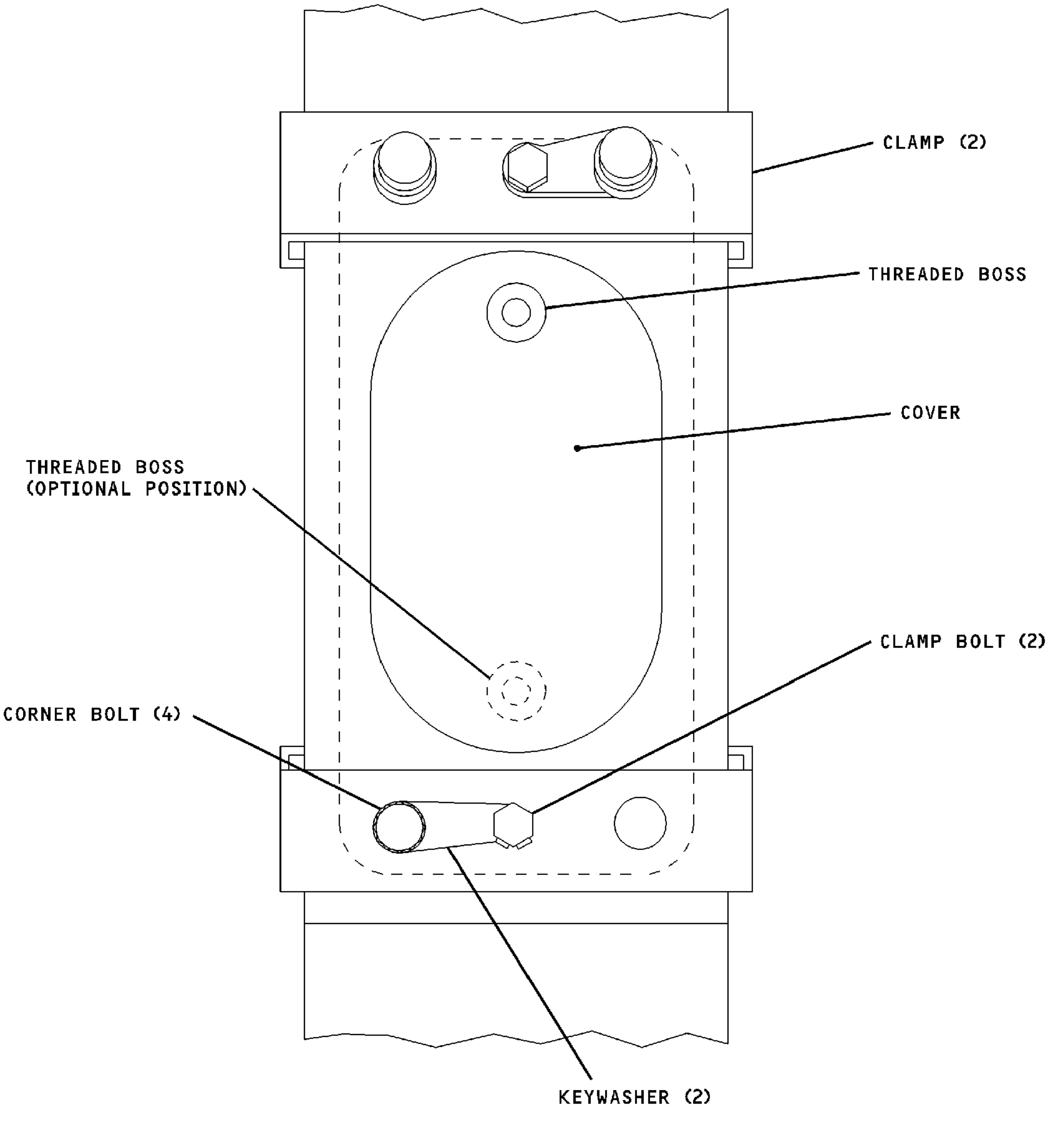
CAG(IGDS)

BBB2-72-221A

Turbine Blade And Second Stage Vane Borescope Inspection (JT8D-217C, -219 Pre SB 6045)
Figure 651/72-00-00-990-A37



Turbine Blade Borescope Inspection
Figure 652/72-00-00-990-A38



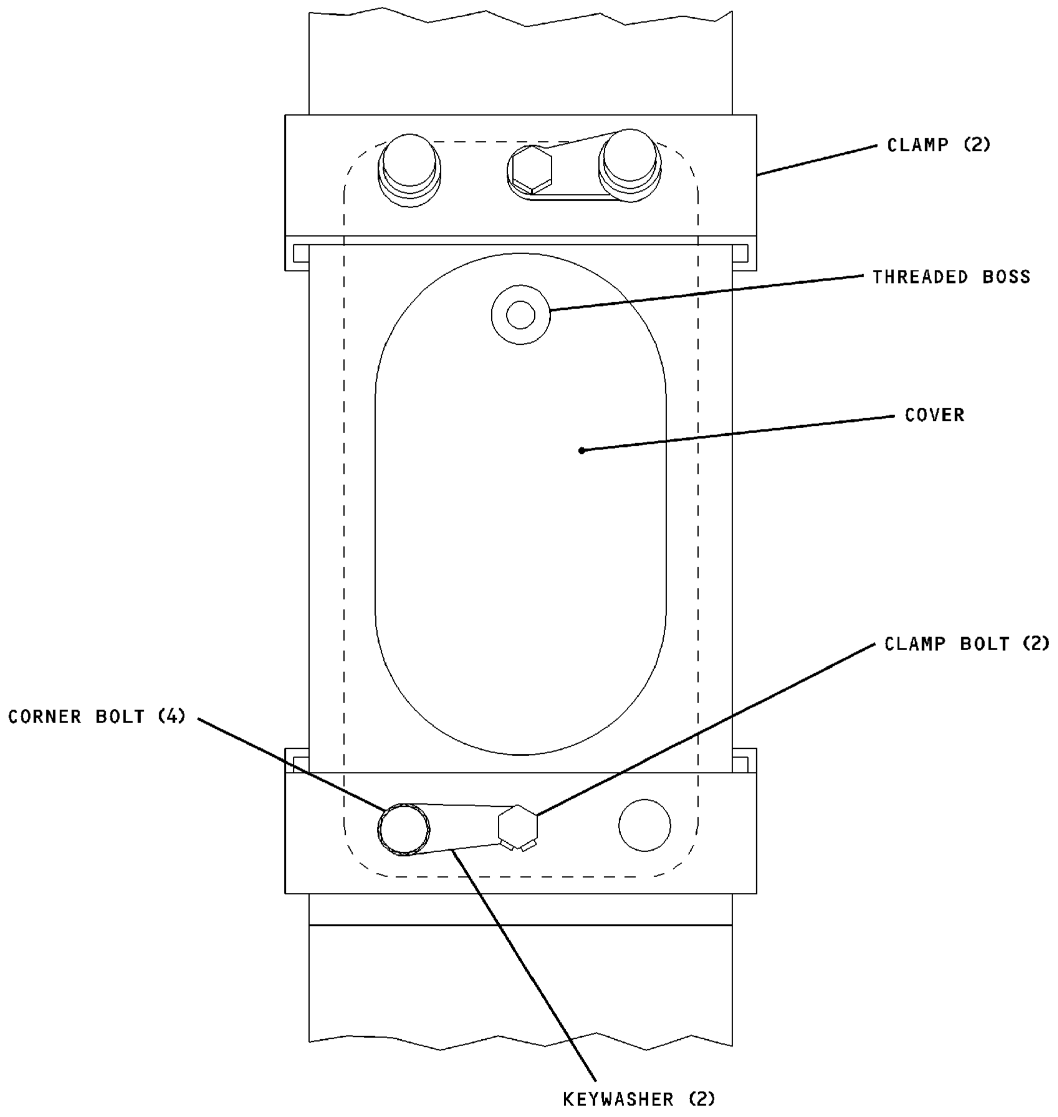
VIEW OF INSTRUMENTATION COVER
(RIGHT OF LEFT SIDE)

L-H1989 (0796)

CAG(IGDS)

BBB2-72-457A

Turbine Blade and Second Stage Vane Borescope Inspection (Post SB 6053)
Figure 653/72-00-00-990-A39 (Sheet 1 of 2)



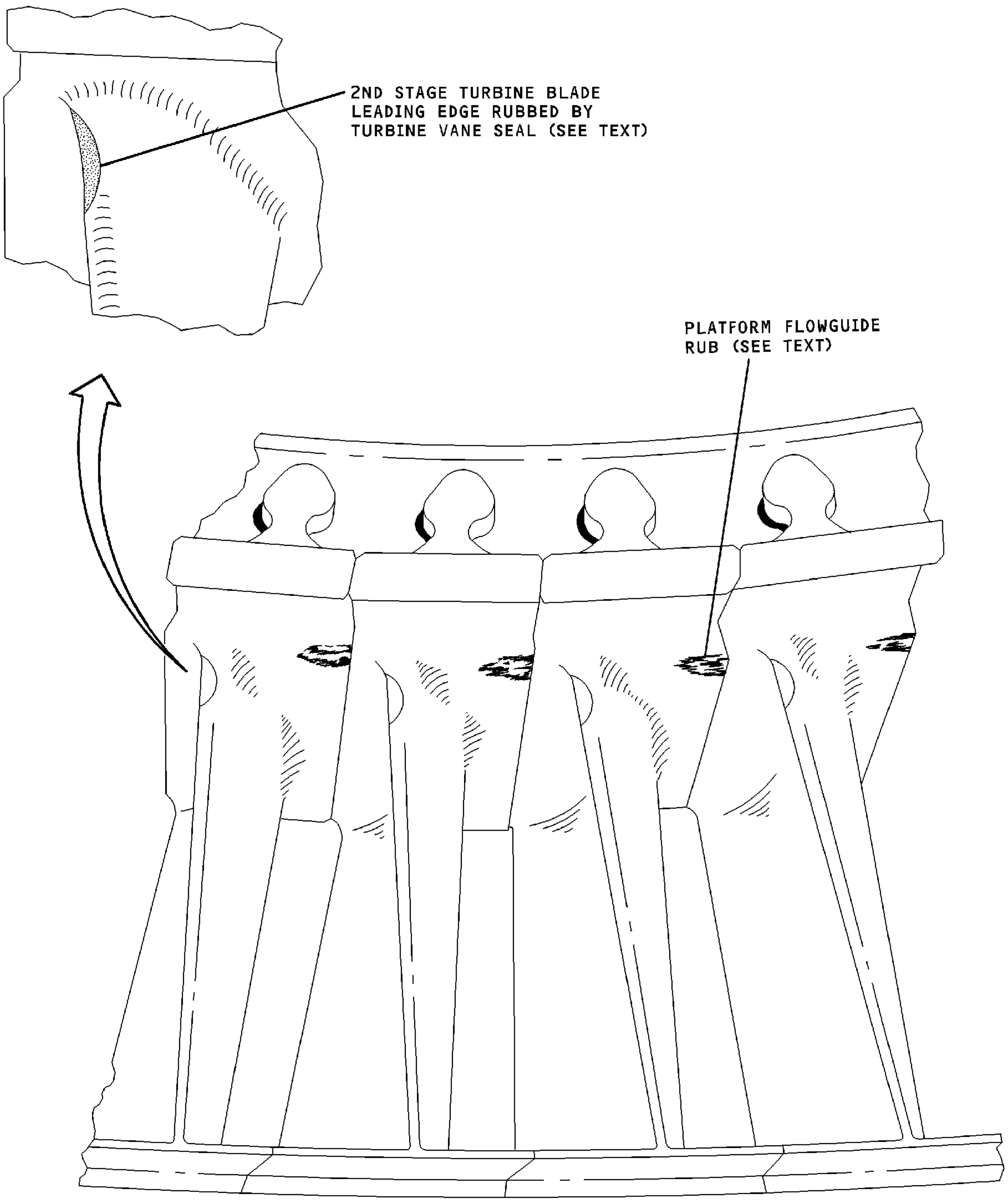
VIEW OF INSTRUMENTATION COVER
(RIGHT OF LEFT SIDE)

L-H1989 (0796)

CAG(IGDS)

BBB2-72-519

Turbine Blade and Second Stage Vane Borescope Inspection (Post SB 6053)
Figure 653/72-00-00-990-A39 (Sheet 2 of 2)



CAG(IGDS)

BBB2-72-458

Turbine Blade Borescope Inspection
Figure 654/72-00-00-990-A40

23. Inspect 3rd and 4th Stage Turbine Blades

A. Equipment And Material Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

Table 608 VISUAL INSPECTION (4th Stage)

Nature Of Inspection	Inspection Time			
	Routine	Minor	Major	Remarks
Dents, Nicks, or Other Evidence of Foreign Object Damage	X	X	X	Visually inspect with bright light and rotate rotor to bring all blades into view. (there are 58 blades and 75 vanes in the 4th stage)

C. Shroud Tightness Inspection

(1) Refer to SB A6224 for 3rd an 4th stage turbine blade shroud tightness inspection requirements. This service bulletin has procedures, limits, and engine management requirements to make sure that the turbine blades continue to be serviceable.

(2) Refer to SB 6416 for inspection procedures applicable to 4th stage turbine blade shroud condition. Examine the 4th stage blades for fractures at the convex (aft) side at the airfoil/outer shroud area.

24. Inspect Turbine Exhaust Case Struts

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

Table 609

Nature Of Inspection	Inspection Time			
	Routine	Minor	Major	Remarks
Distortion, Nicks, Or Erosion	X	X	X	Use bright light inspect rear of engine.

(1) Remove surface damage to the struts with the procedure in PAGEBLOCK 72-54-33/801.

(2) Continued engine operation with repaired surface damage to the struts is permitted if the repair to remove the damage has a depth of no more than 0.075 inch (1.905 mm).

25. Inspect Main Accessory Gearbox Assembly

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

Table 610

Nature Of Inspection	Inspection Time			
	Routine	Minor	Major	Remarks
Check For Oil Leaks		X	X	

26. Inspect No. 4 Bearing Air Check Valve

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

(1) Remove No. 4 bearing air check valve per PAGEBLOCK 72-38-81/401.

(2) Inspect for coke deposits and freedom of ball valve movement.

(3) Disassemble, clean, and assemble valve per NO. 4 BEARING AIR CHECK VALVE, SUBJECT 72-38-81, Repair-01.

(4) Install valve per PAGEBLOCK 72-38-81/401.

27. Inspect PT7 Manifold Condensation Trap

NOTE: See SUBJECT 77-11-04.

28. Hot Section Inspection With A Flexible Fiberoptic Borescope (Applicable Only When Specified Overtemperature Has Occurred)

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure

NOTE: Its permitted to use this procedure only as an alternative procedure for specified overtemperature. Refer to the applicable overtemperature limits shown in ENGINE GENERAL, SUBJECT 72-00-00, Page 501.

WARNING: DO BORESCOPE INSPECTION IN AN AREA WHICH HAS PROTECTION FROM THE WEATHER. IF A BORESCOPE INSPECTION IS DONE IN WET CONDITIONS, USE SUFFICIENT PROTECTION TO PREVENT DAMAGE TO EQUIPMENT OR POSSIBLE ELECTRICAL SHOCK TO THE OPERATOR.

CAUTION: ONLY A PERSON WITH THE APPROVED TRAINING CAN DO THIS PROCEDURE AND GIVE THE CORRECT CONDITION OF THE PARTS. YOU MUST EXAMINE ALL THE PARTS WITH THIS BORESCOPE PROCEDURE. DO NOT MAKE A SAMPLE INSPECTION.

(1) Make an inspection of the combustion chambers from inside the chambers with a flexible fiberoptic borescope. See Paragraph 19. for special equipment and procedure.

(a) Examine each combustion chamber for metal that has melted, burning, cracks and distortion. See Paragraph 19. and Paragraph 20..

(b) Make an inspection of each fuel nozzle and fuel nozzle nut for damage. See limits in Paragraph 21..

(c) Make an inspection of the inner and outer walls of the outlet ducts for damage. See limits in Paragraph 21..

(d) Make an inspection of the 1st stage turbine vanes. See limits in Paragraph 21..

(2) Make an inspection of the 1st stage turbine blades by one of the two procedures as follows:

  (a) Examine the 1st stage turbine blades through the 2nd stage borescope port. See limits in Paragraph 22..

    1) Put the borescope through one of the 2nd stage borescope ports.

    2) Turn the N_2 rotor and examine each blade.

  (b) Examine the 1st stage turbine blades from the combustion chamber. See limits in Paragraph 22..

    1) Put the flexible fiberoptic borescope in the combustion chamber. Refer to Paragraph 28.B.(1).

    2) Put the flexible fiberoptic borescope between the 1st stage turbine vanes.

    3) Turn the N_2 rotor and examine all the 1st stage blades.

    NOTE: There are 80 (JT8D-209, -217, -217A) or 64 (JT8D-217C, -219) blades in the 1st stage turbine.

(3) Make an inspection of the 4th stage turbine blades with a borescope. See limits in Paragraph 23..

(4) Make an inspection of the 2nd stage turbine vanes with a borescope (for ground starting overtemperature only). Refer to SUBJECT 72-00-00, Page 501 and Paragraph 22..

(5) Make an inspection of the 2nd stage turbine blades with a borescope (for ground starting overtemperature only). Refer to SUBJECT 72-00-00, Page 501 and Paragraph 22..

NOTE: There are 78 blades in the 2nd stage turbine rotor.

29. No. 4 Bearing Scavenge Tube Oil Temperature Indicator Inspection

NOTE: If the engine is installed in a Boeing MD-80 aircraft and does not have SB 5945 and SB 5514 (Revision 7 or subsequent) parts, be sure to do inspection procedures in ASB 5944 (Revision 5 or subsequent) before you continue to operate engine.

30. Exhaust Duct Strut Rod Looseness Check (Mounted Engine)

A. Equipment And Materials Required

  (1) Support Equipment - None

  (2) Consumables - None

B. Procedure

  (1) Examine the turbine exhaust duct strut rod for looseness as follows:

    (a) It is permitted to have looseness at one or two exhaust strut rod positions after the engine is attach to the rear mount if the safety wire at the nut is still attached. If the safety wire is still attached, the cause for looseness is strut rod nut movement.

    (b) If the strut rod nut lockwire is broken, do the applicable procedures as follows:

      1) If the lockwire is broken but the nut is tight, install a new lockwire.

      2) If the lockwire is broken and the nut is loose, tighten the nut to 5 - 10 in-lb. (0.565 - 1.130 N·m) and lockwire. It is permitted to continue the engine in service until it is necessary to remove the turbine exhaust case and duct assembly. Make a record to show when the exhaust case and duct assembly is removed, it is necessary to torque the strut rod nuts again to the initial limits.

31. Turbine Exhaust Case Vane Crack Inspection

A. Equipment And Materials Required - None

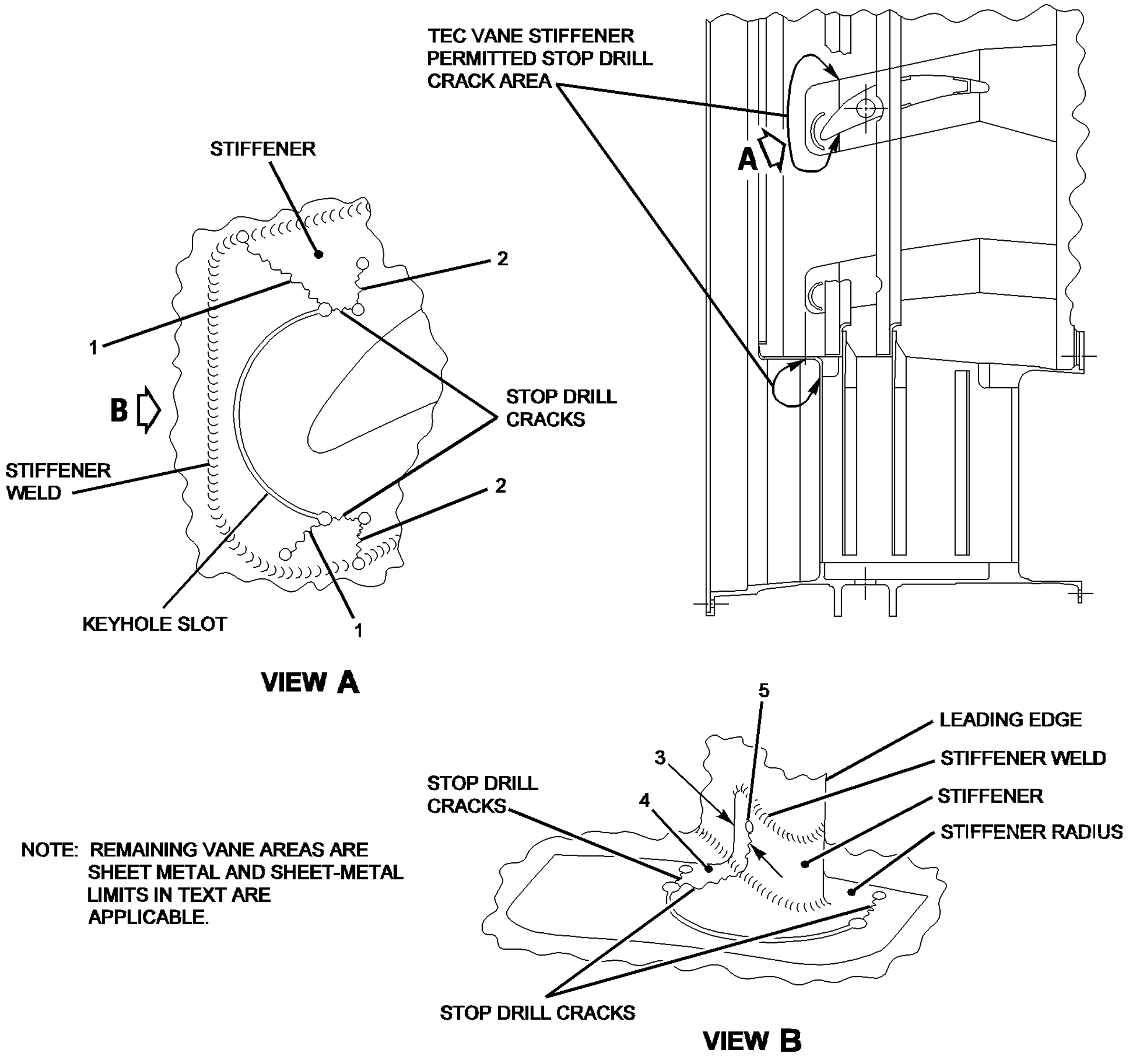
B. Procedure

(1) Examine the flowpath vanes in the turbine exhaust case for cracks. Refer to (Figure 655) for inspection areas. Parts can continue in service with these limits:

  (a) Vanes with cracks a maximum of 1.000 inch (25.4 mm) in length are permitted if they are fully contained in the stiffener and it is not very possible that material will immediately come free. Examine these parts again at the subsequent A Check or at each 750-hour interval (whichever occurs first).

  (b) If cracks are more than the above limit, they must get stop-drill repair before the case can continue in service. Refer to 72-54-01-8, Repair-01 for limits, repair procedures and re-inspection intervals.

  (c) All cracks in the sheet metal part of the vane must get stop-drill repair. Refer to 72-54-01-8, Repair-01 for limits, repair procedures and re-inspection intervals.



NOTE: REMAINING VANE AREAS ARE SHEET METAL AND SHEET-METAL LIMITS IN TEXT ARE APPLICABLE.

LEGEND:

1. CRACK THAT STARTS AT END OF KEYHOLE SLOT AND GOES ADJACENT TO OR HALFWAY ACROSS STIFFENER WELD (REPAIR BY STOP-DRILL)
2. CRACK THAT STARTS AT END OF OLD STOP-DRILL HOLE (DRILLED IN PREVIOUS REPAIR) AND GOES ADJACENT TO OR HALFWAY ACROSS STIFFENER WELD (REPAIR BY STOP-DRILL)
3. 5/16 in. (7.938 mm) MINIMUM DISTANCE TO EDGE OF WELD
4. ONE CRACK PERMITTED FOR EACH STRUT THROUGH STIFFENER RADIUS
5. REFER TO 92-54-01 REPAIR 01 FOR DRILL BITS NECESSARY AT THIS LOCATION

L-H8426 (0109)
PWV

BBB2-72-630
S0000335199V1

Turbine Exhaust Case Vane Crack Inspection
Figure 655/72-00-00-990-C52

32. Birdstrike (Foreign Object Damage - FOD) Inspection

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables

Gloves, Plastic Polyethylene or Equivalent

B. Procedure

WARNING: THERE IS A POSSIBLE HEALTH RISK TO PERSONNEL WHO DO MAINTENANCE TASKS AFTER A BIRD STRIKE. THE SAFETY MEASURES THAT FOLLOW ARE RECOMMENDED.

- USE DISPOSABLE GLOVES (P05-198).
- USE A DISPOSABLE COVERALL IF THERE IS A RISK OF CONTACT WITH BIRD REMAINS WHEN CLEANING.
- DO NOT USE PRESSURIZED AIR OR WATER TO CLEAN THE PART OF THE ENGINE THAT WAS HIT BY THE BIRD.
- REMOVE THE BIRD REMAINS AND PUT THEM IN A PLASTIC BAG.
- DO NOT TOUCH THE FACE, EYES, NOSE, ETC. WITH YOUR GLOVES.
- REMOVE THE GLOVES AND THE DISPOSABLE COVERALL (IF USED) AND PUT THEM IN THE SAME PLASTIC BAG AS THE REMAINS. SEAL THE BAG.
- DISCARD THE BAG WITH THE SAME PROCEDURE USED FOR USUAL GARBAGE.
- CAREFULLY WASH YOUR HANDS WITH SOAP AND WATER.

(1) In the event of a suspected or reported birdstrike, visually inspect the inlet area for damage:

NOTE: Signs of birdstrike can be difficult to find, especially with the passing of time or when weather conditions interfere. Even a small amount of organic material in the inlet is strong evidence of a birdstrike. Bird remains are usually found on the inner surfaces of the rear (concave side) shrouds of low pressure compressor vanes and linkages.

NOTE: Inspection of the inlet area must be guided by a pattern of bird remains to find possibly damaged areas. Fan exit guide vanes and low pressure inlet should be checked in addition to the fan blades and inlet cone.

(2) If any or all of the areas below have damage that are in serviceable limits, but show signs that a bird (object) was ingested through the core engine, do a borescope of the HPC:

(a) Damage to fan blades in area located adjacent to core engine.

(b) Bird remains (damage) on compressor inlet vanes.

(c) Crew report of bird smell in cockpit, etc.

(d) The incident resulted in a surge followed by abnormal engine parameters.

ENGINE GENERAL - CLEANING-01

1. General

A. This procedure has the cleaning of the engine gaspath (with or without detergent) for better engine performance. The procedure includes:

- Clean engine gaspath (water only) for performance improvement - nozzle (hook) method
- Clean engine gaspath for performance improvement (Alternate to Water Wash) - EcoPower (TM) method
- Clean engine gaspath (with detergent) for performance improvement - nozzle (hook) method
- Clean engine gaspath (water only) for performance improvement - hose method
- Turbine wash procedure (optional).

B. It is not necessary to clean all the inner area of the engine on a regular schedule. It is necessary to clean the internal gaspath on a regular schedule to remove the airborne contamination that has collected. This contamination is usually removed by use of the fan blade wash or the engine gas path (core) wash system.

C. Unless different instructions are given, these procedures are the same for both engines.

2. Equipment and Materials

NOTE: Equivalent replacements are permitted for the items that follow.

NOTE: It is possible that some materials in the Consumable Materials chart cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

Table 701

Name and Number	Manufacturer
Distributor (With necessary hoses to give 15 US Gallons (57 Liters) Per Minute Flow) (Optional) PWA 83298)	
Nozzle, Water Wash (PWA 104478)	
Water Wash Cart (Electrical Powered Pump) (Optional) (PWA 104744)	
Potable Water	See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201 (Engine Gaspath Cleaning Solutions) for potable water specifications.
*Isopropyl Alcohol (PMC 9094)	See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201.
NOTE: *Required at ambient temperatures below 40°F (4.4°C).	
Gaspath Cleaner (SPMC 87)	See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201.

Table 701 (Continued)

Name and Number	Manufacturer
Cleaner Wipe (SPMC 148)	See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201.
Clean Shop Air	
Gas, nitrogen (PMC 2214)	

3. CLEANING OF THE ENGINE GASPATH (WITH OR WITHOUT DETERGENT) FOR BETTER ENGINE PERFORMANCE

A. Clean Engine Gaspath (Water Only) For Performance Improvement - Nozzle (Hook) Method

NOTE: Refer to SPOP 425 (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201) for engines that have had gaspath exposed to fire extinguishing agents, hydraulic fluid, oil or fuel.

NOTE: Engine performance deterioration, i.e. high power stalls, increase in low and high compressor speed, Exhaust Gas Temperature (EGT), and thrust specific fuel consumption, may be due to contamination of blades and vanes of both compressors and turbines. This contamination may be removed by washing with fresh water or detergent solution while rotating engine with starter. The following procedure is recommended on a regular basis. However, since environmental conditions vary widely, the frequency of a periodic liquid wash program should be determined by each individual operator.

(1) Conduct pre-wash engine performance checks at EPR's of 1.4, 1.6, and Takeoff. At each point operate engine for three minutes, then record N1, N2, EGT, and fuel flow. For this check engine air bleed and electrical load extraction shall be zero.

NOTE: Under icing conditions thermal anti-icing may be used between check points. This step is optional.

(2) Shut down engine and allow at least 30 minutes for engine to cool.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(3) Open these circuit breakers and install safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
WJE 415-427, 429, 861-866, 868, 869, 871-874, 891			
U	41	B1-2	ENGINE IGNITION RIGHT
U	42	B1-1	ENGINE IGNITION LEFT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

Pull ignition circuit breaker for engine being washed.

(4) Disconnect fuel control Pb sense line and PS3, PT2, and PS4 lines to pressure ratio bleed control (it is not necessary to cap off fittings), and engine ignition leads. Disconnect PT7 manifold lines.

NOTE: PT7 manifold need not be disconnected if system is fitted with a water trap.

On an engine post-SB 5871 (with a 6th stage bleed system), there will be a second pressure ratio bleed control (on the combustion chamber and turbine fan duct) aft of the unit on the diffuser outer fan duct. Disconnect the PT2, PS3.2, PS4, and bleed valve control tubes to this control also.

(5) Disconnect generator cooling inlet (aft) supply duct.

(6) Ensure that start lever for engine being washed is in "off" position.

(7) Ensure that all anti-icing air shutoff and fuel deicing heater shutoff valves (except engine bleed valves) are closed.

(8) Make certain N2 rotation is completely stopped, then engage starter and allow engine to reach full starting rpm (approximately 20% N2). Do not exceed starter duty cycle.

(9) Calibrate PWA 83298 water wash nozzle as follows:

(a) Extend nozzle (or nozzles) to necessary length and lock in position.

(b) Connect hoses, adapters, PWA 83298 Distributor (optional) and PWA 104478 water wash nozzle to water source.

WARNING: MAKE SURE YOU CAP OFF THE DISTRIBUTOR HOSE THAT IS NOT ATTACHED TO A NOZZLE AND ATTACH IT TO A STRUCTURE. IF IT IS NOT CAPPED AND SECURED, THE HOSE CAN MAKE RANDOM MOVEMENTS AND CAUSE INJURY TO PERSONNEL AND/OR DAMAGE TO EQUIPMENT.

(c) If you use only one nozzle, cap off one hose on distributor and secure it to a structure.

(d) Hold or clamp water wash nozzle (or nozzles) to structure on the ground and turn on water.

(e) Adjust distributor to get approximately 10 - 15 gallons (37.85 - 56.78 liters) per minute total flow at 50 - 100 psi (344.7 - 689.5 kPa) for two nozzles, which is 5 - 7.5 gallons (18.93 - 28.39 liters) for each nozzle (or one nozzle).

NOTE: You can calculate flow rate with container of known volume and stop watch.

(f) Make mark on distributor and valve handle for correct position.

(g) Turn off water source.

(h) Remove nozzle (or nozzles) from distributor.

(10) Install water wash nozzle (or nozzles) as follows:

(a) Make sure that N1 and N2 rotation are fully stopped.

(b) You can use one or two nozzles. Install nozzle(s) between adjacent vanes at top of engine.

(c) Use two persons and carefully install nozzle (or nozzles) inside tailpipe and move nozzle assembly forward full length of engine fan duct.

(d) Carefully put spray-tip between LPC guide vanes.

1) Make sure spray-tip clears fan blades.

2) Make sure water flow will go into engine core gaspath.

3) If necessary, adjust length of water wash nozzle.

(e) Attach nozzle assembly to tailpipe with clamp. Connect a hose to connector on handle.

(f) Attach distributor to nozzle (or nozzles).

WARNING: MAKE SURE YOU CAP OFF THE DISTRIBUTOR HOSE THAT IS NOT ATTACHED TO A NOZZLE AND ATTACH IT TO A STRUCTURE. IF IT IS NOT CAPPED AND SECURED, THE HOSE CAN MAKE RANDOM MOVEMENTS AND CAUSE INJURY TO PERSONNEL AND/OR DAMAGE TO EQUIPMENT.

(g) If you use only one nozzle, cap off one hose on distributor and secure it to a structure.

1) Attach distributor and hoses so that they do not move while you motor engine.

(h) Examine equipment installation as follows:

1) If necessary, change the position of nozzle.

2) Visually examine from front to make sure that there is sufficient clearance between fan blades and spray nozzle (or nozzles) for safe engine motoring.

CAUTION: MAKE SURE THAT THE SCRIBE MARKS ON THE DISTRIBUTOR AND VALVE HANDLE ARE ALIGNED. THE MARKS WERE MADE WHEN THE NOZZLE(S) WERE CALIBRATED. IF THE MARKS ARE NOT ALIGNED, THE WATER FLOW WILL NOT BE CORRECT.

3) Make sure that scribe marks on distributor and valve handle are aligned.

4) Make sure that you can turn LPC freely by hand before you use air starter.

WARNING: ISOPROPYL ALCOHOL IS AN AGENT THAT IS FLAMMABLE, EXPLOSIVE, AND POISONOUS. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN ISOPROPYL ALCOHOL IS USED.

- GAS/AIR MIXTURES MORE THAN THE LOWER EXPLOSIVE LIMIT (LEL) CAN CAUSE AN EXPLOSION IF HIGH HEAT, SPARKS, OR FLAMES SUPPLY IGNITION.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET ISOPROPYL ALCOHOL IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

(i) For outside ambient temperatures less than 40° F (4.4° C), mix isopropyl alcohol (P11-014) to water as shown in Table 702. However, a mixture of 50 percent alcohol can be used.

NOTE: At 40°F (4.4°C) and below, you must be careful when you do the water wash. Make sure that no ice forms which could cause damage to the engine.

Table 702 MINIMUM ALCOHOL/WATER MIXTURES

OUTSIDE AMBIENT TEMPERATURE	PERCENT OF ALCOHOL BY VOLUME
40° F (4.4° C)	3

Table 702 MINIMUM ALCOHOL/WATER MIXTURES (Continued)

OUTSIDE AMBIENT TEMPERATURE	PERCENT OF ALCOHOL BY VOLUME
38° F (3.3° C)	6
36° F (2.2° C)	9
33° F (0.6° C)	14
31° F (-0.6° C)	17
28° F (-2.2° C)	20
26° F (-3.3° C)	22
25° F (-3.9° C)	23
20° F (-6.6° C)	27
15° F (-9.4° C)	32
10° F (-12.2° C)	36
5° F (-15° C)	39
0° F (-17.8° C)	43

(j) Motor engine with starter at approximately 2500 RPM N2.

(11) Turn water off and release starter.

(12) While motoring engine, turn on water and flow into engine for approximately 30 - 45 seconds. Stop motoring and allow to stand for 5 minutes. Repeat this cycle three (3) times.

NOTE: If water flow from tailpipe is dirty, additional benefit can be gained by additional wash. The operator can elect to repeat wash procedure at their discretion.

(13) Turn water off and release starter.

(14) Remove nozzle assembly from engine fan duct.

(15) Hand wash LPC 1st stage (fan) blades by one of methods that follow:

(a) Wipe blades with SPMC 148 wipe cleaner and clean cloth. A tampico or nylon brush can be used to scrub fan blades. Wipe off with clean cloth. Rinse is not necessary.

(b) Or, use a solution of SPS 87 gsapath cleaner. Apply with clean cloth, tampico or nylon brush. Rinse blades thoroughly with potable water. See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201, Engine Gaspath Cleaning Solutions.

(16) Motor engine with starter for 30 seconds without water wash to purge water from engine.

(17) Purge all lines with clean shop air or nitrogen before reconnecting them. If engine is to remain inoperative for four hours or more after washing, start engine and run at idle for five minutes.

(18) Reconnect fuel control Pb sense line and PS3, PT2 and PS4 lines to pressure ratio bleed control (and to the second pressure ratio bleed control if post-SB 5871) and reconnect engine ignition leads(IGNITION LEADS - MAINTENANCE PRACTICES, PAGEBLOCK 74-20-01/201). Reconnect PT7 manifold lines.

(19) Connect generator cooling inlet (aft) supply duct.

(20) Remove the safety tags and close these circuit breakers:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
WJE 415-427, 429, 861-866, 868, 869, 871-874, 891			
U	41	B1-2	ENGINE IGNITION RIGHT
U	42	B1-1	ENGINE IGNITION LEFT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(21) Remove plug from fuel control Pb tube moisture trap and check for entrapped water.

(22) Conduct post-wash engine performance check at EPR's of 1.4 data plate (1.6) and takeoff. At each point operate engine for three minutes, then record N1, N2, EGT and fuel flow. For this check engine air bleed and electrical load extraction will be zero. This step should be done immediately after washing engine.

NOTE: Observe N1 rpm for indication of low compressor rotation while rotating engine with starter and before fuel shutoff lever is open.

NOTE: This step is optional.

CAUTION: IN FOLLOWING STEP DO NOT EXCEED GROUND STATIC EGT OPERATIONAL LIMITS WITH ANTI-ICING AIR SYSTEM.

(23) If engine is to remain inoperative for four hours or more after washing, start engine and run at idle for five minutes. Operate anti-icing air shutoff, fuel heat and air conditioning system valves. Operate air conditioning system in full-cold mode to force undrained water through water separator.

NOTE: Under very cold and windy weather conditions, even if water/alcohol mixture is used, there is a high probability of ice formation in engine in less than four hours if engine run-up is not performed after wash, to purge or evaporate residual water.

Observe N1 rpm for indication of low compressor rotation while rotating engine with starter and before fuel shutoff lever is open.

(24) Shut down engine and recheck fuel control Pb tube moisture trap for water. Also check Pb bellows cavity for water.

NOTE: Entrapped water in Pb bellows cavity can prevent proper engine operation.

B. Clean Engine Gaspath for Performance Improvement (Alternate to Water Wash) - EcoPower (TM) Method

CAUTION: EXCEPT FOR WORK OR SUPPLIES TO BE PERFORMED OR FURNISHED BY PRATT & WHITNEY, PRATT & WHITNEY DOES NOT ENDORSE THE WORK PERFORMED BY THE COMPANY OR COMPANIES IDENTIFIED HEREIN OR ANY OTHER COMPANY AND DOES NOT ACCEPT RESPONSIBILITY TO ANY DEGREE FOR THE SELECTION OF SUCH COMPANY OR COMPANIES FOR THE PERFORMANCE OF ANY WORK OR PROCUREMENT OF SUPPLIES.

(1) This is a proprietary procedure. The source licensed for this procedure is Pratt & Whitney line maintenance services, (EcoPower) (TM). To find a franchised source in your area, ask the Pratt & Whitney 24 hour customer help desk, (860) 565-0140 for information about the EcoPower (TM) engine wash system.

(2) Sources must have a license for this proprietary procedure. Write to the address below for information about how to become a licensed source:

- Pratt & Whitney (A United Technologies Company)
- Manager, Joint Ventures, Partnerships and Licensing
- 400 Main Street, Mail Stop 133-58
- East Hartford, CT 06108 USA
- E-mail: gppwlicng@pw.utc.com
- Fax: 860-557-7197

C. Clean Engine Gaspath (With Detergent) For Performance Improvement - Nozzle (Hook) Method

(1) Conduct pre-wash engine performance checks at EPR's of 1.4, 1.6, and Takeoff. At each point operate engine for three minutes, then record N1, N2, EGT, and fuel flow. For this check engine air bleed and electrical load extraction shall be zero.

NOTE: Under icing conditions thermal anti-icing can be used between check points. This step is optional.

(2) Shut down engine and allow at least 30 minutes for engine to cool.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(3) Open these circuit breakers and install safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
WJE 415-427, 429, 861-866, 868, 869, 871-874, 891			
U	41	B1-2	ENGINE IGNITION RIGHT
U	42	B1-1	ENGINE IGNITION LEFT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(4) Disconnect fuel control Pb sense line and PS3, PT2, and PS4 lines to pressure ratio bleed control (it is not necessary to cap off fittings), and engine ignition leads. Disconnect PT7 manifold lines.

NOTE: PT7 manifold need not be disconnected if system is fitted with a water trap.

On an engine post-SB 5871 (with a 6th stage bleed system), there will be a second pressure ratio bleed control (on the combustion chamber and turbine fan duct) aft of the unit on the diffuser outer fan duct. Disconnect the PT2, PS3.2, PS4, and bleed valve control tubes to this control also.

(5) Disconnect generator cooling inlet (aft) supply duct.

(6) Ensure that start lever for engine being washed is in "off" position.

(7) Disconnect generator cooling inlet (aft) supply duct.

(8) Ensure that all anti-icing air shutoff and fuel deicing heater shutoff valves (except engine bleed valves) are closed.

(9) Make certain that N2 rotation is completely stopped, then engage starter and allow engine to reach full starting rpm (approximately 20 percent N2). Do not exceed starter duty cycle. (GENERAL, SUBJECT 71-00-00, Page 501)

(10) Calibrate PWA 104478 water wash nozzle as follows:

(a) Extend nozzle (or nozzles) to necessary length and lock in position.

(b) Connect the hoses, adapters, PWA 83298 distributor (optional) and PWA 104478 water wash nozzle as follows:

WARNING: MAKE SURE YOU CAP OFF THE DISTRIBUTOR HOSE THAT IS NOT ATTACHED TO A NOZZLE AND ATTACH IT TO A STRUCTURE. IF IT IS NOT CAPPED AND SECURED, THE HOSE CAN MAKE RANDOM MOVEMENTS AND CAUSE INJURY TO PERSONNEL AND/OR DAMAGE TO EQUIPMENT.

(c) If you use only one nozzle, cap off one hose on distributor and secure it to a structure.

(d) Hold or clamp water wash nozzle (or nozzles) to structure on the ground and turn on water.

(e) Adjust distributor to get approximately 10 - 15 gallons (37.85 - 56.7 liters) per minute total flow at 50 - 100 psi (344.7 - 689.5 kPa) for two nozzles, which is 5 - 7.5 gallons (18.93 - 28.39 liters) for each nozzle (or one nozzle).

NOTE: You can calculate flow rate with container of known volume and stop watch.

(f) Make a mark on distributor and valve handle for correct position.

(g) Turn off water source.

(h) Remove nozzle (or nozzles) from distributor.

(11) Install water wash nozzle (or nozzles) as follows:

(a) Make sure that N1 and N2 rotation are fully stopped.

(b) You can use one or two nozzles. Install nozzle(s) between adjacent vanes at top of engine.

(c) Use two persons and carefully install nozzle (or nozzles) inside tailpipe and move nozzle assembly forward the full length of engine fan duct.

(d) Carefully put spray-tip between LPC guide vanes.

1) Make sure spray-tip clears fan blades.

2) Make sure water flow will go into engine core gaspath.

3) If necessary, adjust length of water wash nozzle.

(e) Attach nozzle assembly to tailpipe with clamp. Connect a hose to connector on handle.

(f) Attach distributor to nozzle (or nozzles).

WARNING: MAKE SURE YOU CAP OFF THE DISTRIBUTOR HOSE THAT IS NOT ATTACHED TO A NOZZLE AND ATTACH IT TO A STRUCTURE. IF IT IS NOT CAPPED AND SECURED, THE HOSE CAN MAKE RANDOM MOVEMENTS AND CAUSE INJURY TO PERSONNEL AND/OR DAMAGE TO EQUIPMENT.

(g) If you use only one nozzle, cap off one hose on distributor and secure it to a structure.

1) Attach distributor and hoses so that they do not move while you motor engine.

(h) Examine equipment installation as follows:

1) If necessary, change the position of nozzle.

2) Visually examine from front to make sure that there is sufficient clearance between fan blades and spray nozzle (or nozzles) for safe engine motoring.

CAUTION: MAKE SURE THAT THE SCRIBE MARKS ON THE DISTRIBUTOR AND VALVE HANDLE ARE ALIGNED. THE MARKS WERE MADE WHEN THE NOZZLE(S) WERE CALIBRATED. IF THE MARKS ARE NOT ALIGNED, THE WATER FLOW WILL NOT BE CORRECT.

3) Make sure that scribe marks on distributor and valve handle are aligned.

(12) Prepare 20 gallons (75.71 liters) of gaspath cleaner solution for each wash cycle. Refer to STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201, Engine Gaspath Cleaning Solutions.

NOTE: The solution must be completely mixed and you must start water wash within one hour after you mix solution.

WARNING: ISOPROPYL ALCOHOL IS AN AGENT THAT IS FLAMMABLE, EXPLOSIVE, AND POISONOUS. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN ISOPROPYL ALCOHOL IS USED.

- GAS/AIR MIXTURES MORE THAN THE LOWER EXPLOSIVE LIMIT (LEL) CAN CAUSE AN EXPLOSION IF HIGH HEAT, SPARKS, OR FLAMES SUPPLY IGNITION.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET ISOPROPYL ALCOHOL IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

(13) For outside ambient temperatures less than 40° F (4.4° C), mix isopropyl alcohol (P11-014) to water as shown in Table 703. However, a mixture of 50 percent alcohol can be used.

NOTE: At 40°F (4.4°C) and below, you must be careful when you do the water wash. Make sure that no ice forms which could cause damage to the engine.

Table 703 MINIMUM ALCOHOL/WATER MIXTURES

OUTSIDE AMBIENT TEMPERATURE	PERCENT OF ALCOHOL BY VOLUME
40° F (4.4° C)	3

Table 703 MINIMUM ALCOHOL/WATER MIXTURES (Continued)

OUTSIDE AMBIENT TEMPERATURE	PERCENT OF ALCOHOL BY VOLUME
38° F (3.3° C)	6
36° F (2.2° C)	9
33° F (0.6° C)	14
31° F (-0.6° C)	17
28° F (-2.2° C)	20
26° F (-3.3° C)	22
25° F (-3.9° C)	23
20° F (-6.6° C)	27
15° F (-9.4° C)	32
10° F (-12.2° C)	36
5° F (-15° C)	39
0° F (-17.8° C)	43

(14) Motor engine with starter at approximately 2500 RPM N2.

(15) While motoring engine, turn on water and flow into engine for approximately 30 - 45 seconds. Stop motoring and allow to stand for 5 minutes. Repeat this cycle three (3) times.

NOTE: If water flow from tailpipe is dirty, additional benefit can be gained by additional wash. The operator can elect to repeat wash procedure at their discretion.

(16) If you used detergent cleaning solution, do wash procedure two (2) more times with water only.

NOTE: This is necessary to rinse all detergent from gaspath.

(17) Hand wash LPC 1st stage (fan) blades by one of methods that follow:

(a) Wipe blades with SPMC 148 wipe cleaner and clean cloth. A tampico or nylon brush can be used to scrub fan blades. Wipe off with clean cloth. Rinse is not necessary.

(b) Or, use a solution of SPS 87 gsapath cleaner. Apply with clean cloth, tampico or nylon brush. Rinse blades thoroughly with potable water. See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201, Engine Gaspath Cleaning Solutions.

(18) Motor engine with starter for 30 seconds without water wash to purge water from engine.

(19) Purge all lines with clean shop air or nitrogen before reconnecting them. If engine is to remain inoperative for four hours or more after washing, start engine and run at idle for five minutes.

(20) Reconnect fuel control Pb sense line and PS3, PT2 and PS4 lines to pressure ratio bleed control (and to the second pressure ratio bleed control if post-SB 5871) and reconnect engine ignition leads(IGNITION LEADS - MAINTENANCE PRACTICES, PAGEBLOCK 74-20-01/201). Reconnect PT7 manifold lines.

(21) Connect generator cooling inlet (aft) supply duct.

(22) Remove the safety tags and close these circuit breakers:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name

WJE 415-427, 429, 861-866, 868, 869, 871-874, 891

(Continued)

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	41	B1-2	ENGINE IGNITION RIGHT
U	42	B1-1	ENGINE IGNITION LEFT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(23) Remove plug from fuel control Pb tube moisture trap and check for entrapped water.

(24) Drain and fill oil system with new oil.

(25) Conduct post-wash engine performance check at EPR's of 1.4 data plate (1.6) and takeoff. At each point operate engine for three minutes, then record N1, N2, EGT and fuel flow. For this check engine air bleed and electrical load extraction will be zero. This step should be done immediately after washing engine.

NOTE: Observe N1 rpm for indication of low compressor rotation while rotating engine with starter and before fuel shutoff lever is open. This step is optional.

CAUTION: IN FOLLOWING STEP DO NOT EXCEED GROUND STATIC EGT OPERATIONAL LIMITS WITH ANTI-ICING AIR SYSTEM.

(26) If engine is to remain inoperative for four hours or more after washing, start engine and run at idle for five minutes. Operate anti-icing air shutoff, fuel heat and air conditioning system valves. Operate air conditioning system in full-cold mode to force undrained water through water separator.

NOTE: Under very cold and windy weather conditions, even if water/alcohol mixture is used, there is a high probability of ice formation in engine in less than four hours if engine run-up is not performed after wash, to purge or evaporate residual water.

Observe N1 rpm for indication of low compressor rotation while rotating engine with starter and before fuel shutoff lever is open.

(27) Shut down engine and recheck fuel control Pb tube moisture trap for water. Also check Pb bellows cavity for water.

NOTE: Entrapped water in Pb bellows cavity can prevent proper engine operation.

D. Clean Engine Gaspath (Water Only) For Performance Improvement - Hose Method

NOTE: The hose method is the least effective method for cleaning the core engine gaspath because most of the water exists through the fan exhaust air ducts.

(1) Conduct pre-wash engine performance checks at EPR's of 1.4, 1.6, and Takeoff. At each point operate engine for three minutes, then record N1, N2, EGT, and fuel flow. For this check engine air bleed and electrical load extraction shall be zero.

NOTE: Under icing conditions thermal anti-icing can be used between check points. This step is optional.

(2) Allow at least 30 minutes for engine to cool after shutdown.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(3) Open these circuit breakers and install safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
WJE 415-427, 429, 861-866, 868, 869, 871-874, 891			
U	41	B1-2	ENGINE IGNITION RIGHT
U	42	B1-1	ENGINE IGNITION LEFT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(4) Disconnect fuel control Pb sense line and PS3, PT2, and PS4 lines to pressure ratio bleed control (it is not necessary to cap off fittings), and engine ignition leads. Disconnect PT7 manifold lines.

NOTE: PT7 manifold need not be disconnected if system is fitted with a water trap.

On an engine post-SB 5871 (with a 6th stage bleed system), there will be a second pressure ratio bleed control (on the combustion chamber and turbine fan duct) aft of the unit on the diffuser outer fan duct. Disconnect the PT2, PS3.2, PS4, and bleed valve control tubes to this control also.

(5) Ensure that start lever for engine being washed is in "off" position.

Disconnect generator cooling inlet (aft) supply duct.

(6) Disconnect generator cooling inlet (aft) supply duct.

(7) Ensure that all anti-icing air shutoff and fuel deicing heater shutoff valves (except engine bleed valves) are closed.

(8) Make certain that N2 rotation is completely stopped, then engage starter and allow engine to reach full starting rpm (approximately 20 percent N2). Do not exceed starter duty cycle. (GENERAL, SUBJECT 71-00-00, Page 501)

WARNING: IN FOLLOWING WATER SPRAY PROCEDURE, IF HOSE IS HAND-HELD, OPERATOR MUST STAND AT LEAST THREE FEET FROM ENGINE INLET.

(9) With 3/4 inch (.19 mm) ID or larger diameter nozzle, spray potable water into engine inlet at 35 - 45 psi (241.3 - 310.3 kPa) for 30 seconds while motoring engine with starter. Spray should be directed toward center of engine inlet but not directly at nose cone. Approximately 40 - 50 gallons (151.42 - 189.27 liter) of water can be discharged into engine in 30 second period.

NOTE: See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201, for standards applicable to water used to clean engine gaspath.

To prevent freezing, add sufficient alcohol to water up to a maximum of 50 percent by volume. See Table 704 for the required mixture.

Table 704 MINIMUM ALCOHOL/WATER MIXTURES

OUTSIDE AMBIENT TEMPERATURE	PERCENT OF ALCOHOL BY VOLUME
40° F (4.4° C)	3
38° F (3.3° C)	6
36° F (2.2° C)	9
33° F (0.6° C)	14
31° F (-0.6° C)	17
28° F (-2.2° C)	20
26° F (-3.3° C)	22
25° F (-3.9° C)	23
20° F (-6.6° C)	27
15° F (-9.4° C)	32
10° F (-12.2° C)	36
5° F (-15° C)	39
0° F (-17.8° C)	43

(10) Turn water off and release starter.

(11) Allow engine to drain for approximately five minutes.

(12) Repeat steps Paragraph 3.D.(9) thru Paragraph 3.D.(11) three (3) more times.

(13) Hand wash LPC 1st stage (fan) blades by one of methods that follow:

- (a) Wipe blades with SPMC 148 wipe cleaner and clean cloth. A tampico or nylon brush can be used to scrub fan blades. Wipe off with clean cloth. Rinse is not necessary.
- (b) Or, use a solution of SPS 87 gsapath cleaner. Apply with clean cloth, tampico or nylon brush. Rinse blades thoroughly with potable water. See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201, Engine Gaspath Cleaning Solutions.
- (c) Motor engine with starter for 30 seconds without water wash to purge water from engine.

(14) Purge all lines with clean shop air or nitrogen before reconnecting them.

(15) Reconnect fuel control Pb sense line and PS3, PT2 and PS4 lines to pressure ratio bleed control (and to the second pressure ratio bleed control if post-SB 5871) and reconnect engine ignition leads(IGNITION LEADS - MAINTENANCE PRACTICES, PAGEBLOCK 74-20-01/201). Reconnect PT7 manifold lines.

(16) Connect generator cooling inlet (aft) supply duct.

(17) Remove the safety tags and close these circuit breakers:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
WJE 415-427, 429, 861-866, 868, 869, 871-874, 891			
U	41	B1-2	ENGINE IGNITION RIGHT

(Continued)

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	42	B1-1	ENGINE IGNITION LEFT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(18) Remove plug from fuel control Pb tube moisture trap and check for entrapped water.

(19) Conduct post-wash engine performance check at EPR's of 1.4 data plate (1.6) and takeoff. At each point operate engine for three minutes, then record N1, N2, EGT and fuel flow. For this check engine air bleed and electrical load extraction will be zero. This step should be done immediately after washing engine.

NOTE: Observe N1 rpm for indication of low compressor rotation while rotating engine with starter and before fuel shutoff lever is open. This step is optional.

CAUTION: IN FOLLOWING STEP DO NOT EXCEED GROUND STATIC EGT OPERATIONAL LIMITS WITH ANTI-ICING AIR SYSTEM.

(20) If engine is to remain inoperative for four hours or more after washing, start engine and run at idle for five minutes. Operate anti-icing air shutoff and air conditioning system in full-cold mode to force undrained water through water separator.

NOTE: Under very cold and windy weather conditions, even if water/alcohol mixture is used, there is a high probability of ice formation in engine in less than four hours if engine run-up is not performed after wash, to purge or evaporate residual water.

Observe N1 rpm for indication of low compressor rotation while rotating engine with starter and before fuel shutoff lever is open.

(21) Shut down engine and recheck fuel control Pb tube moisture trap for water. Also check Pb bellows cavity for water.

NOTE: Entrapped water in Pb bellow cavity can prevent proper engine operation.

E. Turbine Wash Procedure. (Optional) See Figure 701

NOTE: This procedure is available as necessary to keep turbine blade airfoil sulfidation to a minimum. This procedure uses one or two PWA 33594 Water Wash Probes, as necessary. If done frequently, this procedure can help to keep engine performance margins (EGT and TSFC) at their correct level. This procedure will have an effect only on turbine blade and vane airfoils, with either one or two probes in operation during the procedure.

(1) Let the engine become cool (30 minutes minimum after engine shutdown).

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(2) Open these circuit breakers and install safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
WJE 415-427, 429, 861-866, 868, 869, 871-874, 891			
U	41	B1-2	ENGINE IGNITION RIGHT
U	42	B1-1	ENGINE IGNITION LEFT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(3) Make sure that the start lever for the engine is in the OFF position.

(4) Make sure that all anti-icing air shutoff and fuel deicing heater shutoff valves (but not the bleed valves) are closed.

(5) Do a check of the silicone oil level in the fuel control burner pressure (Pb) bellows as specified in FUEL CONTROL, SUBJECT 73-20-01, Page 201.

(6) Disconnect the two igniter plug leads and remove the packing holders from the igniter plug bosses. Remove the igniter plugs.

(7) Install PWA 33594 Water Wash Probes in the igniter plug bosses. Extend the probes into the No. 4 and/or No. 7 combustion chamber.

NOTE: It is possible to use one or two PWA 33594 Probes. When only one probe is used, it is permitted to put the probe in the No. 4 or No. 7 combustion chamber position.

Be sure to adjust the probe or probes to extend into the engine for the correct depth. The probe must be at Change Letter A to have a Detail 5 stopper (this will give the correct fit with the duct boss of a JT8D-200 series engine).

(8) Push the rubber stopper along the probe in the direction of the probe connector to let the probe be fully extended into the engine (see the NOTE above).

(9) Put the probe into the right or left side igniter plug boss, through the combustion chamber outer case boss, and into the No. 4 or 7 combustion chamber (as applicable).

(10) Carefully move the probe into the engine until the inner end of the probe hits the inner surface of the combustion chamber. Pull the probe back out approximately one-quarter inch (6.350 mm), to keep the end of the probe away from the combustion chamber inner surface. (Figure 701)

(11) Push the rubber stopper along the probe until it is possible to put the stopper tightly into the fan outer duct boss when the probe is extended to its correct depth in the engine. Make sure the mark on the tube (Figure 701) is pointed to the rear of the engine.

NOTE: When the probe is correctly adjusted, it will be possible to use the probe on the right or left side of all JT8D-200 series engines without other adjustments. However, it is recommended that you make sure regularly that the stopper is in the correct position for the engine it is used on.

(12) Put the other probe (if used) in the igniter boss on the other side of the engine and adjust the stopper on the probe as specified above.

(13) Connect a water hose to the probe(s) and supply clean, potable water (Paragraph 2.) at 40 psi minimum.

NOTE: Refer to Chapter/Section 70-00-00, Standard Practices for the standards applicable to water used to clean the engine.

If necessary to prevent freezing, add sufficient alcohol to the water up to a maximum of 50 percent by volume. (Table 705)

Table 705 MINIMUM ALCOHOL/WATER MIXTURES

OUTSIDE AMBIENT TEMPERATURE	PERCENT OF ALCOHOL BY VOLUME
40° F (4.4° C)	3
38° F (3.3° C)	6
36° F (2.2° C)	9
33° F (0.6° C)	14
31° F (-0.6° C)	17
28° F (-2.2° C)	20
26° F (-3.3° C)	22
25° F (-3.9° C)	23
20° F (-6.6° C)	27
15° F (-9.4° C)	32
10° F (-12.2° C)	36
5° F (-15° C)	39
0° F (-17.8° C)	43

(14) Engage the starter and motor the N2 rotor to approximately 3000 rpm. Do not operate the starter more than its duty cycle limits.

(15) Put water into the combustion section of the engine through the probes at 40 - 45 psi pressure for 30 seconds.

(16) Stop the water flow and disconnect the starter.

(17) Let the water drain from the engine for approximately five minutes.

(18) Do the water wash operation two more times (if only one probe is used, do the water wash operation five more times).

(19) Remove the probe(s) and install the igniter plugs (IGNITER PLUG, SUBJECT 74-20-02, Page 201). Install the packing holders and connect the igniter plug leads (IGNITION LEAD, SUBJECT 74-20-01, Page 201).

(20) Remove the safety tags and close these circuit breakers:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
WJE 415-427, 429, 861-866, 868, 869, 871-874, 891			
U	41	B1-2	ENGINE IGNITION RIGHT
U	42	B1-1	ENGINE IGNITION LEFT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(21) Remove the plug from the fuel control Pb moisture trap and make sure there is no water in the trap.

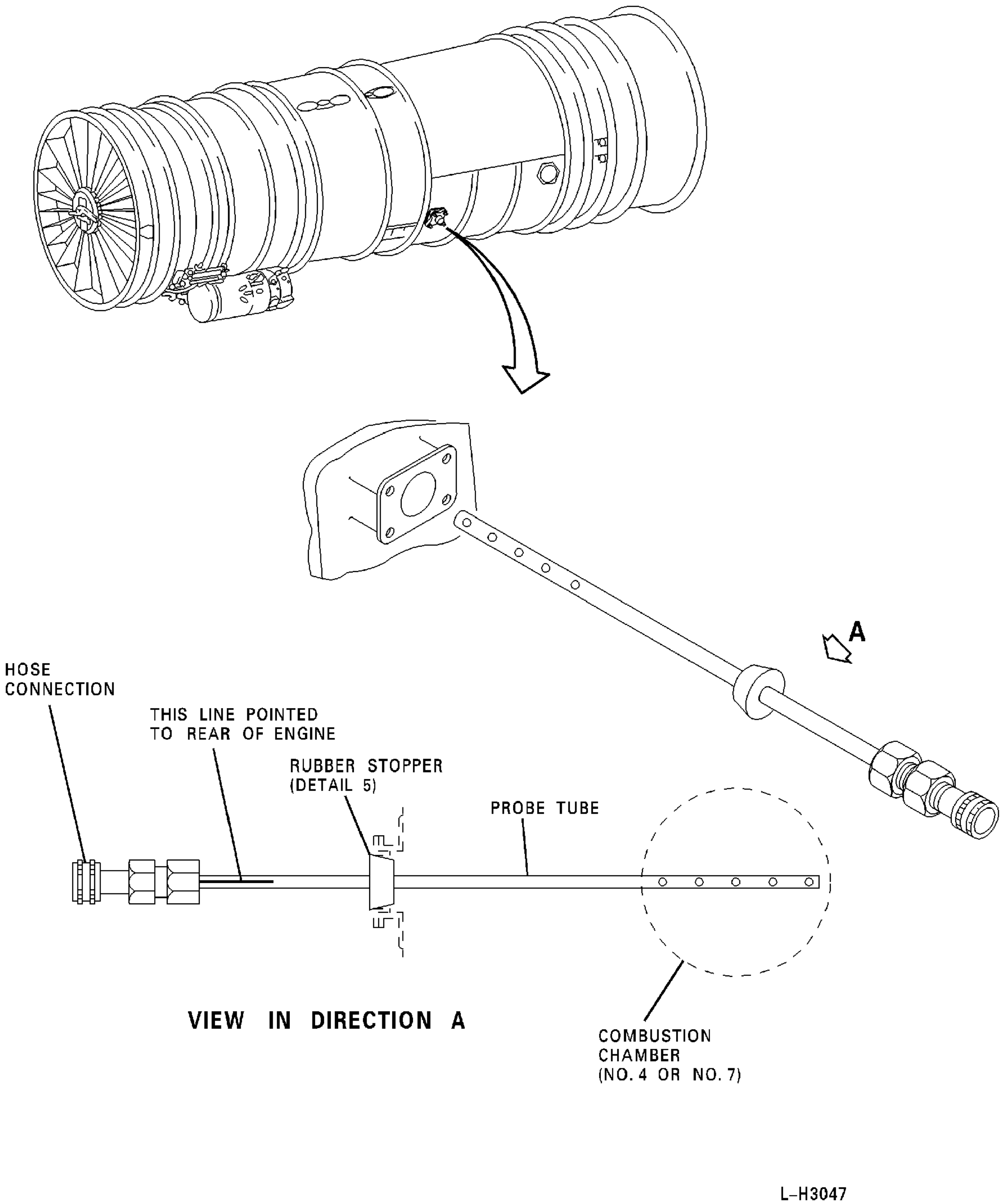
CAUTION: IN FOLLOWING STEP DO NOT EXCEED GROUND STATIC EGT OPERATIONAL LIMITS WITH ANTI-ICING AIR SYSTEM.

(22) If it will be four hours or more before the engine goes back into operation, start the engine and operate it at Idle for five minutes. Operate anti-icing air shutoff and air conditioning system in full-cold mode to force undrained water through water separator.

NOTE: If it is cold with high-wind conditions, it is possible that ice can occur in the engine (an alcohol/water mix cannot prevent this under all conditions). Operate the engine as soon as possible to get all the remaining water out.

Make sure that the N1 rotor turns during the start cycle after water wash, before you put the fuel shutoff lever to ON. Ice can cause blockage of the N1 rotor.

(23) Do a shutdown and examine the fuel control Pb moisture again for water.



CAG(IGDS)

BBB2-72-517

Turbine Wash Tool
Figure 701/72-00-00-990-801

4. Engine Cleaning After Contact With Fire Extinguishing Agents, Hydraulic Fluid, Oil Or Fuel

A. Procedure

(1) SPOP 425 provides information in determining appropriate actions for engines that have come in contact with fire extinguishing agents, hydraulic fluid, oils or fuel. Refer to SPOP 425, STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201.

ENGINE GENERAL - TROUBLESHOOTING -01 (GENERAL)

1. General

A. Troubleshooting is a process of identifying engine problems through observation and evaluation of engine behavior. When an engine develops a problem, maintenance personnel must evaluate the symptoms and identify the cause of the problem, using evidence which supports a certain cause or disqualifies other causes. In order to save time, the most probable cause, as determined by maintenance experience and by the recommendations of this section, should be examined first. If review of engine records indicates a previous maintenance action or frequent repetitive actions, this indicates a need for more extensive troubleshooting.

B. Before attempting to work on an engine which has been reported as malfunctioning, it is important to know as much as possible about the engine. Not only is the engine's behavior at the time of its malfunctioning important, but also the recent history of the engine, together with the engine's response to troubleshooting action, should be considered. Recent engine history includes information such as flight crew reports, maintenance actions, time since overhaul or major component replacements, time since the last trim or ground check, or the relationship in service time between the engine and other engines in the aircraft. Consult the pilot's flight report, engine log books, engine condition monitoring data and any other available sources. It is important that all of these sources of information be used, analyzed and coordinated to formulate the most appropriate maintenance action.

C. These troubleshooting procedures are prepared with the assumption that maintenance personnel are familiar with the design and structure of the JT8D Turbofan engine. See the Descrip- tion sections in the engine and accessory component chapters for details on the various areas of the engine.

D. Approved removal and installation procedures for various engine parts and components are described in their respective sections in this manual. Special assembly procedures, special torques, etc. are listed in applicable Removal/Installation or Inspection/Check sections; all maintenance procedures not covered by special limits shall conform to the techniques and limits in GENERAL, SUBJECT 70-00-00.

2. Troubleshooting Section Structure

A. Troubleshooting procedures are divided into sections related to engine areas in which problems are found, as follows:

NOTE: Previous revisions to this manual replaced troubleshooting procedures that were in table form with the diagram procedures seen in the sections below.

(1) Troubleshooting-02, Lubrication System: This section has procedures for problems related to oil pressure, temperature, or leakage. There are procedures for these problems:

(a) High Oil Consumption

(b) High Oil Temperature

(c) Oil Filter/Strainer Differential Pressure Light On

(d) Black Oil

(e) Oil Fumes In The Aircraft Cabin

(f) Oil Pressure Problem (Low/No Oil Pressure, Fluctuating Oil Pressure, Oil Pressure Follows The Power Lever, High Oil Pressure).

(2) Troubleshooting-03, Engine Indication System: This section has procedures for problems related to the engine pressure and temperature indication systems. There are procedures for these problems:

(a) Engine Exhaust Gas Temperature (EGT) problems (EGT Indication Does Not Operate, Or EGT Indication Is High Or Low Compared To Other Engine Parameters)

(b) Engine Pressure Ratio (EPR) problems (EPR Is Low Or Not Stable).

(3) Troubleshooting-04, Power and Engine Response: This section has procedures for problems related to engine performance and operation levels. There are procedures for these problems:

(a) Low Idle N2

(b) Surge (Off-Idle, High Power/Takeoff/Steady State, Deceleration Surge)

(c) Slow Acceleration

(d) Unable To Reach Takeoff Power

(e) Start Problems (No Start, Hot Start, Hung Start)

(f) Engine Flameout

(g) Auto-Acceleration

(h) Fuel Filter Differential Pressure Light Stays On With Fuel Heat

(i) Fuel Temperature Does Not Increase with Fuel Heat

(j) Power Levers Not Aligned (Throttle Stagger)

(k) High Fuel Flow (With No EGT Increase)

(l) External Fuel Leaks

(4) Troubleshooting-05, Engine Vibration: This section has procedures for engine vibration problems, N1 and N2 type.

B. The scope of this section is to locate the cause of engine malfunction and to prescribe corrective action. Detailed inspection and check procedures on engine subassemblies and accessory components are found in the applicable engine or accessory component subsection of this manual; where detailed inspection of a subassembly or component would be helpful and practical in troubleshooting the engine, specific reference will be made to the section in which that procedure is found.

C. For detailed treatment of engine-related systems not part of the basic JT8D engine, consult the applicable airframe maintenance manual.

3. Subsystem Troubleshooting Procedures

A. Operational inputs provided by flight crews and by maintenance crews can be very valuable to personnel who are troubleshooting engine malfunctions. Typical operational comments on specific malfunctions have been incorporated to aid maintenance personnel in identifying and resolving abnormal engine operation. There are some problems which do not have any related inputs noted. In these instances no specific inputs have (as yet) been generated. Additional inputs will be added, as dictated by in-service experience, as they are developed.

B. Visual checks are included to provide what should be the first step in verifying and isolating engine problems. These checks are to be employed prior to starting any extensive systems troubleshooting. In some instances items listed as visual checks will be found in the normal problem solving sequence. However, by presenting them separately, they are highlighted so they will receive proper attention and application in the troubleshooting process. Use of visual checks will reduce the amount of time spent in solving reported engine problems.

(1) The following discrepancies are listed and defined to clarify the meaning of various conditions and expressions used in troubleshooting.

Table 101

Discrepancies	Definition
Auto Acceleration	Power increases without a corresponding power lever movement.
Auto Deceleration	Power decreases without a corresponding power lever movement (engine continues to operate at reduced power).
EGT Limited	Inability to obtain desired power at Maximum EGT.
EPR Shortfall	Inability to obtain takeoff target EPR with a fully advanced thrust lever and no other param eter is limiting.
Flameout	Interruption of engine operation due to total loss of combustion while fuel control unit is in ON position as evidenced by sudden drop in EGT with rotor speeds falling to windmilling levels.
Fluctuating Power Level	Cyclic power increase and decrease without power lever movement.
Hot Start	EGT exceeds start EGT limit.
Hung Start	N2 and EGT ceases to increase before reaching normal idle N2 with no subsequent power lever response.
Impending Hot Start	Start aborted due to EGT increasing at an abnormally fast rate with indication it would exceed start EGT limit if allowed to continue.
Indication Abnormal	Engine parameters (EGT, WF, N1, N2) differ appreciably from other engine(s) at comparable EPR.
Light Off	Light Off is indicated by EGT rise after start lever advance.
No Light	No indicated increase in EGT after start lever advance.
N2 Limited	Inability to obtain desired EPR at N2 Orange/ Redline.
Power Fluctuates	Cyclic power increases and decreases without power lever movement.
Power Lever Limited	Inability to obtain desired EPR at maximum power lever position.
Power Lever Misalignment	Power lever are not aligned for given power setting.
Slow Acceleration	Slower than normal acceleration after initial EGT rise. All engine parameters are slow to respond to power lever movement.
Slow or No Power Lever Response	Engine does not respond or is slow to respond (relative to other engine(s)) to power lever movement.
Surge	Abrupt power loss due to compressor instability which may or may not be audible and usually accompanied by EGT increase.
Wet Start	No indicated increase in EGT after start lever is advanced with fuel flow confirmed.

ENGINE GENERAL - TROUBLESHOOTING -02 (LUBRICATION SYSTEM)

1. Excessive Oil Consumption/Oil Leakage

NOTE: This section has troubleshooting diagrams which have procedures for problems related to the lubrication system.

A. Operational Inputs

(1) When oil quantity decreases check and record other oil system indications on affected engine:

(a) Oil quantity: __________ gal.

(b) Oil temperature: __________ °C.

(c) Oil pressure: __________ PSI.

(d) Engine oil pressure light (illuminated).

(e) Compute consumption.

(2) When all other oil system indications are normal:

(a) Swap oil quantity gages to confirm decreasing quantity.

(3) If oil leakage is seen on engine or in inlet, tailpipe or cowling, use procedures for Excessive Oil Consumption to find and correct leak.

B. Excessive Oil Consumption/Oil Leakage Procedures. (Figure 101 through Figure 108)

C. Blue Dye Oil Leakage Check (Optional).

(1) Use this procedure as an alternate to the powder developer method to find leaks in the oil system. (Figure 101)

(2) It will be necessary to drain the oil from the engine after this check is completed.

(3) This check will make it possible to know the difference between oil leakage from engine seams (which is not a problem) and leakage from the engine lubrication system (which can cause engine problems).

CAUTION: BE SURE TO OBEY THE LIMITS IN THE OIL DRAIN PROCEDURE BEFORE THE OIL TANK CAP IS OPENED. INJURY CAN OCCUR IF THE OIL PRESSURE IS NOT RELEASED.

(4) Oil system preparation. (ENGINE OIL SYSTEM - SERVICING, PAGEBLOCK 12-12-04/301)

(a) Drain the oil system.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(b) Fill the oil tank with PS 197 blue dye. Refer to STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201 for the procedure to prepare and mix the dye solution.

(c) Clean all remaining oil from engine external surfaces, tubes, components, and accessories by SPOP 1 or SPOP 208. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

(5) Close the cowl doors.

(6) Idle power leak check.

WJE 415-427, 429, 861-866, 868, 869, 871, 872, 891

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 1)

WJE 401-412, 414, 880, 881, 883, 884, 886, 887

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 8 or GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 7 or GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 5)

WJE 401-404, 412, 414, 875-879

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 7)

WJE 405-412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 8)

WJE ALL

(a) Start the engine.

(b) Set the power lever to idle. Keep the engine at idle until the oil temperature is at operating temperature.

(c) Let the engine become stable at minimum idle for 5 minutes.

(d) Make sure that all engine parameters are in the permitted limits.

(e) Do an engine shutdown.

(f) Do a visual inspection of the entire engine for leaks. Blue fluid at the tube joints or components will be an indication of internal oil leakage.

NOTE: Leakage which has an amber color is a result of assembly fluid leakage. Blue fluid leakage is the result of engine oil leaks.

(g) Look at the seal drains for indications of blue oil leakage. (POWERPLANT DRAIN SYSTEM - CHECK, PAGEBLOCK 71-70-01/601)

(h) When necessary, repair the leaks in tubes or components. After the leaks are repaired, clean the dye indications by SPOP 1 or SPOP 208 and do the leak check at idle power again. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

NOTE: It is possible that it will be necessary to operate the engine for a longer time and at higher power to see the wet indications of oil leaks. Keep the engine operation to a minimum to prevent too much leakage.

(i) When leak check results are satisfactory, go on to Paragraph 1.C.(8).

(7) Takeoff power leak check (Optional).

WJE 415-427, 429, 861-866, 868, 869, 871, 872, 891

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 1)

WJE 401-412, 414, 880, 881, 883, 884, 886, 887

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 8 or GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 7 or GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 5)

WJE 401-404, 412, 414, 875-879

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 7)

WJE 405-412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 8)

WJE ALL

NOTE: This high power check is not necessary if all leaks were found by the idle power leak check above.

(a) Start the engine.

(b) Let the engine become stable for of 5 minutes at minimum idle.

(c) Make sure that all engine parameters are in the permitted limits.

(d) Set the power lever to takeoff and operate the engine at this level for one minute.

(e) Decrease the power to 1.3 EPR and stay at this power level for 2 - 3 minutes.

(f) Open the cowl doors.

(g) Do an engine shutdown.

(h) Do a visual inspection of the entire engine for leaks. Blue fluid at the tube joints or components will be an indication of oil leakage.

NOTE: Leakage which has an amber color is a result of assembly fluid leakage. Blue fluid leakage is the result of engine oil leaks.

(i) Look at the seal drains for indications of blue oil leakage. (POWERPLANT DRAIN SYSTEM - CHECK, PAGEBLOCK 71-70-01/601)

(j) When necessary, repair the leaks in tubes or components. After the leaks are repaired, clean the dye indications by SPOP 1 or SPOP 208 and do the leak check at takeoff power again. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

(8) Procedure after all leaks are repaired.

(a) After all the leaks are repaired, drain the dyed oil from the oil system. Drain the oil from the oil tank, main gearbox, and magnetic chip collectors as specified. (ENGINE OIL SYSTEM - SERVICING, PAGEBLOCK 12-12-04/301)

(b) Replace the main oil filter or strainer. (MAIN OIL FILTER - 15/70 MICRON - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-54/401) (MAIN OIL FILTER - 40 MICRON - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-55/401)

(c) Fill the oil system with clean oil. (ENGINE OIL SYSTEM - SERVICING, PAGEBLOCK 12-12-04/301)

WJE 415-427, 429, 861-866, 868, 869, 871, 872, 891

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 1)

WJE 401-412, 414, 880, 881, 883, 884, 886, 887

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 8 or GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 7 or GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 5)

WJE 401-404, 412, 414, 875-879

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 7)

WJE 405-412, 414-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

(GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501 Config 8)

WJE ALL

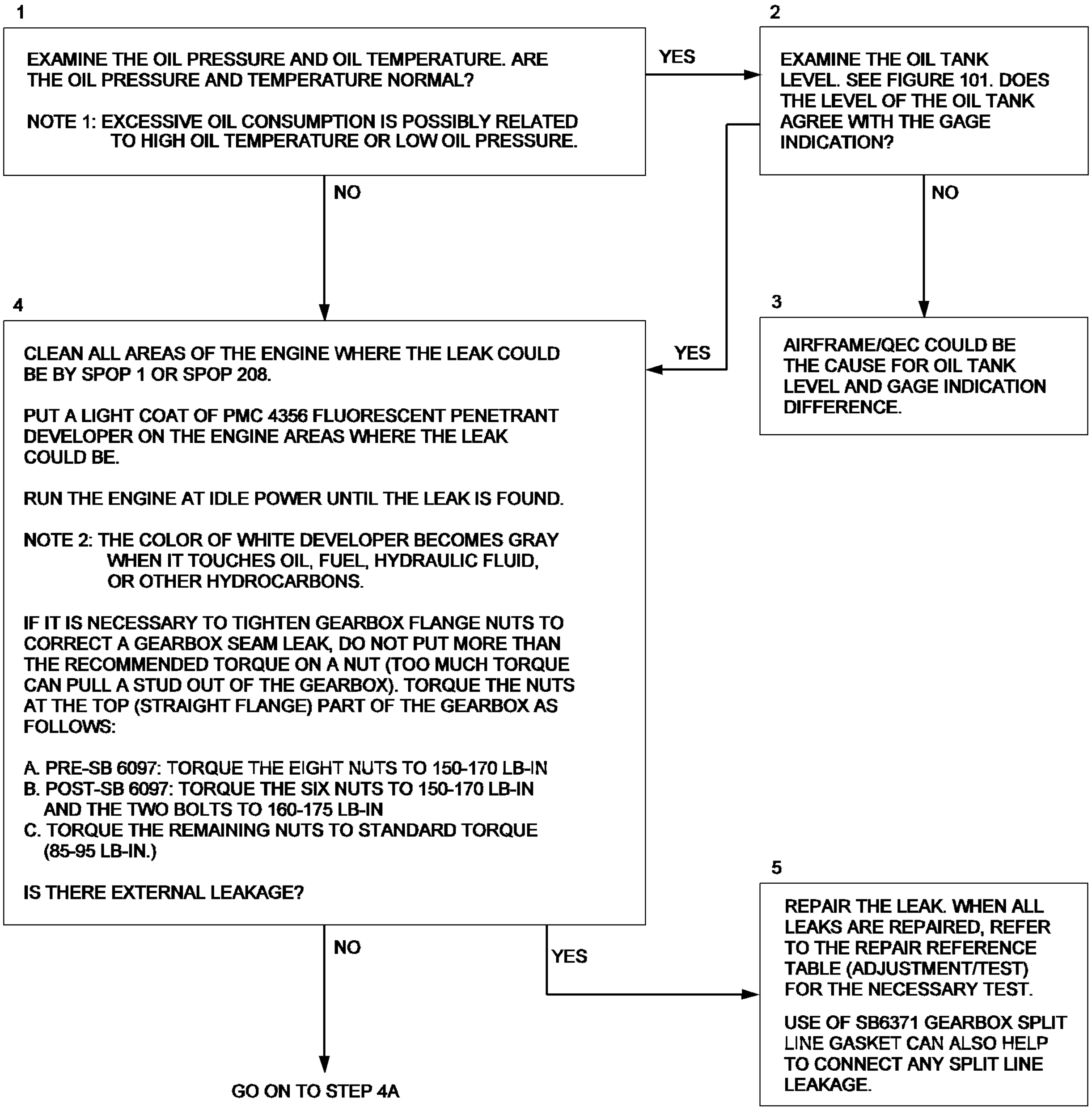
(d) Start the engine.

(e) Operate the engine at idle for a minimum for 3 minutes.

(f) Do a shutdown procedure.

(g) Do a check of the repaired areas for leaks. None are permitted.

EXCESSIVE OIL CONSUMPTION



1 EXAMINE THE OIL PRESSURE AND OIL TEMPERATURE. ARE THE OIL PRESSURE AND TEMPERATURE NORMAL?

NOTE 1: EXCESSIVE OIL CONSUMPTION IS POSSIBLY RELATED TO HIGH OIL TEMPERATURE OR LOW OIL PRESSURE.

2 EXAMINE THE OIL TANK LEVEL. SEE FIGURE 101. DOES THE LEVEL OF THE OIL TANK AGREE WITH THE GAGE INDICATION?

3 AIRFRAME/QEC COULD BE THE CAUSE FOR OIL TANK LEVEL AND GAGE INDICATION DIFFERENCE.

4 CLEAN ALL AREAS OF THE ENGINE WHERE THE LEAK COULD BE BY SPOP 1 OR SPOP 208.

PUT A LIGHT COAT OF PMC 4356 FLUORESCENT PENETRANT DEVELOPER ON THE ENGINE AREAS WHERE THE LEAK COULD BE.

RUN THE ENGINE AT IDLE POWER UNTIL THE LEAK IS FOUND.

NOTE 2: THE COLOR OF WHITE DEVELOPER BECOMES GRAY WHEN IT TOUCHES OIL, FUEL, HYDRAULIC FLUID, OR OTHER HYDROCARBONS.

IF IT IS NECESSARY TO TIGHTEN GEARBOX FLANGE NUTS TO CORRECT A GEARBOX SEAM LEAK, DO NOT PUT MORE THAN THE RECOMMENDED TORQUE ON A NUT (TOO MUCH TORQUE CAN PULL A STUD OUT OF THE GEARBOX). TORQUE THE NUTS AT THE TOP (STRAIGHT FLANGE) PART OF THE GEARBOX AS FOLLOWS:

A. PRE-SB 6097: TORQUE THE EIGHT NUTS TO 150-170 LB-IN
B. POST-SB 6097: TORQUE THE SIX NUTS TO 150-170 LB-IN AND THE TWO BOLTS TO 160-175 LB-IN
C. TORQUE THE REMAINING NUTS TO STANDARD TORQUE (85-95 LB-IN.)

IS THERE EXTERNAL LEAKAGE?

5 REPAIR THE LEAK. WHEN ALL LEAKS ARE REPAIRED, REFER TO THE REPAIR REFERENCE TABLE (ADJUSTMENT/TEST) FOR THE NECESSARY TEST.

USE OF SB6371 GEARBOX SPLIT LINE GASKET CAN ALSO HELP TO CONNECT ANY SPLIT LINE LEAKAGE.

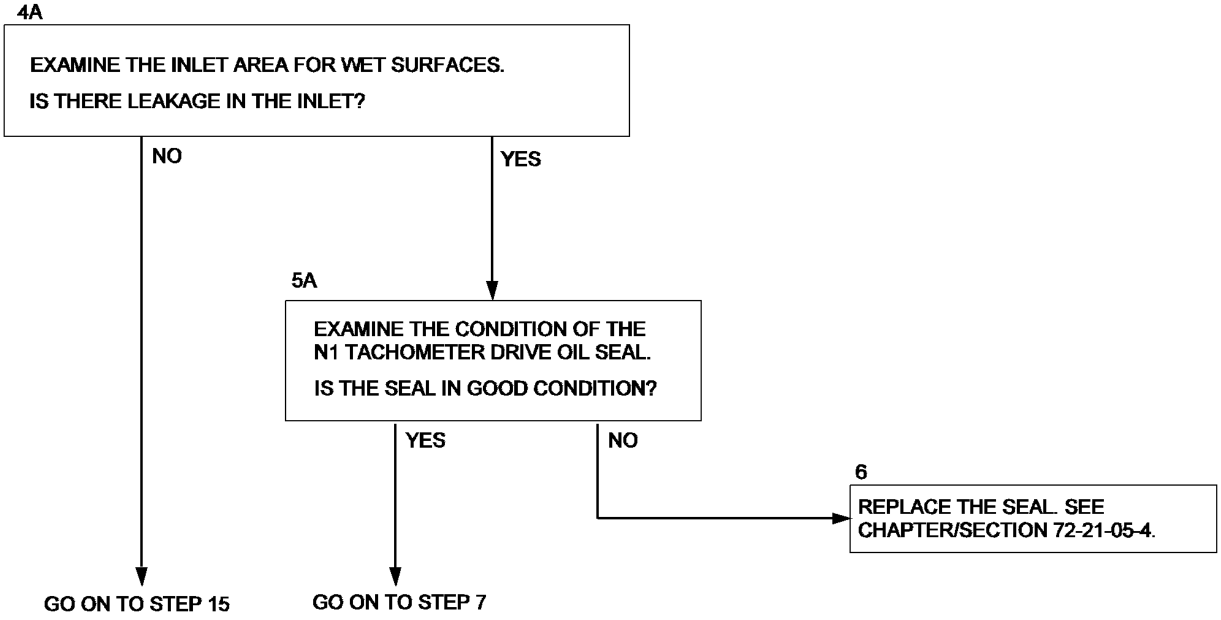
GO ON TO STEP 4A

L-H0845 (0502)

BBB2-72-300F
S0006554899V2

Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 1 of 15)

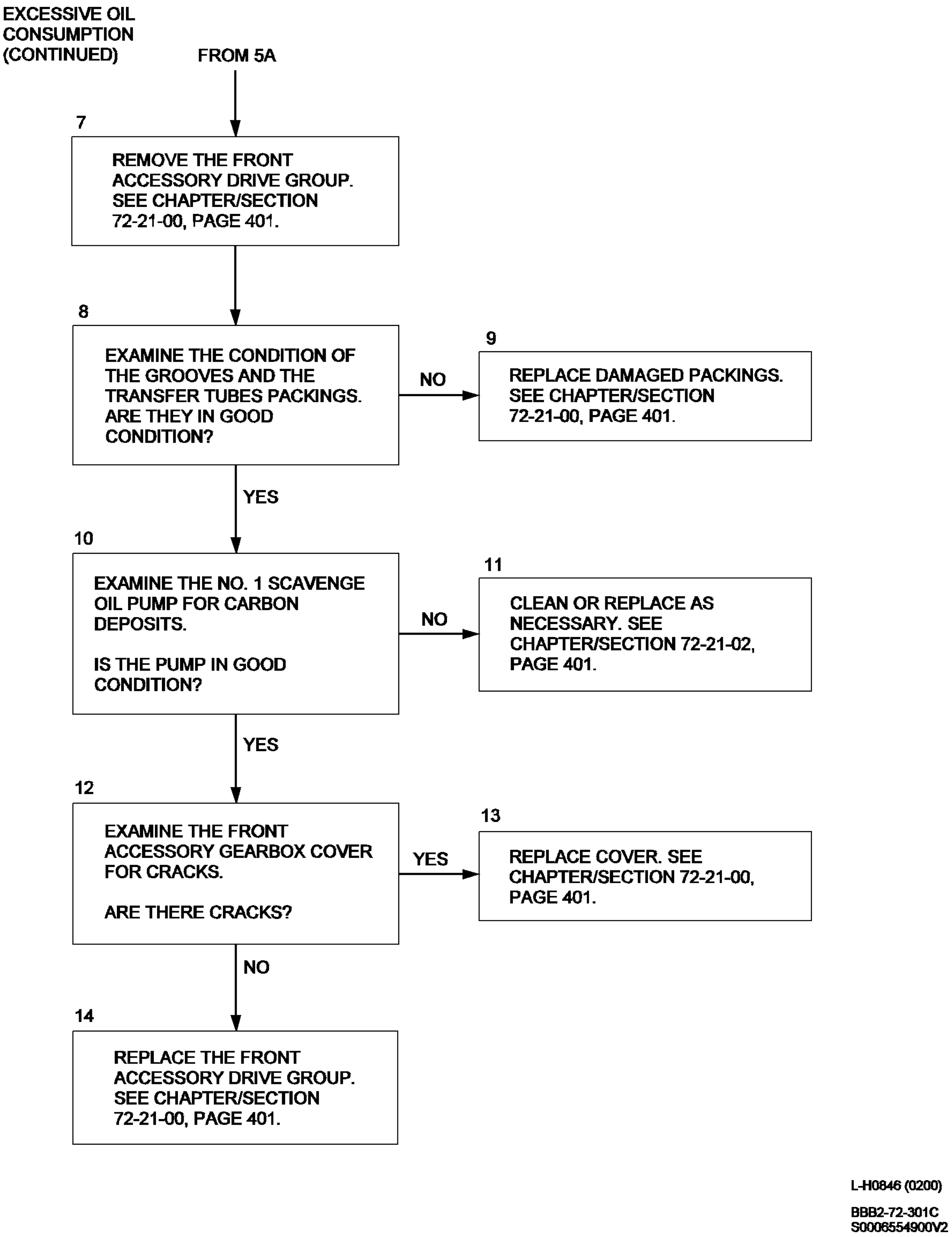
EXCESSIVE OIL CONSUMPTION
(CONTINUED)



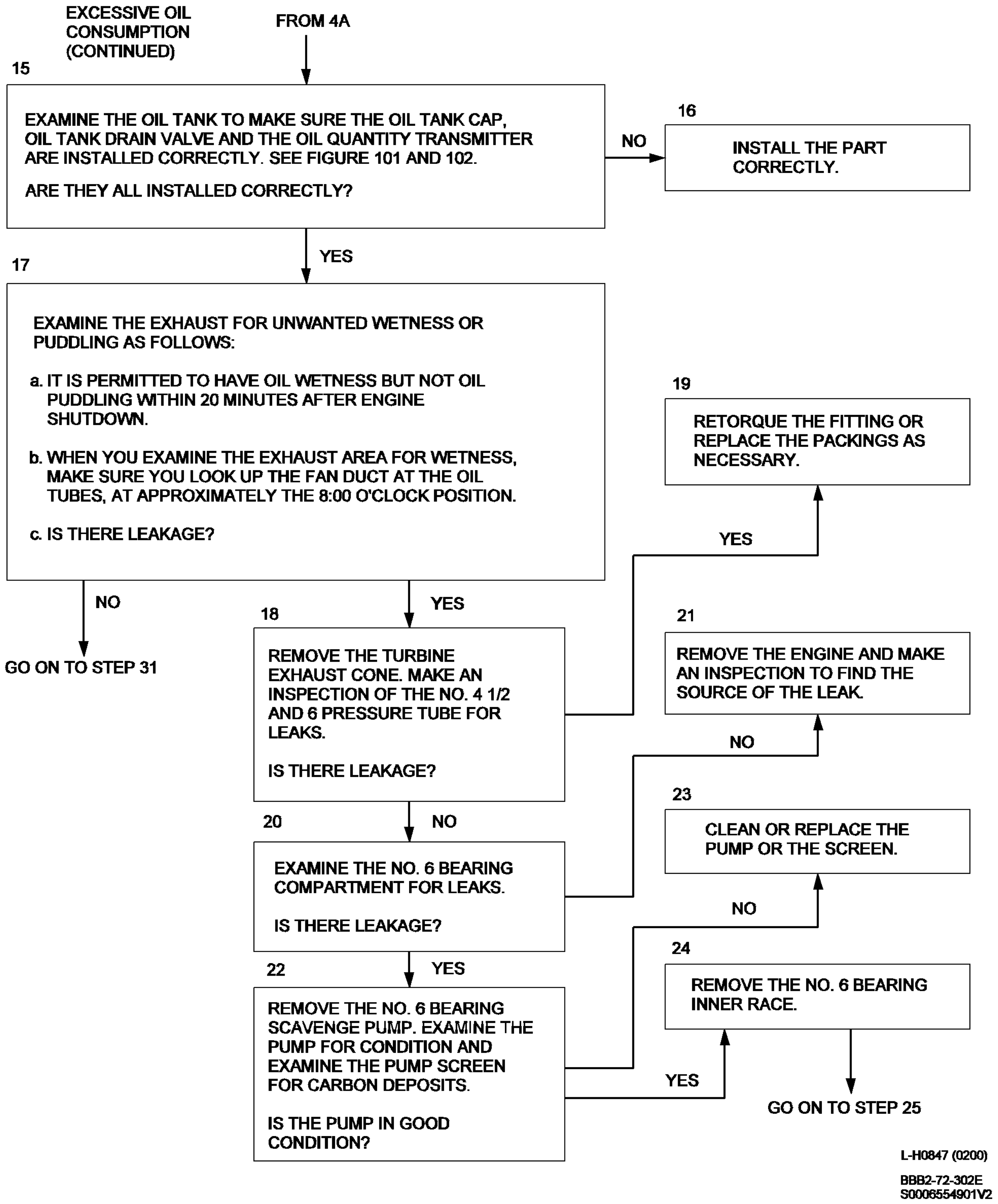
L-H4088 (0200)

BBB2-72-582
S0000173398V1

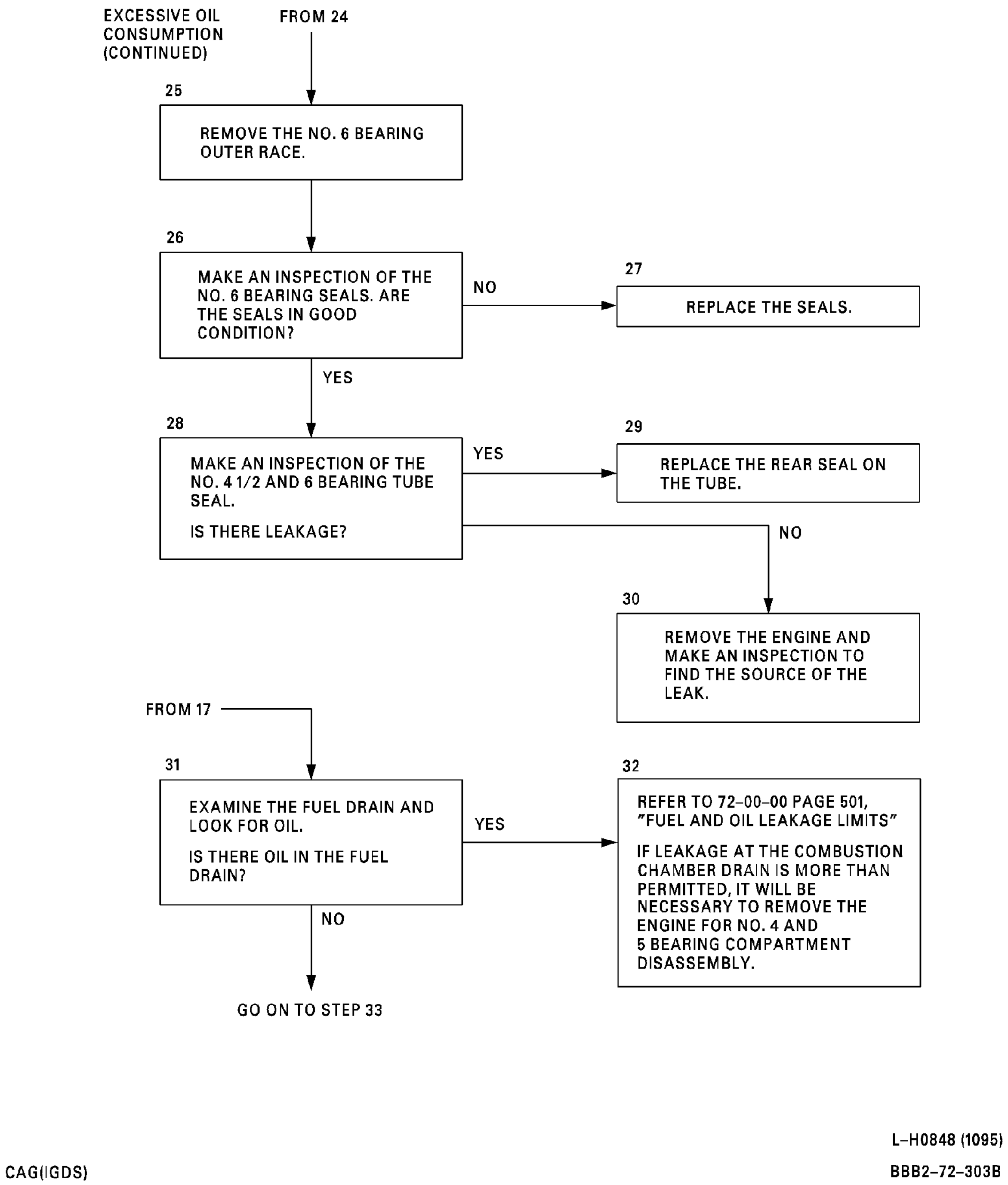
Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 2 of 15)



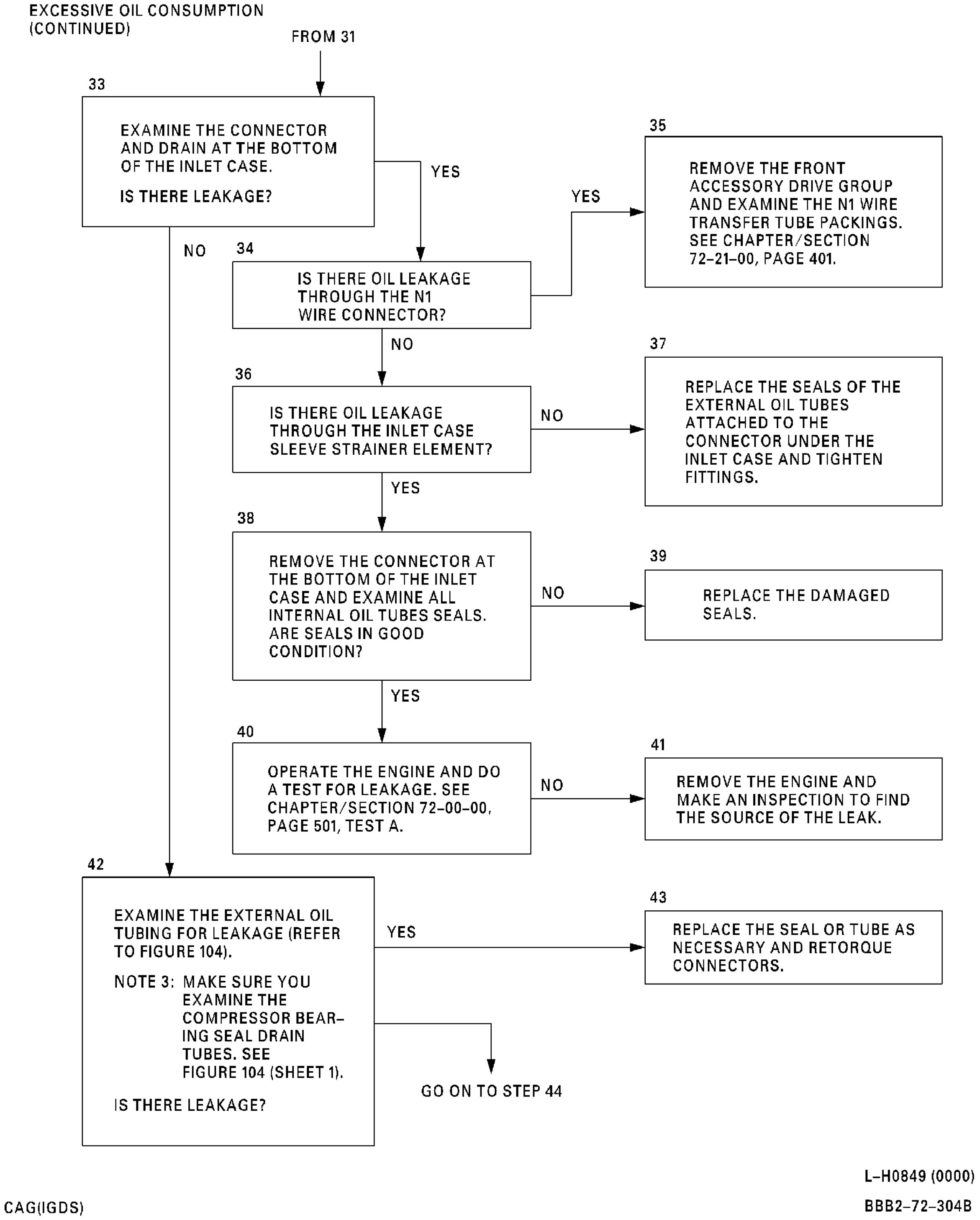
Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 3 of 15)



Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 4 of 15)



Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 5 of 15)



33 EXAMINE THE CONNECTOR AND DRAIN AT THE BOTTOM OF THE INLET CASE.

IS THERE LEAKAGE?

34 IS THERE OIL LEAKAGE THROUGH THE N1 WIRE CONNECTOR?

35 REMOVE THE FRONT ACCESSORY DRIVE GROUP AND EXAMINE THE N1 WIRE TRANSFER TUBE PACKINGS. SEE CHAPTER/SECTION 72-21-00, PAGE 401.

36 IS THERE OIL LEAKAGE THROUGH THE INLET CASE SLEEVE STRAINER ELEMENT?

37 REPLACE THE SEALS OF THE EXTERNAL OIL TUBES ATTACHED TO THE CONNECTOR UNDER THE INLET CASE AND TIGHTEN FITTINGS.

38 REMOVE THE CONNECTOR AT THE BOTTOM OF THE INLET CASE AND EXAMINE ALL INTERNAL OIL TUBES SEALS. ARE SEALS IN GOOD CONDITION?

39 REPLACE THE DAMAGED SEALS.

40 OPERATE THE ENGINE AND DO A TEST FOR LEAKAGE. SEE CHAPTER/SECTION 72-00-00, PAGE 501, TEST A.

41 REMOVE THE ENGINE AND MAKE AN INSPECTION TO FIND THE SOURCE OF THE LEAK.

42 EXAMINE THE EXTERNAL OIL TUBING FOR LEAKAGE (REFER TO FIGURE 104).

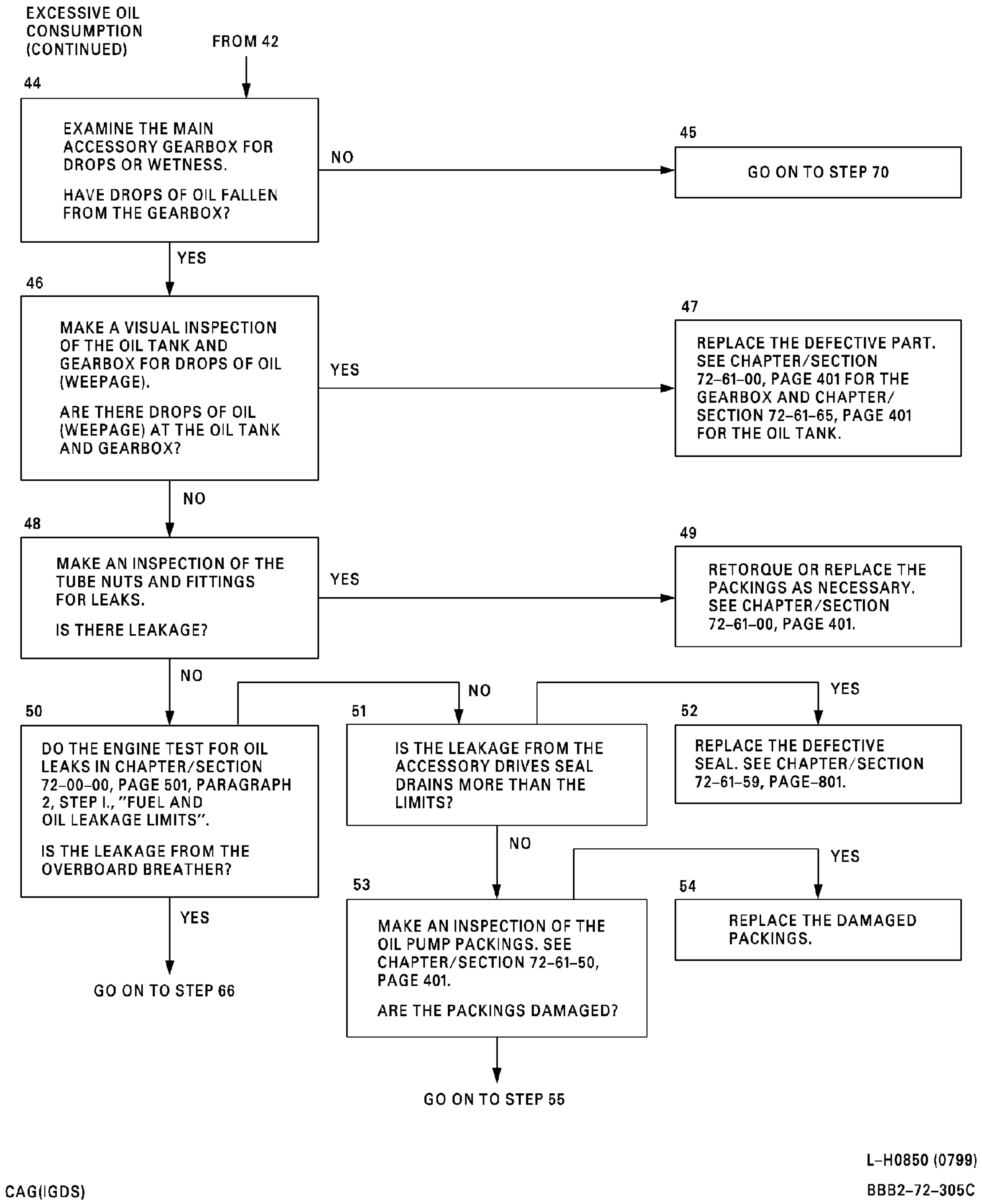
NOTE 3: MAKE SURE YOU EXAMINE THE COMPRESSOR BEARING SEAL DRAIN TUBES. SEE FIGURE 104 (SHEET 1).

IS THERE LEAKAGE?

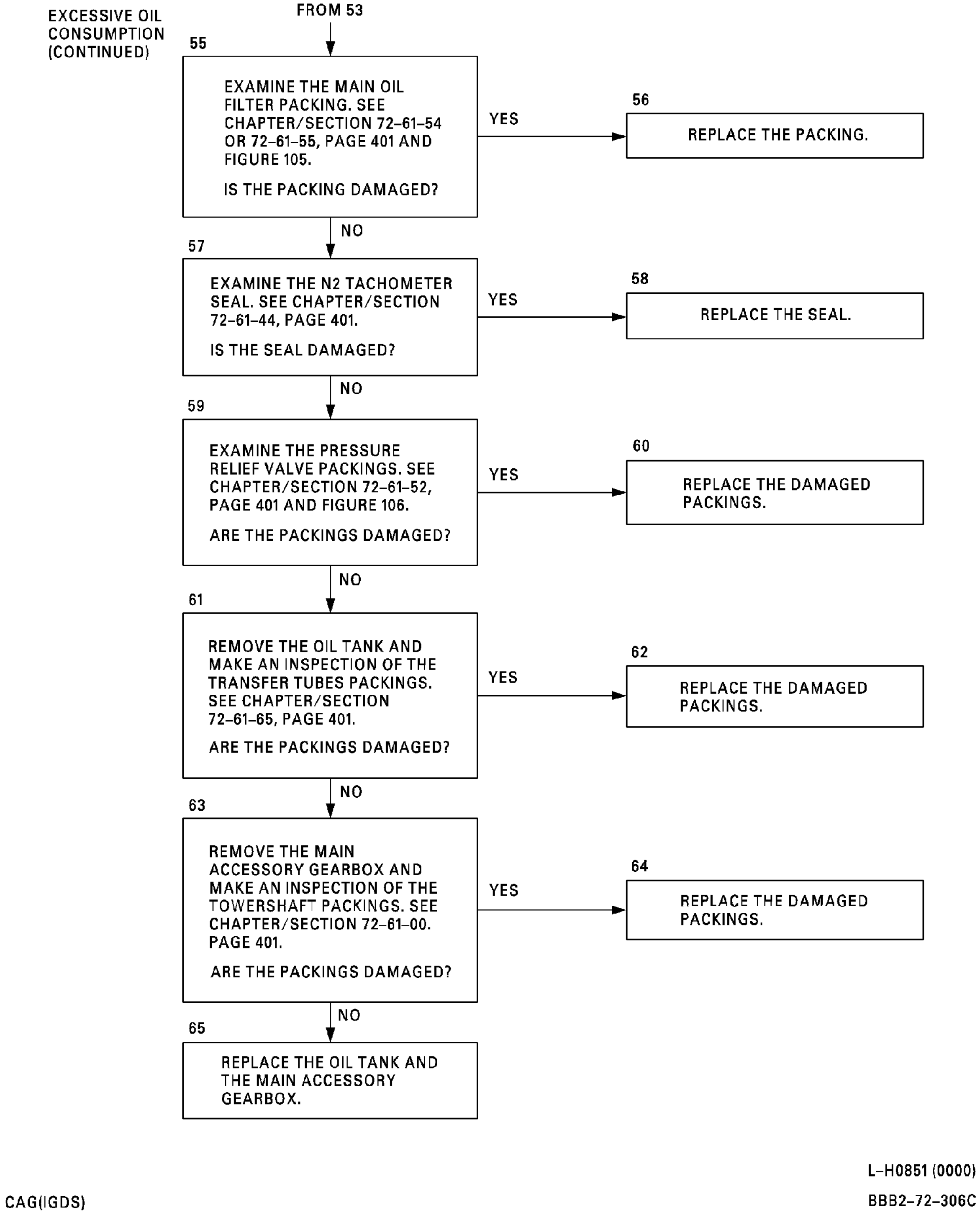
43 REPLACE THE SEAL OR TUBE AS NECESSARY AND RETORQUE CONNECTORS.

GO ON TO STEP 44

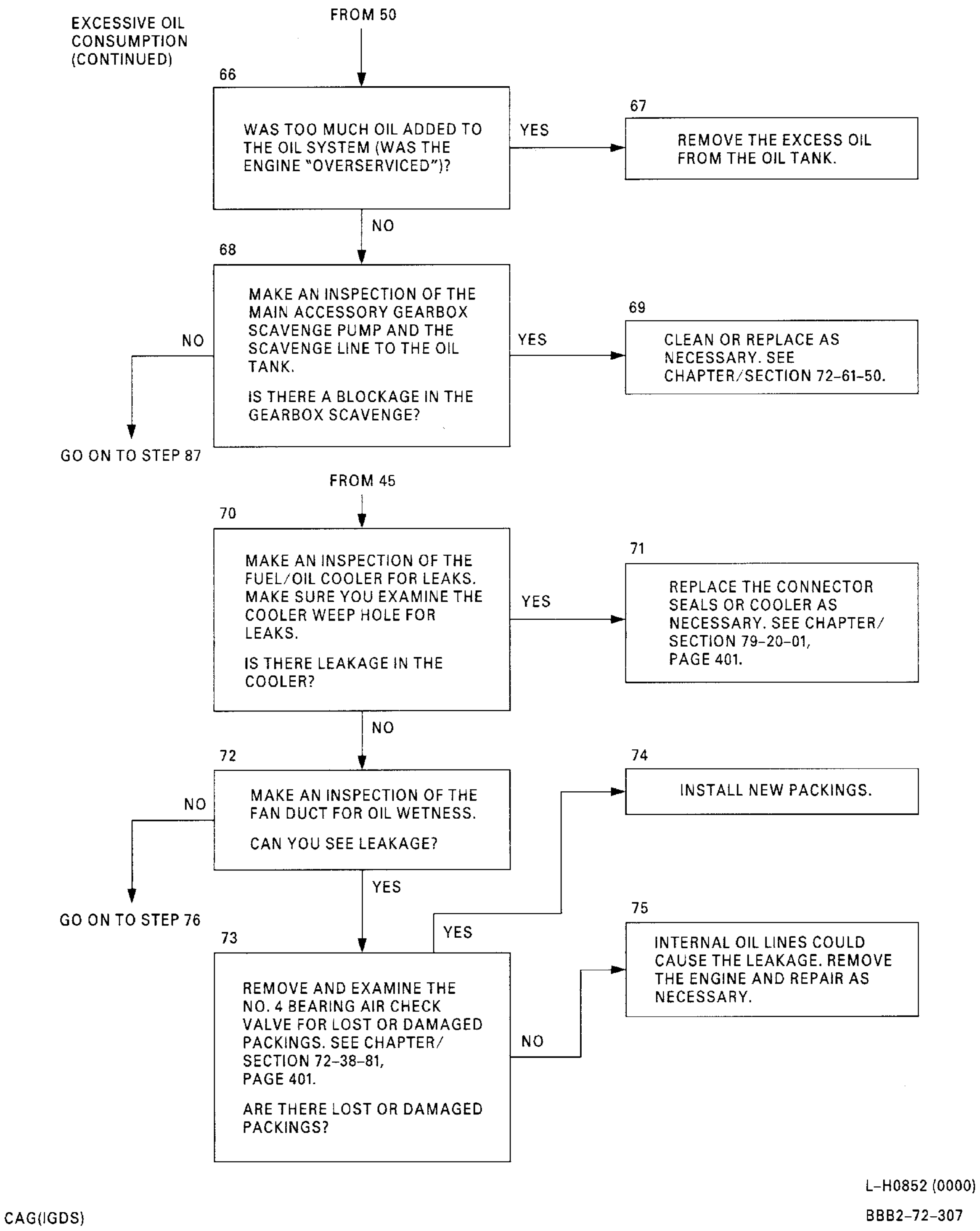
Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 6 of 15)



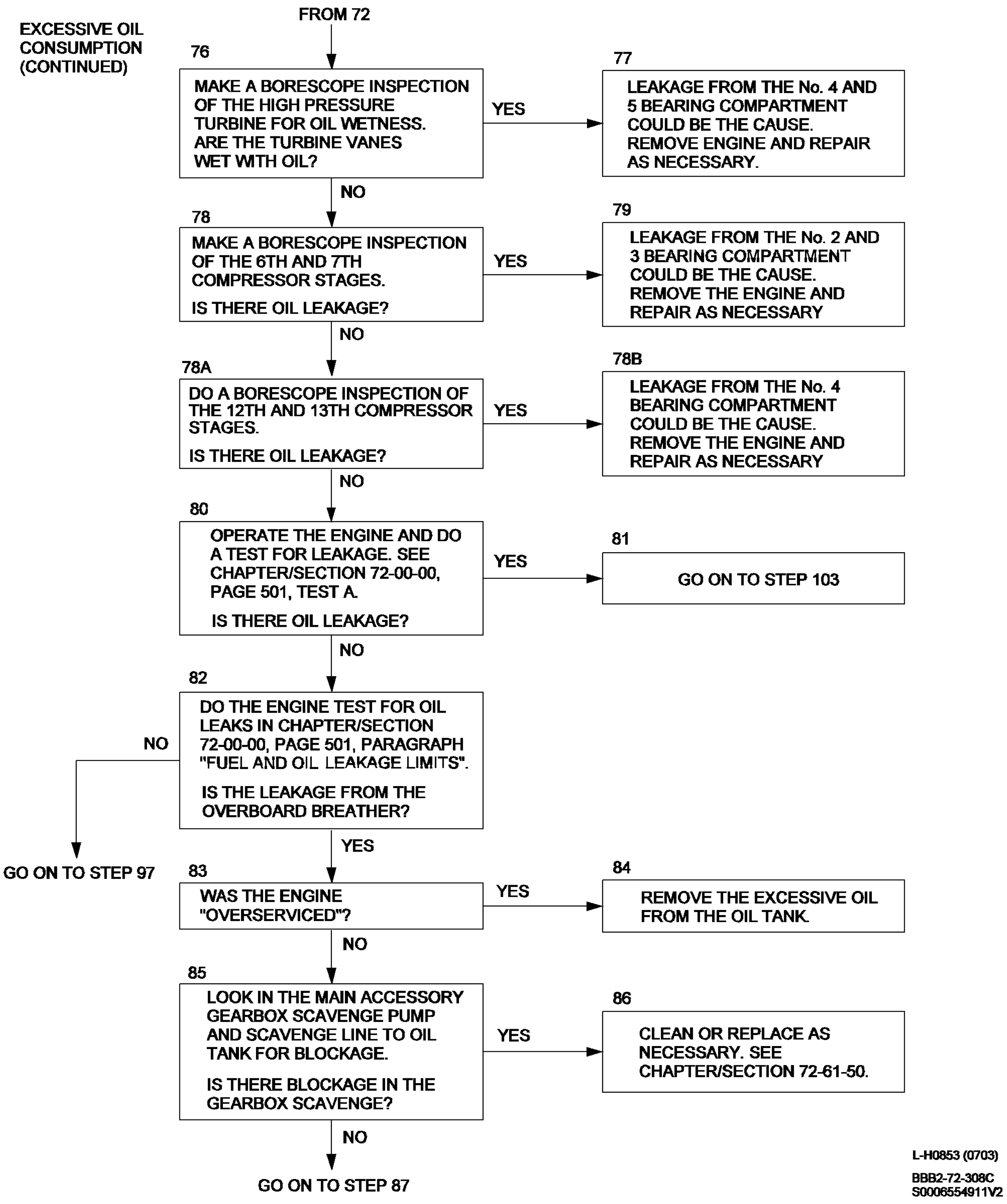
Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 7 of 15)



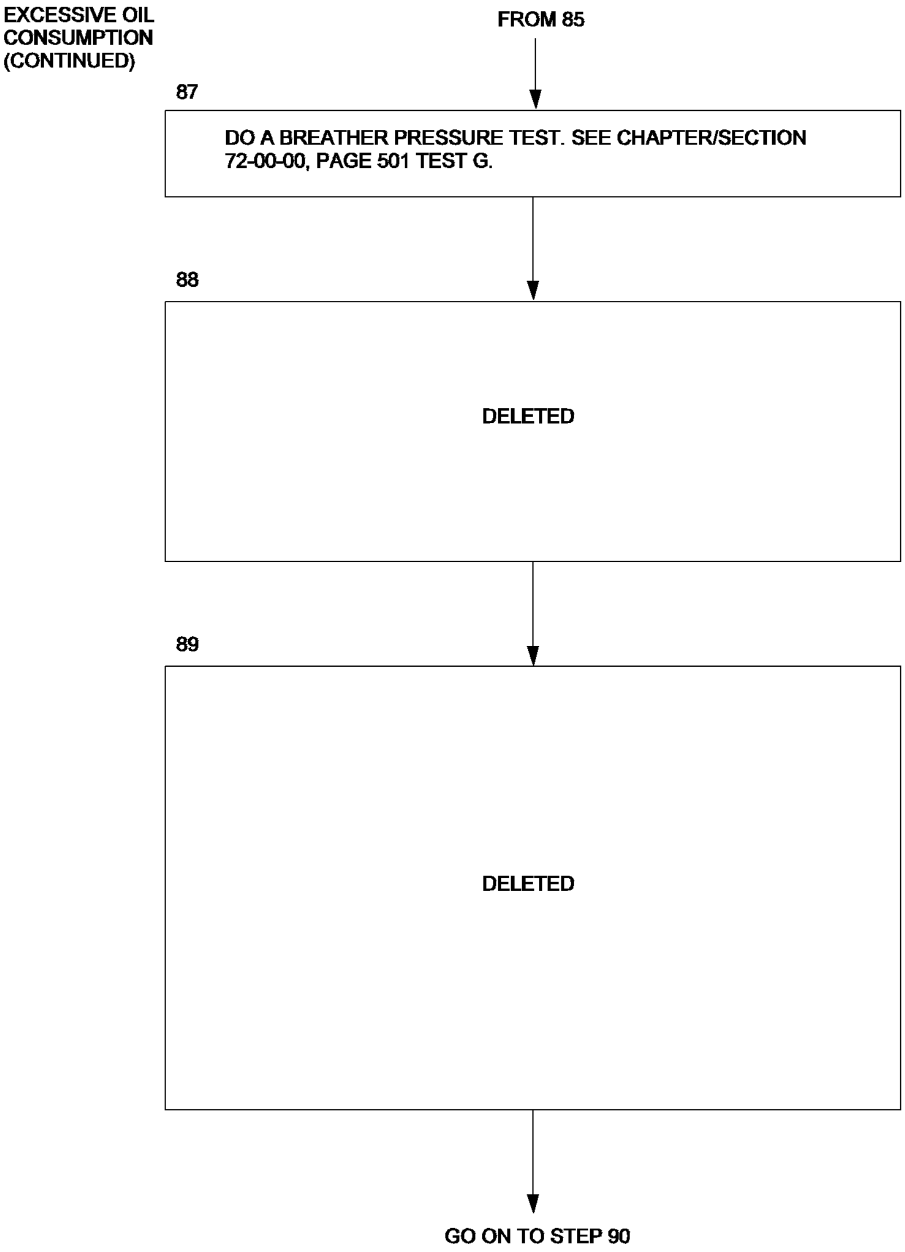
Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 8 of 15)



Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 9 of 15)



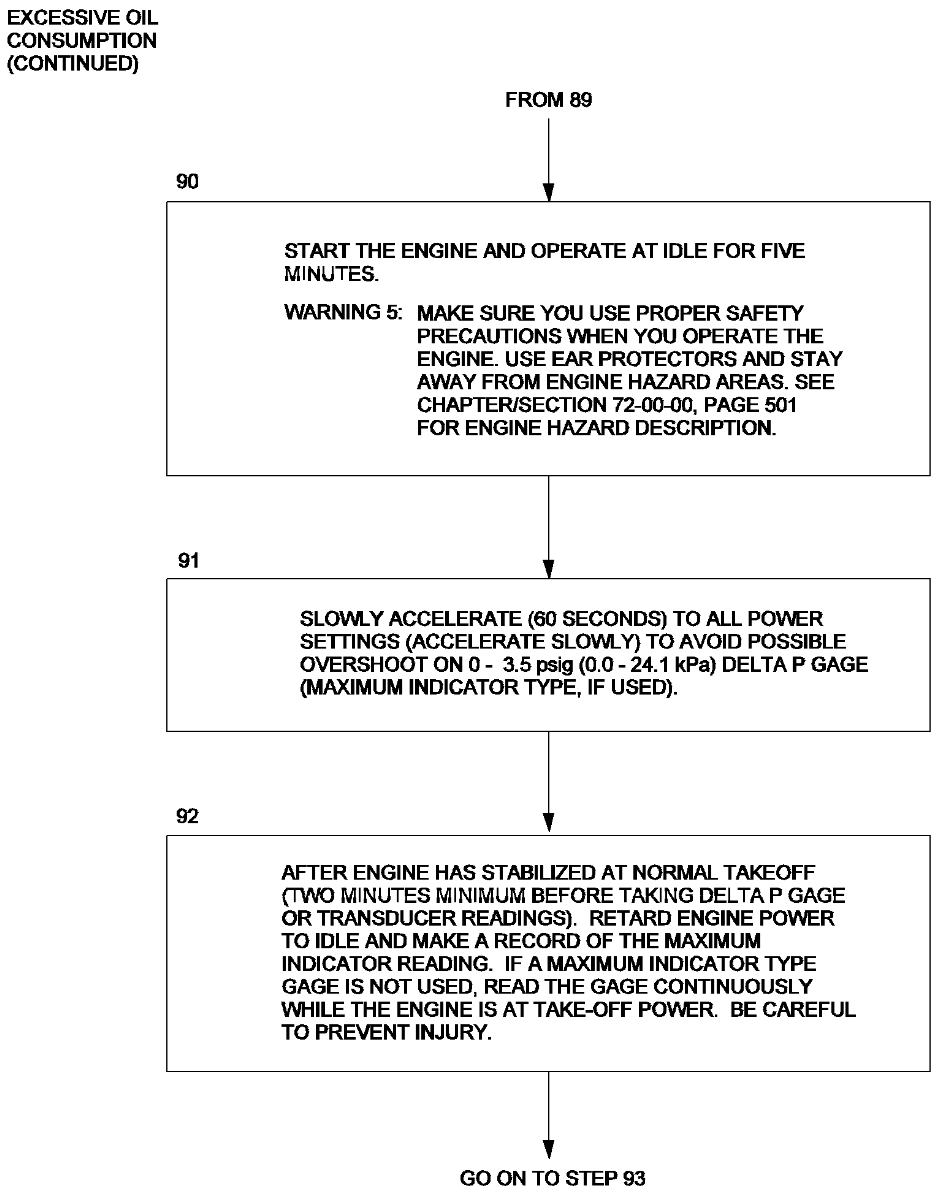
Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 10 of 15)



DO A BREATHER PRESSURE TEST. SEE CHAPTER/SECTION 72-00-00, PAGE 501 TEST G.

L-H0854 (0802)
BBB2-72-309E
S0006554913V2

Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 11 of 15)



EXCESSIVE OIL CONSUMPTION (CONTINUED)

FROM 89

90

START THE ENGINE AND OPERATE AT IDLE FOR FIVE MINUTES.

WARNING 5: MAKE SURE YOU USE PROPER SAFETY PRECAUTIONS WHEN YOU OPERATE THE ENGINE. USE EAR PROTECTORS AND STAY AWAY FROM ENGINE HAZARD AREAS. SEE CHAPTER/SECTION 72-00-00, PAGE 501 FOR ENGINE HAZARD DESCRIPTION.

91

SLOWLY ACCELERATE (60 SECONDS) TO ALL POWER SETTINGS (ACCELERATE SLOWLY) TO AVOID POSSIBLE OVERSHOOT ON 0 - 3.5 psig (0.0 - 24.1 kPa) DELTA P GAGE (MAXIMUM INDICATOR TYPE, IF USED).

92

AFTER ENGINE HAS STABILIZED AT NORMAL TAKEOFF (TWO MINUTES MINIMUM BEFORE TAKING DELTA P GAGE OR TRANSDUCER READINGS). RETARD ENGINE POWER TO IDLE AND MAKE A RECORD OF THE MAXIMUM INDICATOR READING. IF A MAXIMUM INDICATOR TYPE GAGE IS NOT USED, READ THE GAGE CONTINUOUSLY WHILE THE ENGINE IS AT TAKE-OFF POWER. BE CAREFUL TO PREVENT INJURY.

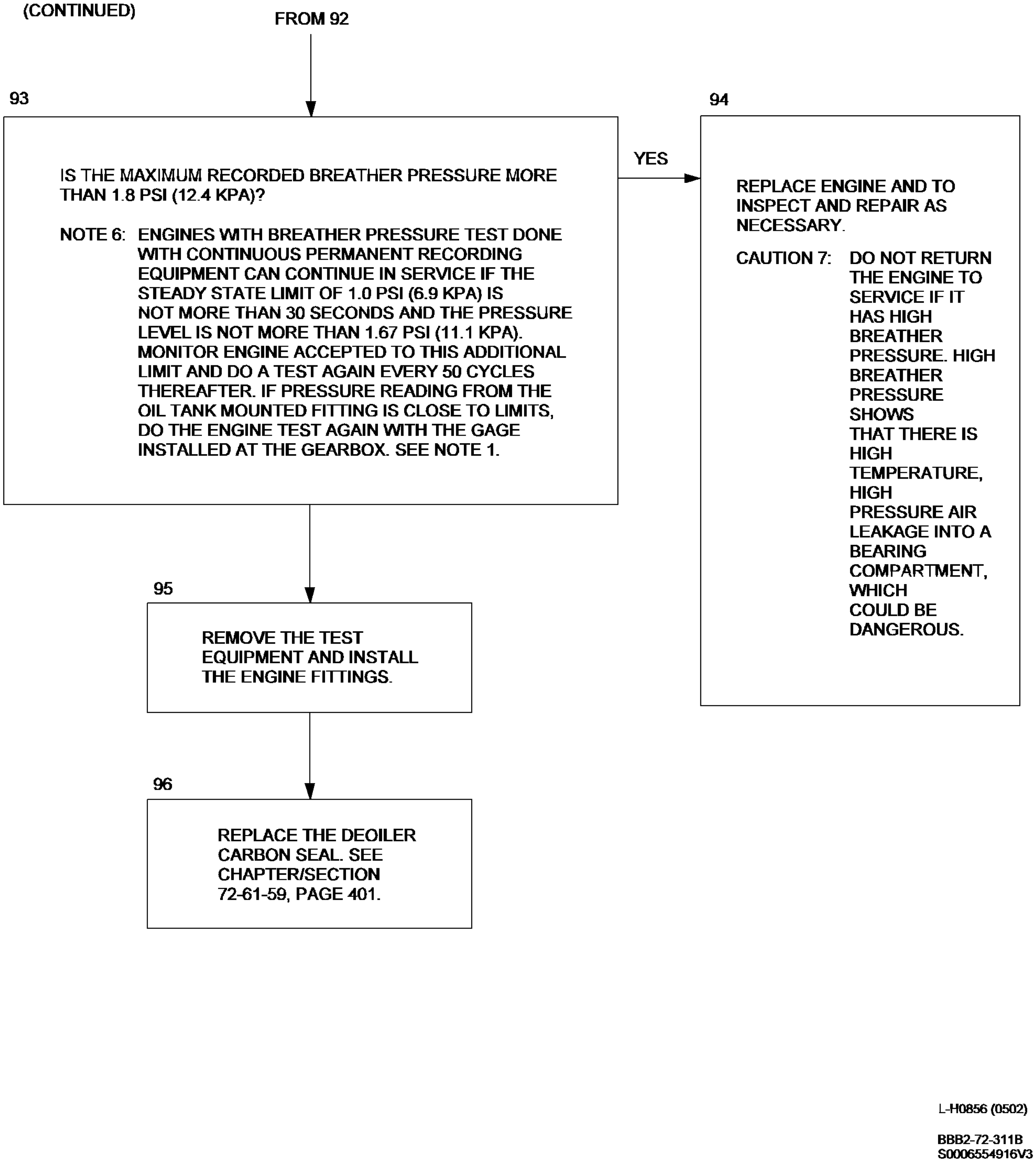
GO ON TO STEP 93

L-H0855 (0502)

BBB2-72-310A
S0006554914V2

Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 12 of 15)

EXCESSIVE OIL CONSUMPTION (CONTINUED)



93: IS THE MAXIMUM RECORDED BREATHER PRESSURE MORE THAN 1.8 PSI (12.4 KPA)?

NOTE 6: ENGINES WITH BREATHER PRESSURE TEST DONE WITH CONTINUOUS PERMANENT RECORDING EQUIPMENT CAN CONTINUE IN SERVICE IF THE STEADY STATE LIMIT OF 1.0 PSI (6.9 KPA) IS NOT MORE THAN 30 SECONDS AND THE PRESSURE LEVEL IS NOT MORE THAN 1.67 PSI (11.1 KPA). MONITOR ENGINE ACCEPTED TO THIS ADDITIONAL LIMIT AND DO A TEST AGAIN EVERY 50 CYCLES THEREAFTER. IF PRESSURE READING FROM THE OIL TANK MOUNTED FITTING IS CLOSE TO LIMITS, DO THE ENGINE TEST AGAIN WITH THE GAGE INSTALLED AT THE GEARBOX. SEE NOTE 1.

94: REPLACE ENGINE AND TO INSPECT AND REPAIR AS NECESSARY.

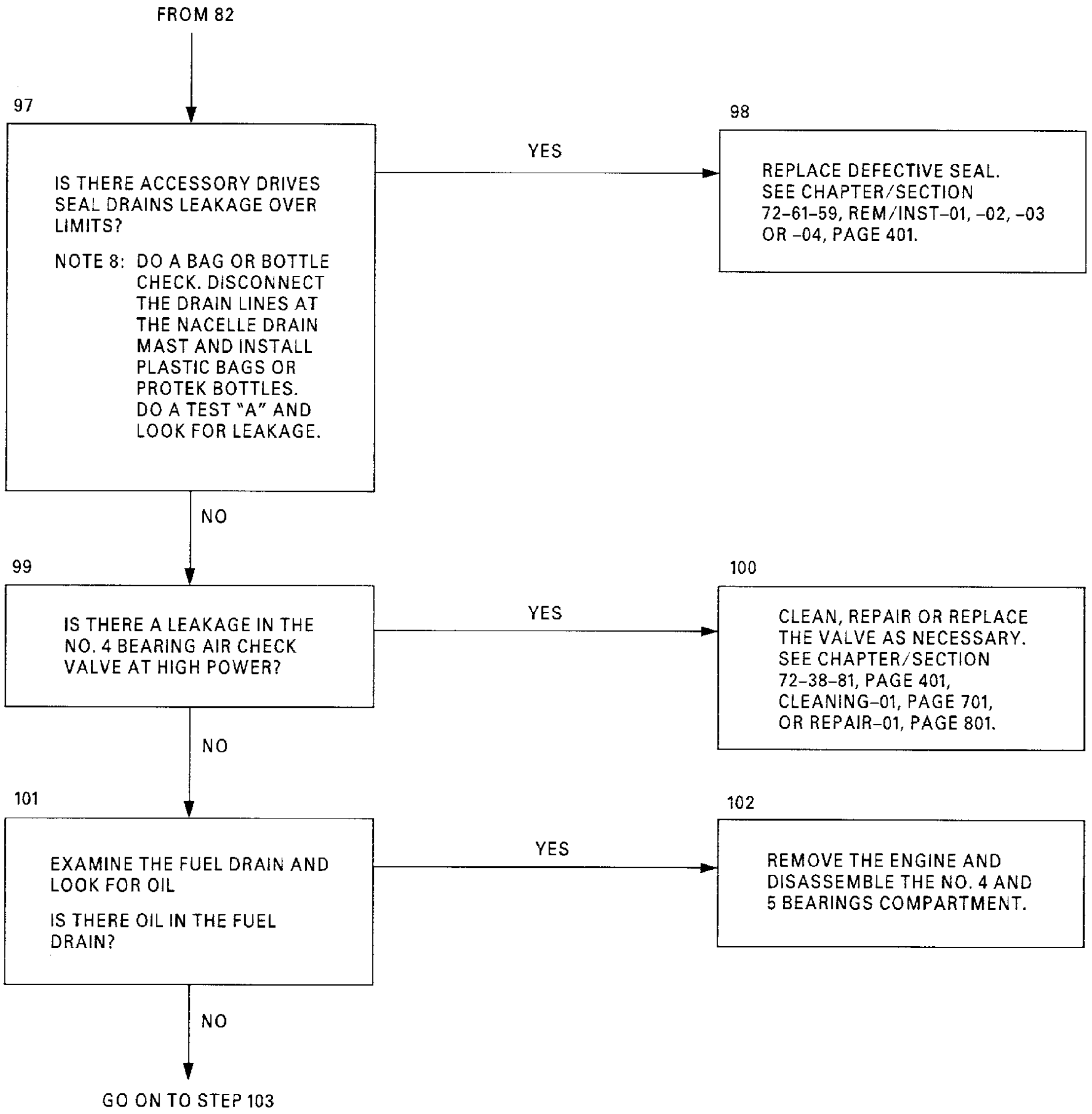
CAUTION 7: DO NOT RETURN THE ENGINE TO SERVICE IF IT HAS HIGH BREATHER PRESSURE. HIGH BREATHER PRESSURE SHOWS THAT THERE IS HIGH TEMPERATURE, HIGH PRESSURE AIR LEAKAGE INTO A BEARING COMPARTMENT, WHICH COULD BE DANGEROUS.

95: REMOVE THE TEST EQUIPMENT AND INSTALL THE ENGINE FITTINGS.

96: REPLACE THE DEOILER CARBON SEAL. SEE CHAPTER/SECTION 72-61-59, PAGE 401.

Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 13 of 15)

EXCESSIVE OIL CONSUMPTION
(CONTINUED)



97 IS THERE ACCESSORY DRIVES SEAL DRAINS LEAKAGE OVER LIMITS?

NOTE 8: DO A BAG OR BOTTLE CHECK. DISCONNECT THE DRAIN LINES AT THE NACELLE DRAIN MAST AND INSTALL PLASTIC BAGS OR PROTEK BOTTLES. DO A TEST "A" AND LOOK FOR LEAKAGE.

98 REPLACE DEFECTIVE SEAL. SEE CHAPTER/SECTION 72-61-59, REM/INST-01, -02, -03 OR -04, PAGE 401.

99 IS THERE A LEAKAGE IN THE NO. 4 BEARING AIR CHECK VALVE AT HIGH POWER?

100 CLEAN, REPAIR OR REPLACE THE VALVE AS NECESSARY. SEE CHAPTER/SECTION 72-38-81, PAGE 401, CLEANING-01, PAGE 701, OR REPAIR-01, PAGE 801.

101 EXAMINE THE FUEL DRAIN AND LOOK FOR OIL

IS THERE OIL IN THE FUEL DRAIN?

102 REMOVE THE ENGINE AND DISASSEMBLE THE NO. 4 AND 5 BEARINGS COMPARTMENT.

GO ON TO STEP 103

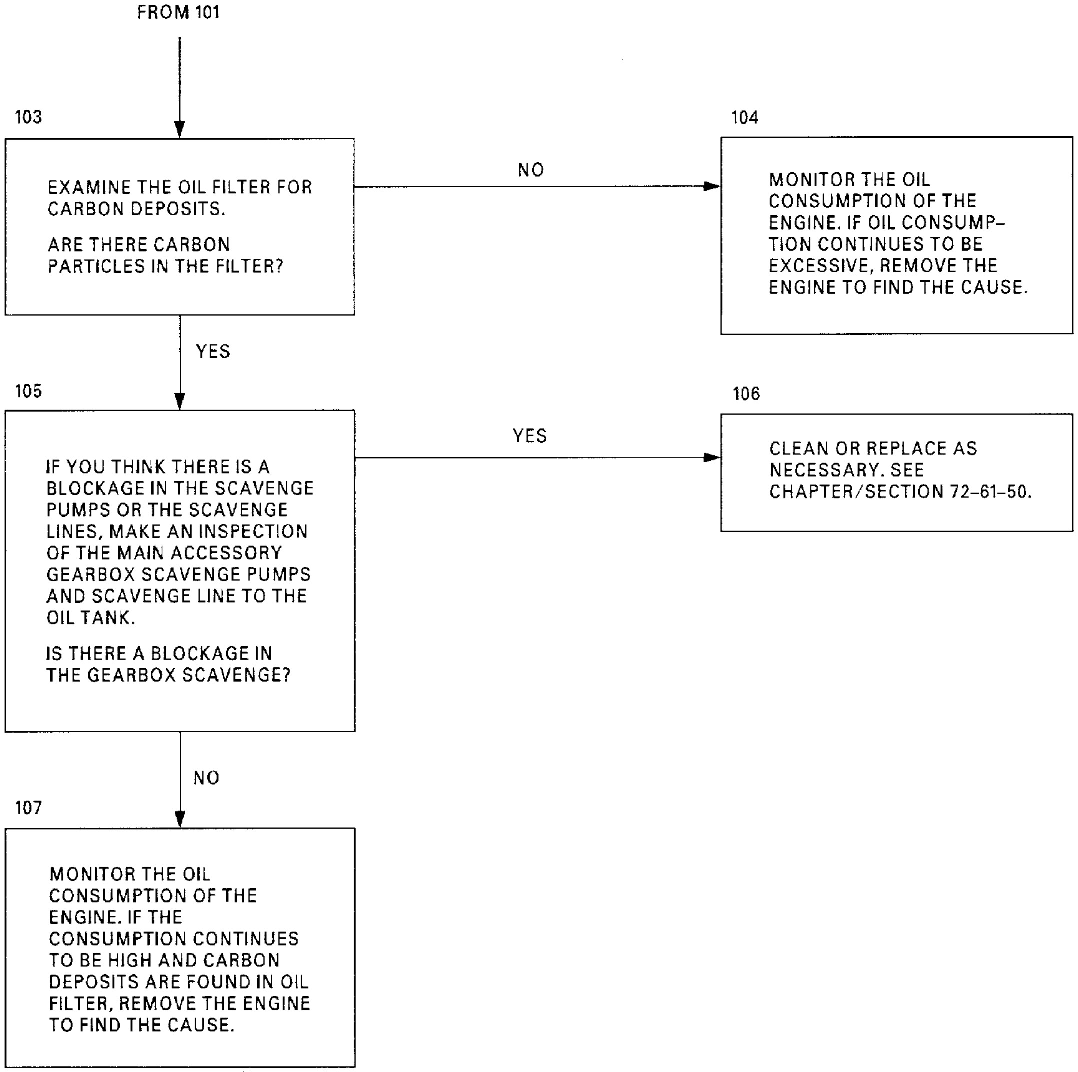
L-H0857 (0000)

CAG(IGDS)

BBB2-72-312

Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 14 of 15)

EXCESSIVE OIL CONSUMPTION (CONTINUED)



103: EXAMINE THE OIL FILTER FOR CARBON DEPOSITS.

ARE THERE CARBON PARTICLES IN THE FILTER?

104: MONITOR THE OIL CONSUMPTION OF THE ENGINE. IF OIL CONSUMPTION CONTINUES TO BE EXCESSIVE, REMOVE THE ENGINE TO FIND THE CAUSE.

105: IF YOU THINK THERE IS A BLOCKAGE IN THE SCAVENGE PUMPS OR THE SCAVENGE LINES, MAKE AN INSPECTION OF THE MAIN ACCESSORY GEARBOX SCAVENGE PUMPS AND SCAVENGE LINE TO THE OIL TANK.

IS THERE A BLOCKAGE IN THE GEARBOX SCAVENGE?

106: CLEAN OR REPLACE AS NECESSARY. SEE CHAPTER/SECTION 72-61-50.

107: MONITOR THE OIL CONSUMPTION OF THE ENGINE. IF THE CONSUMPTION CONTINUES TO BE HIGH AND CARBON DEPOSITS ARE FOUND IN OIL FILTER, REMOVE THE ENGINE TO FIND THE CAUSE.

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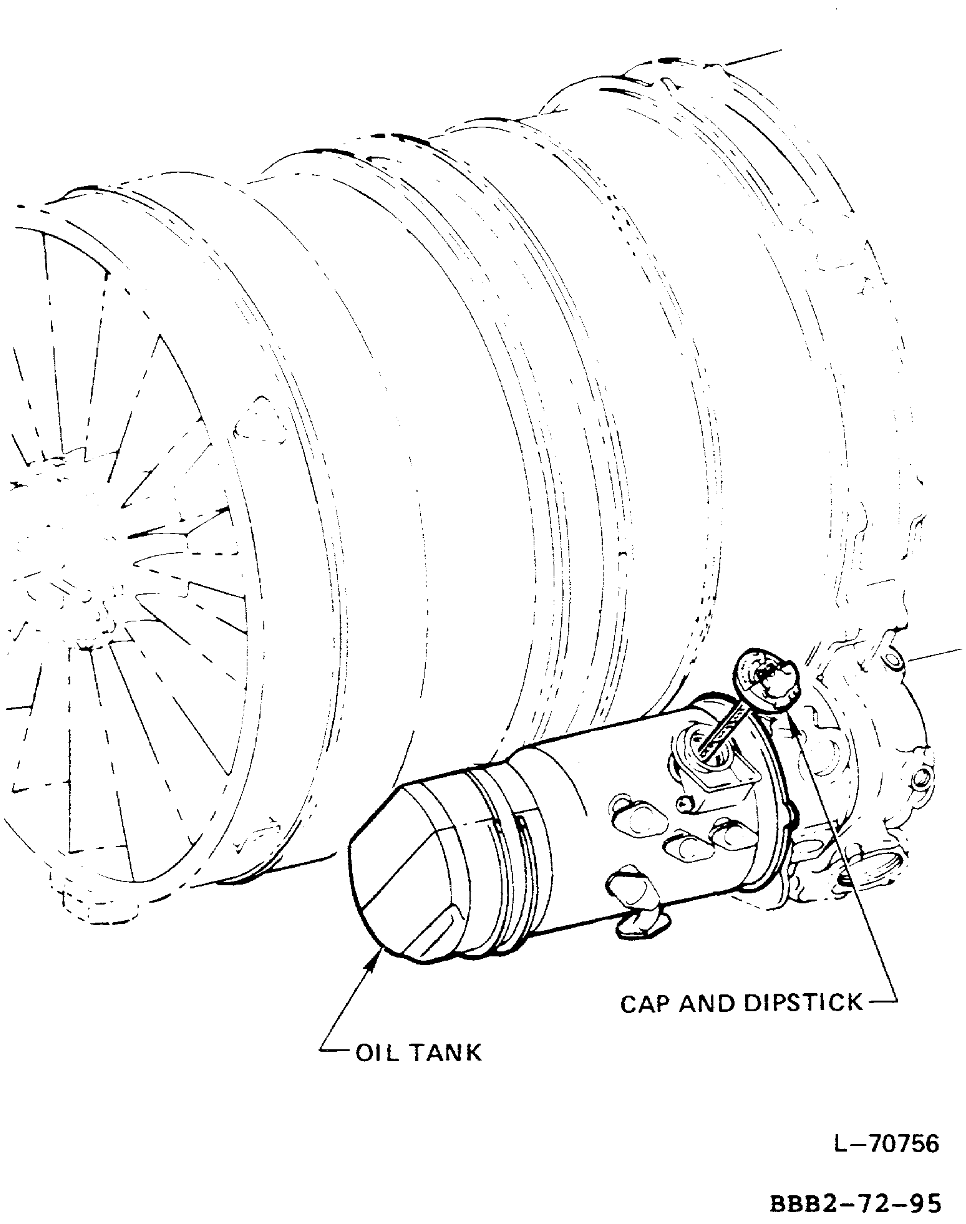
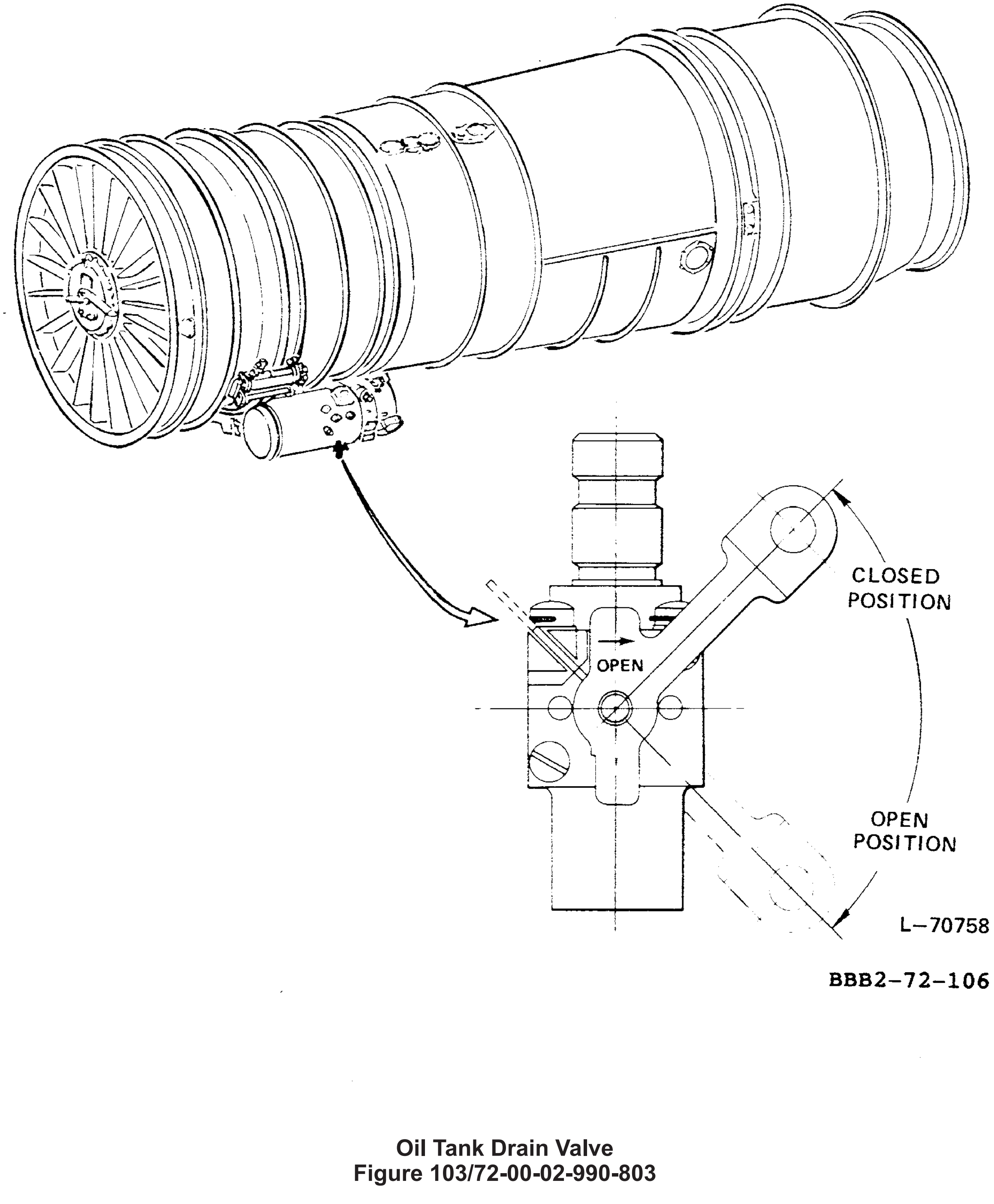
CAG(IGDS)

BBB2-72-313

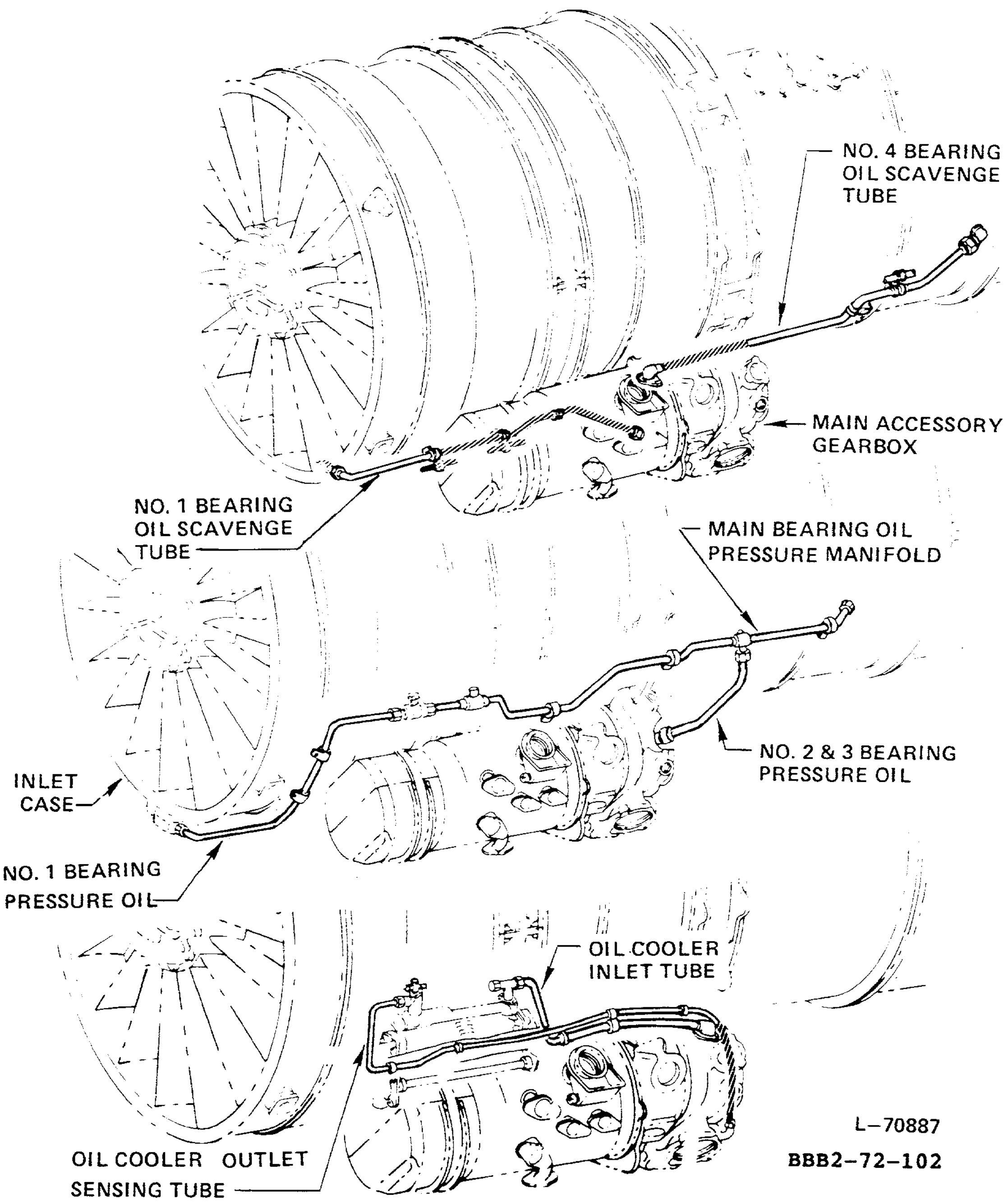
Excessive Oil Consumption Troubleshooting
Figure 101/72-00-02-990-801 (Sheet 15 of 15)



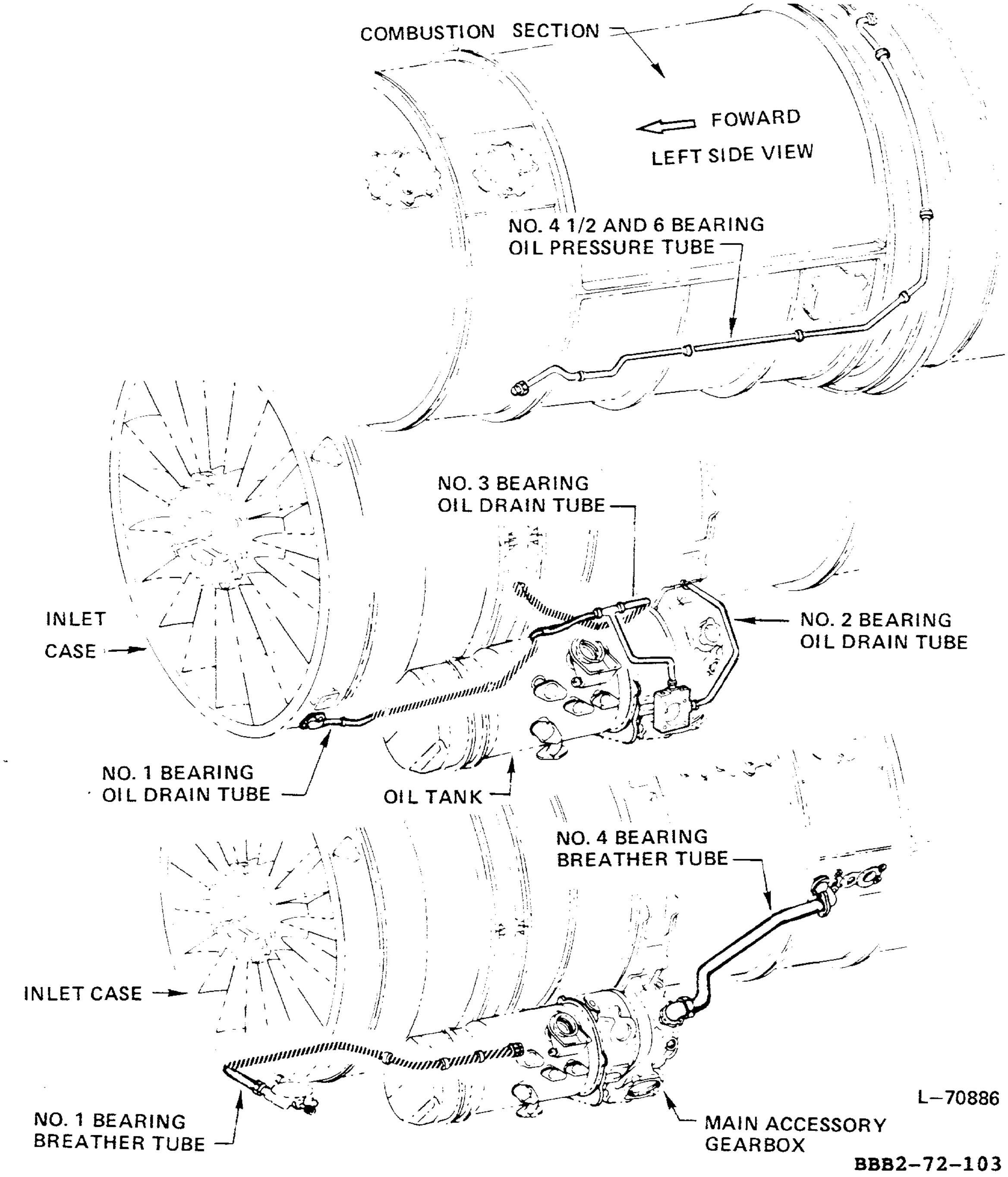
Oil Tank and Dip Stick
Figure 102/72-00-02-990-802



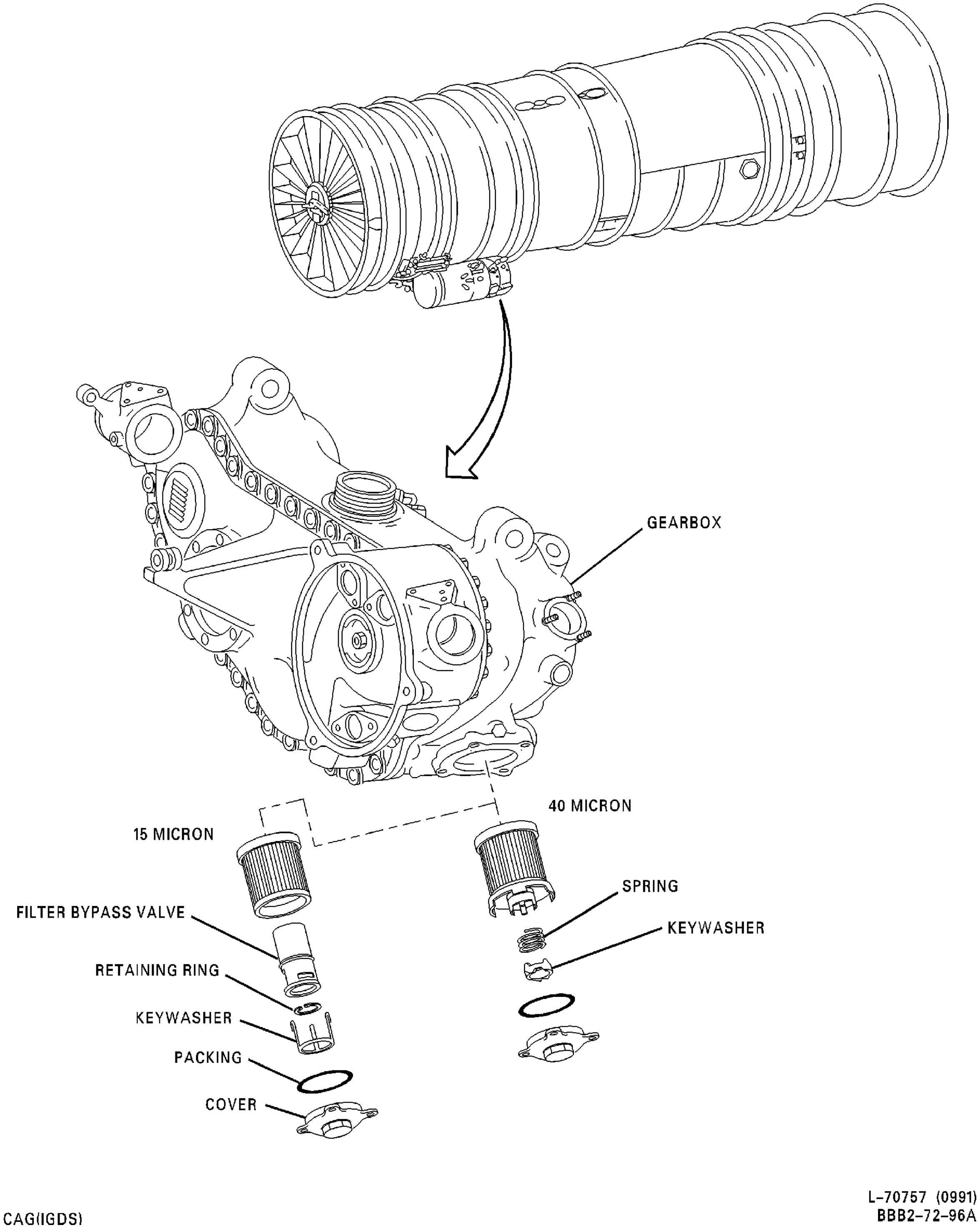
Oil Tank Drain Valve
Figure 103/72-00-02-990-803



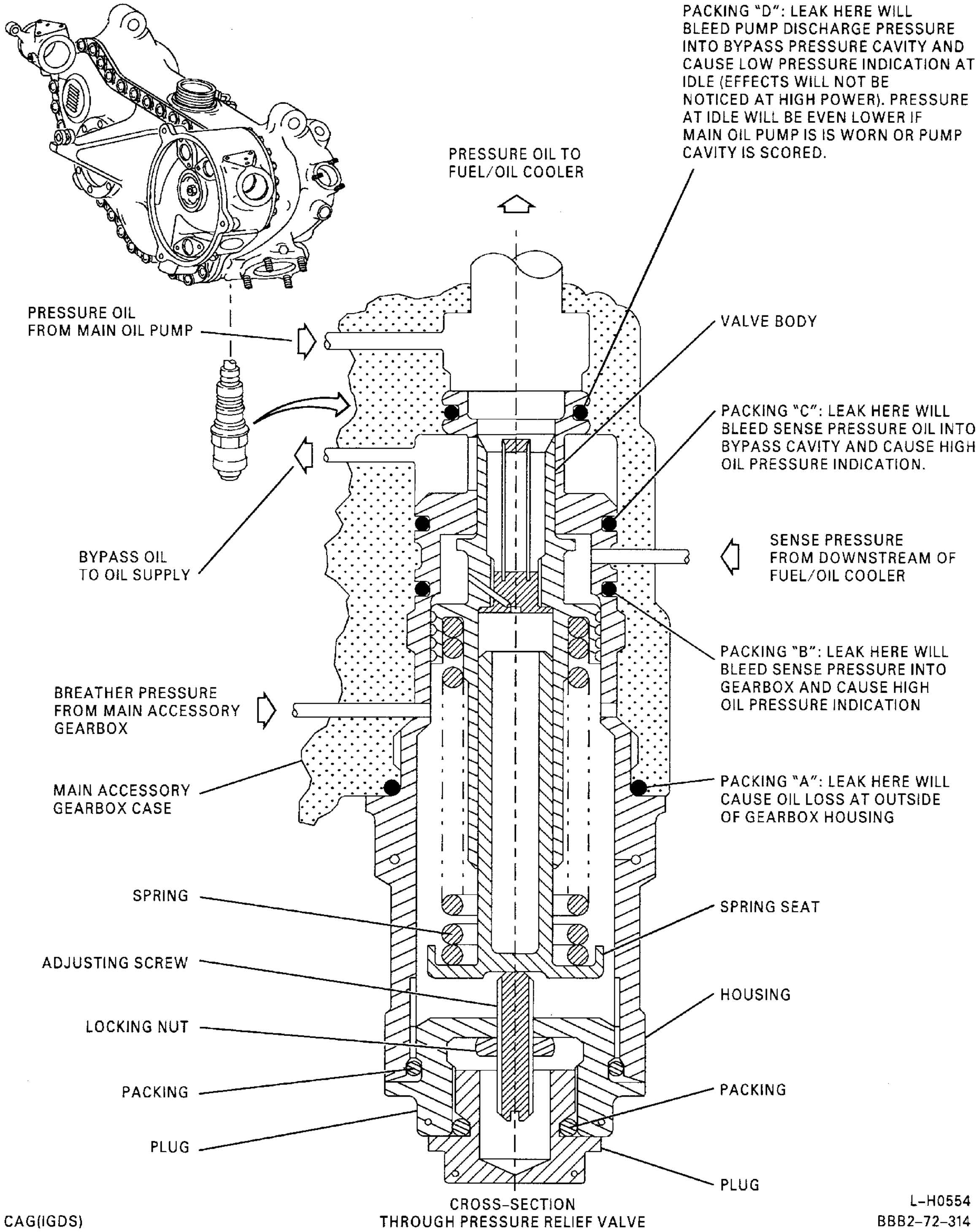
External Oil Tubes
Figure 104/72-00-02-990-804 (Sheet 1 of 2)



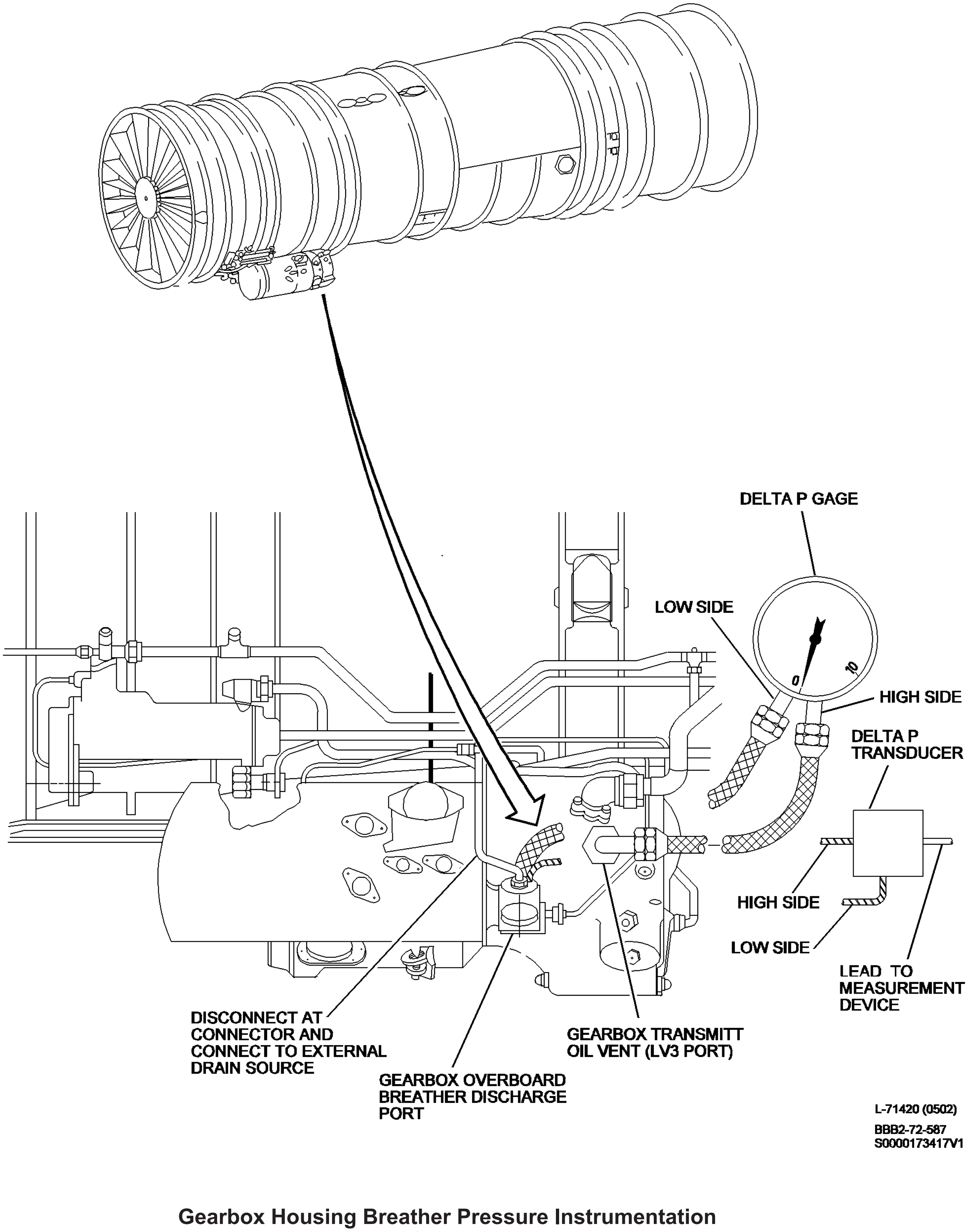
External Oil Tubes
Figure 104/72-00-02-990-804 (Sheet 2 of 2)



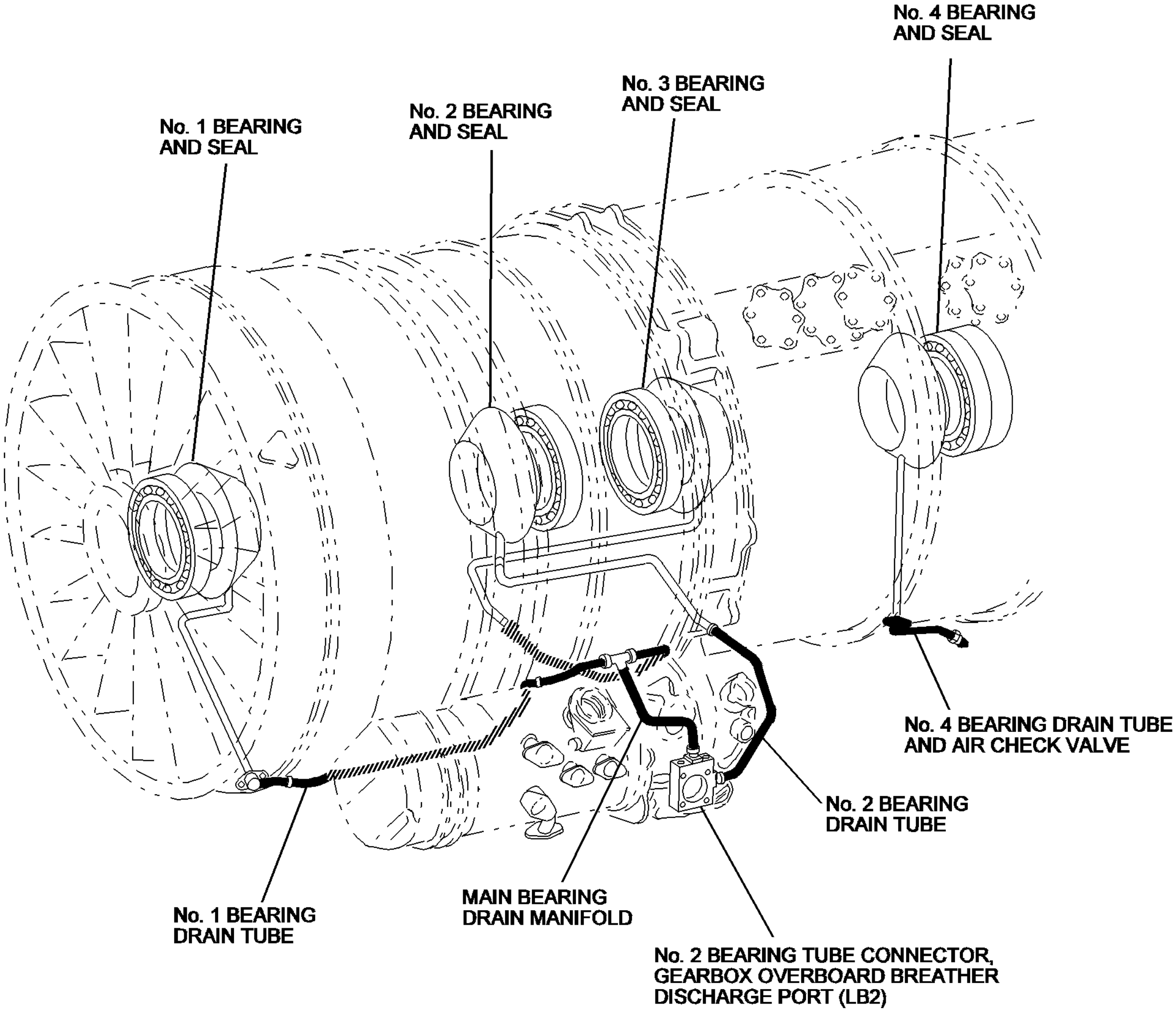
Main Oil Strainer
Figure 105/72-00-02-990-805



Main Oil Pressure Relief Valve Check
Figure 106/72-00-02-990-806



Gearbox Housing Breather Pressure Instrumentation
Figure 107/72-00-02-990-807



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BBB2-72-588
S0000173418V1

Oil Tank Breather Pressure Instrumentation
Figure 108/72-00-02-990-808

2. High Oil Temperature

A. Before you do this High Oil Temperature Troubleshooting, it is recommended that you visually examine the three areas below.

(1) Make an inspection of the oil tank level.

(2) Make an inspection of the fuel de-icing valve indicator. Make sure the indicator is in the "off" position.

WJE 401-411, 415-427, 429, 861-866, 868, 869, 871-881, 883, 884, 886, 887, 891-893

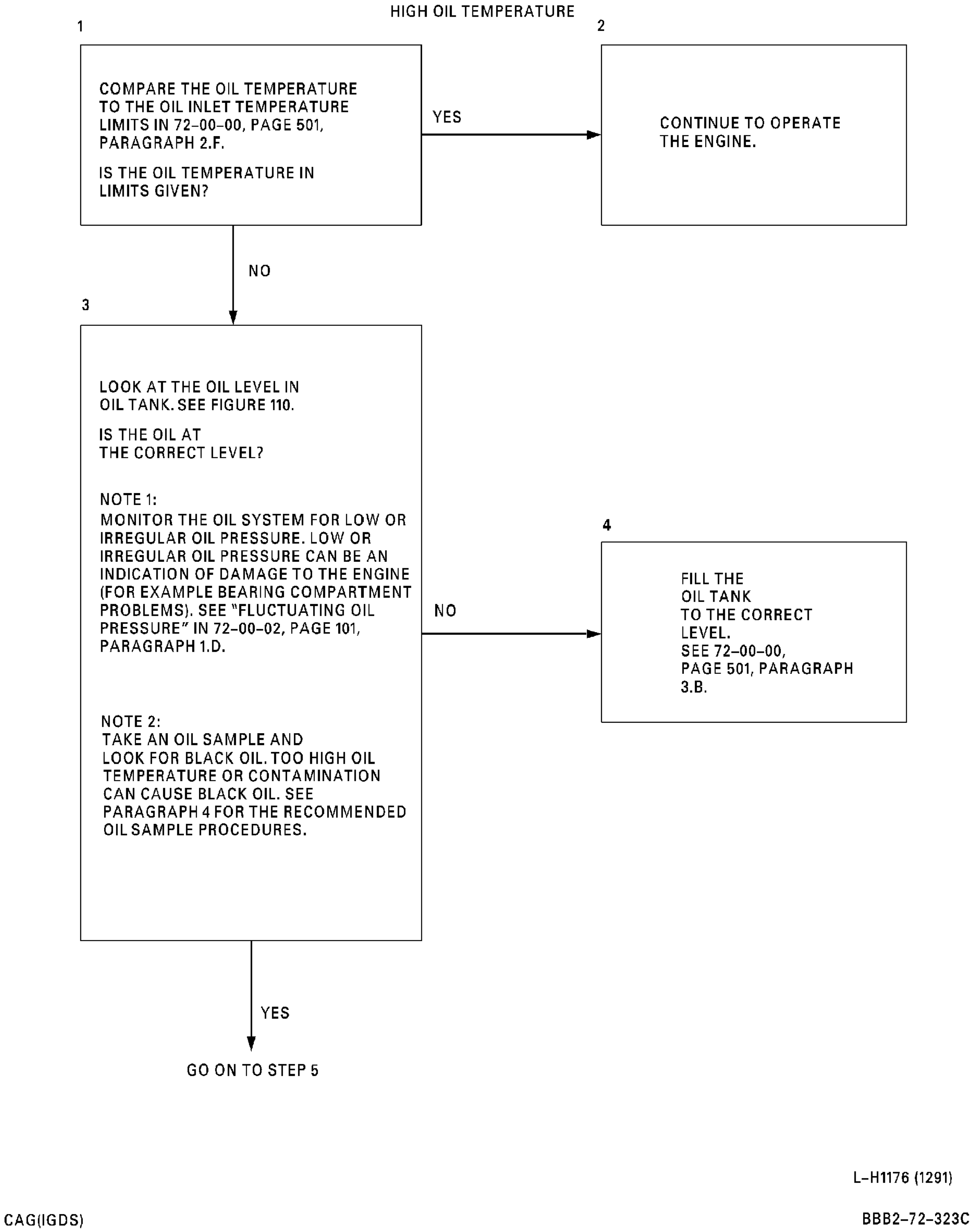
(3) Make an inspection of the No. 4 and 5 bearing scavenge tube oil temperature indicators (refer to ASB 5944 Revision 5).

WJE ALL

B. The above areas could be the cause for high oil temperature indication. If one of these areas has defects, continue to the applicable troubleshooting step below.

C. High Oil Temperature Indication. (Figure 109 (Figure 110) (Figure 111)

(Figure 112)



1

COMPARE THE OIL TEMPERATURE TO THE OIL INLET TEMPERATURE LIMITS IN 72–00–00, PAGE 501, PARAGRAPH 2.F.

IS THE OIL TEMPERATURE IN LIMITS GIVEN?

2

CONTINUE TO OPERATE THE ENGINE.

3

LOOK AT THE OIL LEVEL IN OIL TANK. SEE FIGURE 110.

IS THE OIL AT THE CORRECT LEVEL?

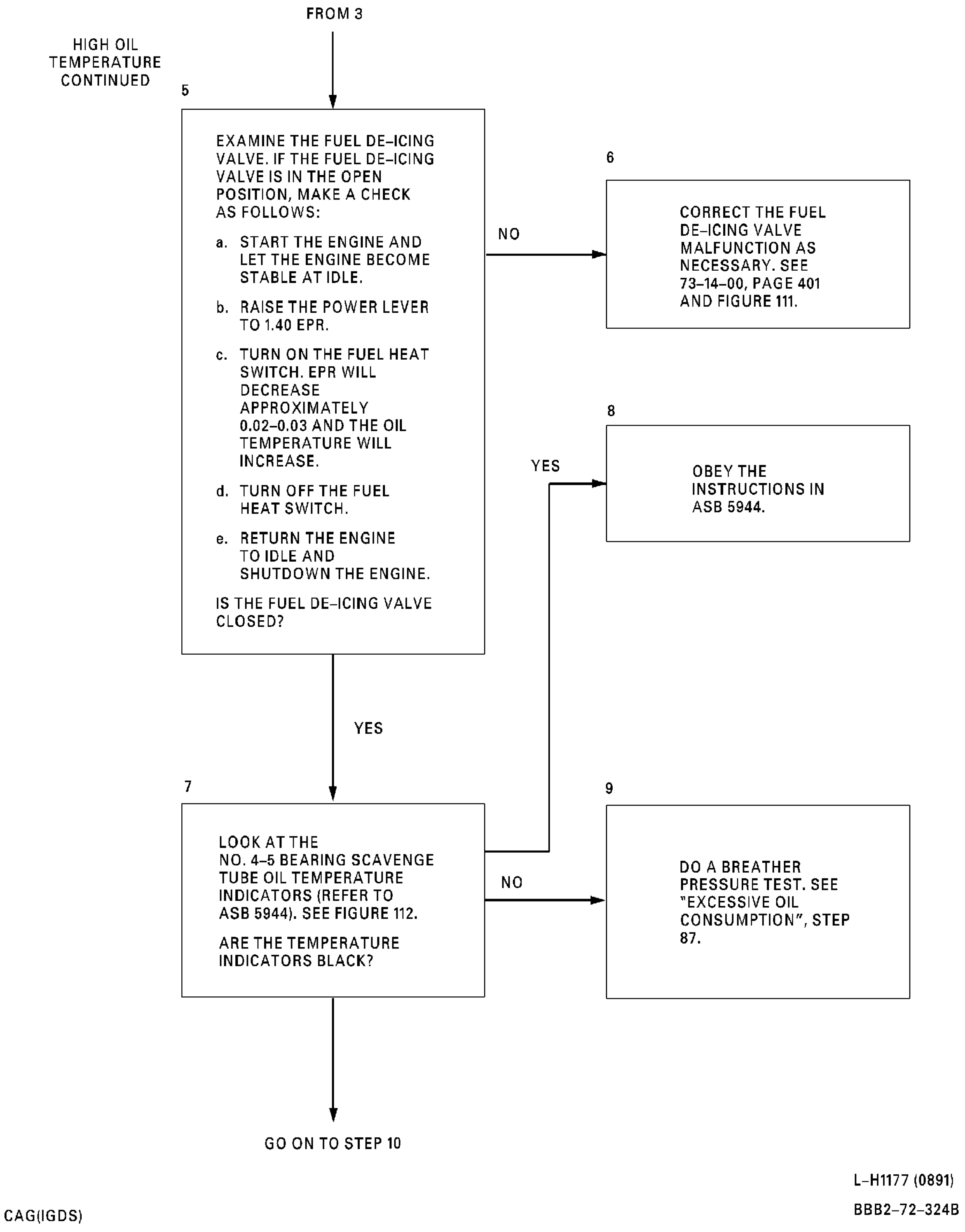
NOTE 1:
MONITOR THE OIL SYSTEM FOR LOW OR IRREGULAR OIL PRESSURE. LOW OR IRREGULAR OIL PRESSURE CAN BE AN INDICATION OF DAMAGE TO THE ENGINE (FOR EXAMPLE BEARING COMPARTMENT PROBLEMS). SEE "FLUCTUATING OIL PRESSURE" IN 72–00–02, PAGE 101, PARAGRAPH 1.D.

NOTE 2:
TAKE AN OIL SAMPLE AND LOOK FOR BLACK OIL. TOO HIGH OIL TEMPERATURE OR CONTAMINATION CAN CAUSE BLACK OIL. SEE PARAGRAPH 4 FOR THE RECOMMENDED OIL SAMPLE PROCEDURES.

4

FILL THE OIL TANK TO THE CORRECT LEVEL. SEE 72–00–00, PAGE 501, PARAGRAPH 3.B.

High Oil Temperature Troubleshooting
Figure 109/72-00-02-990-809 (Sheet 1 of 3)



EXAMINE THE FUEL DE–ICING VALVE. IF THE FUEL DE–ICING VALVE IS IN THE OPEN POSITION, MAKE A CHECK AS FOLLOWS:

a. START THE ENGINE AND LET THE ENGINE BECOME STABLE AT IDLE.

b. RAISE THE POWER LEVER TO 1.40 EPR.

c. TURN ON THE FUEL HEAT SWITCH. EPR WILL DECREASE APPROXIMATELY 0.02–0.03 AND THE OIL TEMPERATURE WILL INCREASE.

d. TURN OFF THE FUEL HEAT SWITCH.

e. RETURN THE ENGINE TO IDLE AND SHUTDOWN THE ENGINE.

IS THE FUEL DE–ICING VALVE CLOSED?

CORRECT THE FUEL DE–ICING VALVE MALFUNCTION AS NECESSARY. SEE 73–14–00, PAGE 401 AND FIGURE 111.

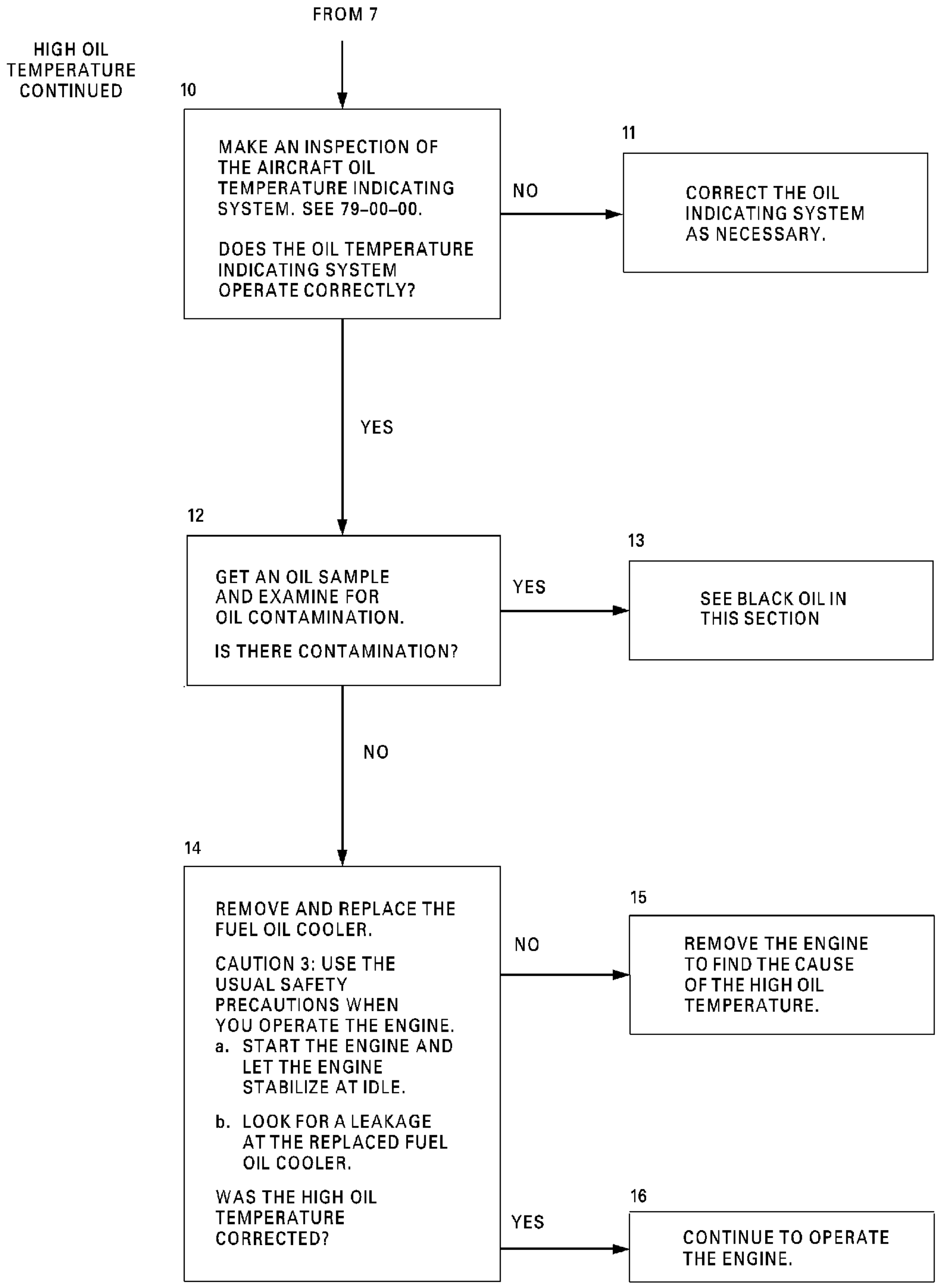
OBEY THE INSTRUCTIONS IN ASB 5944.

LOOK AT THE NO. 4–5 BEARING SCAVENGE TUBE OIL TEMPERATURE INDICATORS (REFER TO ASB 5944). SEE FIGURE 112.

ARE THE TEMPERATURE INDICATORS BLACK?

DO A BREATHER PRESSURE TEST. SEE "EXCESSIVE OIL CONSUMPTION", STEP 87.

High Oil Temperature Troubleshooting
Figure 109/72-00-02-990-809 (Sheet 2 of 3)



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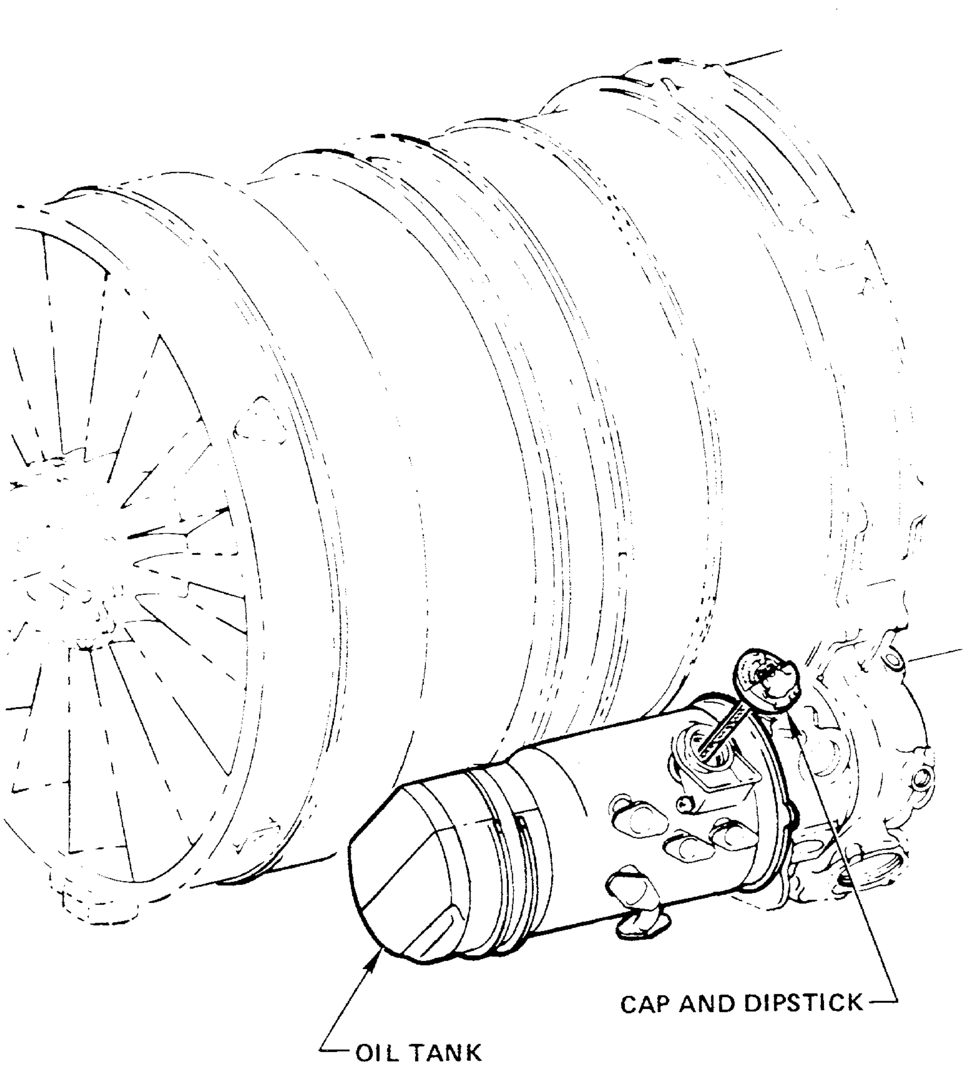
CAG(IGDS)

BBB2-72-326B

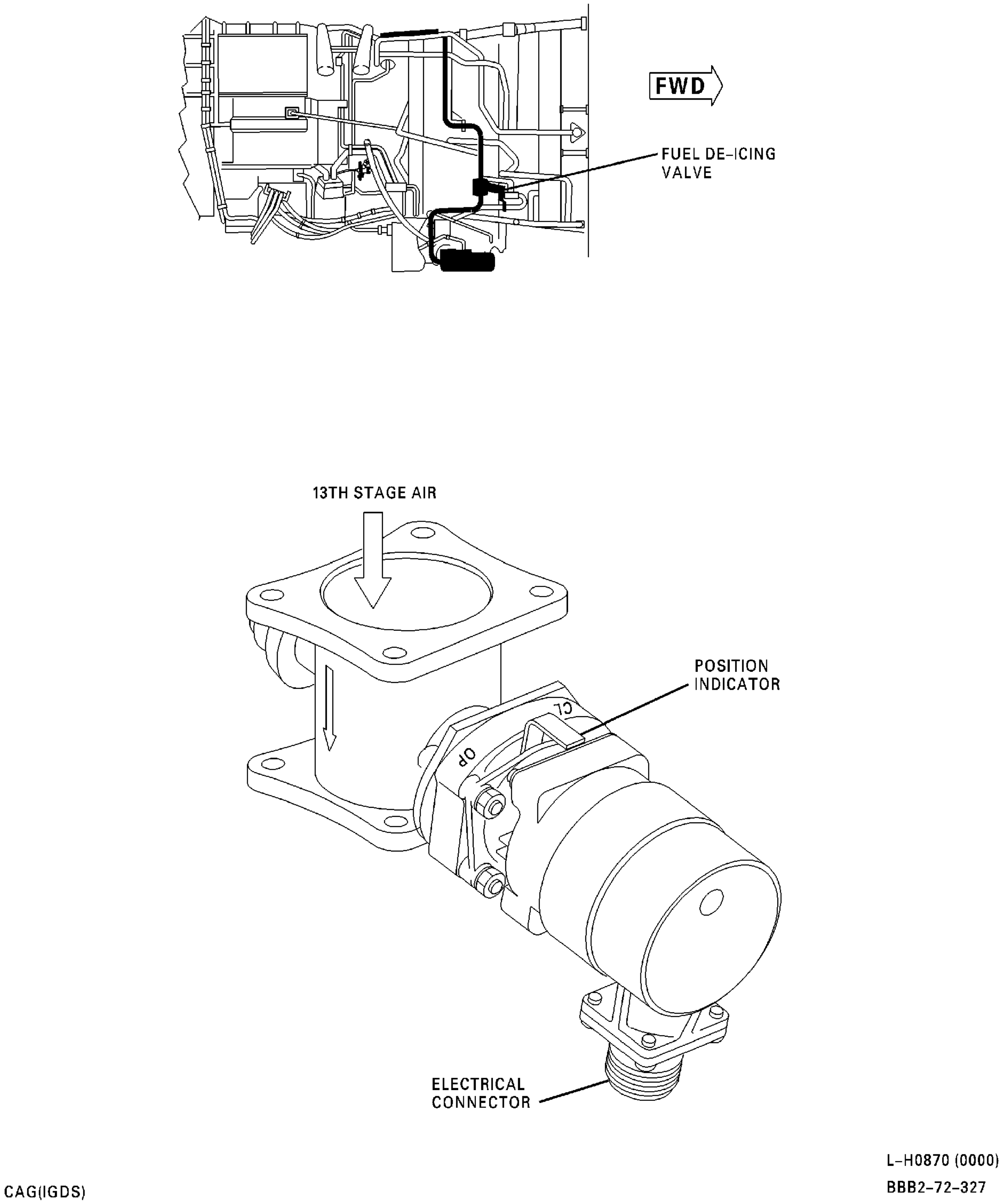
High Oil Temperature Troubleshooting
Figure 109/72-00-02-990-809 (Sheet 3 of 3)



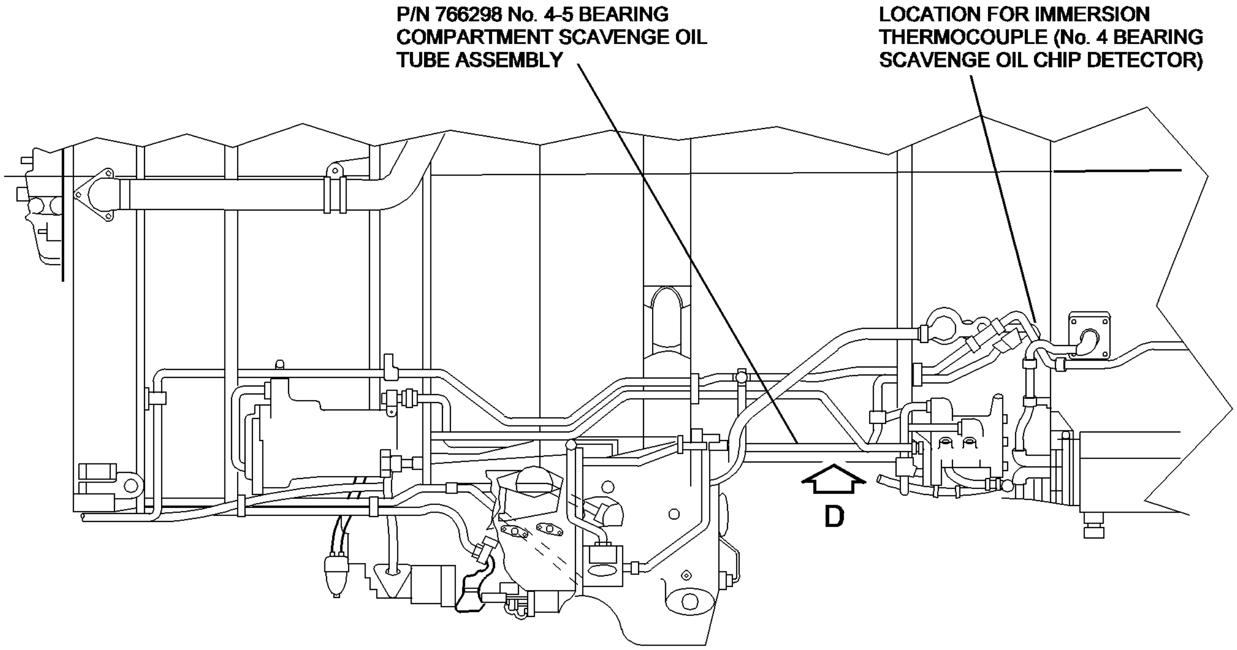
L–70756

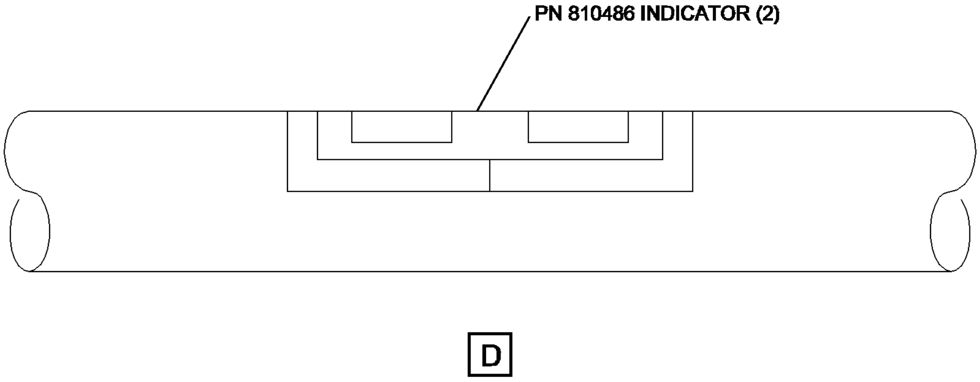
BBB2–72–95

Oil Tank And Dip Stick
Figure 110/72-00-02-990-810



Fuel De-Icing Valve Check
Figure 111/72-00-02-990-811





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BBB2-72-557A
S0006554931V2

No. 4 - 5 Bearing Scavenge Tube Oil Temperature Indicators (ASB5944)
Figure 112/72-00-02-990-813

3. Oil Filter/Strainer Differential Pressure (Delta P) Light On

A. General

(1) If the oil filter differential pressure light comes on in the flight deck, defects in the indicating system or blockage in the main oil filter is usually the cause.

(2) Oil temperature less than 77°F (25°C) can also cause the oil filter differential pressure light to come on after the engine is started. However, after the oil becomes warm (within five minutes), the "delta P" light will usually go off.

(3) If there is a small quantity of contamination in the oil filter/strainer, clean the strainer (40 micron type) or replace the filter (15 micron type).

(4) Do a ground run at part power for 3 to 5 minutes and accelerate from idle to part power 1 or 2 times.

(5) Examine the filter/strainer again. If the filter/strainer is clean, release the engine to service and examine the filter/strainer again after 50 hours of service.

(6) If the filter/strainer is not clean after 50 hours of operation, check for turned or damaged temp tabs, replace oil tank, drain gearbox, install new filter, release engine to service and examine the filter/strainer again after 50 hours of service.

(7) If the filter/strainer is not clean after 50 hours of operation, remove the engine for internal inspection.

(8) Examine the particles found in the filter/strainer. See servicing for procedures to identify particles. Also, see NOTE 1 below for metal particles and note 2 below for coke and carbon seal material.

NOTE: 1: Operator experience shows that inspection of the chip detectors is very sensitive. When bearing damage starts, very small particles will become free and move through the oil system into the chip detectors. It is difficult to identify these particles, and careful analysis is necessary. A microscope with binocular magnification will make this analysis easier.

When a bearing is "spalled", particles broken away from the surface will be shiny, flat flakes. One face of these flakes will be different from the other when you look at it, and the surface finish of the two sides will be different. The outer surface of a flake of a spalled bearing is highly polished and can have parallel impressions, but the inner side will have a rough, granular texture with waves.

These particles will be thin, thinner at the edges, and with cracks. When the outer layer of the bearing surface is damaged, the material under this surface starts to break into small particles. This will cause a rougher and darker surface. The flake from a spalled bearing is usually harder and less ductile than other metal particles. If it is not known where a chip came from, spectrographic analysis or chemical tests are recommended. See Servicing for metal particle identification procedures.

NOTE: 2: It is possible to find both oil coke and carbon seal material in the oil filter or strainer. It is sometimes very difficult to see the difference between oil coke and carbon seal material during visual inspection, unless the particles are so large that it is possible to see by the shape that they are pieces of a carbon seal (for example, a seal lip). Most of the time, however, the particles found are small particles which make a sludge when mixed with the oil. If these particles are porous, low in density, and easily broken, it is very possible that the material is pieces of carbon seal. A carbon seal in bad condition will frequently make the oil condition worse, and this will cause oil coke. Because of this, it is recommended to do the analysis of oil coke or contamination with laboratory procedures.

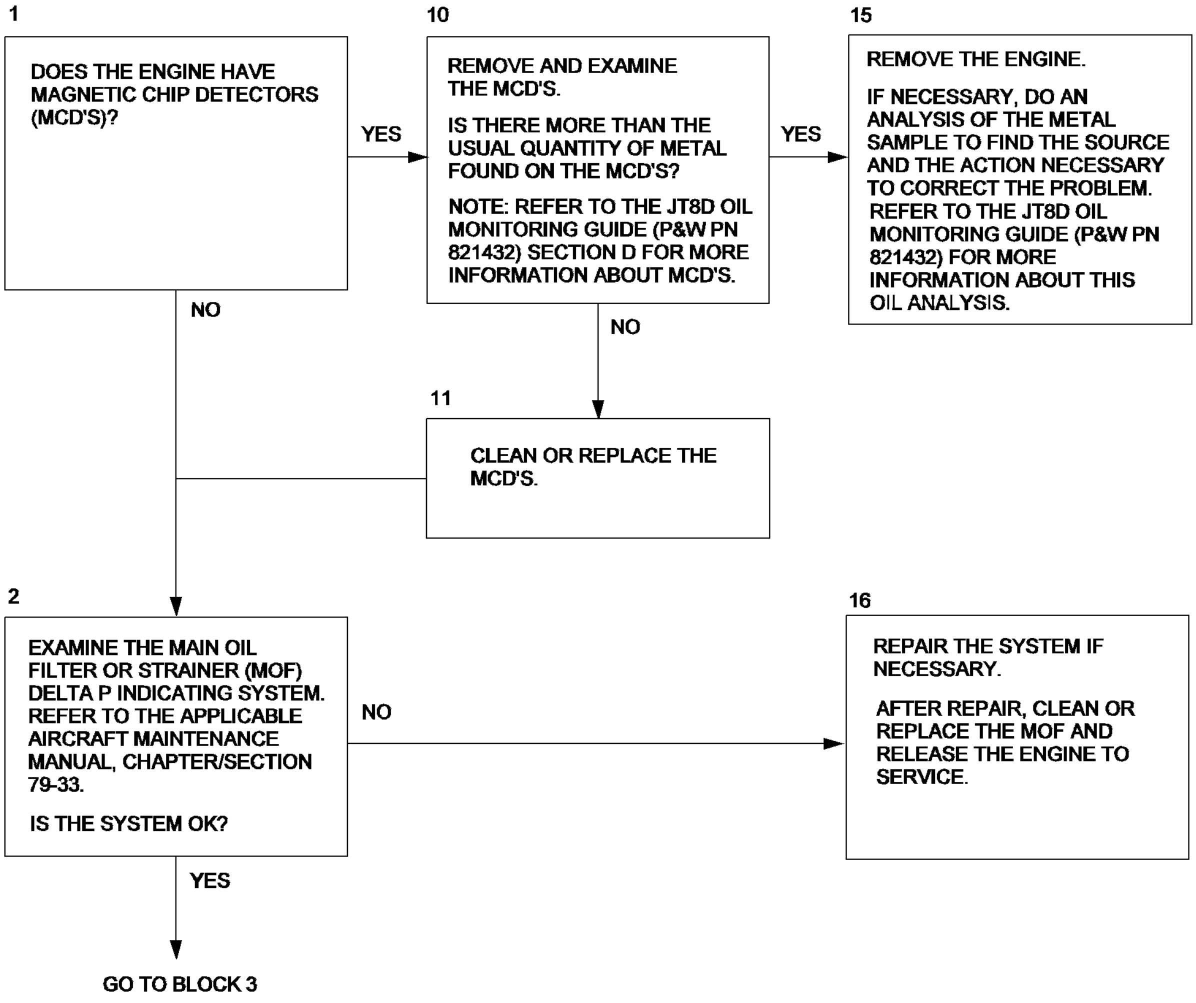
B. Procedures. (Figure 113) (Figure 114) (Figure 115)

OIL FILTER/STRAINER DIFFERENTIAL PRESSURE (DELTA P) LIGHT ON.

FAULT DESCRIPTION: THE MAIN OIL FILTER/STRAINER DIFFERENTIAL PRESSURE LIGHT COMES ON. IT IS POSSIBLE THAT THE FILTER/STRAINER IS CLOGGED.

FREQUENT CAUSES: AIRCRAFT INDICATING SYSTEM OR OIL SYSTEM CONTAMINATION.

NOTE: THE SEQUENCE OF EVENTS SHOWN BELOW IS A SUGGESTION, RELATED TO THE PROBABILITY THAT THE STEP WILL IDENTIFY THE CAUSE, HOW EASY THE STEP IS TO DO, AND WHAT EFFECT THE CORRECTIVE ACTION WILL HAVE. IT IS PERMITTED TO CHANGE THE STEP SEQUENCE IF ENGINE EXPERIENCE SHOWS THAT THIS IS NECESSARY.



1 DOES THE ENGINE HAVE MAGNETIC CHIP DETECTORS (MCD'S)?

10 REMOVE AND EXAMINE THE MCD'S.

IS THERE MORE THAN THE USUAL QUANTITY OF METAL FOUND ON THE MCD'S?

NOTE: REFER TO THE JT8D OIL MONITORING GUIDE (P&W PN 821432) SECTION D FOR MORE INFORMATION ABOUT MCD'S.

15 REMOVE THE ENGINE.

IF NECESSARY, DO AN ANALYSIS OF THE METAL SAMPLE TO FIND THE SOURCE AND THE ACTION NECESSARY TO CORRECT THE PROBLEM. REFER TO THE JT8D OIL MONITORING GUIDE (P&W PN 821432) FOR MORE INFORMATION ABOUT THIS OIL ANALYSIS.

11 CLEAN OR REPLACE THE MCD'S.

2 EXAMINE THE MAIN OIL FILTER OR STRAINER (MOF) DELTA P INDICATING SYSTEM. REFER TO THE APPLICABLE AIRCRAFT MAINTENANCE MANUAL, CHAPTER/SECTION 79-33.

IS THE SYSTEM OK?

16 REPAIR THE SYSTEM IF NECESSARY.

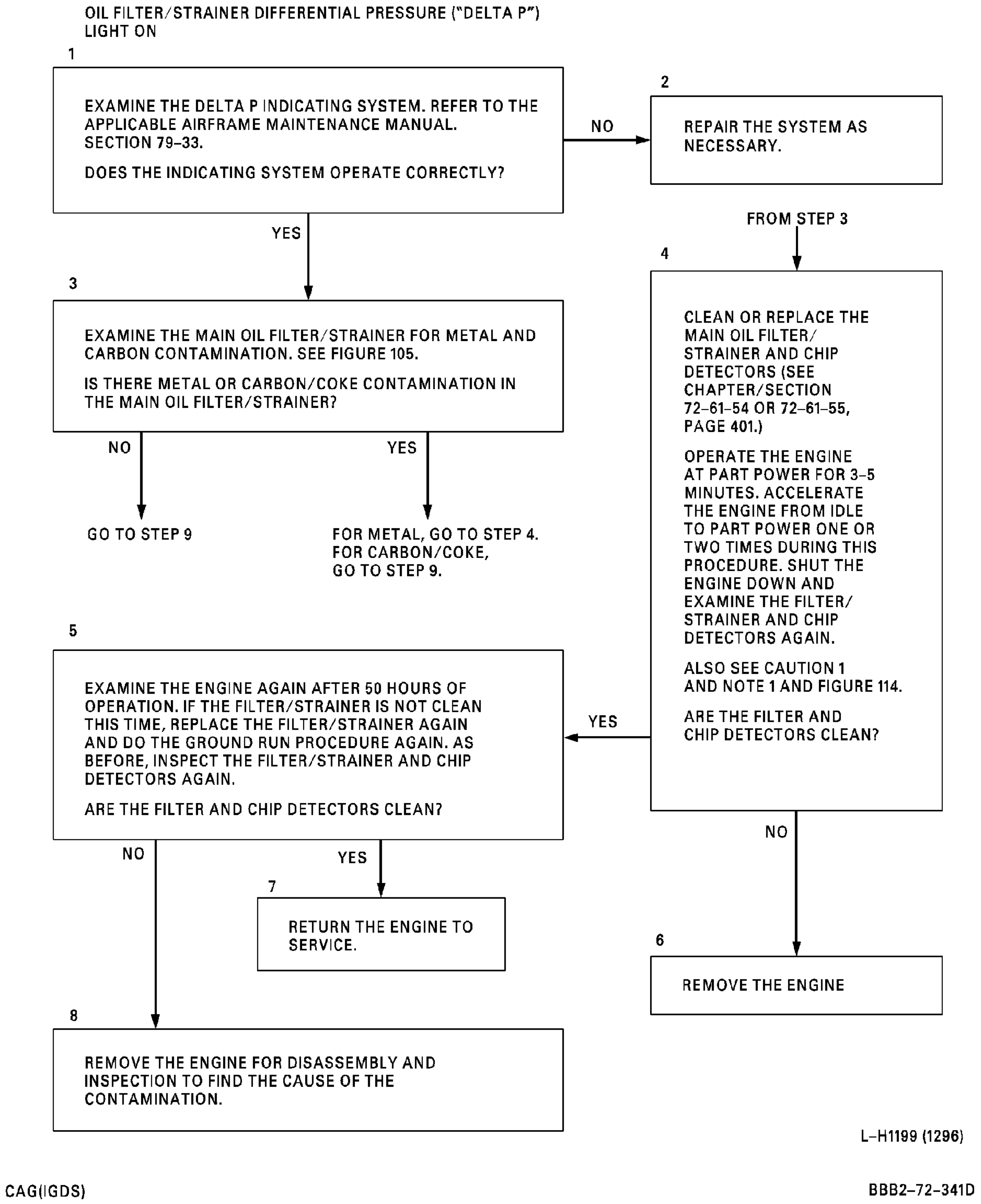
AFTER REPAIR, CLEAN OR REPLACE THE MOF AND RELEASE THE ENGINE TO SERVICE.

GO TO BLOCK 3

L-H6473 (0803)
PW V

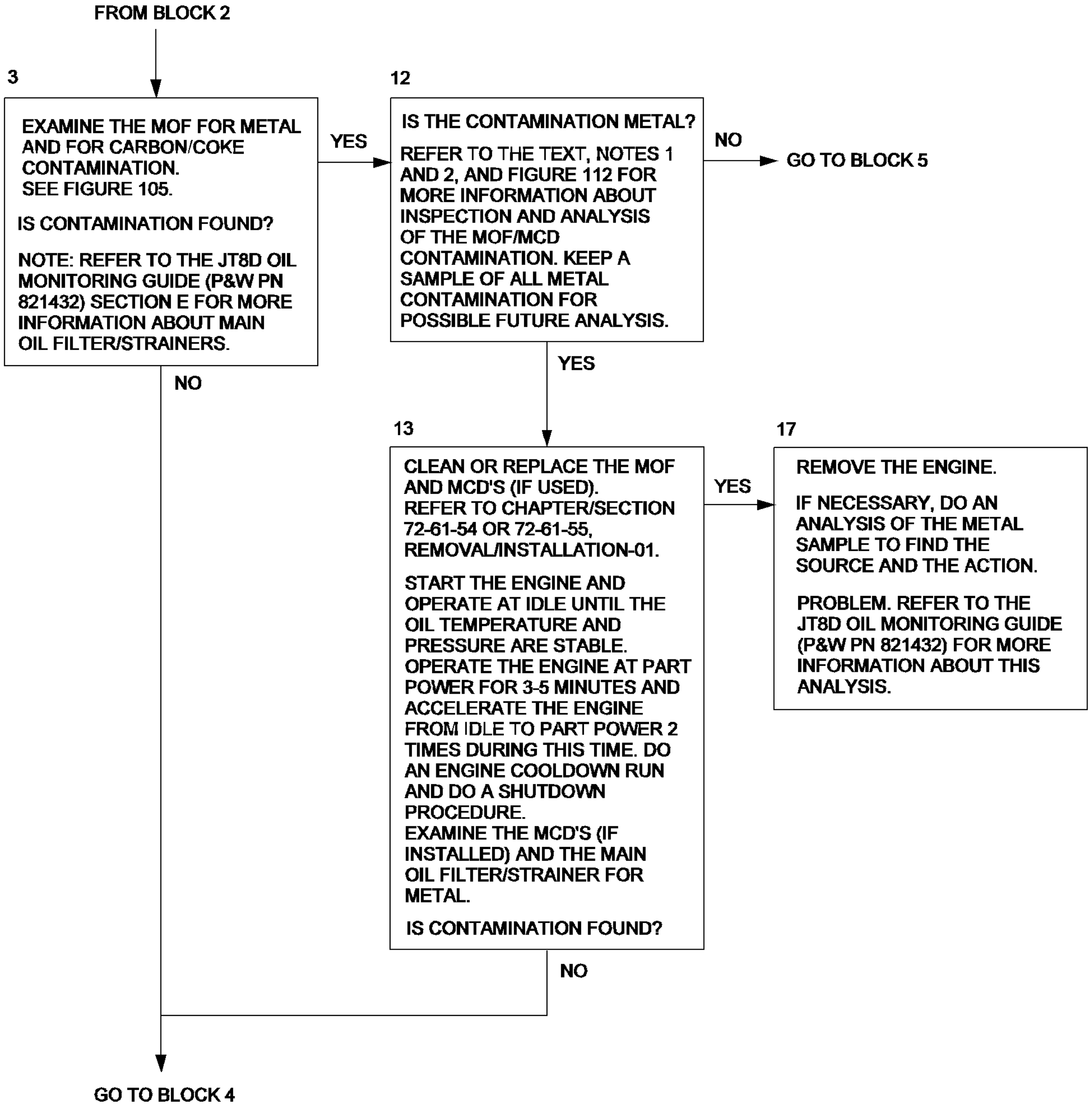
BBB2-72-583
S0000173419V1

Oil Filter/Strainer Differential
Figure 113/72-00-02-990-820 (Sheet 1 of 7)



Oil Filter/Strainer Differential
Figure 113/72-00-02-990-820 (Sheet 2 of 7)

OIL FILTER/STRAINER DIFFERENTIAL PRESSURE
(DELTA P) LIGHT ON (CONTINUED)



3
EXAMINE THE MOF FOR METAL AND FOR CARBON/COKE CONTAMINATION.
SEE FIGURE 105.

IS CONTAMINATION FOUND?

NOTE: REFER TO THE JT8D OIL MONITORING GUIDE (P&W PN 821432) SECTION E FOR MORE INFORMATION ABOUT MAIN OIL FILTER/STRAINERS.

12
IS THE CONTAMINATION METAL?

REFER TO THE TEXT, NOTES 1 AND 2, AND FIGURE 112 FOR MORE INFORMATION ABOUT INSPECTION AND ANALYSIS OF THE MOF/MCD CONTAMINATION. KEEP A SAMPLE OF ALL METAL CONTAMINATION FOR POSSIBLE FUTURE ANALYSIS.

13
CLEAN OR REPLACE THE MOF AND MCD'S (IF USED).
REFER TO CHAPTER/SECTION 72-61-54 OR 72-61-55, REMOVAL/INSTALLATION-01.

START THE ENGINE AND OPERATE AT IDLE UNTIL THE OIL TEMPERATURE AND PRESSURE ARE STABLE.
OPERATE THE ENGINE AT PART POWER FOR 3-5 MINUTES AND ACCELERATE THE ENGINE FROM IDLE TO PART POWER 2 TIMES DURING THIS TIME. DO AN ENGINE COOLDOWN RUN AND DO A SHUTDOWN PROCEDURE.
EXAMINE THE MCD'S (IF INSTALLED) AND THE MAIN OIL FILTER/STRAINER FOR METAL.

IS CONTAMINATION FOUND?

17
REMOVE THE ENGINE.

IF NECESSARY, DO AN ANALYSIS OF THE METAL SAMPLE TO FIND THE SOURCE AND THE ACTION.

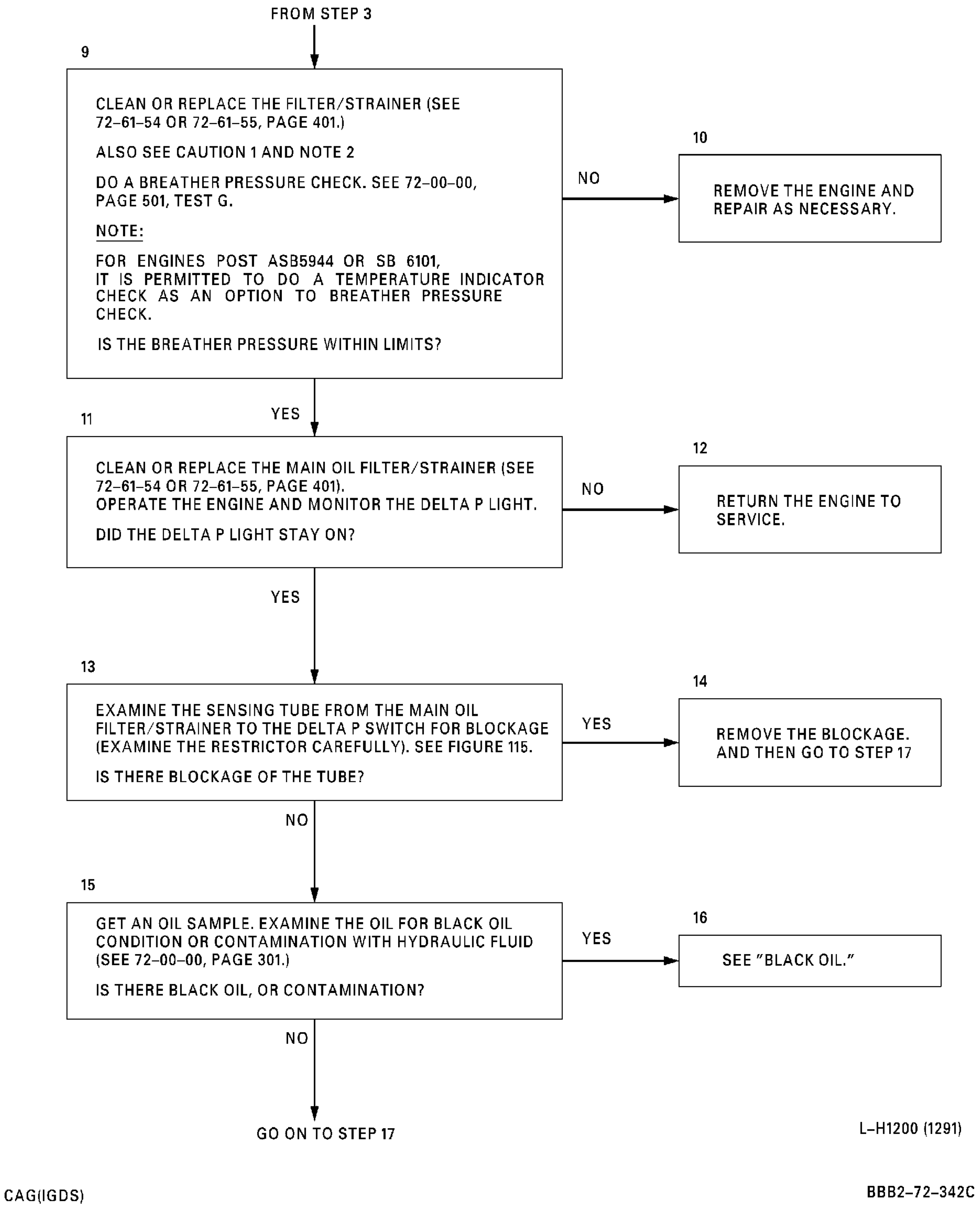
PROBLEM. REFER TO THE JT8D OIL MONITORING GUIDE (P&W PN 821432) FOR MORE INFORMATION ABOUT THIS ANALYSIS.

L-H6474 (0803)
PW V

BBB2-72-584
S0000173421V1

Oil Filter/Strainer Differential
Figure 113/72-00-02-990-820 (Sheet 3 of 7)

DELTA P LIGHT STAYS ON (CONTINUED)



9 CLEAN OR REPLACE THE FILTER/STRAINER (SEE 72–61–54 OR 72–61–55, PAGE 401.)

ALSO SEE CAUTION 1 AND NOTE 2

DO A BREATHER PRESSURE CHECK. SEE 72–00–00, PAGE 501, TEST G.

NOTE:

FOR ENGINES POST ASB5944 OR SB 6101, IT IS PERMITTED TO DO A TEMPERATURE INDICATOR CHECK AS AN OPTION TO BREATHER PRESSURE CHECK.

IS THE BREATHER PRESSURE WITHIN LIMITS?

10 REMOVE THE ENGINE AND REPAIR AS NECESSARY.

11 CLEAN OR REPLACE THE MAIN OIL FILTER/STRAINER (SEE 72–61–54 OR 72–61–55, PAGE 401). OPERATE THE ENGINE AND MONITOR THE DELTA P LIGHT.

DID THE DELTA P LIGHT STAY ON?

12 RETURN THE ENGINE TO SERVICE.

13 EXAMINE THE SENSING TUBE FROM THE MAIN OIL FILTER/STRAINER TO THE DELTA P SWITCH FOR BLOCKAGE (EXAMINE THE RESTRICTOR CAREFULLY). SEE FIGURE 115.

IS THERE BLOCKAGE OF THE TUBE?

14 REMOVE THE BLOCKAGE. AND THEN GO TO STEP 17

15 GET AN OIL SAMPLE. EXAMINE THE OIL FOR BLACK OIL CONDITION OR CONTAMINATION WITH HYDRAULIC FLUID (SEE 72–00–00, PAGE 301.)

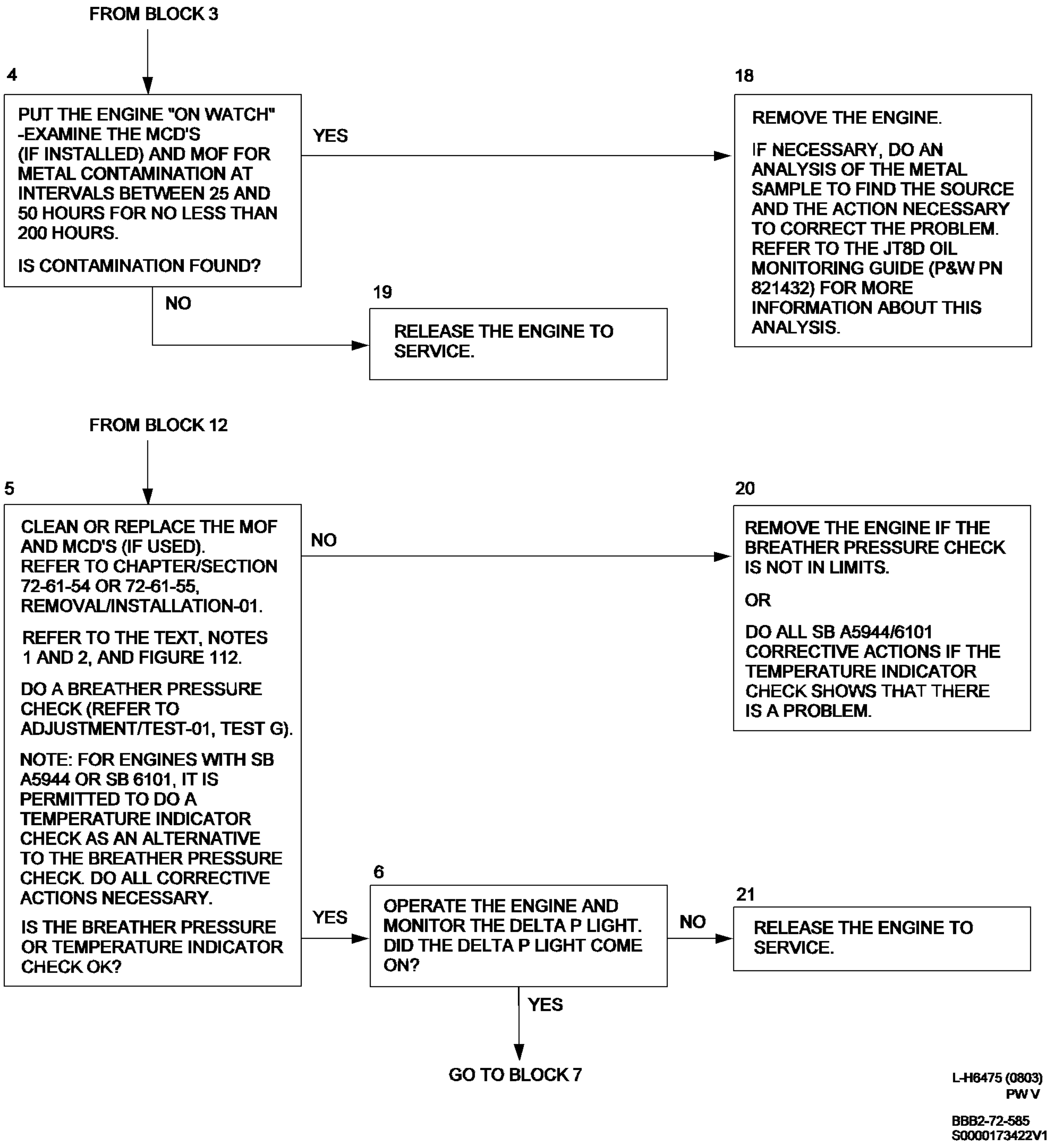
IS THERE BLACK OIL, OR CONTAMINATION?

16 SEE "BLACK OIL."

GO ON TO STEP 17

Oil Filter/Strainer Differential
Figure 113/72-00-02-990-820 (Sheet 4 of 7)

OIL FILTER/STRAINER DIFFERENTIAL PRESSURE
(DELTA P) LIGHT ON (CONTINUED)



FROM BLOCK 3

4
PUT THE ENGINE "ON WATCH" -EXAMINE THE MCD'S (IF INSTALLED) AND MOF FOR METAL CONTAMINATION AT INTERVALS BETWEEN 25 AND 50 HOURS FOR NO LESS THAN 200 HOURS.

IS CONTAMINATION FOUND?

YES → 18
REMOVE THE ENGINE.

IF NECESSARY, DO AN ANALYSIS OF THE METAL SAMPLE TO FIND THE SOURCE AND THE ACTION NECESSARY TO CORRECT THE PROBLEM. REFER TO THE JT8D OIL MONITORING GUIDE (P&W PN 821432) FOR MORE INFORMATION ABOUT THIS ANALYSIS.

NO → 19
RELEASE THE ENGINE TO SERVICE.

FROM BLOCK 12

5
CLEAN OR REPLACE THE MOF AND MCD'S (IF USED). REFER TO CHAPTER/SECTION 72-61-54 OR 72-61-55, REMOVAL/INSTALLATION-01.

REFER TO THE TEXT, NOTES 1 AND 2, AND FIGURE 112.

DO A BREATHER PRESSURE CHECK (REFER TO ADJUSTMENT/TEST-01, TEST G).

NOTE: FOR ENGINES WITH SB A5944 OR SB 6101, IT IS PERMITTED TO DO A TEMPERATURE INDICATOR CHECK AS AN ALTERNATIVE TO THE BREATHER PRESSURE CHECK. DO ALL CORRECTIVE ACTIONS NECESSARY.

IS THE BREATHER PRESSURE OR TEMPERATURE INDICATOR CHECK OK?

NO → 20
REMOVE THE ENGINE IF THE BREATHER PRESSURE CHECK IS NOT IN LIMITS.

OR

DO ALL SB A5944/6101 CORRECTIVE ACTIONS IF THE TEMPERATURE INDICATOR CHECK SHOWS THAT THERE IS A PROBLEM.

YES → 6
OPERATE THE ENGINE AND MONITOR THE DELTA P LIGHT. DID THE DELTA P LIGHT COME ON?

NO → 21
RELEASE THE ENGINE TO SERVICE.

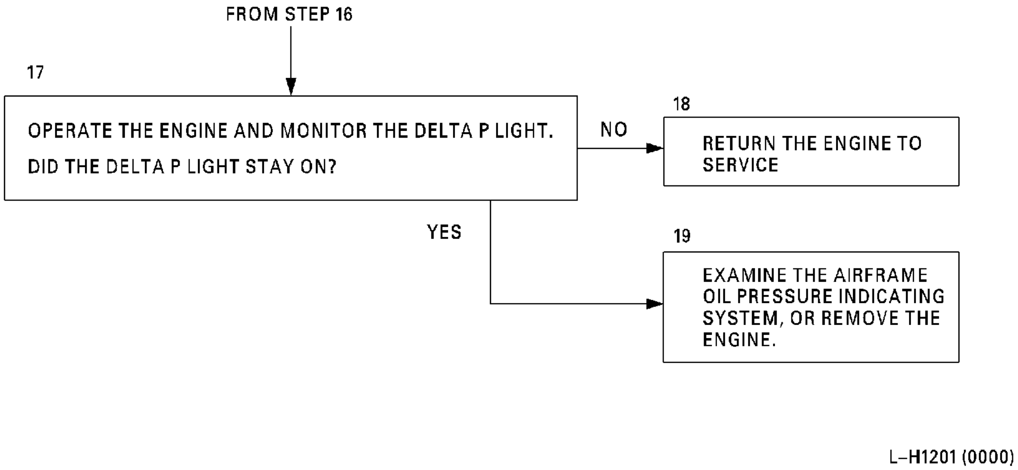
YES → GO TO BLOCK 7

L-H6475 (0803)
PW V

BBB2-72-585
S0000173422V1

Oil Filter/Strainer Differential
Figure 113/72-00-02-990-820 (Sheet 5 of 7)

DELTA P LIGHT STAYS ON (CONTINUED)



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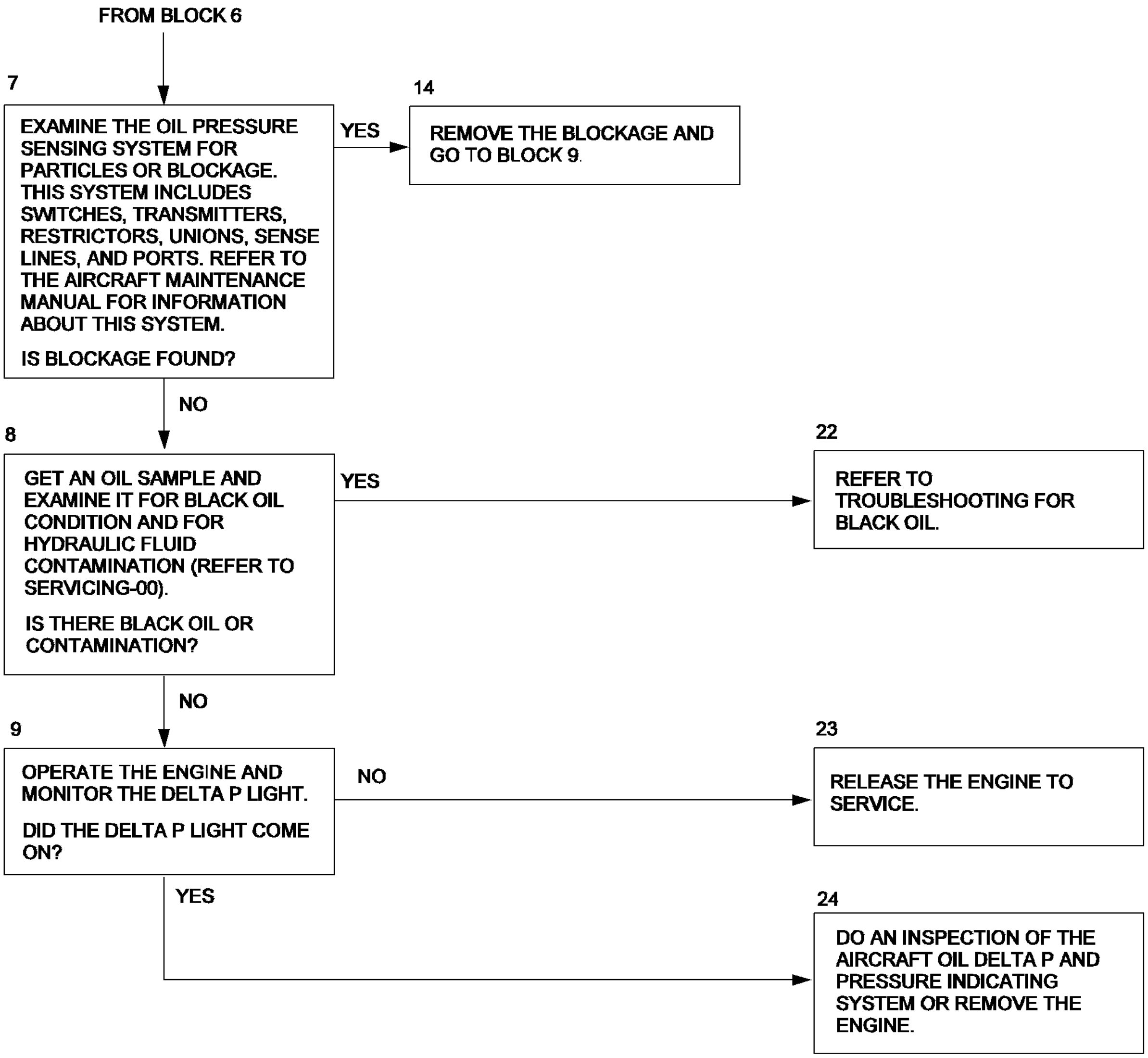
BBB2–72–343

Oil Filter/Strainer Differential
Figure 113/72-00-02-990-820 (Sheet 6 of 7)

OIL FILTER/STRAINER DIFFERENTIAL PRESSURE
(DELTA P) LIGHT ON (CONTINUED)



7 EXAMINE THE OIL PRESSURE SENSING SYSTEM FOR PARTICLES OR BLOCKAGE. THIS SYSTEM INCLUDES SWITCHES, TRANSMITTERS, RESTRICTORS, UNIONS, SENSE LINES, AND PORTS. REFER TO THE AIRCRAFT MAINTENANCE MANUAL FOR INFORMATION ABOUT THIS SYSTEM.

IS BLOCKAGE FOUND?

14 REMOVE THE BLOCKAGE AND GO TO BLOCK 9.

8 GET AN OIL SAMPLE AND EXAMINE IT FOR BLACK OIL CONDITION AND FOR HYDRAULIC FLUID CONTAMINATION (REFER TO SERVICING-00).

IS THERE BLACK OIL OR CONTAMINATION?

22 REFER TO TROUBLESHOOTING FOR BLACK OIL.

9 OPERATE THE ENGINE AND MONITOR THE DELTA P LIGHT.

DID THE DELTA P LIGHT COME ON?

23 RELEASE THE ENGINE TO SERVICE.

24 DO AN INSPECTION OF THE AIRCRAFT OIL DELTA P AND PRESSURE INDICATING SYSTEM OR REMOVE THE ENGINE.

NON-FREQUENT CAUSES: REFER TO THE ENGINE MAINTENANCE RECORD FOR MAINTENANCE DONE ON THE ENGINE BEFORE. DO ALL NECESSARY CORRECTIVE ACTIONS.

L-H6472 (0603)
PW V

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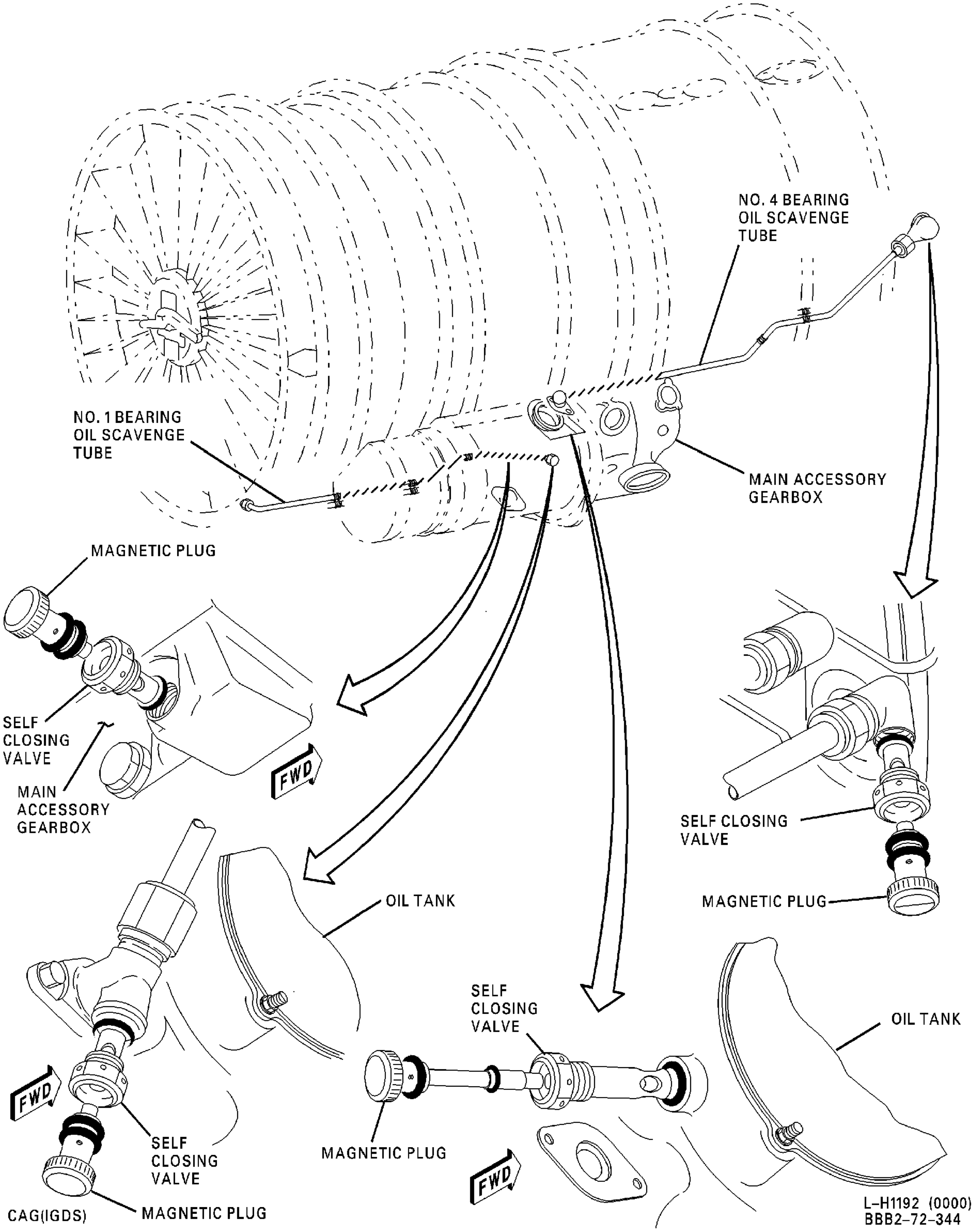
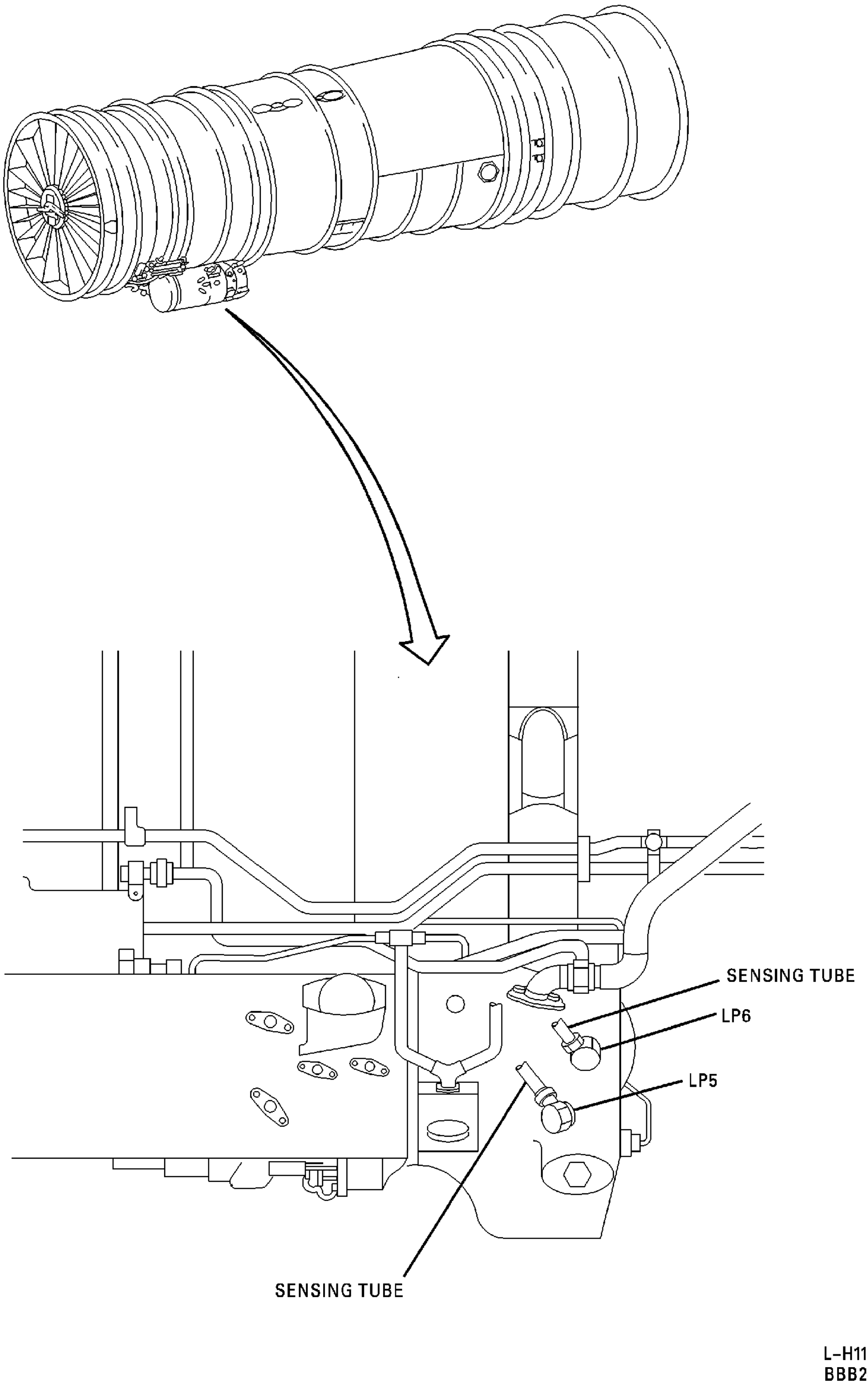
Oil Filter/Strainer Differential
Figure 113/72-00-02-990-820 (Sheet 7 of 7)



Magnetic Chip Detectors Optional Locations
Figure 114/72-00-02-990-821



Airframe (Delta P) Sensing Tubes
Figure 115/72-00-02-990-822

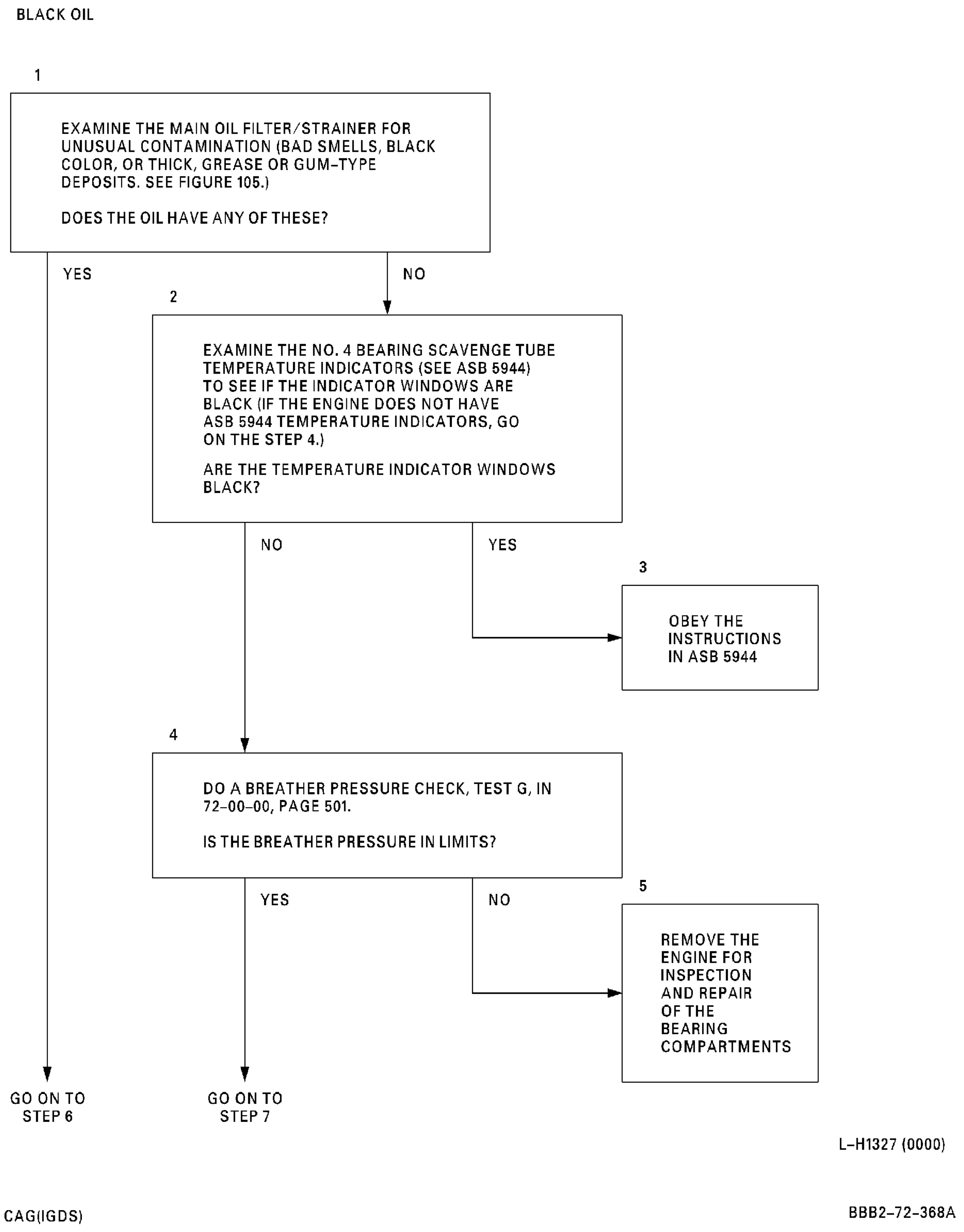
4. Black Oil

A. General

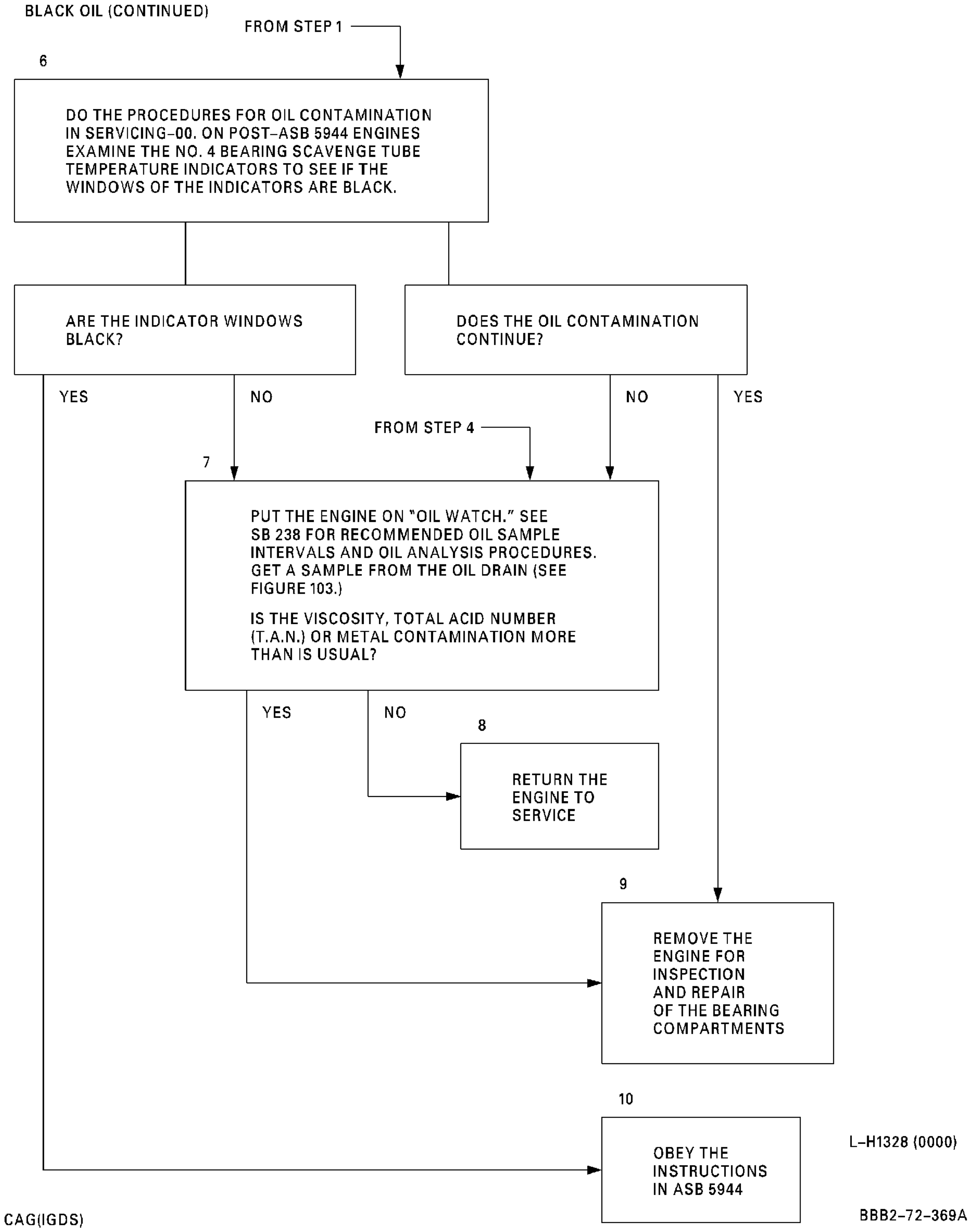
(1) Black oil is usually the result of oil system contamination and/or oil that became too hot. Although contamination or high oil temperature do not occur very often, contamination can come from hydraulic fluid which was put in error into the oil tank. High oil temperature is the result of continued high internal engine temperatures.

(2) If the oil got too hot or has hydraulic fluid contamination, the oil can have a strong odor related to the black oil condition, and the oil can become thick. Oil can also apparently become dark as a result of coke or carbon particles in the oil system which become loose and go into the oil as it flows through the system. This type of contamination is caused by other conditions such as mixed oil types or fuel contamination (there are other causes also). This loose-particle contamination is not the same as "black oil". If an oil sample is visually identified as black oil, do the procedures that follow to find the cause of the black condition.

B. Procedures. (Figure 116)



Black Oil Troubleshooting
Figure 116/72-00-02-990-823 (Sheet 1 of 2)



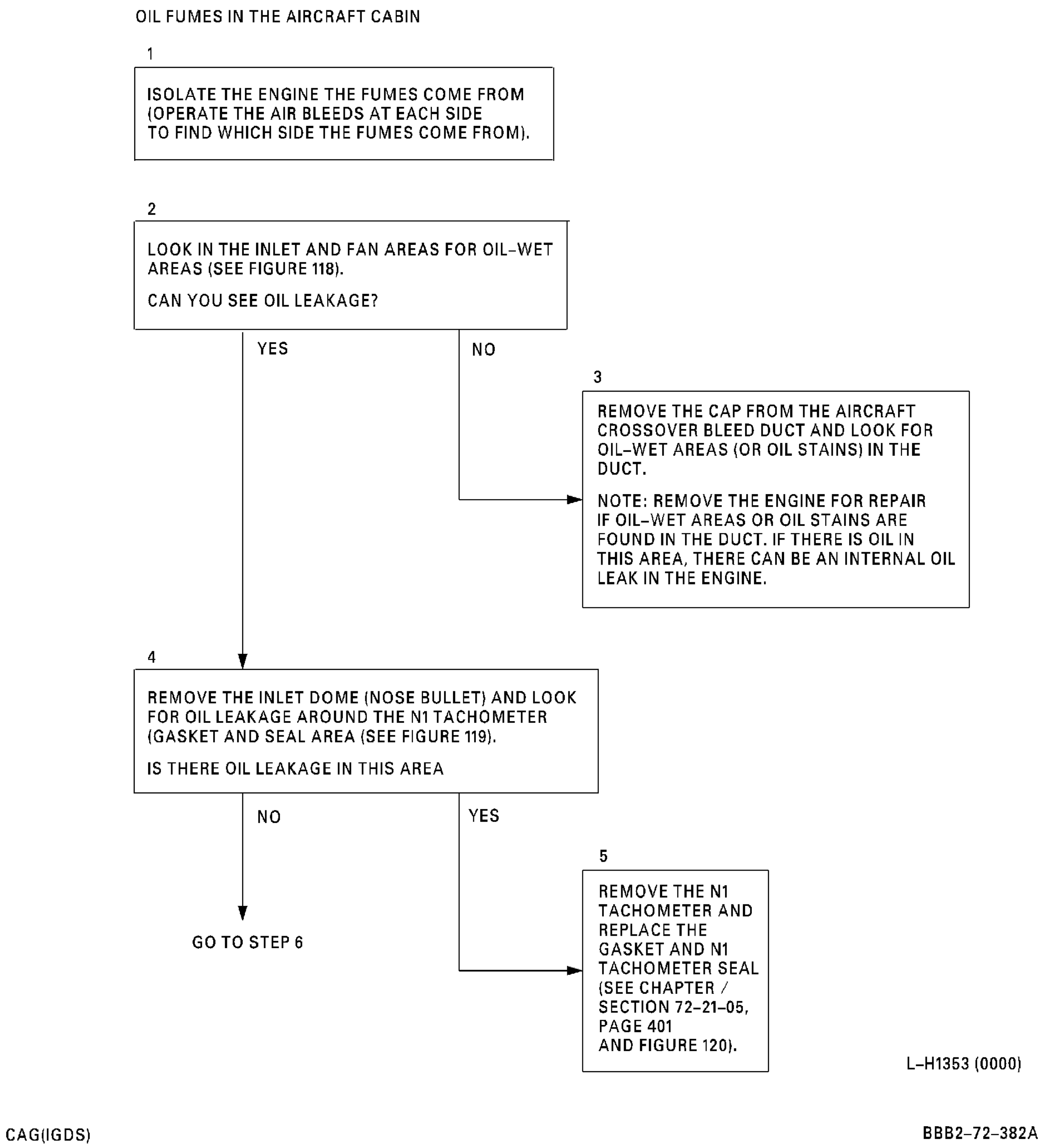
Black Oil Troubleshooting
Figure 116/72-00-02-990-823 (Sheet 2 of 2)

5. Oil Fumes In The Aircraft Cabin

A. General

(1) Fumes in the cabin can be the result of oil leaking into the compressor section of the main engines because of compressor bearing compartment damage. Oil fumes can then travel through the engine supplied bleed air to the cabin. Other sources for oil fumes in the cabin are the air cycle machine and the auxiliary power unit (APU).

B. Procedures. (Figure 117) (Figure 118) (Figure 119) (Figure 120) Figure 121)



OIL FUMES IN THE AIRCRAFT CABIN

1 ISOLATE THE ENGINE THE FUMES COME FROM (OPERATE THE AIR BLEEDS AT EACH SIDE TO FIND WHICH SIDE THE FUMES COME FROM).

2 LOOK IN THE INLET AND FAN AREAS FOR OIL-WET AREAS (SEE FIGURE 118).

CAN YOU SEE OIL LEAKAGE?

3 REMOVE THE CAP FROM THE AIRCRAFT CROSSOVER BLEED DUCT AND LOOK FOR OIL-WET AREAS (OR OIL STAINS) IN THE DUCT.

NOTE: REMOVE THE ENGINE FOR REPAIR IF OIL-WET AREAS OR OIL STAINS ARE FOUND IN THE DUCT. IF THERE IS OIL IN THIS AREA, THERE CAN BE AN INTERNAL OIL LEAK IN THE ENGINE.

4 REMOVE THE INLET DOME (NOSE BULLET) AND LOOK FOR OIL LEAKAGE AROUND THE N1 TACHOMETER (GASKET AND SEAL AREA (SEE FIGURE 119).

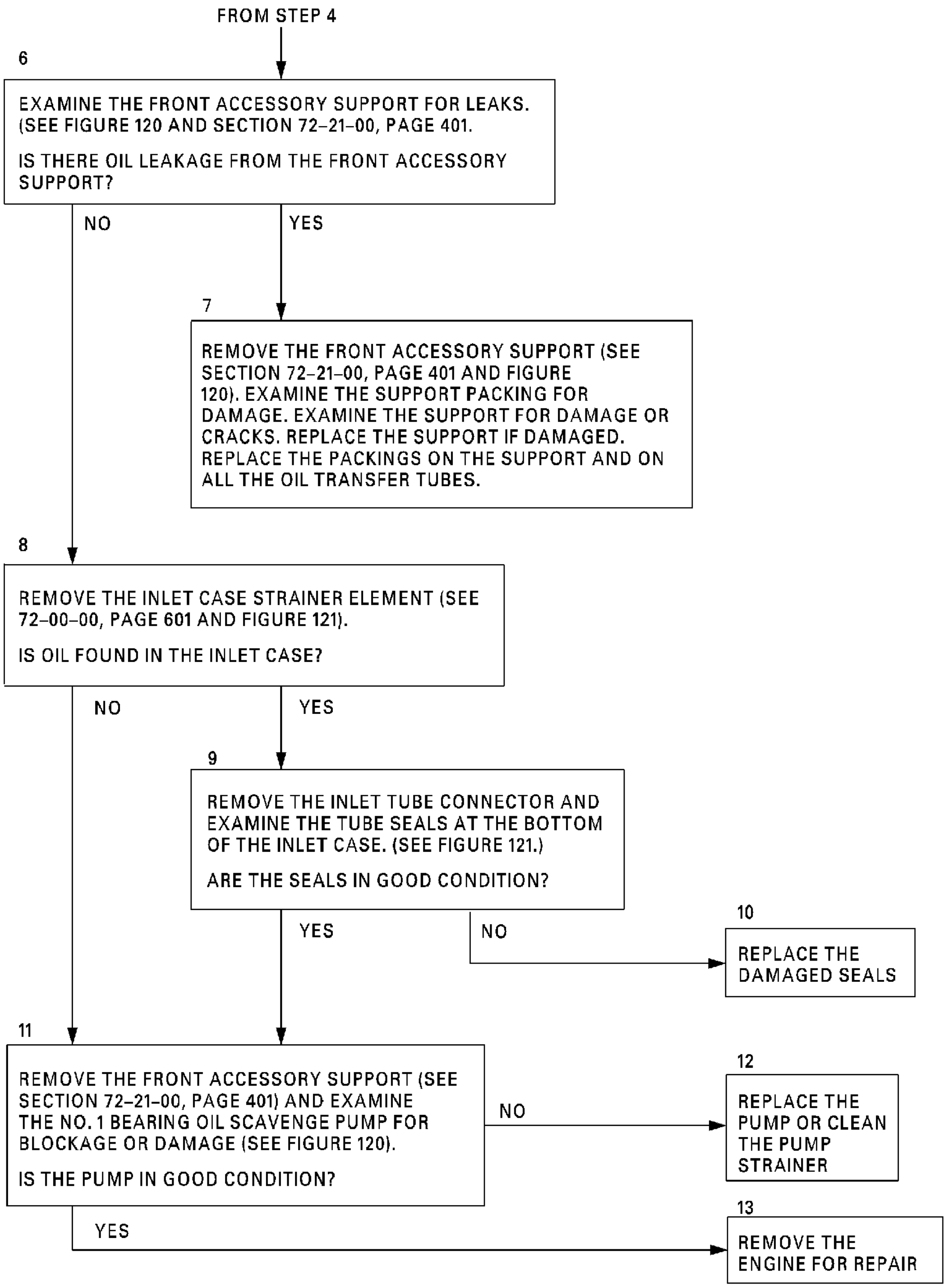
IS THERE OIL LEAKAGE IN THIS AREA

GO TO STEP 6

5 REMOVE THE N1 TACHOMETER AND REPLACE THE GASKET AND N1 TACHOMETER SEAL (SEE CHAPTER / SECTION 72-21-05, PAGE 401 AND FIGURE 120).

Oil Fumes In The Cabin
Figure 117/72-00-02-990-824 (Sheet 1 of 2)

OIL FUMES IN THE AIRCRAFT CABIN (CONTINUED)



6 EXAMINE THE FRONT ACCESSORY SUPPORT FOR LEAKS. (SEE FIGURE 120 AND SECTION 72–21–00, PAGE 401.

IS THERE OIL LEAKAGE FROM THE FRONT ACCESSORY SUPPORT?

7 REMOVE THE FRONT ACCESSORY SUPPORT (SEE SECTION 72–21–00, PAGE 401 AND FIGURE 120). EXAMINE THE SUPPORT PACKING FOR DAMAGE. EXAMINE THE SUPPORT FOR DAMAGE OR CRACKS. REPLACE THE SUPPORT IF DAMAGED. REPLACE THE PACKINGS ON THE SUPPORT AND ON ALL THE OIL TRANSFER TUBES.

8 REMOVE THE INLET CASE STRAINER ELEMENT (SEE 72–00–00, PAGE 601 AND FIGURE 121).

IS OIL FOUND IN THE INLET CASE?

9 REMOVE THE INLET TUBE CONNECTOR AND EXAMINE THE TUBE SEALS AT THE BOTTOM OF THE INLET CASE. (SEE FIGURE 121.)

ARE THE SEALS IN GOOD CONDITION?

10 REPLACE THE DAMAGED SEALS

11 REMOVE THE FRONT ACCESSORY SUPPORT (SEE SECTION 72–21–00, PAGE 401) AND EXAMINE THE NO. 1 BEARING OIL SCAVENGE PUMP FOR BLOCKAGE OR DAMAGE (SEE FIGURE 120).

IS THE PUMP IN GOOD CONDITION?

12 REPLACE THE PUMP OR CLEAN THE PUMP STRAINER

13 REMOVE THE ENGINE FOR REPAIR

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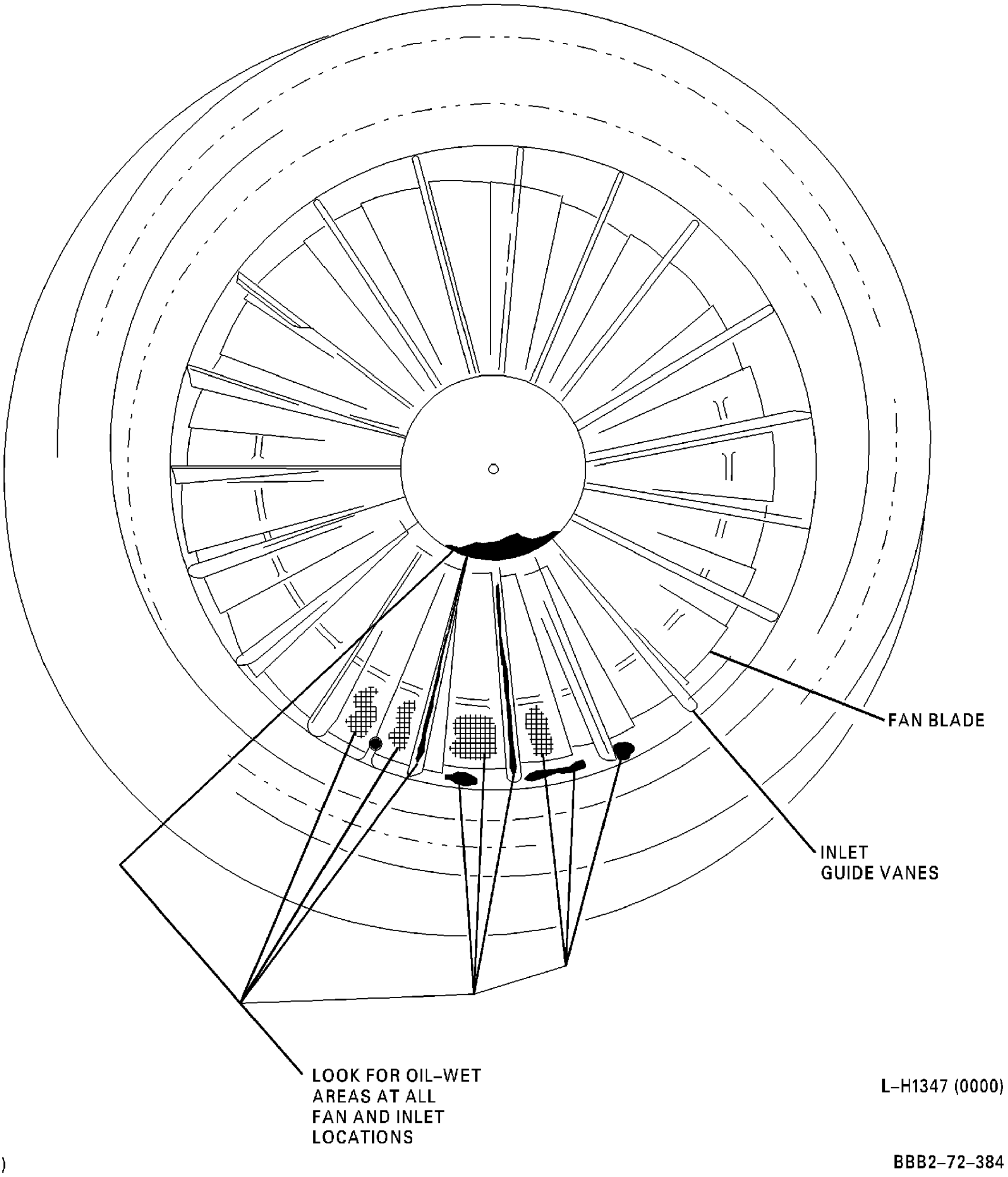
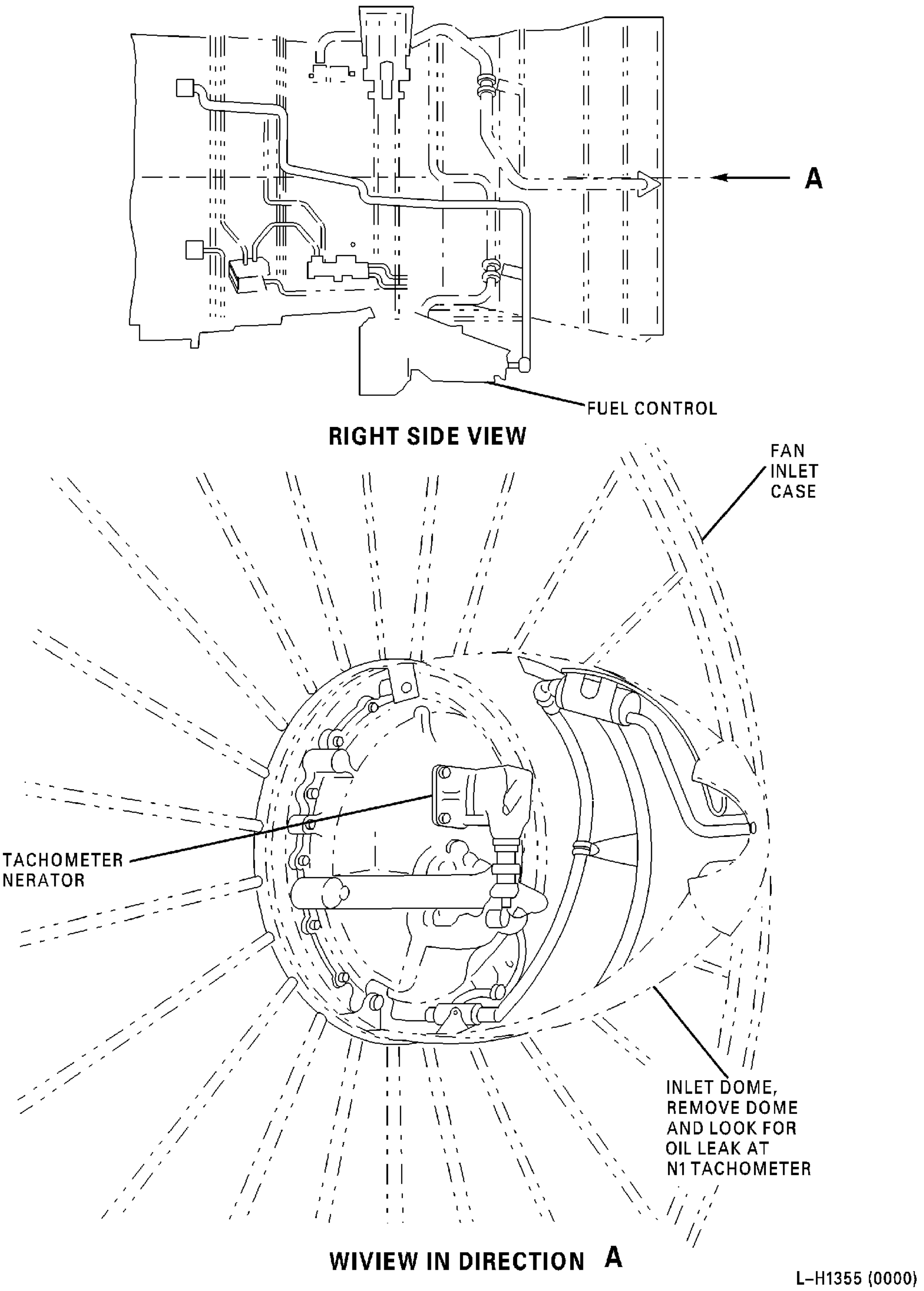
Oil Fumes In The Cabin
Figure 117/72-00-02-990-824 (Sheet 2 of 2)



Engine Inlet Check For Oil Leaks
Figure 118/72-00-02-990-825



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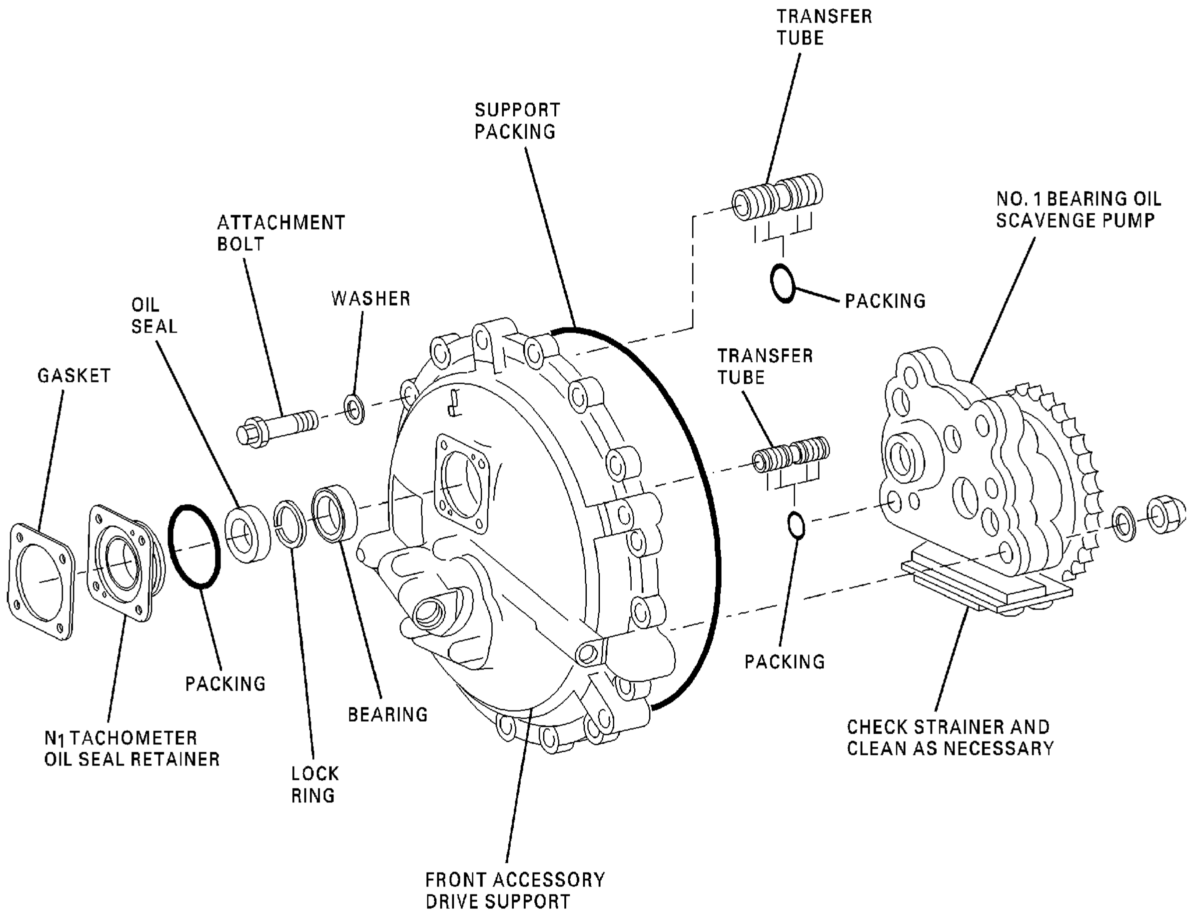
Inlet Dome And N1 Tachometer Check For Oil Leaks
Figure 119/72-00-02-990-826



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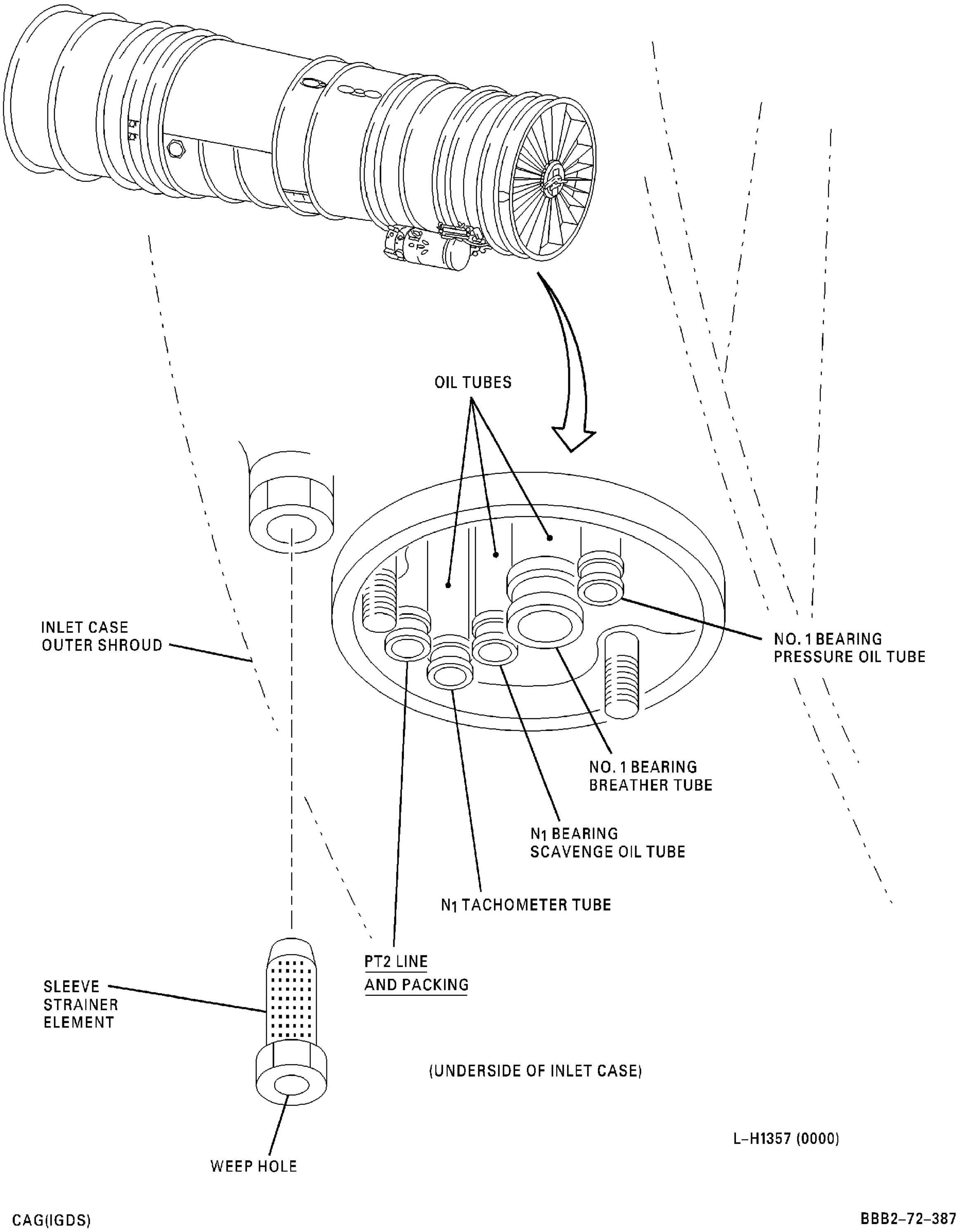
Front Accessory Drive Support and Oil Pump Check For Leaks
Figure 120/72-00-02-990-827



Inlet Case Connector and Strainer Check For Oil Leaks
Figure 121/72-00-02-990-828

6. Oil Pressure Problems

A. General

(1) Problems with engine oil pressure are caused by:

- Supply (no oil in the tank, or not sufficient oil quantity to supply the oil pump)
- Pressure system defects (damage to the main oil pump or to the pressure relief valve)
- Defects in the powerplant/aircraft oil pressure indication system
- Blockage of oil passages with unwanted material
- Internal engine damage (broken oil jets, tubes, etc.).

B. Fluctuating Oil Pressure

(1) There are check operations in the troubleshooting Figures for defects in the oil system that can cause fluctuating oil pressure. These causes (and their solutions) are in the order in which they will probably occur. Black oil, oil which is not sufficient, or leaks in the oil system can cause fluctuating oil pressure. There can be a defect in the aircraft oil pressure indication system (for example the restrictor in the oil pressure indication line can be not in position). There can also be damage to the pressure relief valve which causes the internal parts to not move. It is possible that the main oil pump will have intermittent oil flow, or that there is blockage of the internal gearbox passages.

C. Oil Pressure Follows the Power Lever

(1) Oil pressure "follows the power lever" when the oil pressure gets higher as the engine power increases. This occurs usually because the oil pressure relief valve does not operate correctly. The pressure relief valve has a bypass circuit which releases oil back to the pump when the pressure gets above the set limit. If this system has a failure, only power lever movement will control oil pressure.

- One cause of this condition can be blockage in the gearbox passage which has the bypass oil in it.
- Another cause can be blockage of the oil pressure sense line from the fuel-oil cooler to the gearbox housing.
- Another cause can be a pressure relief valve which does not operate correctly (because the internal parts will not move).

(2) The pressure relief valve has an internal piston with a spring load. Spring rate and breather pressure push this piston in the direction of decreased oil bypass flow. Oil pressure (downstream of the fuel-oil cooler) goes through a sense line to the opposite side of the valve piston. When this sense line pressure decreases, the valve piston lets less oil into the bypass circuit and more oil into the engine. If the passage for bypass oil in the gearbox is blocked, there will be no bypass oil flow; if the oil pressure sense line from the fuel-oil cooler to the gearbox is blocked, there will be no pressure on the internal spring to open the valve into the bypass passage. Blockage of either the sense line or the bypass passage will cause engine oil pressure to follow the engine power lever.

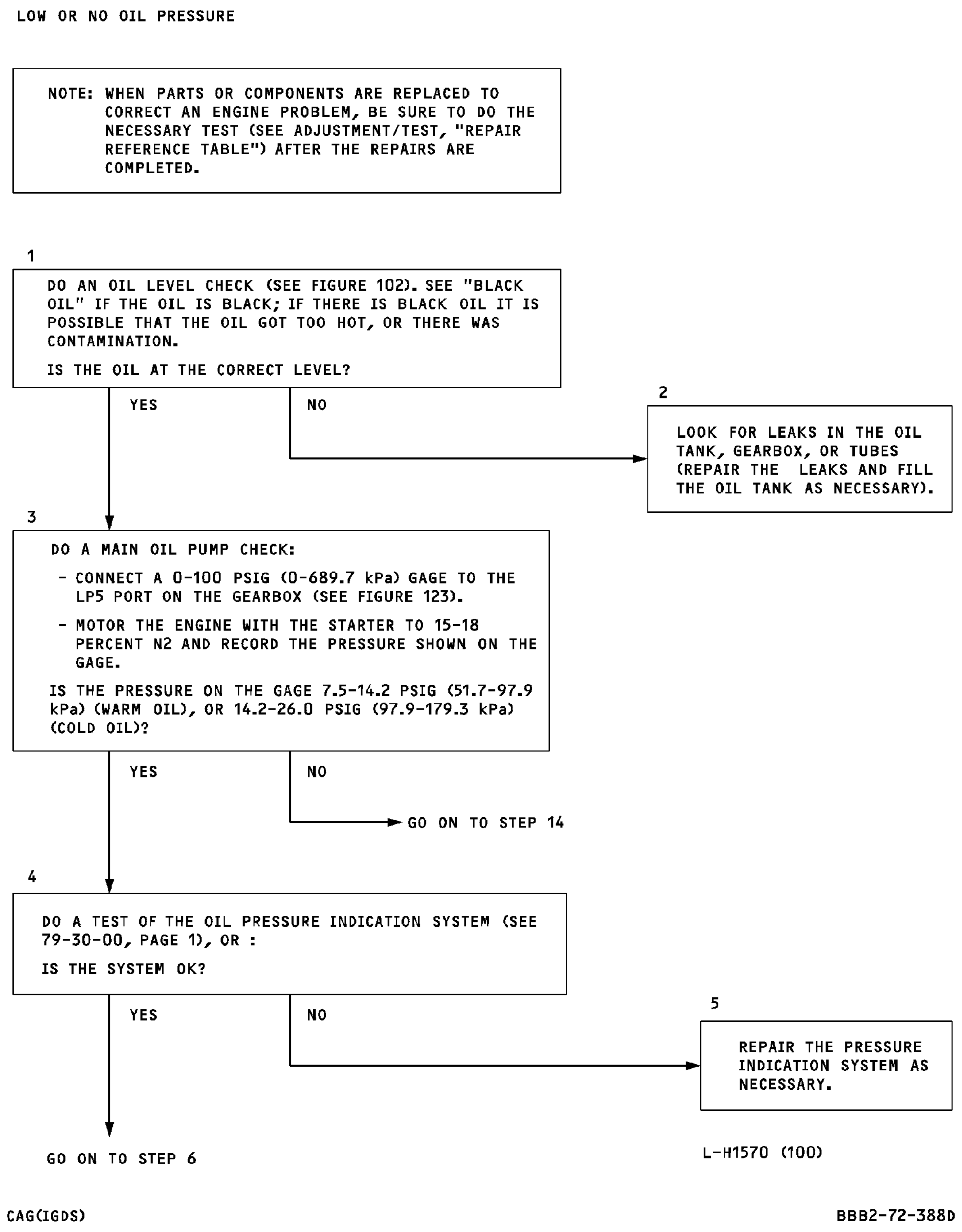
D. Procedures

(1) Low Or No Oil Pressure. (Figure 122 (Figure 123) (Figure 124) Figure 125)

(2) Fluctuating Oil Pressure. (Figure 126)

(3) Oil Pressure Follows The Power Lever. (Figure 127)

(4) High Oil Pressure. (Figure 128)



LOW OR NO OIL PRESSURE

NOTE: WHEN PARTS OR COMPONENTS ARE REPLACED TO CORRECT AN ENGINE PROBLEM, BE SURE TO DO THE NECESSARY TEST (SEE ADJUSTMENT/TEST, "REPAIR REFERENCE TABLE") AFTER THE REPAIRS ARE COMPLETED.

1 DO AN OIL LEVEL CHECK (SEE FIGURE 102). SEE "BLACK OIL" IF THE OIL IS BLACK; IF THERE IS BLACK OIL IT IS POSSIBLE THAT THE OIL GOT TOO HOT, OR THERE WAS CONTAMINATION.

IS THE OIL AT THE CORRECT LEVEL?

2 LOOK FOR LEAKS IN THE OIL TANK, GEARBOX, OR TUBES (REPAIR THE LEAKS AND FILL THE OIL TANK AS NECESSARY).

3 DO A MAIN OIL PUMP CHECK:

- CONNECT A 0-100 PSIG (0-689.7 kPa) GAGE TO THE LP5 PORT ON THE GEARBOX (SEE FIGURE 123).
- MOTOR THE ENGINE WITH THE STARTER TO 15-18 PERCENT N2 AND RECORD THE PRESSURE SHOWN ON THE GAGE.

IS THE PRESSURE ON THE GAGE 7.5-14.2 PSIG (51.7-97.9 kPa) (WARM OIL), OR 14.2-26.0 PSIG (97.9-179.3 kPa) (COLD OIL)?

GO ON TO STEP 14

4 DO A TEST OF THE OIL PRESSURE INDICATION SYSTEM (SEE 79-30-00, PAGE 1), OR :

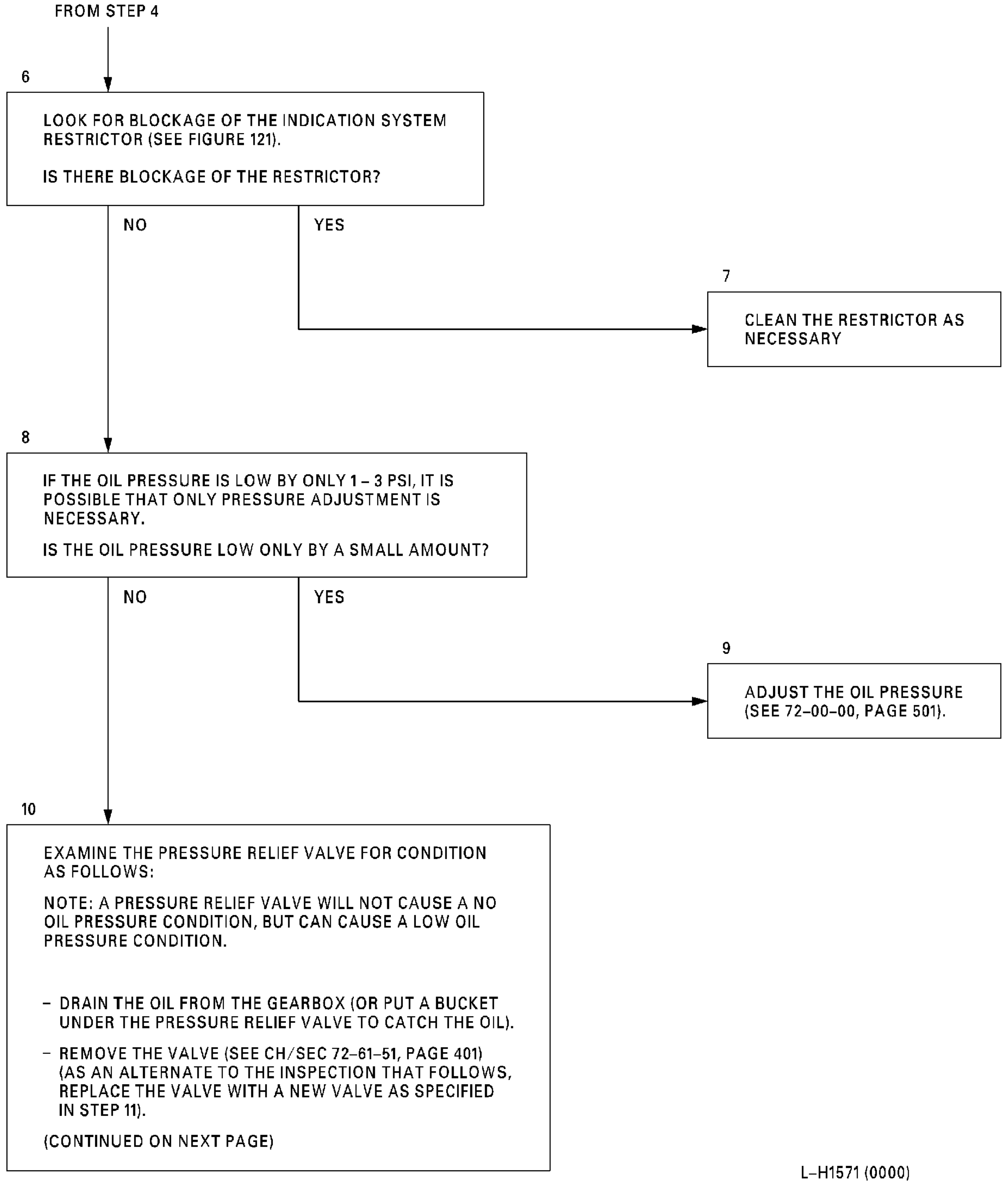
IS THE SYSTEM OK?

5 REPAIR THE PRESSURE INDICATION SYSTEM AS NECESSARY.

GO ON TO STEP 6

No or Low Oil Pressure Troubleshooting
Figure 122/72-00-02-990-829 (Sheet 1 of 4)

LOW OR NO OIL PRESSURE (CONTINUED)



6 LOOK FOR BLOCKAGE OF THE INDICATION SYSTEM RESTRICTOR (SEE FIGURE 121).

IS THERE BLOCKAGE OF THE RESTRICTOR?

7 CLEAN THE RESTRICTOR AS NECESSARY

8 IF THE OIL PRESSURE IS LOW BY ONLY 1 – 3 PSI, IT IS POSSIBLE THAT ONLY PRESSURE ADJUSTMENT IS NECESSARY.

IS THE OIL PRESSURE LOW ONLY BY A SMALL AMOUNT?

9 ADJUST THE OIL PRESSURE (SEE 72–00–00, PAGE 501).

10 EXAMINE THE PRESSURE RELIEF VALVE FOR CONDITION AS FOLLOWS:

NOTE: A PRESSURE RELIEF VALVE WILL NOT CAUSE A NO OIL PRESSURE CONDITION, BUT CAN CAUSE A LOW OIL PRESSURE CONDITION.

- DRAIN THE OIL FROM THE GEARBOX (OR PUT A BUCKET UNDER THE PRESSURE RELIEF VALVE TO CATCH THE OIL).
- REMOVE THE VALVE (SEE CH/SEC 72–61–51, PAGE 401) (AS AN ALTERNATE TO THE INSPECTION THAT FOLLOWS, REPLACE THE VALVE WITH A NEW VALVE AS SPECIFIED IN STEP 11).

(CONTINUED ON NEXT PAGE)

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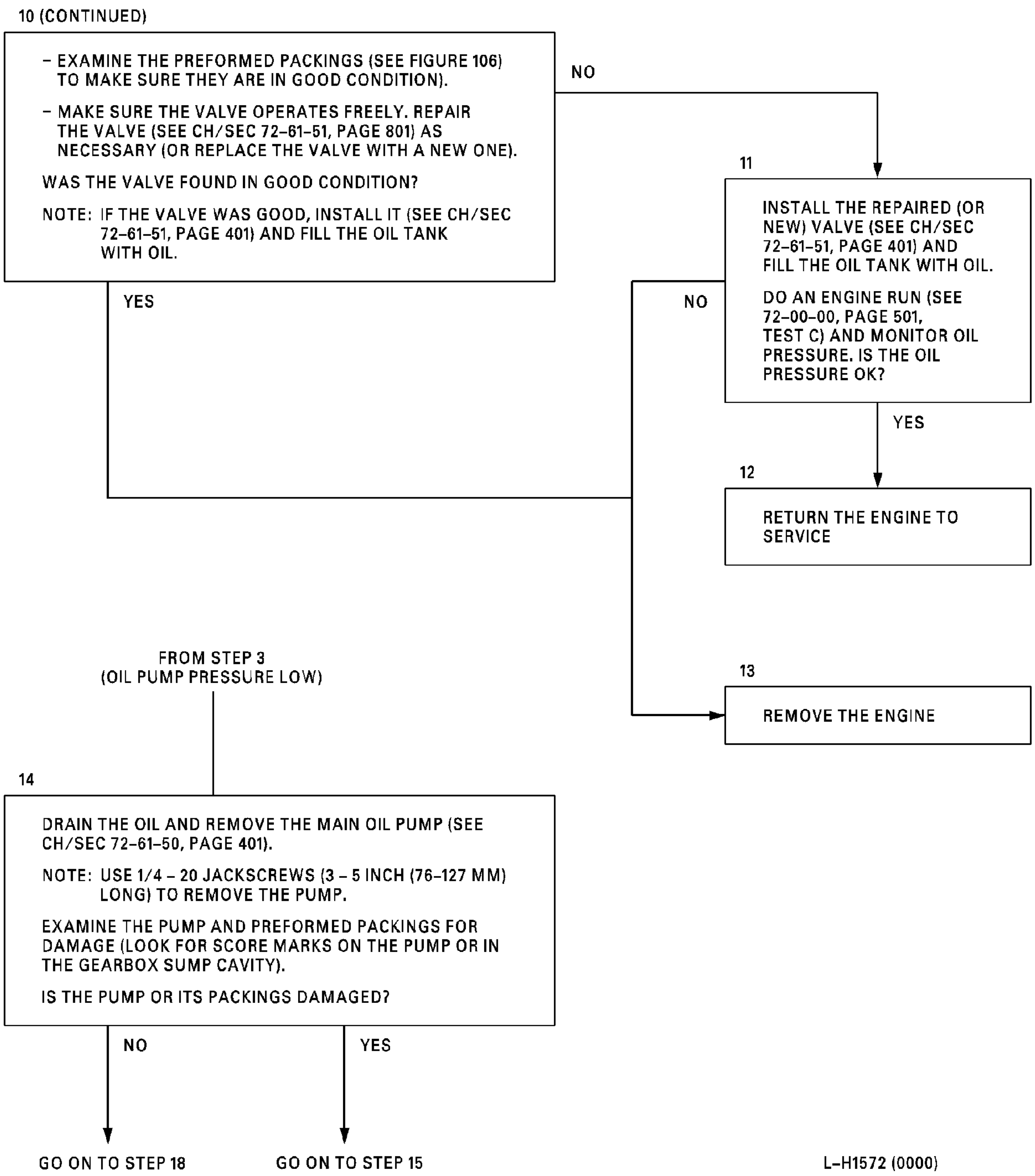
No or Low Oil Pressure Troubleshooting
Figure 122/72-00-02-990-829 (Sheet 2 of 4)

LOW OR NO OIL PRESSURE (CONTINUED)



10 (CONTINUED)

- EXAMINE THE PREFORMED PACKINGS (SEE FIGURE 106) TO MAKE SURE THEY ARE IN GOOD CONDITION).
- MAKE SURE THE VALVE OPERATES FREELY. REPAIR THE VALVE (SEE CH/SEC 72-61-51, PAGE 801) AS NECESSARY (OR REPLACE THE VALVE WITH A NEW ONE).

WAS THE VALVE FOUND IN GOOD CONDITION?

NOTE: IF THE VALVE WAS GOOD, INSTALL IT (SEE CH/SEC 72-61-51, PAGE 401) AND FILL THE OIL TANK WITH OIL.

11

INSTALL THE REPAIRED (OR NEW) VALVE (SEE CH/SEC 72-61-51, PAGE 401) AND FILL THE OIL TANK WITH OIL.

DO AN ENGINE RUN (SEE 72-00-00, PAGE 501, TEST C) AND MONITOR OIL PRESSURE. IS THE OIL PRESSURE OK?

12

RETURN THE ENGINE TO SERVICE

13

REMOVE THE ENGINE

FROM STEP 3
(OIL PUMP PRESSURE LOW)

14

DRAIN THE OIL AND REMOVE THE MAIN OIL PUMP (SEE CH/SEC 72-61-50, PAGE 401).

NOTE: USE 1/4 – 20 JACKSCREWS (3 – 5 INCH (76-127 MM) LONG) TO REMOVE THE PUMP.

EXAMINE THE PUMP AND PREFORMED PACKINGS FOR DAMAGE (LOOK FOR SCORE MARKS ON THE PUMP OR IN THE GEARBOX SUMP CAVITY).

IS THE PUMP OR ITS PACKINGS DAMAGED?

GO ON TO STEP 18

GO ON TO STEP 15

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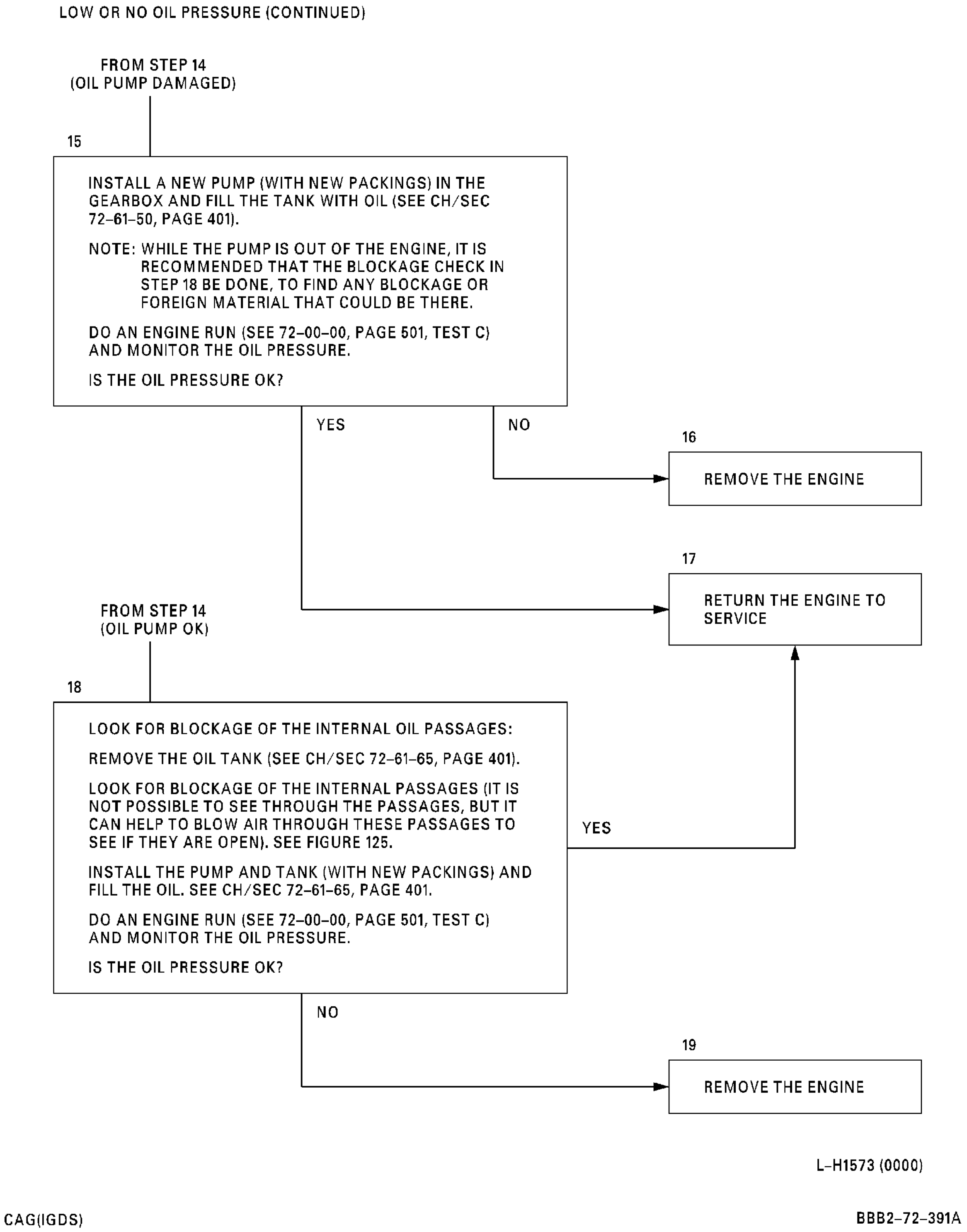
CAG(IGDS)

BBB2-72-390A

No or Low Oil Pressure Troubleshooting
Figure 122/72-00-02-990-829 (Sheet 3 of 4)



INSTALL A NEW PUMP (WITH NEW PACKINGS) IN THE GEARBOX AND FILL THE TANK WITH OIL (SEE CH/SEC 72–61–50, PAGE 401).

NOTE: WHILE THE PUMP IS OUT OF THE ENGINE, IT IS RECOMMENDED THAT THE BLOCKAGE CHECK IN STEP 18 BE DONE, TO FIND ANY BLOCKAGE OR FOREIGN MATERIAL THAT COULD BE THERE.

DO AN ENGINE RUN (SEE 72–00–00, PAGE 501, TEST C) AND MONITOR THE OIL PRESSURE.

IS THE OIL PRESSURE OK?

REMOVE THE ENGINE

RETURN THE ENGINE TO SERVICE

LOOK FOR BLOCKAGE OF THE INTERNAL OIL PASSAGES:

REMOVE THE OIL TANK (SEE CH/SEC 72–61–65, PAGE 401).

LOOK FOR BLOCKAGE OF THE INTERNAL PASSAGES (IT IS NOT POSSIBLE TO SEE THROUGH THE PASSAGES, BUT IT CAN HELP TO BLOW AIR THROUGH THESE PASSAGES TO SEE IF THEY ARE OPEN). SEE FIGURE 125.

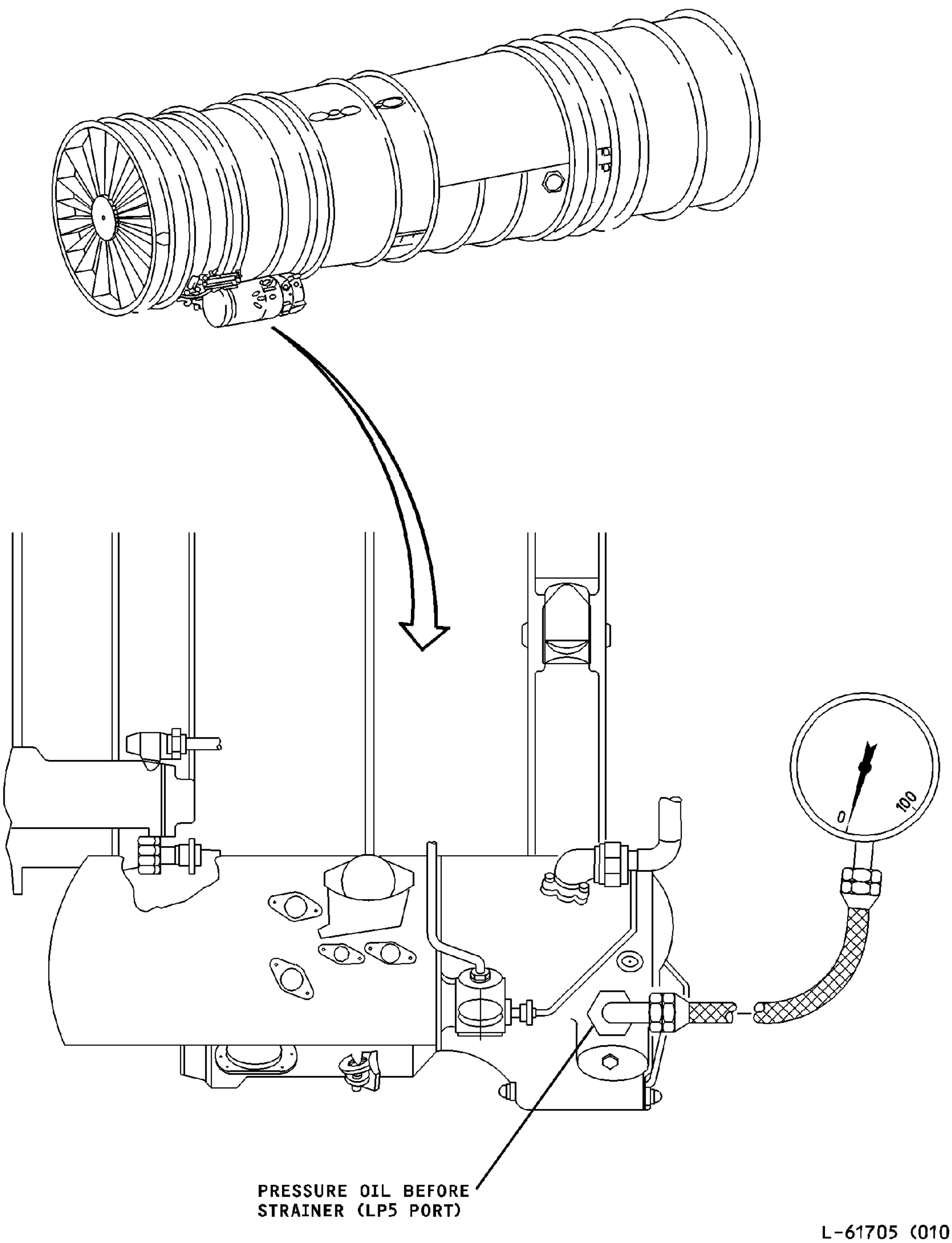
INSTALL THE PUMP AND TANK (WITH NEW PACKINGS) AND FILL THE OIL. SEE CH/SEC 72–61–65, PAGE 401.

DO AN ENGINE RUN (SEE 72–00–00, PAGE 501, TEST C) AND MONITOR THE OIL PRESSURE.

IS THE OIL PRESSURE OK?

REMOVE THE ENGINE

No or Low Oil Pressure Troubleshooting
Figure 122/72-00-02-990-829 (Sheet 4 of 4)



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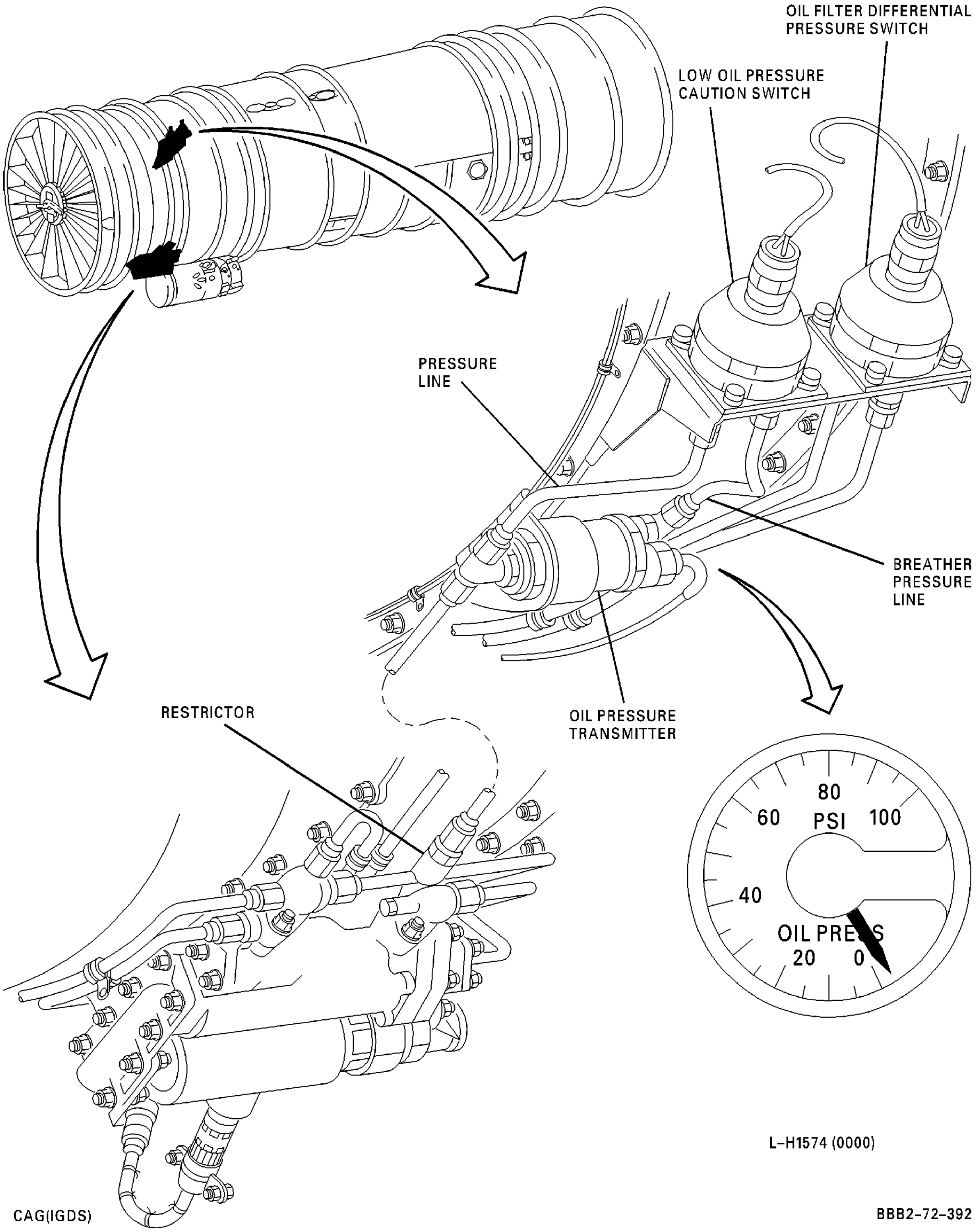
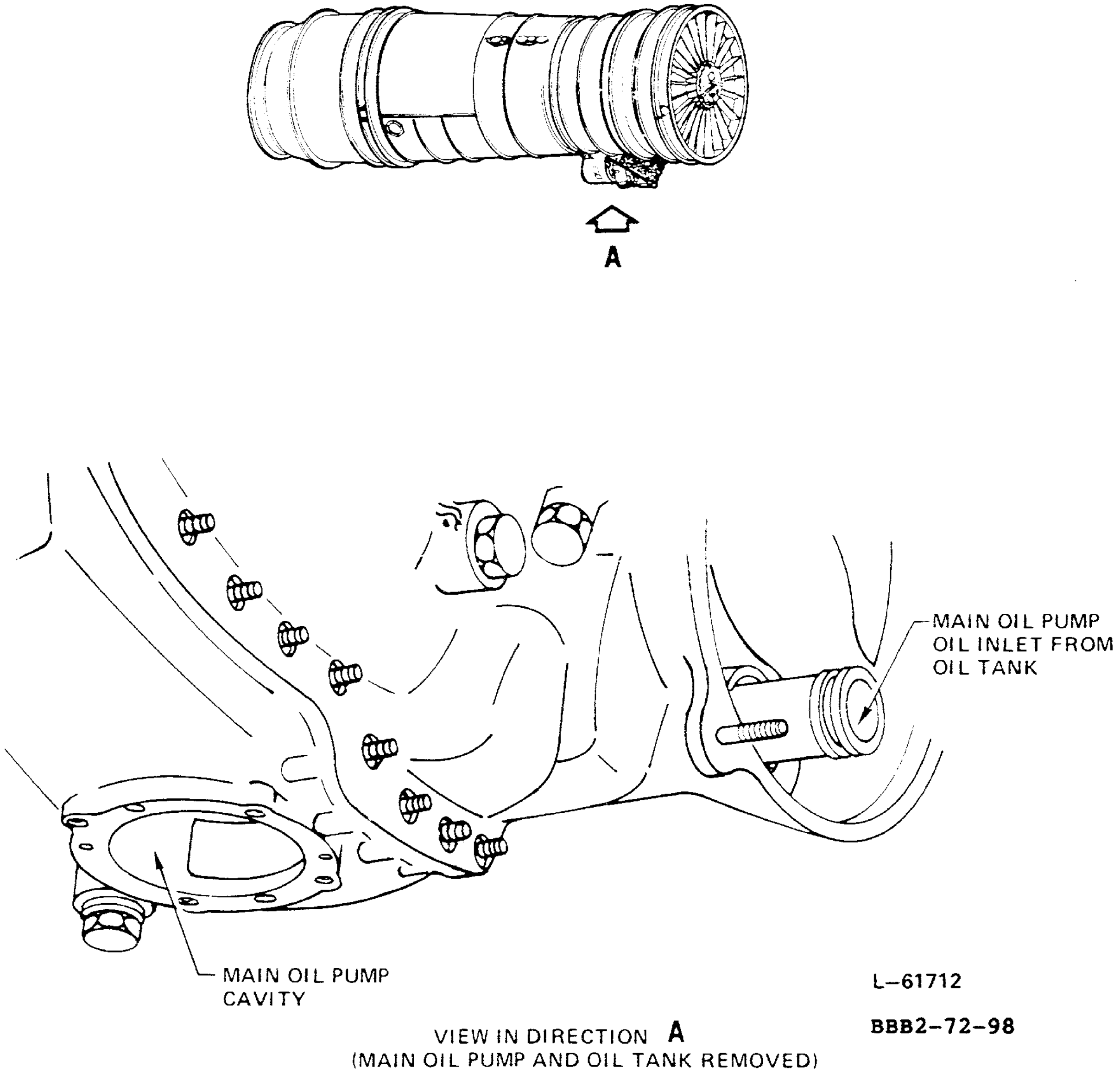
Main Oil Pump Operation Check
Figure 123/72-00-02-990-830

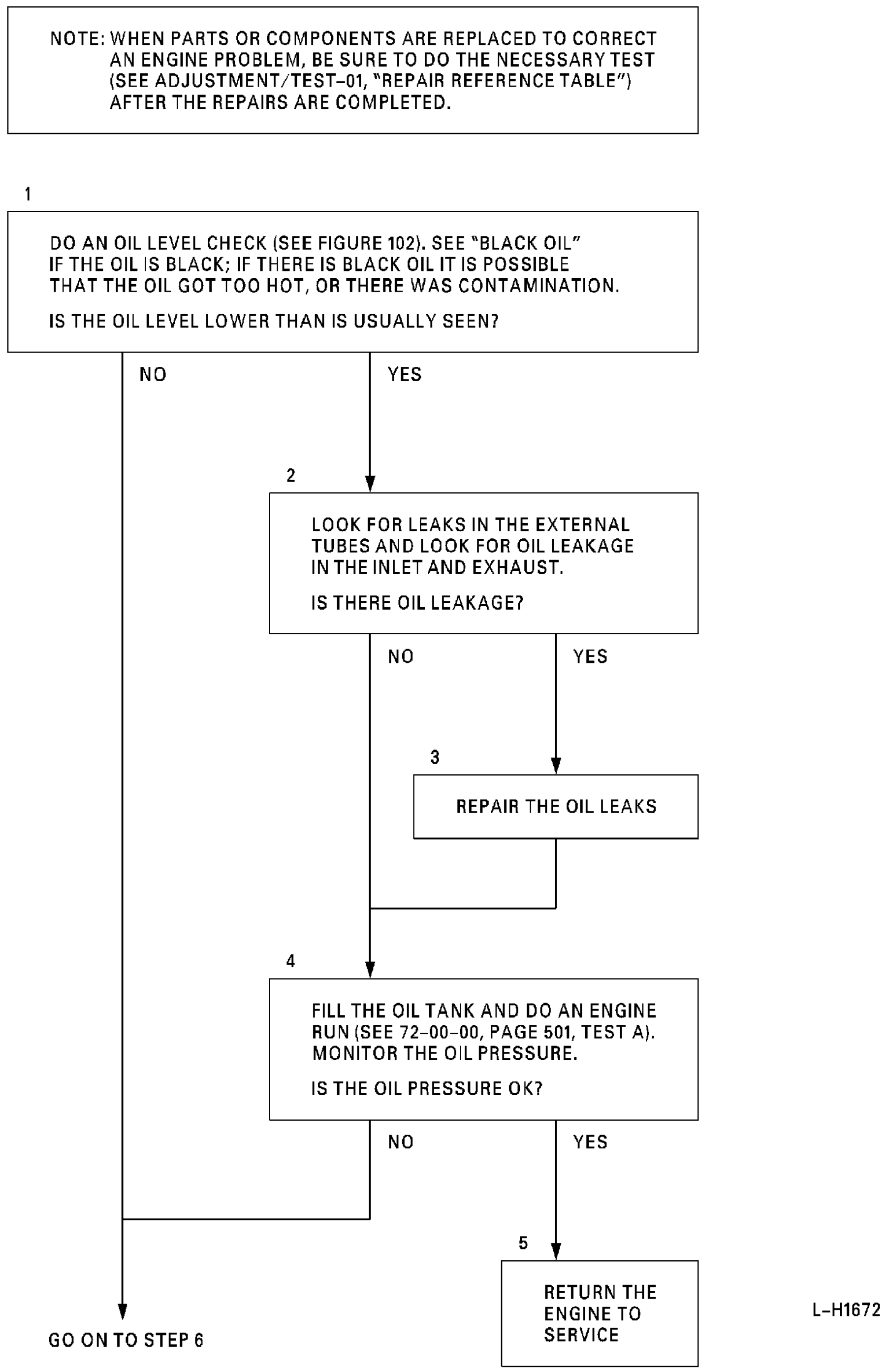


Powerplant Oil Pressure Indicating System
Figure 124/72-00-02-990-831



Main Oil Pump/Oil Tank Passage Check
Figure 125/72-00-02-990-832

FLUCTUATING OIL PRESSURE



NOTE: WHEN PARTS OR COMPONENTS ARE REPLACED TO CORRECT AN ENGINE PROBLEM, BE SURE TO DO THE NECESSARY TEST (SEE ADJUSTMENT/TEST–01, "REPAIR REFERENCE TABLE") AFTER THE REPAIRS ARE COMPLETED.

1 DO AN OIL LEVEL CHECK (SEE FIGURE 102). SEE "BLACK OIL" IF THE OIL IS BLACK; IF THERE IS BLACK OIL IT IS POSSIBLE THAT THE OIL GOT TOO HOT, OR THERE WAS CONTAMINATION.

IS THE OIL LEVEL LOWER THAN IS USUALLY SEEN?

2 LOOK FOR LEAKS IN THE EXTERNAL TUBES AND LOOK FOR OIL LEAKAGE IN THE INLET AND EXHAUST.

IS THERE OIL LEAKAGE?

3 REPAIR THE OIL LEAKS

4 FILL THE OIL TANK AND DO AN ENGINE RUN (SEE 72–00–00, PAGE 501, TEST A). MONITOR THE OIL PRESSURE.

IS THE OIL PRESSURE OK?

5 RETURN THE ENGINE TO SERVICE

GO ON TO STEP 6

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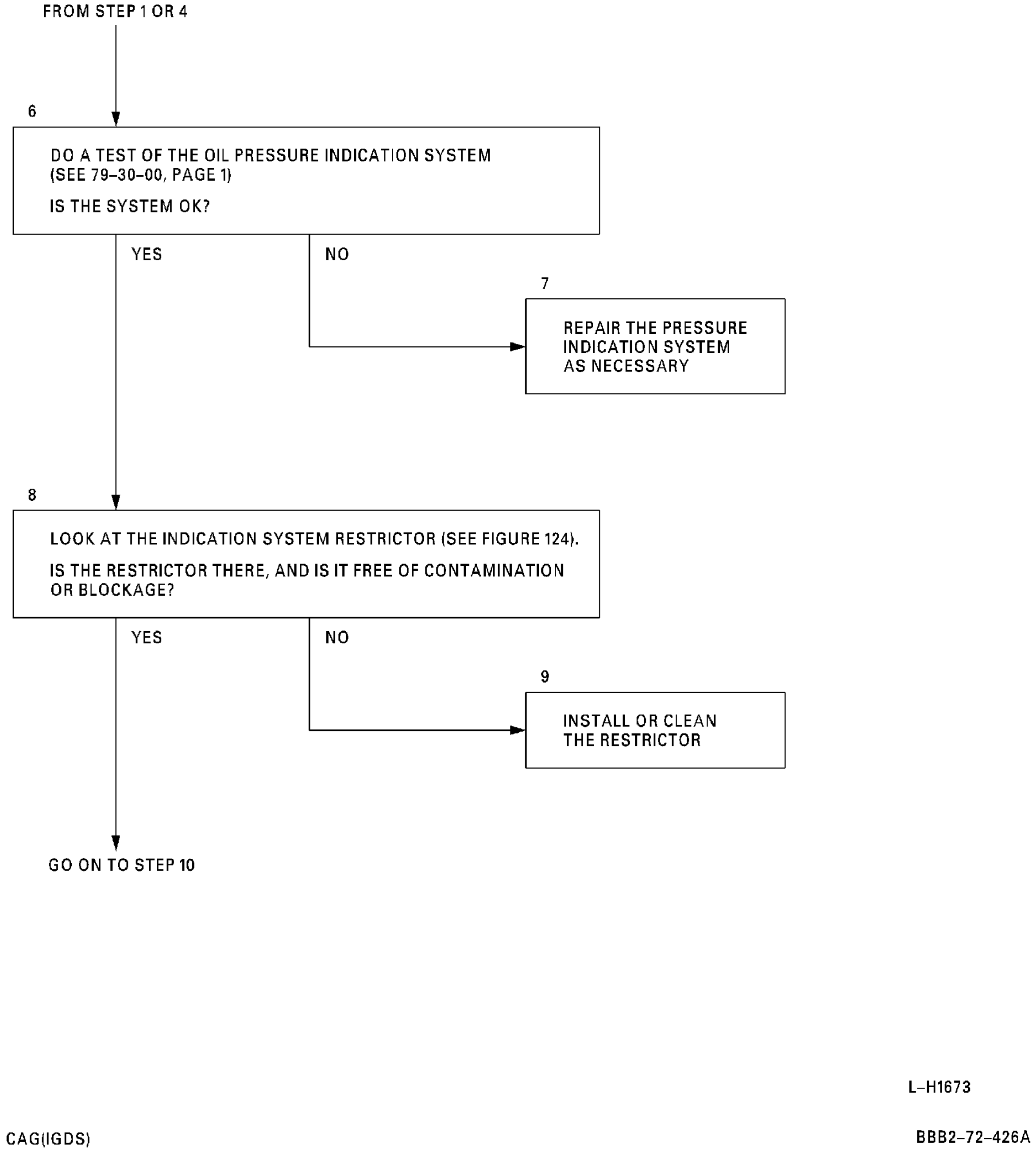
Fluctuating Oil Pressure Troubleshooting
Figure 126/72-00-02-990-833 (Sheet 1 of 5)

FLUCTUATING OIL PRESSURE (CONTINUED)



6 DO A TEST OF THE OIL PRESSURE INDICATION SYSTEM (SEE 79–30–00, PAGE 1)

IS THE SYSTEM OK?

7 REPAIR THE PRESSURE INDICATION SYSTEM AS NECESSARY

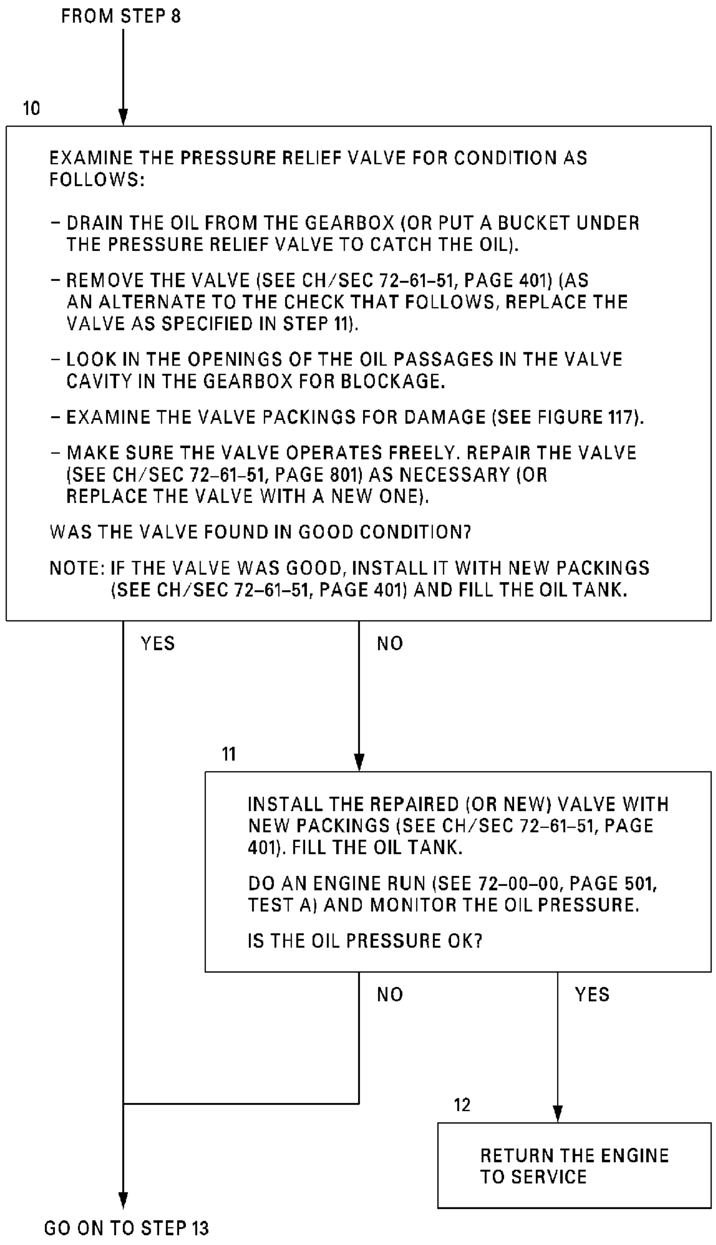
8 LOOK AT THE INDICATION SYSTEM RESTRICTOR (SEE FIGURE 124).

IS THE RESTRICTOR THERE, AND IS IT FREE OF CONTAMINATION OR BLOCKAGE?

9 INSTALL OR CLEAN THE RESTRICTOR

Fluctuating Oil Pressure Troubleshooting
Figure 126/72-00-02-990-833 (Sheet 2 of 5)

FLUCTUATING OIL PRESSURE (CONTINUED)



FROM STEP 8

10

EXAMINE THE PRESSURE RELIEF VALVE FOR CONDITION AS FOLLOWS:

- DRAIN THE OIL FROM THE GEARBOX (OR PUT A BUCKET UNDER THE PRESSURE RELIEF VALVE TO CATCH THE OIL).
- REMOVE THE VALVE (SEE CH/SEC 72–61–51, PAGE 401) (AS AN ALTERNATE TO THE CHECK THAT FOLLOWS, REPLACE THE VALVE AS SPECIFIED IN STEP 11).
- LOOK IN THE OPENINGS OF THE OIL PASSAGES IN THE VALVE CAVITY IN THE GEARBOX FOR BLOCKAGE.
- EXAMINE THE VALVE PACKINGS FOR DAMAGE (SEE FIGURE 117).
- MAKE SURE THE VALVE OPERATES FREELY. REPAIR THE VALVE (SEE CH/SEC 72–61–51, PAGE 801) AS NECESSARY (OR REPLACE THE VALVE WITH A NEW ONE).

WAS THE VALVE FOUND IN GOOD CONDITION?

NOTE: IF THE VALVE WAS GOOD, INSTALL IT WITH NEW PACKINGS (SEE CH/SEC 72–61–51, PAGE 401) AND FILL THE OIL TANK.

11

INSTALL THE REPAIRED (OR NEW) VALVE WITH NEW PACKINGS (SEE CH/SEC 72–61–51, PAGE 401). FILL THE OIL TANK.

DO AN ENGINE RUN (SEE 72–00–00, PAGE 501, TEST A) AND MONITOR THE OIL PRESSURE.

IS THE OIL PRESSURE OK?

12

RETURN THE ENGINE TO SERVICE

GO ON TO STEP 13

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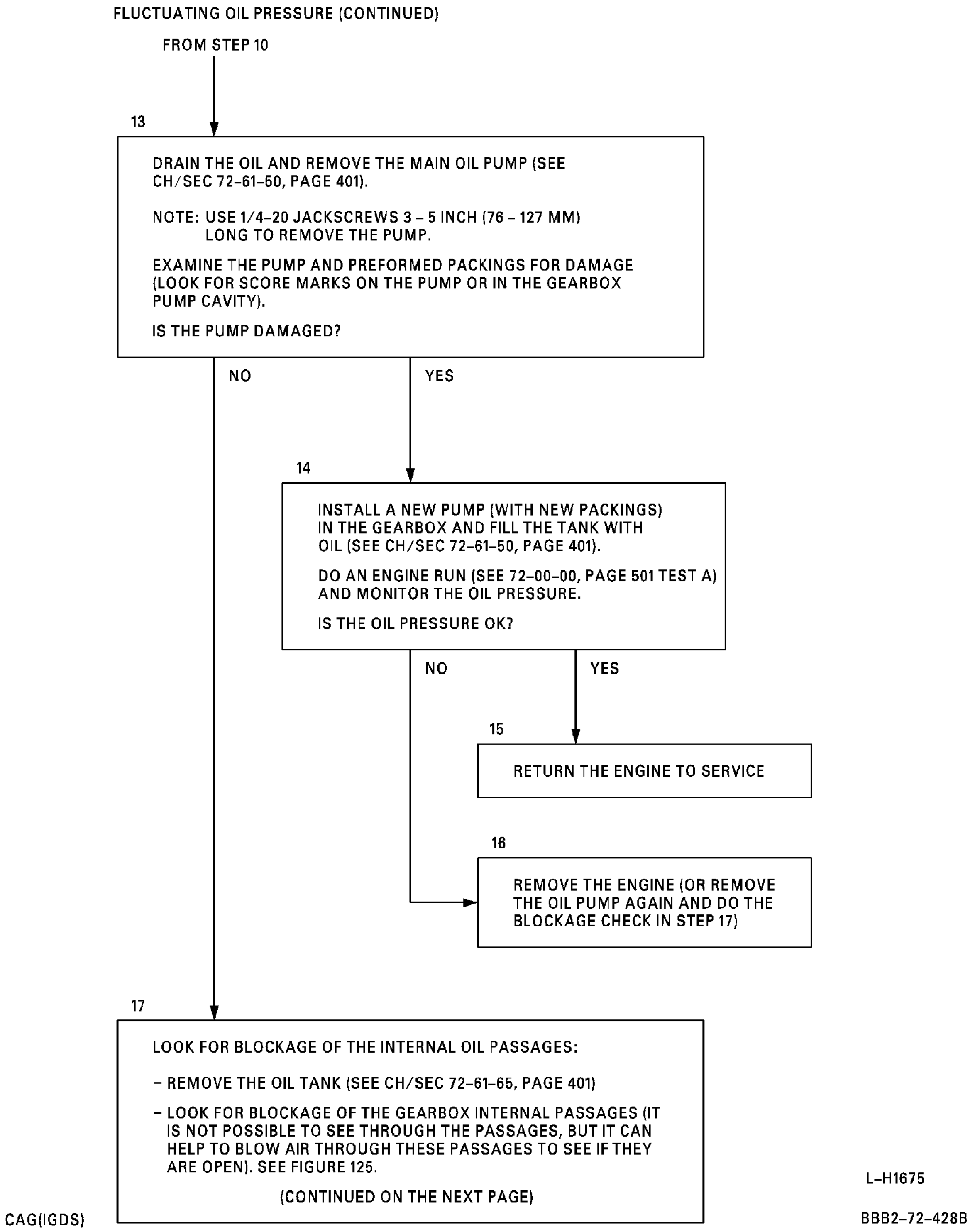
CAG(IGDS)

BBB2–72–427

Fluctuating Oil Pressure Troubleshooting
Figure 126/72-00-02-990-833 (Sheet 3 of 5)


FLUCTUATING OIL PRESSURE (CONTINUED)

FROM STEP 10

13 DRAIN THE OIL AND REMOVE THE MAIN OIL PUMP (SEE CH/SEC 72-61-50, PAGE 401).

NOTE: USE 1/4-20 JACKSCREWS 3 - 5 INCH (76 - 127 MM) LONG TO REMOVE THE PUMP.

EXAMINE THE PUMP AND PREFORMED PACKINGS FOR DAMAGE (LOOK FOR SCORE MARKS ON THE PUMP OR IN THE GEARBOX PUMP CAVITY).

IS THE PUMP DAMAGED?

14 INSTALL A NEW PUMP (WITH NEW PACKINGS) IN THE GEARBOX AND FILL THE TANK WITH OIL (SEE CH/SEC 72-61-50, PAGE 401).

DO AN ENGINE RUN (SEE 72-00-00, PAGE 501 TEST A) AND MONITOR THE OIL PRESSURE.

IS THE OIL PRESSURE OK?

15 RETURN THE ENGINE TO SERVICE

16 REMOVE THE ENGINE (OR REMOVE THE OIL PUMP AGAIN AND DO THE BLOCKAGE CHECK IN STEP 17)

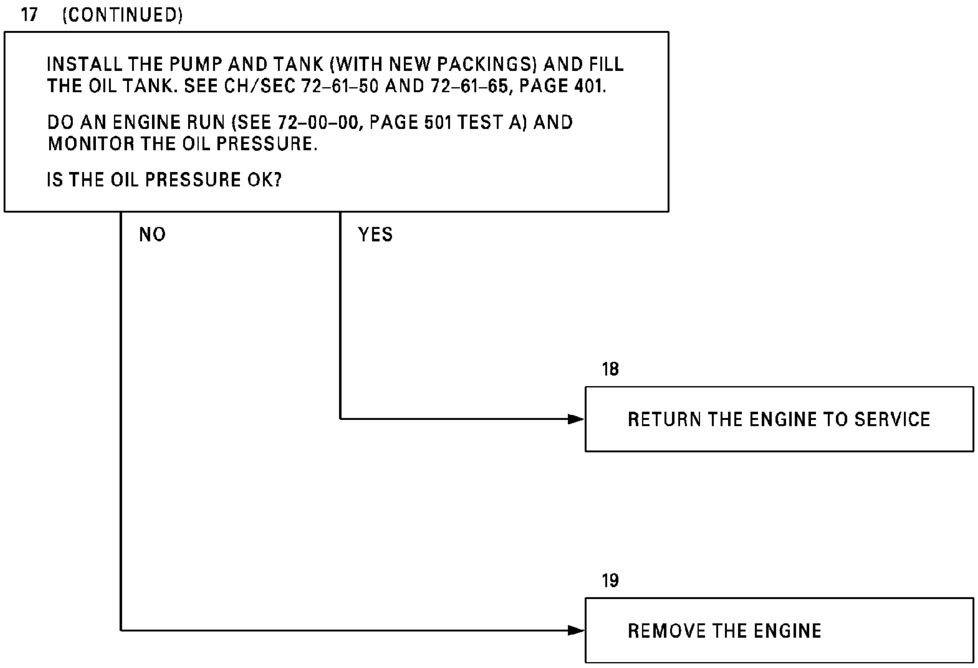
17 LOOK FOR BLOCKAGE OF THE INTERNAL OIL PASSAGES:

- REMOVE THE OIL TANK (SEE CH/SEC 72-61-65, PAGE 401)
- LOOK FOR BLOCKAGE OF THE GEARBOX INTERNAL PASSAGES (IT IS NOT POSSIBLE TO SEE THROUGH THE PASSAGES, BUT IT CAN HELP TO BLOW AIR THROUGH THESE PASSAGES TO SEE IF THEY ARE OPEN). SEE FIGURE 125.

(CONTINUED ON THE NEXT PAGE)

Fluctuating Oil Pressure Troubleshooting
Figure 126/72-00-02-990-833 (Sheet 4 of 5)

FLUCTUATING OIL PRESSURE (CONTINUED)



CAG(IGDS)

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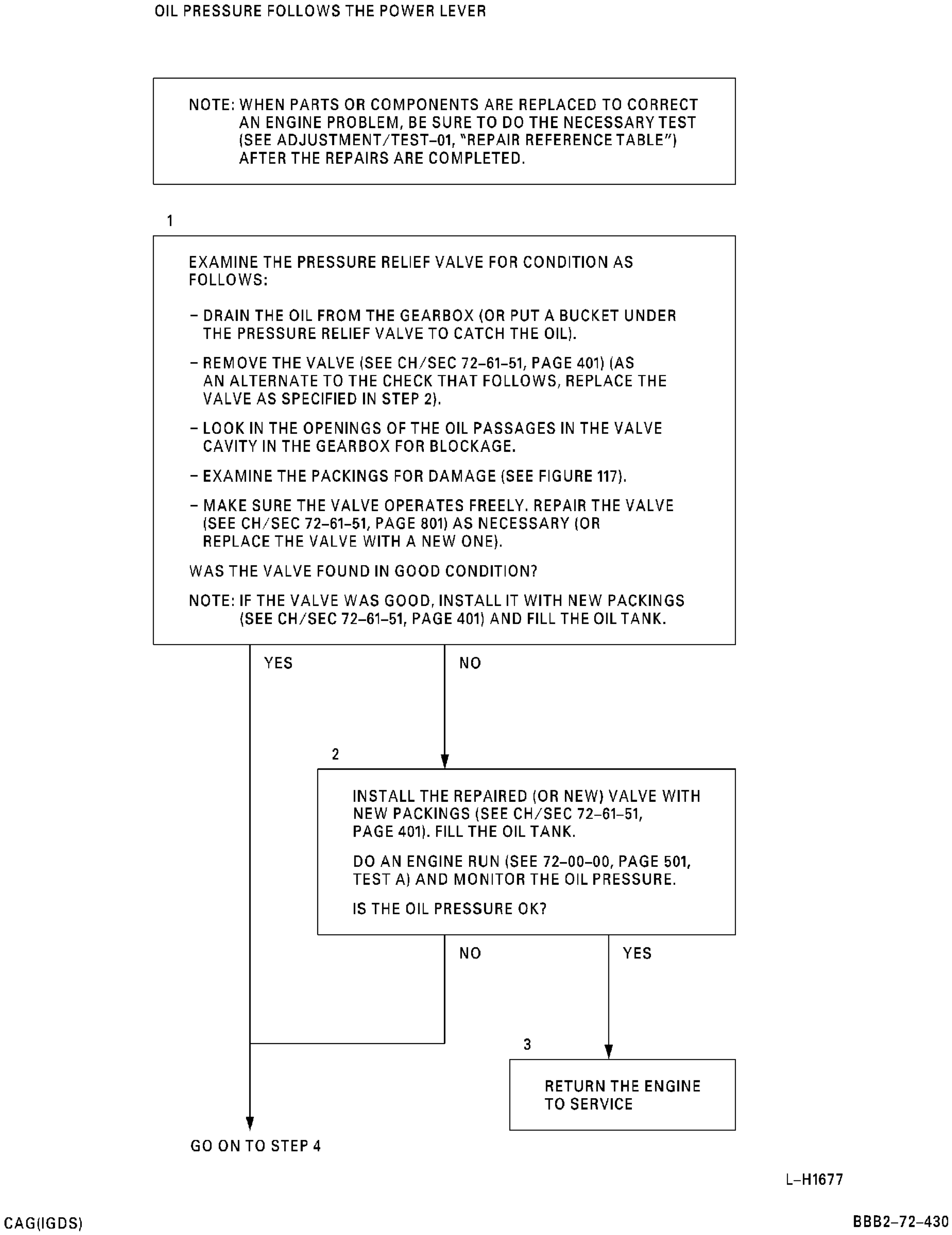
BBB2-72-429A

Fluctuating Oil Pressure Troubleshooting
Figure 126/72-00-02-990-833 (Sheet 5 of 5)



OIL PRESSURE FOLLOWS THE POWER LEVER

NOTE: WHEN PARTS OR COMPONENTS ARE REPLACED TO CORRECT AN ENGINE PROBLEM, BE SURE TO DO THE NECESSARY TEST (SEE ADJUSTMENT/TEST-01, "REPAIR REFERENCE TABLE") AFTER THE REPAIRS ARE COMPLETED.

1

EXAMINE THE PRESSURE RELIEF VALVE FOR CONDITION AS FOLLOWS:

- DRAIN THE OIL FROM THE GEARBOX (OR PUT A BUCKET UNDER THE PRESSURE RELIEF VALVE TO CATCH THE OIL).
- REMOVE THE VALVE (SEE CH/SEC 72-61-51, PAGE 401) (AS AN ALTERNATE TO THE CHECK THAT FOLLOWS, REPLACE THE VALVE AS SPECIFIED IN STEP 2).
- LOOK IN THE OPENINGS OF THE OIL PASSAGES IN THE VALVE CAVITY IN THE GEARBOX FOR BLOCKAGE.
- EXAMINE THE PACKINGS FOR DAMAGE (SEE FIGURE 117).
- MAKE SURE THE VALVE OPERATES FREELY. REPAIR THE VALVE (SEE CH/SEC 72-61-51, PAGE 801) AS NECESSARY (OR REPLACE THE VALVE WITH A NEW ONE).

WAS THE VALVE FOUND IN GOOD CONDITION?

NOTE: IF THE VALVE WAS GOOD, INSTALL IT WITH NEW PACKINGS (SEE CH/SEC 72-61-51, PAGE 401) AND FILL THE OIL TANK.

2

INSTALL THE REPAIRED (OR NEW) VALVE WITH NEW PACKINGS (SEE CH/SEC 72-61-51, PAGE 401). FILL THE OIL TANK.

DO AN ENGINE RUN (SEE 72-00-00, PAGE 501, TEST A) AND MONITOR THE OIL PRESSURE.

IS THE OIL PRESSURE OK?

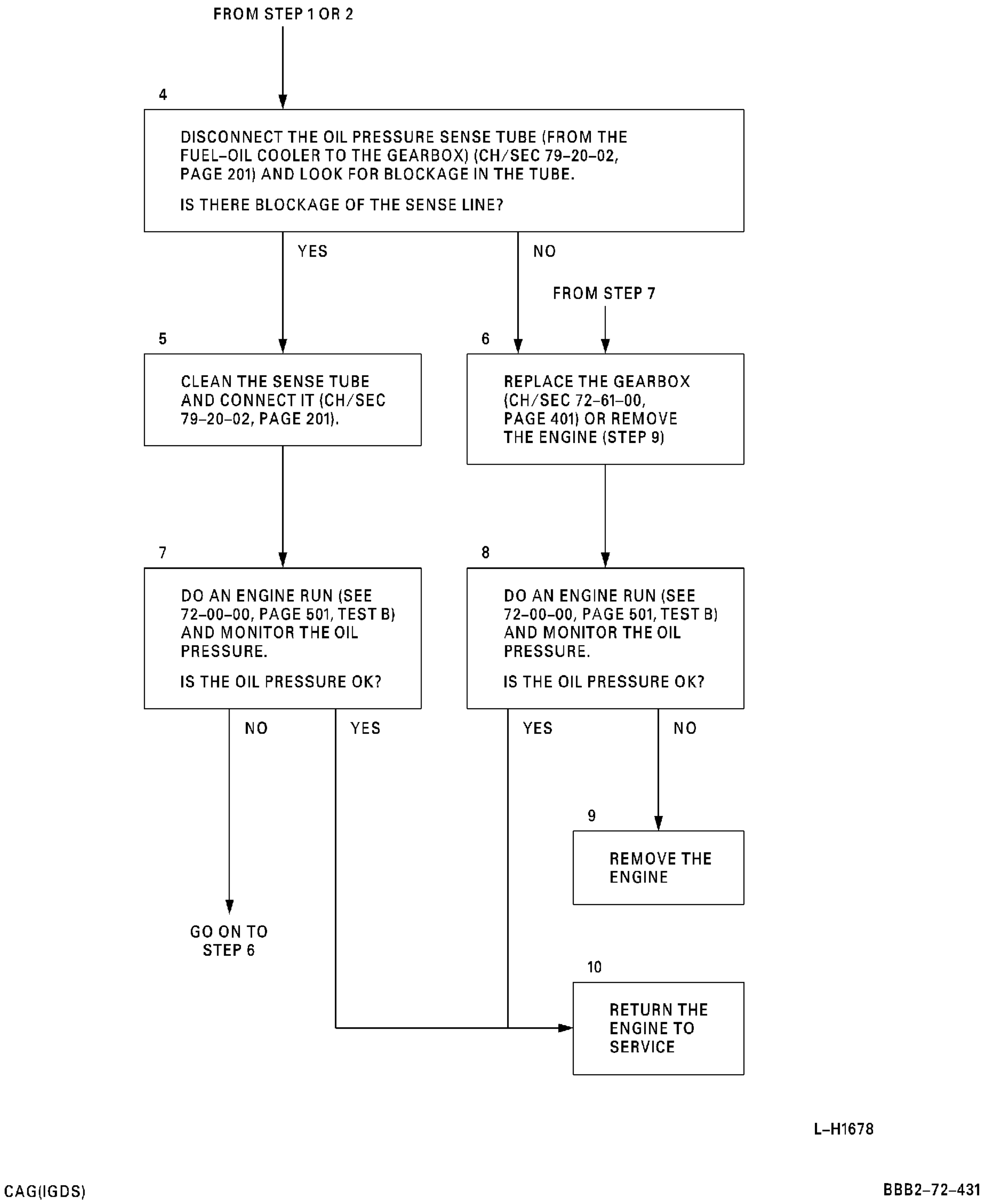
3

RETURN THE ENGINE TO SERVICE

GO ON TO STEP 4

Oil Pressure Follows the Power Lever Troubleshooting
Figure 127/72-00-02-990-834 (Sheet 1 of 2)

OIL PRESSURE FOLLOWS POWER LEVER (CONTINUED)



4 DISCONNECT THE OIL PRESSURE SENSE TUBE (FROM THE FUEL–OIL COOLER TO THE GEARBOX) (CH/SEC 79–20–02, PAGE 201) AND LOOK FOR BLOCKAGE IN THE TUBE.

IS THERE BLOCKAGE OF THE SENSE LINE?

5 CLEAN THE SENSE TUBE AND CONNECT IT (CH/SEC 79–20–02, PAGE 201).

6 REPLACE THE GEARBOX (CH/SEC 72–61–00, PAGE 401) OR REMOVE THE ENGINE (STEP 9)

7 DO AN ENGINE RUN (SEE 72–00–00, PAGE 501, TEST B) AND MONITOR THE OIL PRESSURE.

IS THE OIL PRESSURE OK?

8 DO AN ENGINE RUN (SEE 72–00–00, PAGE 501, TEST B) AND MONITOR THE OIL PRESSURE.

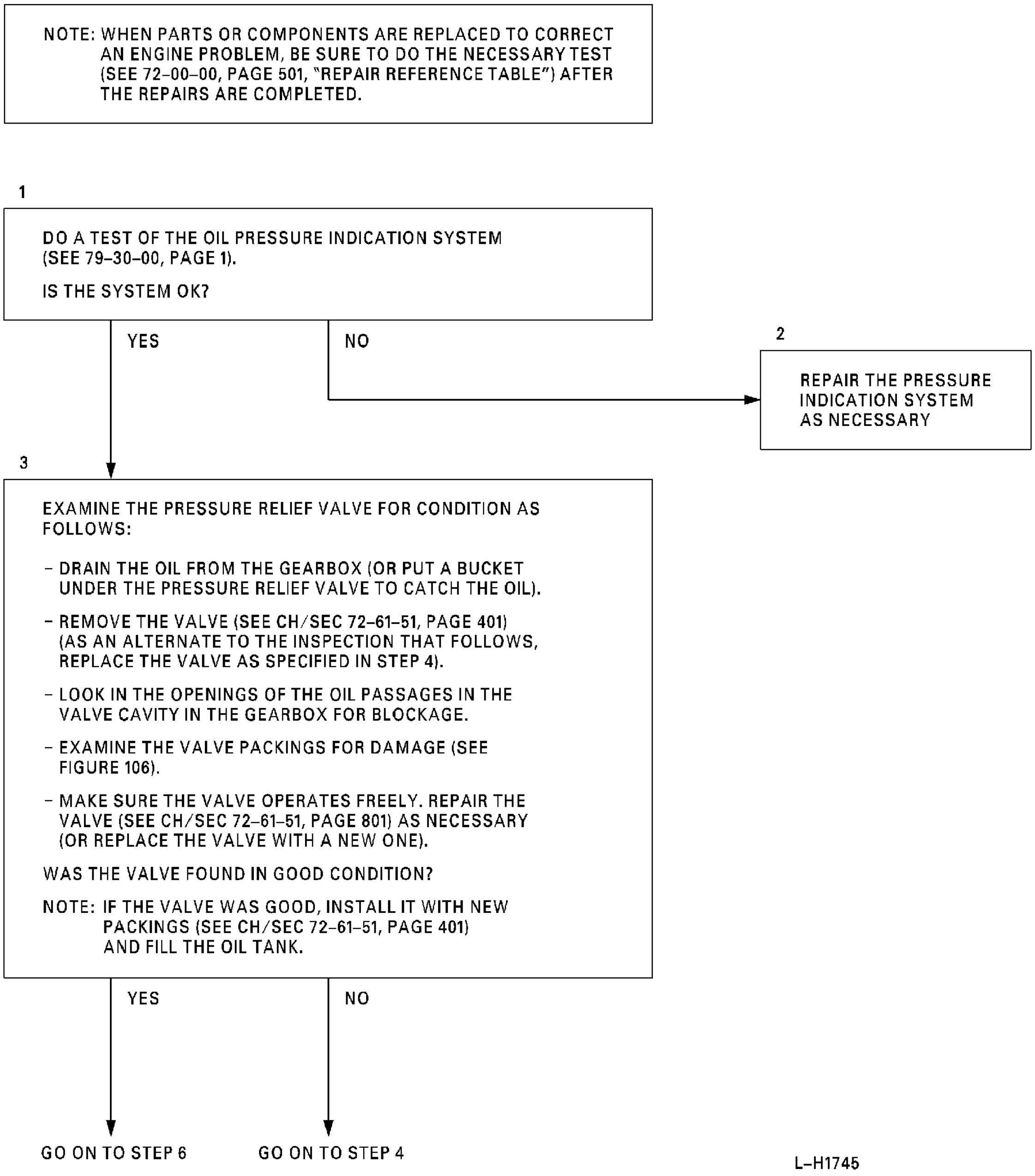
IS THE OIL PRESSURE OK?

9 REMOVE THE ENGINE

10 RETURN THE ENGINE TO SERVICE

Oil Pressure Follows the Power Lever Troubleshooting
Figure 127/72-00-02-990-834 (Sheet 2 of 2)

HIGH OIL PRESSURE



NOTE: WHEN PARTS OR COMPONENTS ARE REPLACED TO CORRECT AN ENGINE PROBLEM, BE SURE TO DO THE NECESSARY TEST (SEE 72-00-00, PAGE 501, "REPAIR REFERENCE TABLE") AFTER THE REPAIRS ARE COMPLETED.

1

DO A TEST OF THE OIL PRESSURE INDICATION SYSTEM (SEE 79-30-00, PAGE 1).

IS THE SYSTEM OK?

2

REPAIR THE PRESSURE INDICATION SYSTEM AS NECESSARY

3

EXAMINE THE PRESSURE RELIEF VALVE FOR CONDITION AS FOLLOWS:

- DRAIN THE OIL FROM THE GEARBOX (OR PUT A BUCKET UNDER THE PRESSURE RELIEF VALVE TO CATCH THE OIL).
- REMOVE THE VALVE (SEE CH/SEC 72-61-51, PAGE 401) (AS AN ALTERNATE TO THE INSPECTION THAT FOLLOWS, REPLACE THE VALVE AS SPECIFIED IN STEP 4).
- LOOK IN THE OPENINGS OF THE OIL PASSAGES IN THE VALVE CAVITY IN THE GEARBOX FOR BLOCKAGE.
- EXAMINE THE VALVE PACKINGS FOR DAMAGE (SEE FIGURE 106).
- MAKE SURE THE VALVE OPERATES FREELY. REPAIR THE VALVE (SEE CH/SEC 72-61-51, PAGE 801) AS NECESSARY (OR REPLACE THE VALVE WITH A NEW ONE).

WAS THE VALVE FOUND IN GOOD CONDITION?

NOTE: IF THE VALVE WAS GOOD, INSTALL IT WITH NEW PACKINGS (SEE CH/SEC 72-61-51, PAGE 401) AND FILL THE OIL TANK.

GO ON TO STEP 6

GO ON TO STEP 4

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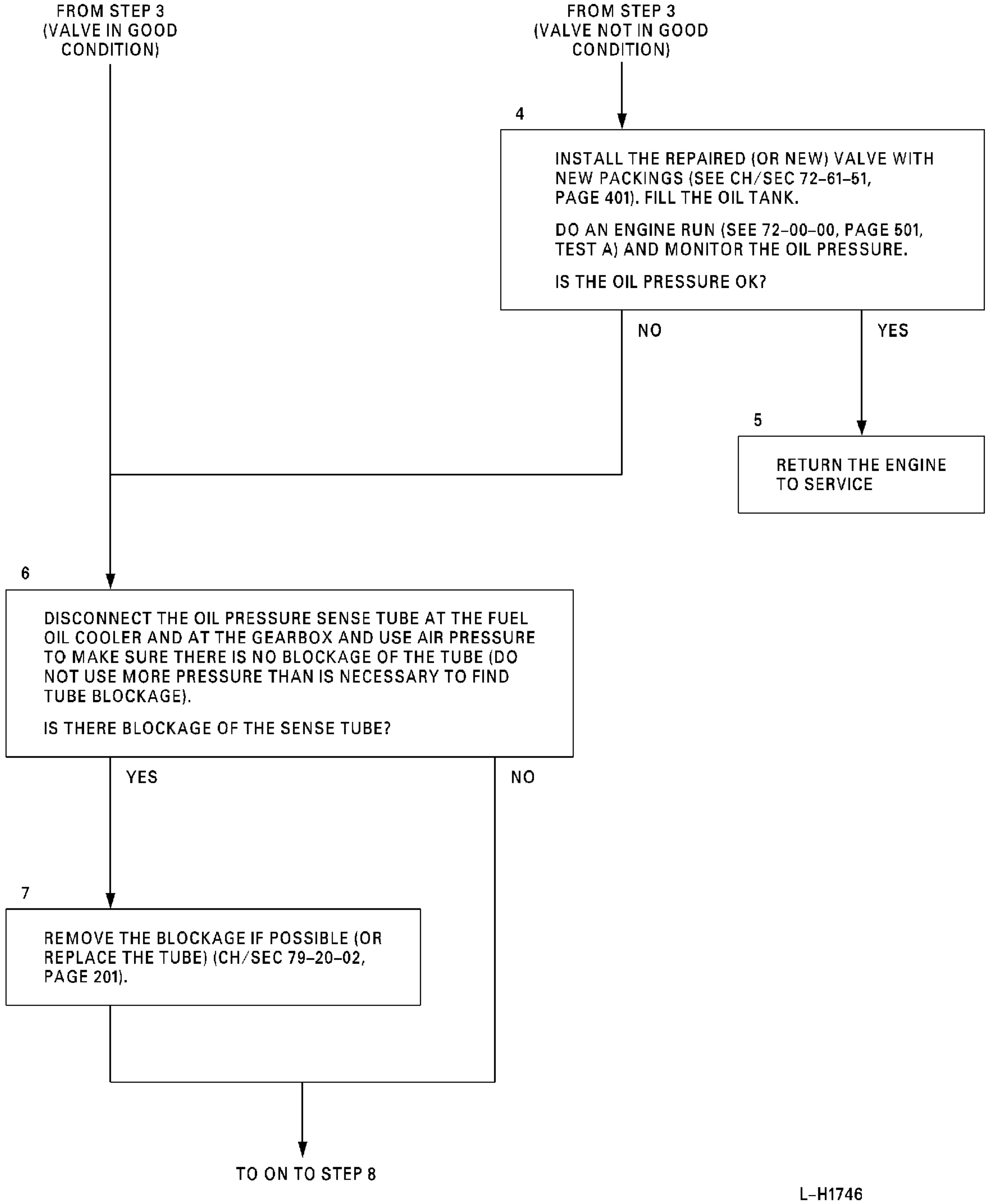
High Oil Pressure Troubleshooting
Figure 128/72-00-02-990-835 (Sheet 1 of 3)

HIGH OIL PRESSURE (CONTINUED)



4 INSTALL THE REPAIRED (OR NEW) VALVE WITH NEW PACKINGS (SEE CH/SEC 72-61-51, PAGE 401). FILL THE OIL TANK.

DO AN ENGINE RUN (SEE 72-00-00, PAGE 501, TEST A) AND MONITOR THE OIL PRESSURE.

IS THE OIL PRESSURE OK?

5 RETURN THE ENGINE TO SERVICE

6 DISCONNECT THE OIL PRESSURE SENSE TUBE AT THE FUEL OIL COOLER AND AT THE GEARBOX AND USE AIR PRESSURE TO MAKE SURE THERE IS NO BLOCKAGE OF THE TUBE (DO NOT USE MORE PRESSURE THAN IS NECESSARY TO FIND TUBE BLOCKAGE).

IS THERE BLOCKAGE OF THE SENSE TUBE?

7 REMOVE THE BLOCKAGE IF POSSIBLE (OR REPLACE THE TUBE) (CH/SEC 79-20-02, PAGE 201).

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CAG(IGDS)

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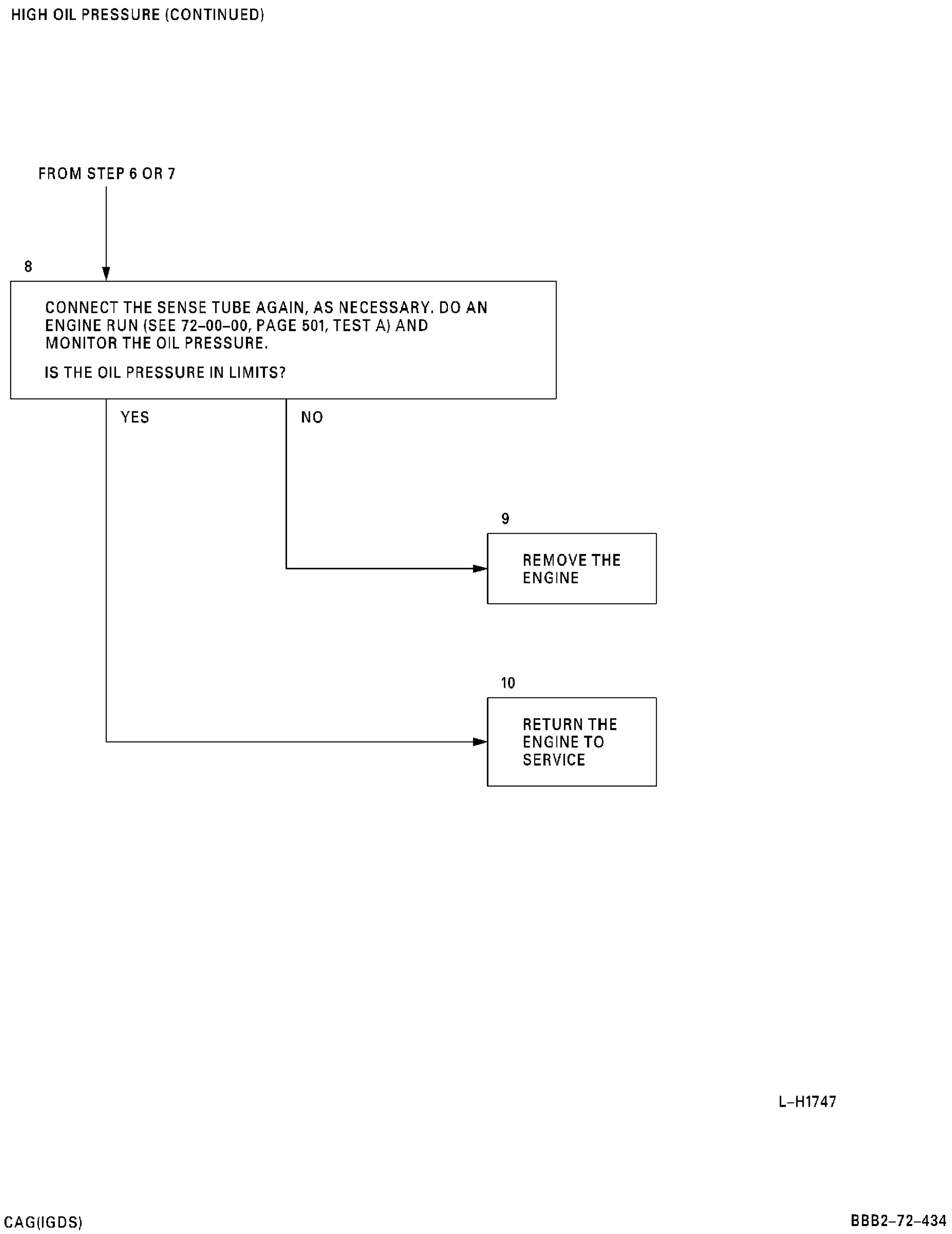
High Oil Pressure Troubleshooting
Figure 128/72-00-02-990-835 (Sheet 2 of 3)



High Oil Pressure Troubleshooting
Figure 128/72-00-02-990-835 (Sheet 3 of 3)

ENGINE GENERAL - TROUBLESHOOTING-03 (INDICATION SYSTEM)

1. General

This troubleshooting section is about the engine part of the exhaust gas temperature (EGT) indication system. Problems in the airframe indication system cause a large number of aircraft EGT complaints.

2. EGT Exceedance (High operating EGT)

A. EGT System High Operating Temperature Troubleshooting

(1) Do a check of engine operating limits and performance data. (GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 71-00-00/501)

(a) Review and follow notes of the applicable engine check chart shown in the reference.

(2) Overtemperature segments will point to the appropriate graph and chart.

(3) Clean the engine gas path. (ENGINE GENERAL - CLEANING-01, PAGEBLOCK 72-00-00/701)

NOTE: Doing this procedure could help recover some EGT margin; however, this one time cleaning will not provide long term corrective action.

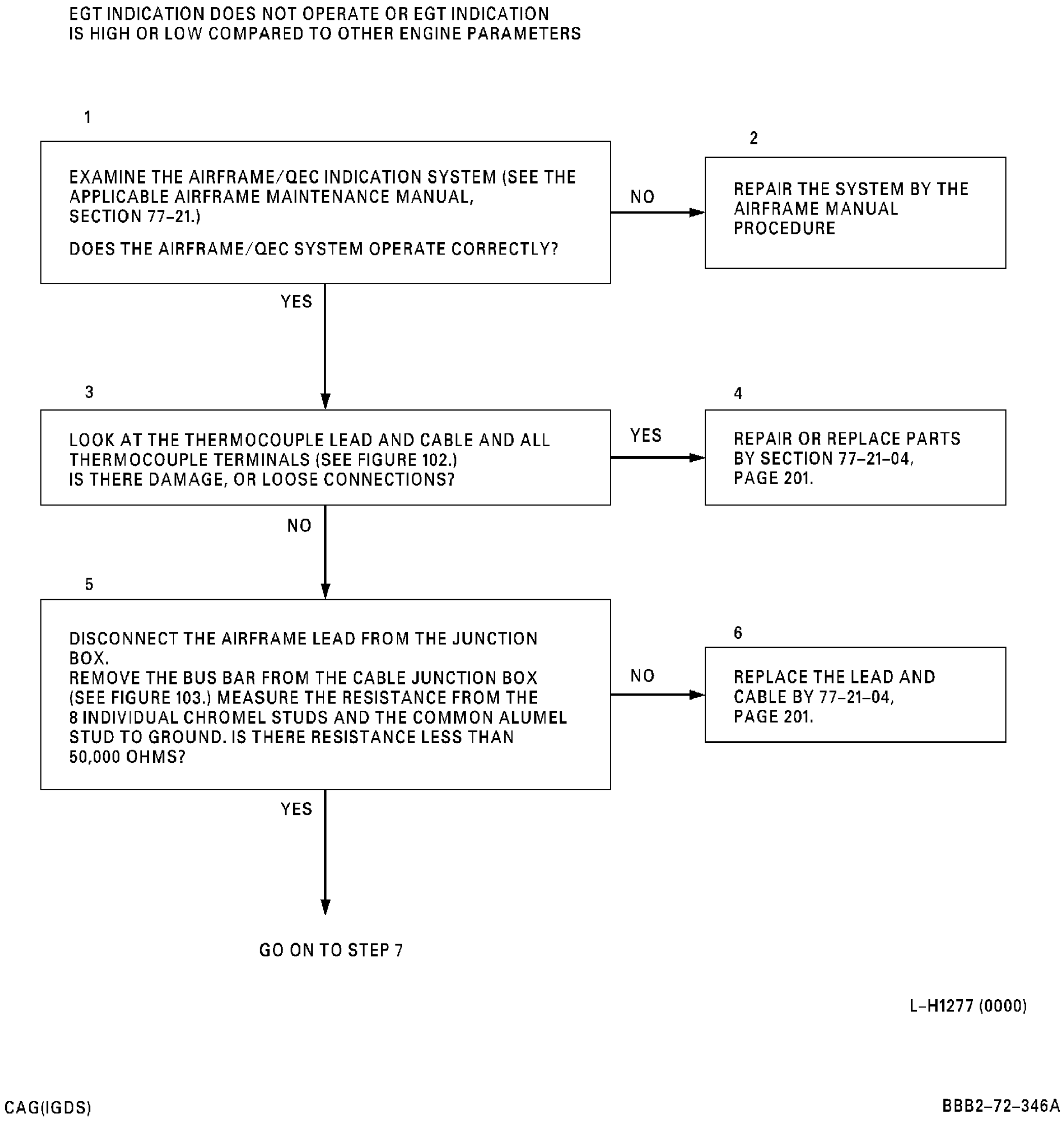
3. EGT System

A. EGT System Temperature Troubleshooting (Figure 101) (Figure 102) (Figure 103)

(1) Examine the airframe/Quick Engine Change (QEC). If the cause of the problem is not in the airframe/QEC, look for loose connections, or open circuits related to damaged terminals.

(2) Do resistance checks in sequence to find short circuits to ground (which are usually found when the EGT indication is low) or open circuits (which are usually found when the EGT indication is high).

NOTE: An open EGT circuit will cause the indication to drop to zero. A shorted EGT circuit to ground may result in a lower reading depending on the temperature of the thermal junction created by the short. A shorted EGT circuit to a powered wire may result in a high or full scale indication.



EGT INDICATION DOES NOT OPERATE OR EGT INDICATION IS HIGH OR LOW COMPARED TO OTHER ENGINE PARAMETERS

1 EXAMINE THE AIRFRAME/QEC INDICATION SYSTEM (SEE THE APPLICABLE AIRFRAME MAINTENANCE MANUAL, SECTION 77-21.)

DOES THE AIRFRAME/QEC SYSTEM OPERATE CORRECTLY?

2 REPAIR THE SYSTEM BY THE AIRFRAME MANUAL PROCEDURE

3 LOOK AT THE THERMOCOUPLE LEAD AND CABLE AND ALL THERMOCOUPLE TERMINALS (SEE FIGURE 102.) IS THERE DAMAGE, OR LOOSE CONNECTIONS?

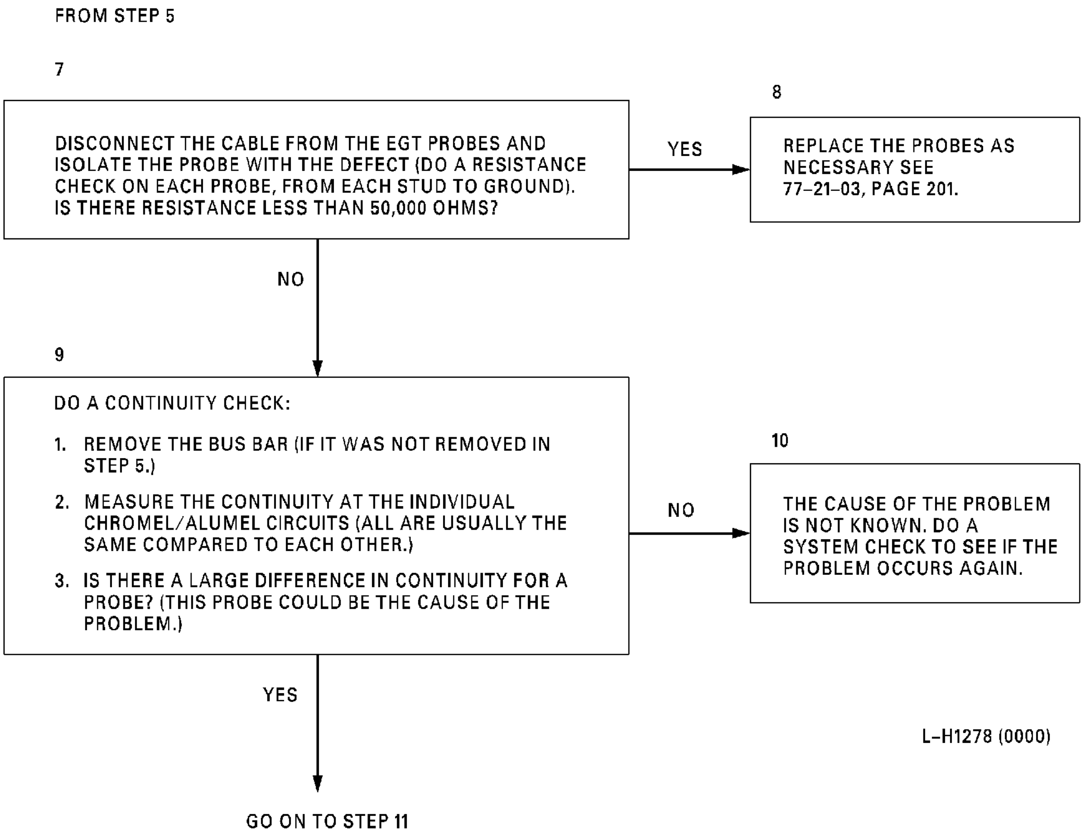
4 REPAIR OR REPLACE PARTS BY SECTION 77-21-04, PAGE 201.

5 DISCONNECT THE AIRFRAME LEAD FROM THE JUNCTION BOX. REMOVE THE BUS BAR FROM THE CABLE JUNCTION BOX (SEE FIGURE 103.) MEASURE THE RESISTANCE FROM THE 8 INDIVIDUAL CHROMEL STUDS AND THE COMMON ALUMEL STUD TO GROUND. IS THERE RESISTANCE LESS THAN 50,000 OHMS?

6 REPLACE THE LEAD AND CABLE BY 77-21-04, PAGE 201.

GO ON TO STEP 7

EGT System Troubleshooting
Figure 101/72-00-03-990-801 (Sheet 1 of 3)



FROM STEP 5

7 DISCONNECT THE CABLE FROM THE EGT PROBES AND ISOLATE THE PROBE WITH THE DEFECT (DO A RESISTANCE CHECK ON EACH PROBE, FROM EACH STUD TO GROUND). IS THERE RESISTANCE LESS THAN 50,000 OHMS?

8 REPLACE THE PROBES AS NECESSARY SEE 77-21-03, PAGE 201.

9 DO A CONTINUITY CHECK:

1. REMOVE THE BUS BAR (IF IT WAS NOT REMOVED IN STEP 5.)
2. MEASURE THE CONTINUITY AT THE INDIVIDUAL CHROMEL/ALUMEL CIRCUITS (ALL ARE USUALLY THE SAME COMPARED TO EACH OTHER.)
3. IS THERE A LARGE DIFFERENCE IN CONTINUITY FOR A PROBE? (THIS PROBE COULD BE THE CAUSE OF THE PROBLEM.)

10 THE CAUSE OF THE PROBLEM IS NOT KNOWN. DO A SYSTEM CHECK TO SEE IF THE PROBLEM OCCURS AGAIN.

GO ON TO STEP 11

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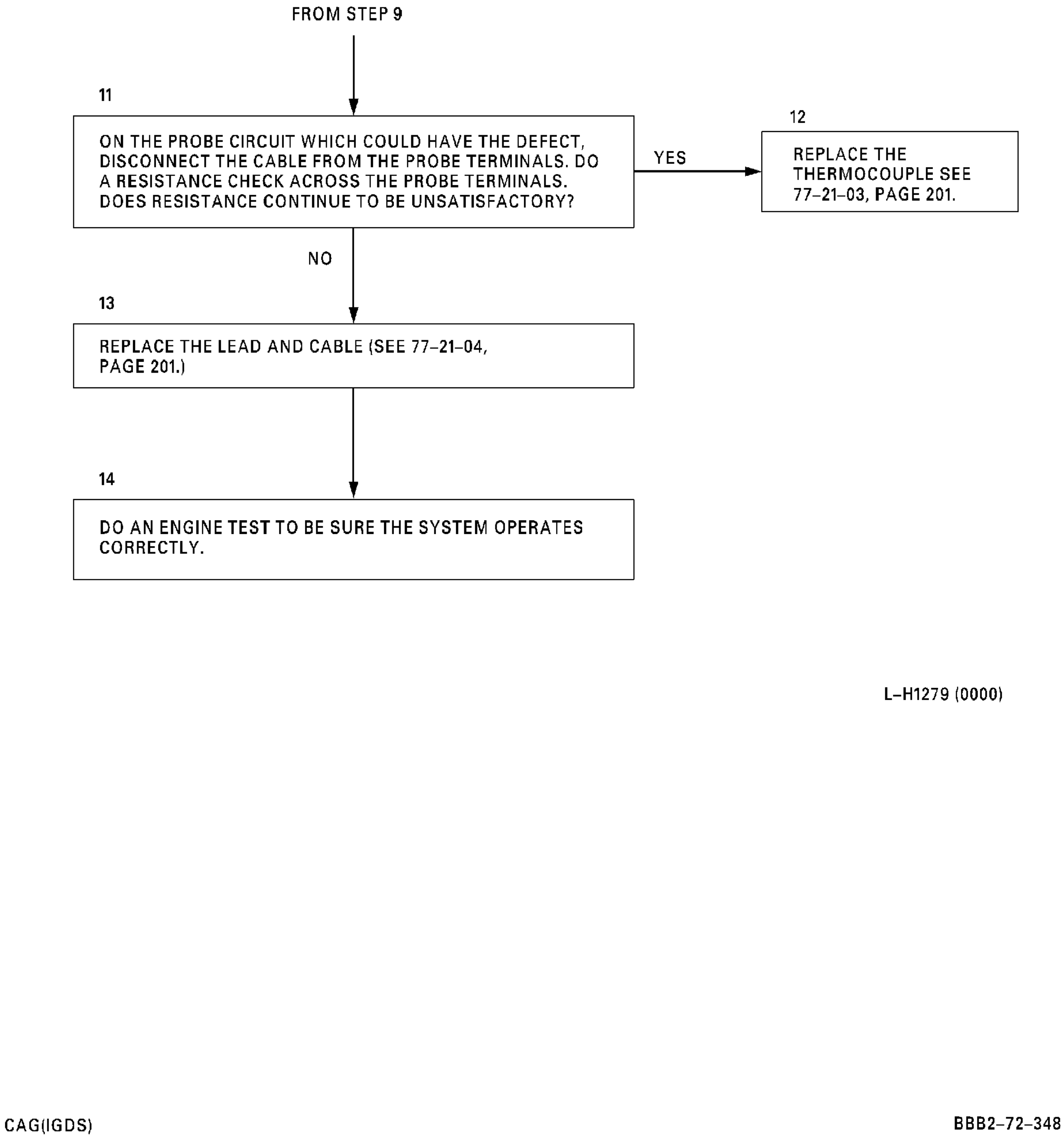
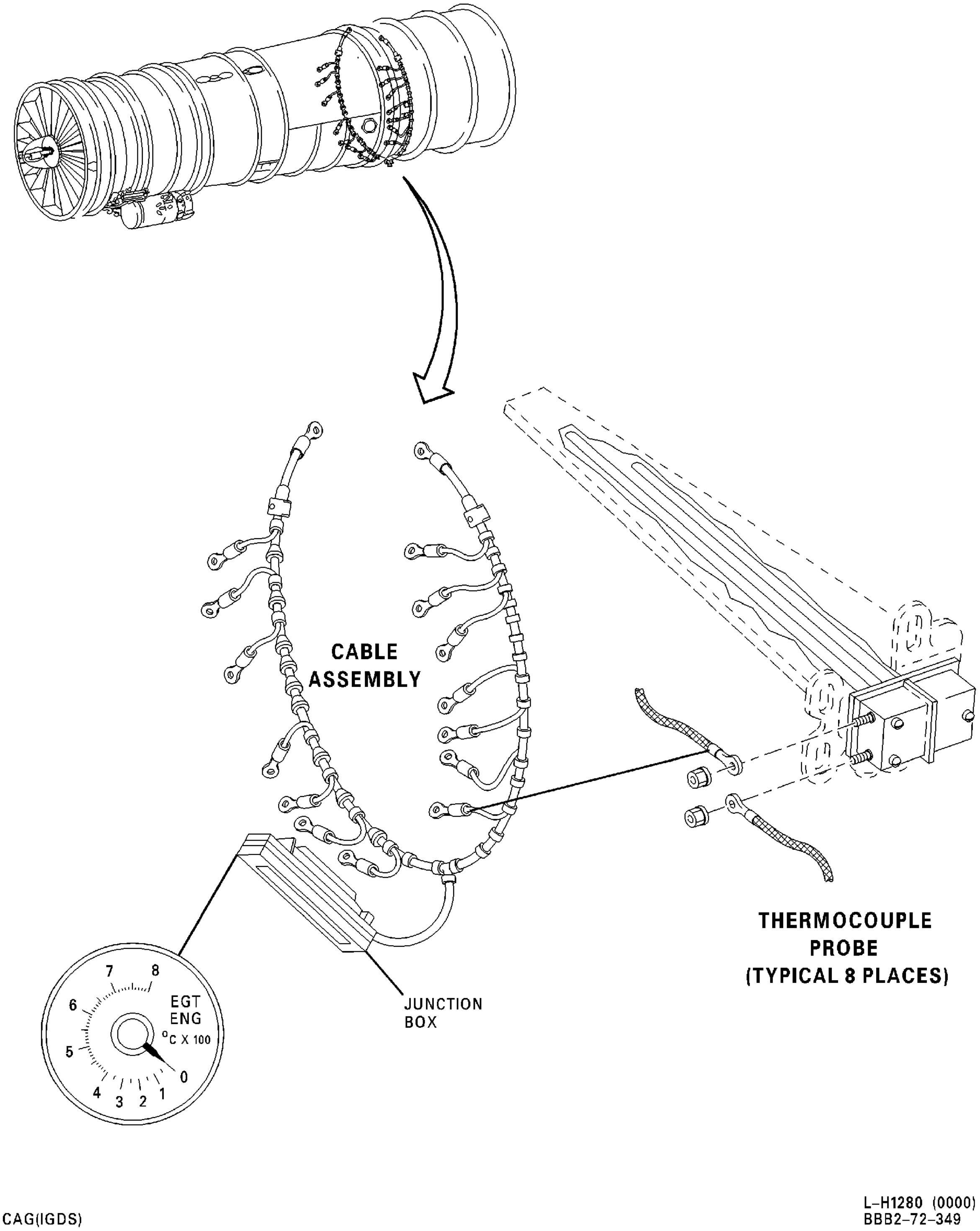
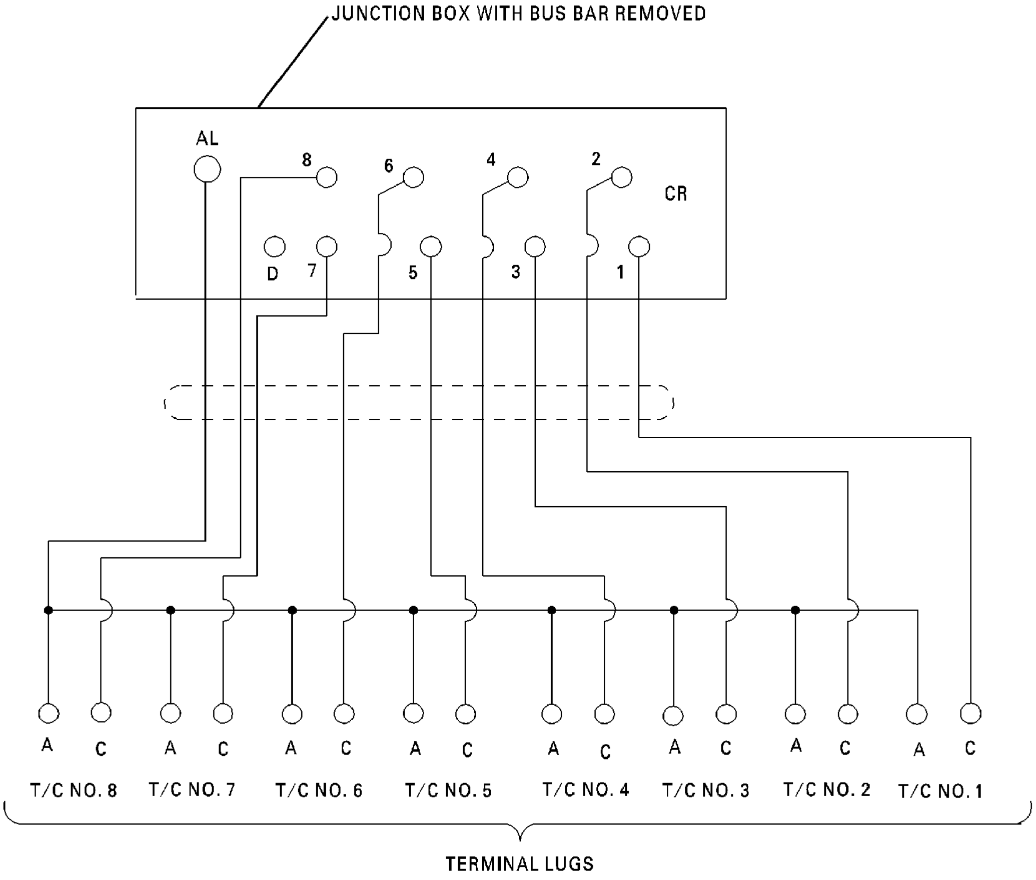
EGT System Troubleshooting
Figure 101/72-00-03-990-801 (Sheet 2 of 3)



EGT System Troubleshooting
Figure 101/72-00-03-990-801 (Sheet 3 of 3)



EGT Indication System
Figure 102/72-00-03-990-802



A – ALUMEL
C – CHROMEL

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CAG(IGDS)

BBB2–72–350

EGT Thermocouple Box and Cable Assembly Schematic
Figure 103/72-00-03-990-803

4. EPR System Troubleshooting

A. General This troubleshooting section is about different EPR complaints:

(1) That the EPR indication alone is not stable at a given power level

(2) That the EPR indication moves up and down with other engine parameters, and

(3) That the EPR indication is low or high in relation to other engine parameters.

EPR is the result of the division of Pt7 by Pt2. This measurement occurs in a transmitter which is part of the aircraft's equipment. Pt2 and Pt7 pressure signals from the engine are connected to this transmitter. The transmitter sends an electrical signal (the proportion of these two pressure signals) to the flight deck.

The first EPR complaint, that the EPR indication alone is not stable, can be the result of a loose connection in the system. This can cause a change which is only in the EPR indication. The second complaint, that the EPR indication moves up and down with other engine parameters, can be the result either of a defect in the fuel control or an aircraft bleed or alternator which starts and stops (this can cause all engine indications to change up and down). The third complaint can be the result of a leak in the Pt2 tube in the nose cone (this will make the Pt2 pressure signal to the transmitter lower than usual, and the EPR will appear to be higher compared to other engine parameters. A leak in the Pt2 tube outside of the nose cone can occur, but it will not be possible to find this on the ground because the Pt2 pressure and the pressure at the area of the leak will be almost the same. It is possible that this kind of leak will cause a high EPR indication at altitude but will not show on the ground. At altitude nacelle pressure (which will be lower than Pt2) will pressurize the leak. If the Pt7 tube has a leak, the EPR indication will be low compared to other engine parameters.

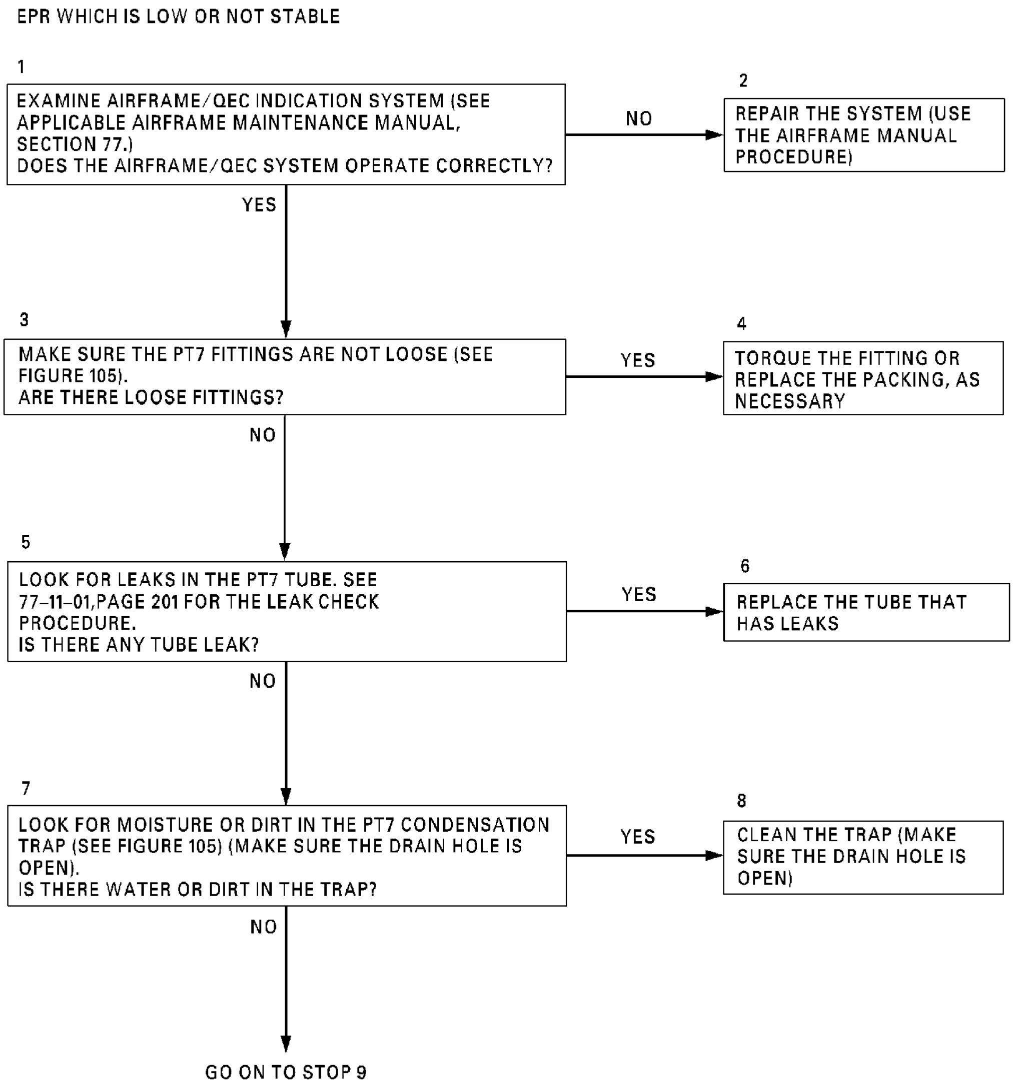
The steps in the troubleshooting diagram are about complaints No. 1 and 3, in this sequence:

Steps 1 and 2: Defects in the electrical part of the EPR system. These steps are to correct an EPR indication that is not stable.

Steps 3 thru 8: Defects in the Pt7 system. These steps are to correct an EPR indication which is not stable, or an EPR indication which is low in relation to other engine parameters.

Steps 9 thru 19: Defects in the Pt2 system. These steps are to correct an EPR indication which is not stable or an EPR which is high compared to other engine parameters.

B. Procedures. See Figure 104 thru Figure 107.



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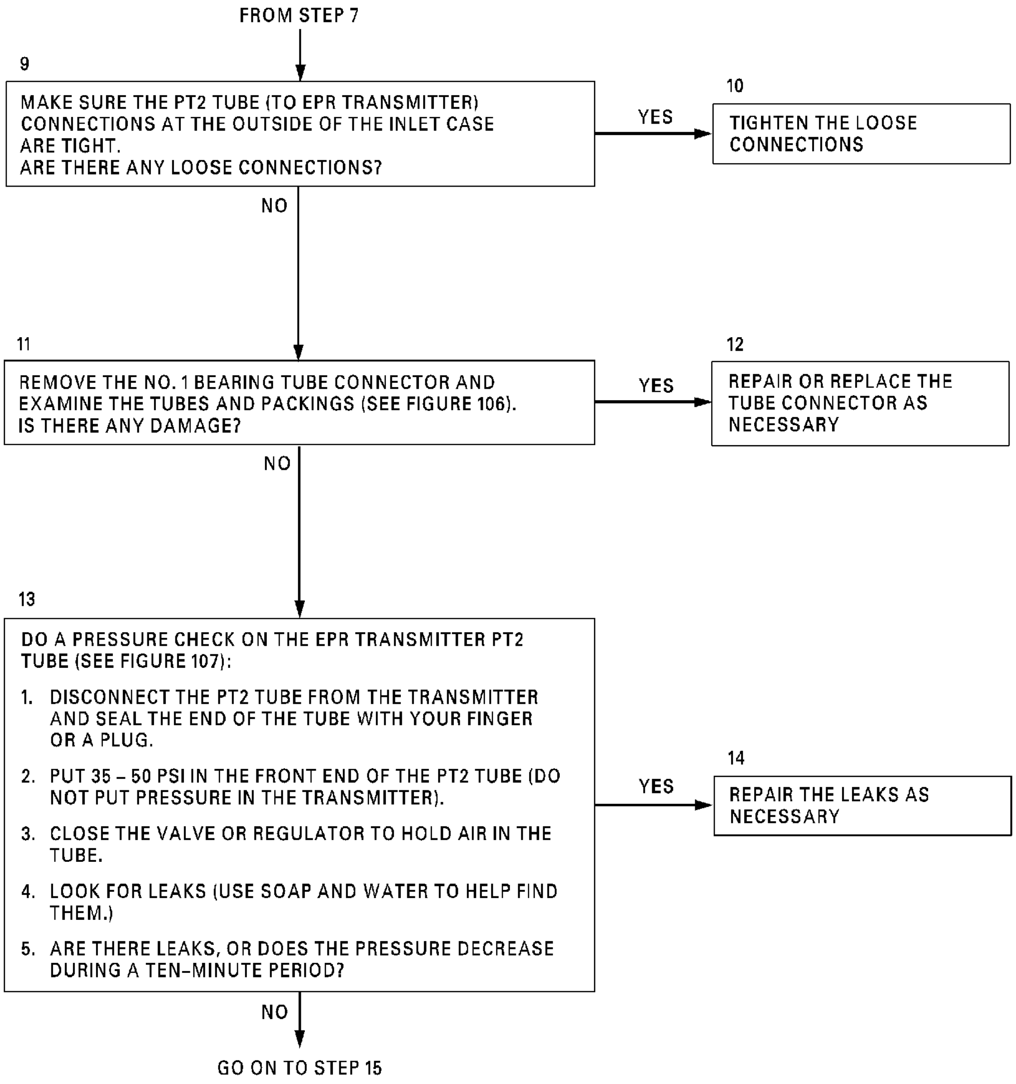
EPR System Troubleshooting
Figure 104/72-00-03-990-804 (Sheet 1 of 3)



9 MAKE SURE THE PT2 TUBE (TO EPR TRANSMITTER) CONNECTIONS AT THE OUTSIDE OF THE INLET CASE ARE TIGHT.
ARE THERE ANY LOOSE CONNECTIONS?

10 TIGHTEN THE LOOSE CONNECTIONS

11 REMOVE THE NO. 1 BEARING TUBE CONNECTOR AND EXAMINE THE TUBES AND PACKINGS (SEE FIGURE 106).
IS THERE ANY DAMAGE?

12 REPAIR OR REPLACE THE TUBE CONNECTOR AS NECESSARY

13 DO A PRESSURE CHECK ON THE EPR TRANSMITTER PT2 TUBE (SEE FIGURE 107):

1. DISCONNECT THE PT2 TUBE FROM THE TRANSMITTER AND SEAL THE END OF THE TUBE WITH YOUR FINGER OR A PLUG.
2. PUT 35 – 50 PSI IN THE FRONT END OF THE PT2 TUBE (DO NOT PUT PRESSURE IN THE TRANSMITTER).
3. CLOSE THE VALVE OR REGULATOR TO HOLD AIR IN THE TUBE.
4. LOOK FOR LEAKS (USE SOAP AND WATER TO HELP FIND THEM.)
5. ARE THERE LEAKS, OR DOES THE PRESSURE DECREASE DURING A TEN-MINUTE PERIOD?

14 REPAIR THE LEAKS AS NECESSARY

CAG(IGDS)

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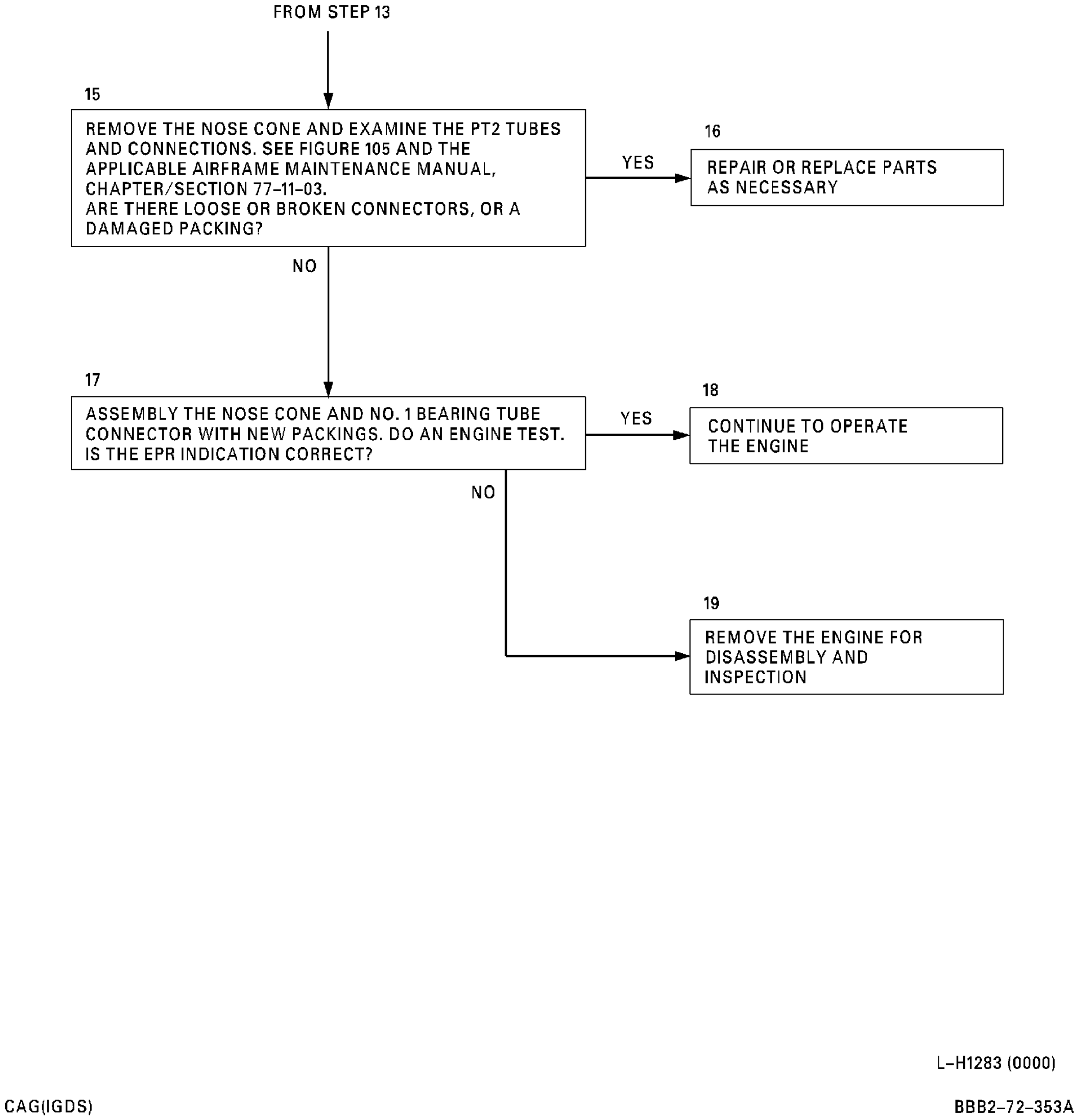
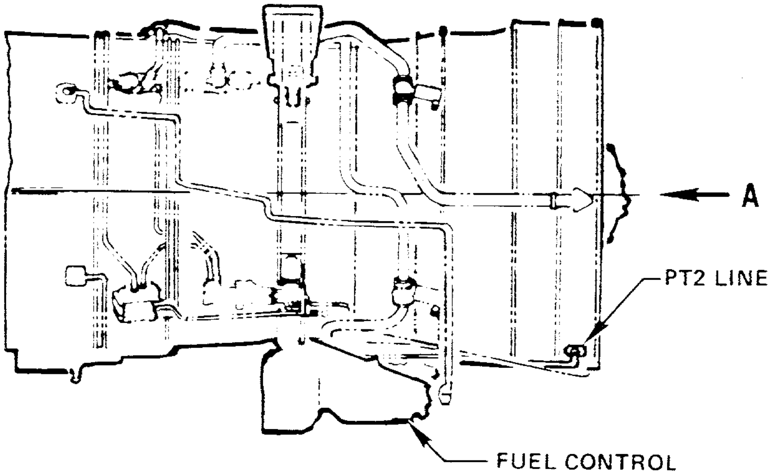
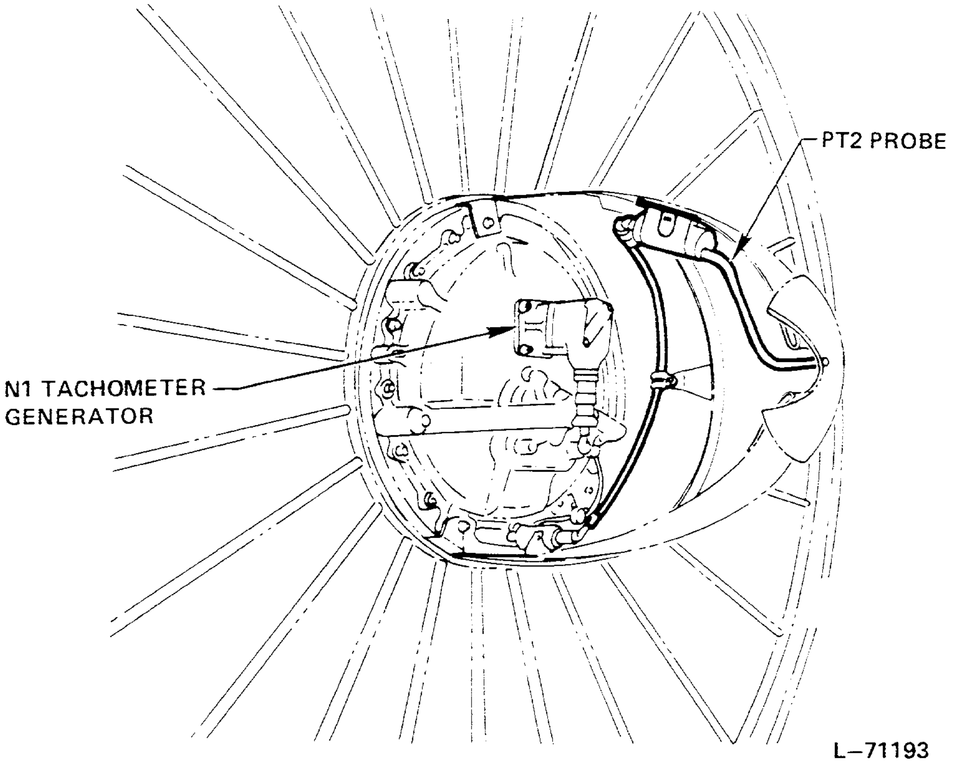
EPR System Troubleshooting
Figure 104/72-00-03-990-804 (Sheet 2 of 3)



EPR System Troubleshooting
Figure 104/72-00-03-990-804 (Sheet 3 of 3)



RIGHT SIDE VIEW



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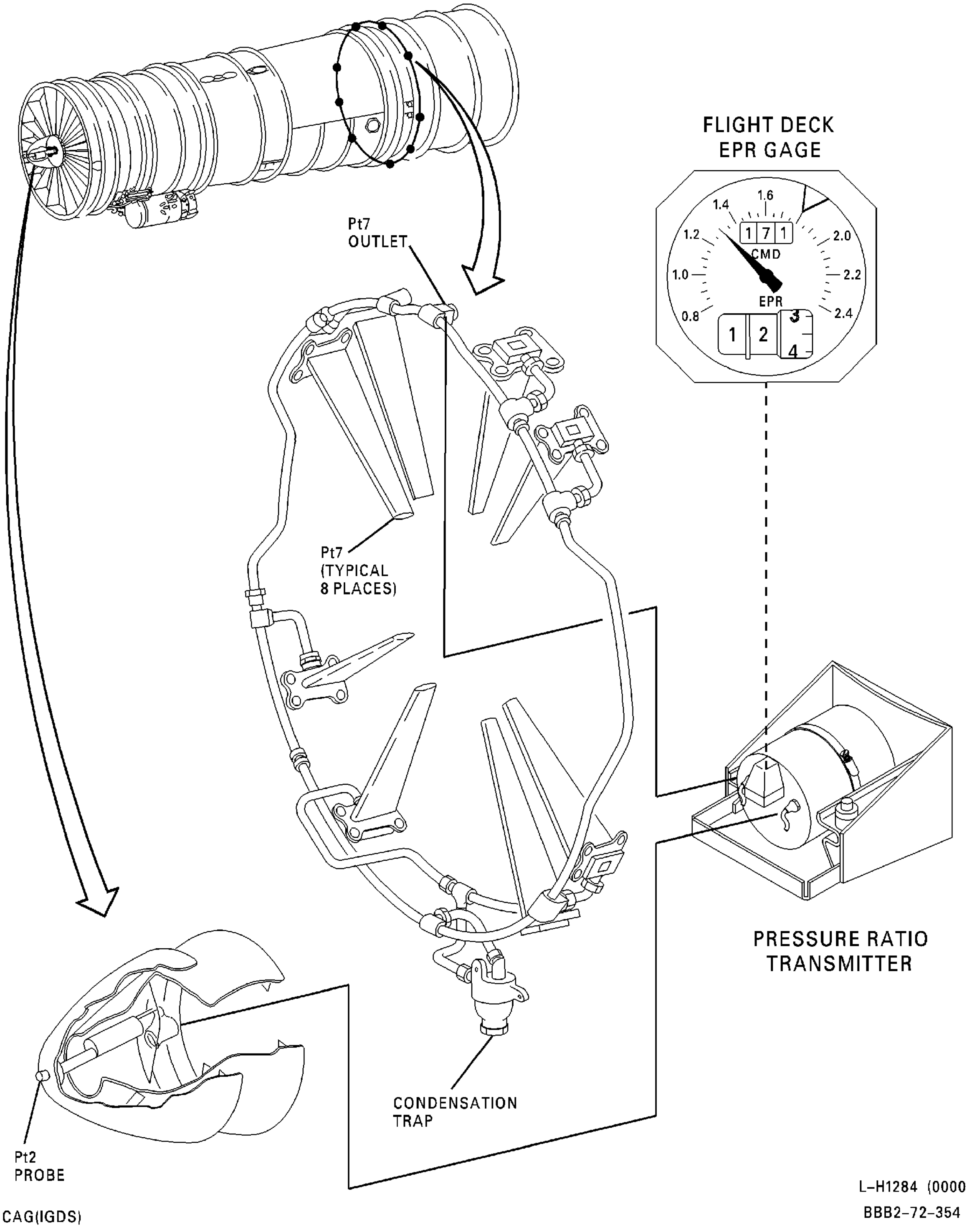
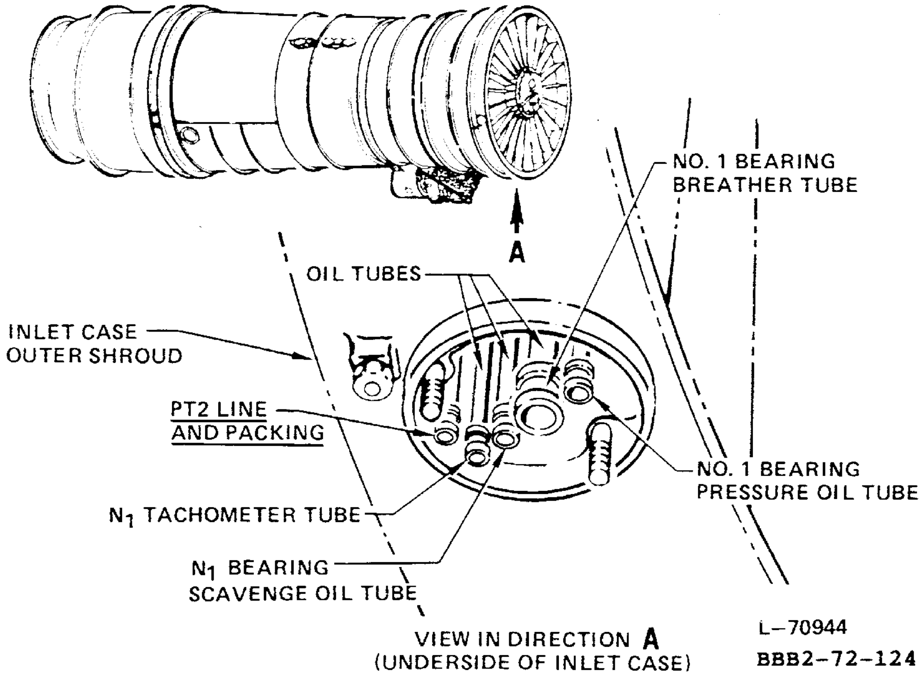
VIEW IN DIRECTION A

BBB2–72–125

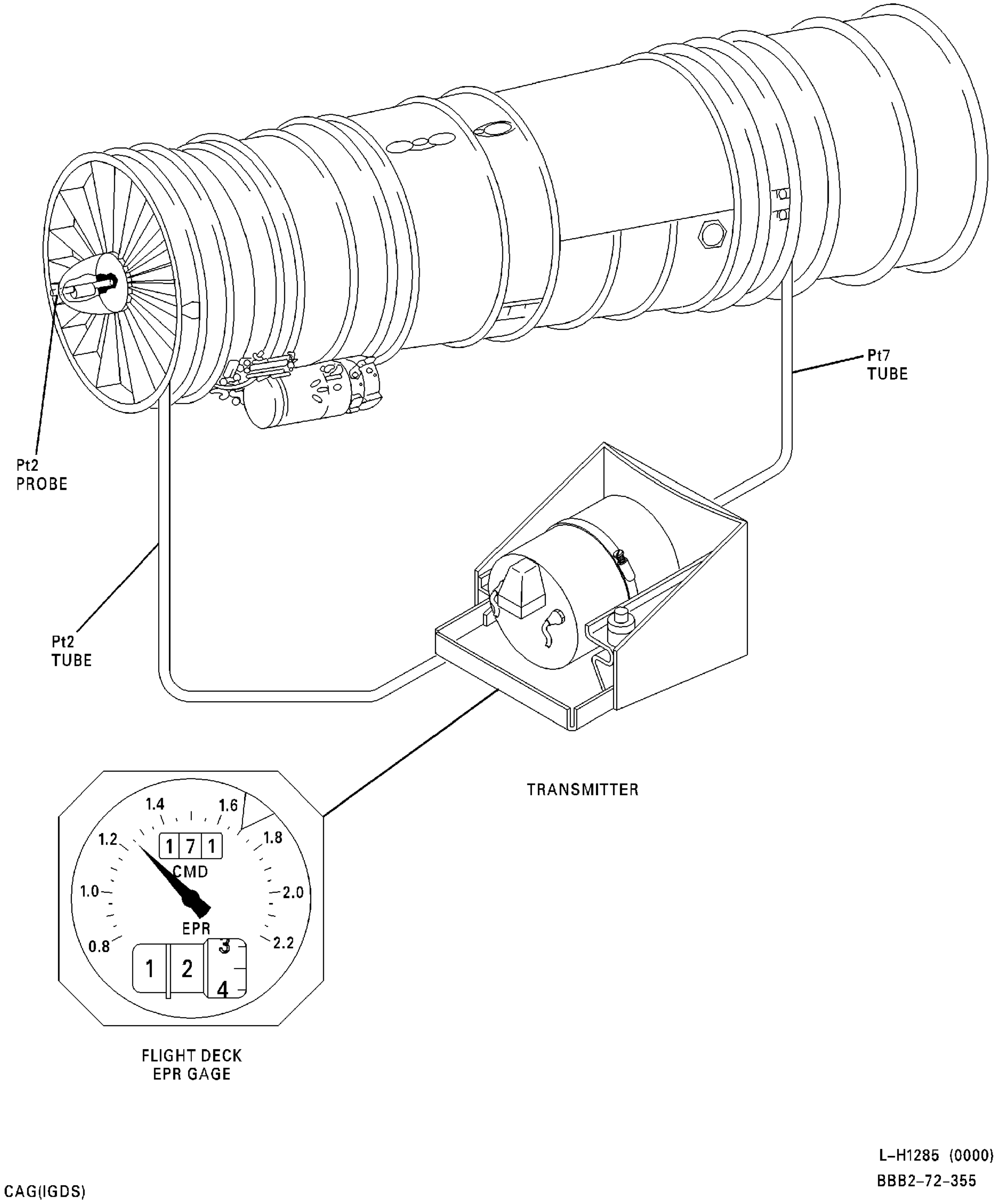
EPR Indication System
Figure 105/72-00-03-990-805 (Sheet 1 of 2)



EPR Indication System
Figure 105/72-00-03-990-805 (Sheet 2 of 2)



No. 1 Bearing Inlet Case Tubes
Figure 106/72-00-03-990-806



Aircraft EPR Transmitter and Tubes
Figure 107/72-00-03-990-807

ENGINE GENERAL - TROUBLESHOOTING-04 (POWER AND ENGINE RESPONSE)

1. General

A. This procedure has the following troubleshooting practices for the engine:

- Low Idle N_2
- Surge
- Unable To Reach Takeoff Power
- Start Problems
- Engine Flameout
- Auto-Acceleration
- Fuel Filter Delta P Light Stays On When Fuel Heat Is Energized
- Fuel Temperature Does Not Increase When Fuel Heat Is Energized
- High Fuel Flow (With No Increase in EGT)
- Power Levers Not Aligned ("Throttle Stagger")
- External Fuel Leaks
- Vibration Trouble Shooting
- Engine Parameter Fluctuaton

2. Low Idle N2

A. General

(1) This troubleshooting section is about low Idle N_2 complaints caused by:

- An Idle adjustment ("trim") procedure that was not correct
- A 13th stage bleed valve (in the start bleed system) that stays open
- A fuel control that does not operate correctly
- Damage to the combustion section.

(2) Idle Trim Procedure

(a) For the Idle N_2 to be in limits, it is necessary to have a good fuel control "trim" procedure with all related precautions, such as ambient temperature accurately measured, air conditioning packs off, and minimum generator (Constant Speed Drive (CSD)) and hydraulic pump loads on the engine. If these conditions are not good at the initial trim procedure or on a later trim check, the engine can have a lower N_2 at Idle.

(3) Start Bleed Control Valve

(a) A low N_2 complaint on an engine with a start bleed system (three 8th stage surge bleed valves and one 13th stage start bleed valve) can occur when the 13th stage start bleed valve stays open at Idle. The result of this will be an Idle speed low by 3 - 5 percent. To close the 13th stage start bleed valve, move the power lever to a sufficiently high N_2 to cause the start bleed valve control valve to close the 13th stage start bleed valve (approximately 65 percent N_2). When the power lever is moved back to the Idle position, the N_2 will be in the correct Idle trim band. If this procedure is not done, the Idle will continue to be 3 - 5 percent low. If the Idle trim is correctly set, and the power lever was moved sufficiently to close the 13th stage start bleed valve, the Idle N_2 will be apparently correct during the remaining checks.

(b) If the start bleed control valve does not operate, it is possible that the 13th stage start bleed valve will stay closed. If the 13th stage bleed valve is closed during the start procedure, there will be a higher exhaust gas temperature (EGT) than is usual during the start. This can cause hot starts (high EGT) or "hung" starts (where the engine does not fully accelerate). It is possible to get a good start with some engines during the first start of the day. As the ambient temperature increases during the day, the EGT can increase with each start until a hot or "hung" start occurs. It is important that the start bleed control valve operate correctly, for the initial Idle trim procedure and for normal Idle operation and normal start procedures.

(4) Fuel Control

(a) If the fuel control does not operate correctly, this can show in different ways, and low Idle N_2 can be the result. If it is not possible to get good Idle trim or to do a good Idle trim check with all the usual precautions, this can be because the fuel control did not operate correctly. Other complaints can occur because of the fuel control, such as power lever handles at different positions for the same power level in all engines ("throttle stagger") or slow engine acceleration when the power lever is moved. Complaints of "throttle stagger" and slow acceleration can also be the result of combustion chamber distress.

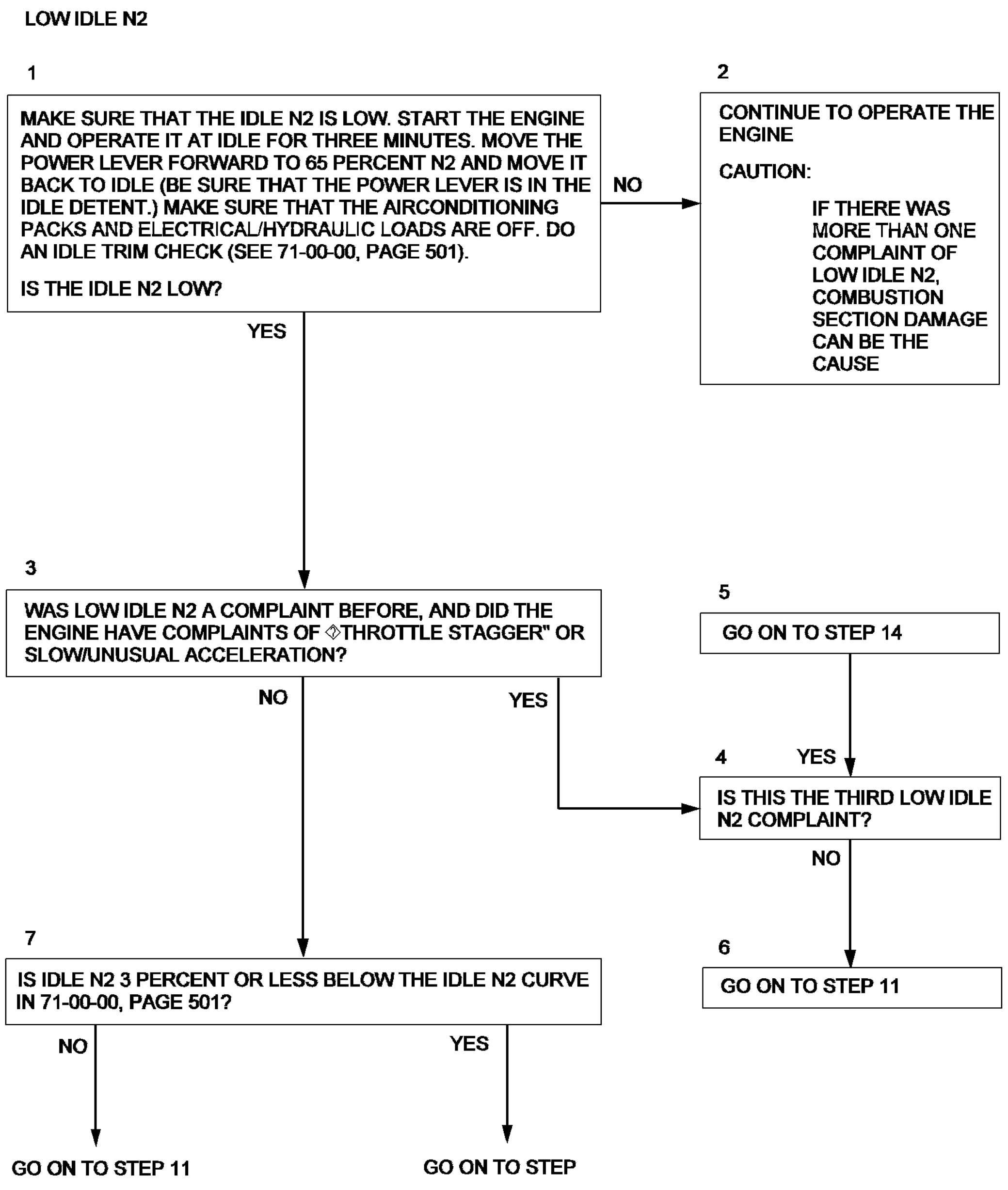
(5) Combustion Chamber Distress

(a) Damage to the combustion section can cause bad performance, with the result that the Idle N_2 is not in limits. The damage can get worse and can change from day to day. If the damage gets worse, it is possible that a mechanic will do an Idle trim procedure again and again, in error, to correct low Idle N_2 . With some combustion chamber damage, part of the combustion chamber can separate and let the chamber move aft (this causes distortion of the gas flow into the turbine vanes). This condition can show as irregular Idle N_2 if the broken part of the combustion chamber moves during engine operation. It can also show as complaints of "throttle stagger" or slow acceleration. If an Idle trim check does not find the cause of the complaint, the cause can be combustion chamber damage which causes the problem one time and then is not seen at other times. When an Idle trim check is done, it is possible that this condition will not show as low Idle N_2 during the engine check run.

(b) If the Idle N_2 is adjusted ("trimmed") more than two times, and the cause of the low Idle N_2 is not found, the cause of the low Idle N_2 can be combustion chamber damage. Combustion section inspection is necessary with such an engine to prevent continued engine operation with combustion section damage.

(c) The steps in the troubleshooting diagram are about low Idle N_2 complaints, with procedures in this sequence:(Figure 101)

- Steps 1 thru 10: Do an Idle trim check to be sure that the engine was adjusted ("trimmed") correctly, and to be sure that there were no complaints before about low Idle N_2 "throttle stagger", or slow acceleration
- Steps 11 thru 13: Do a check of start bleed control valve operation
- Steps 14 thru 17: Look for damage to the combustion section.



LOW IDLE N2

1 MAKE SURE THAT THE IDLE N2 IS LOW. START THE ENGINE AND OPERATE IT AT IDLE FOR THREE MINUTES. MOVE THE POWER LEVER FORWARD TO 65 PERCENT N2 AND MOVE IT BACK TO IDLE (BE SURE THAT THE POWER LEVER IS IN THE IDLE DETENT.) MAKE SURE THAT THE AIRCONDITIONING PACKS AND ELECTRICAL/HYDRAULIC LOADS ARE OFF. DO AN IDLE TRIM CHECK (SEE 71-00-00, PAGE 501).

IS THE IDLE N2 LOW?

2 CONTINUE TO OPERATE THE ENGINE

CAUTION:

IF THERE WAS MORE THAN ONE COMPLAINT OF LOW IDLE N2, COMBUSTION SECTION DAMAGE CAN BE THE CAUSE

3 WAS LOW IDLE N2 A COMPLAINT BEFORE, AND DID THE ENGINE HAVE COMPLAINTS OF ◇THROTTLE STAGGER" OR SLOW/UNUSUAL ACCELERATION?

4 IS THIS THE THIRD LOW IDLE N2 COMPLAINT?

5 GO ON TO STEP 14

6 GO ON TO STEP 11

7 IS IDLE N2 3 PERCENT OR LESS BELOW THE IDLE N2 CURVE IN 71-00-00, PAGE 501?

GO ON TO STEP 11

GO ON TO STEP

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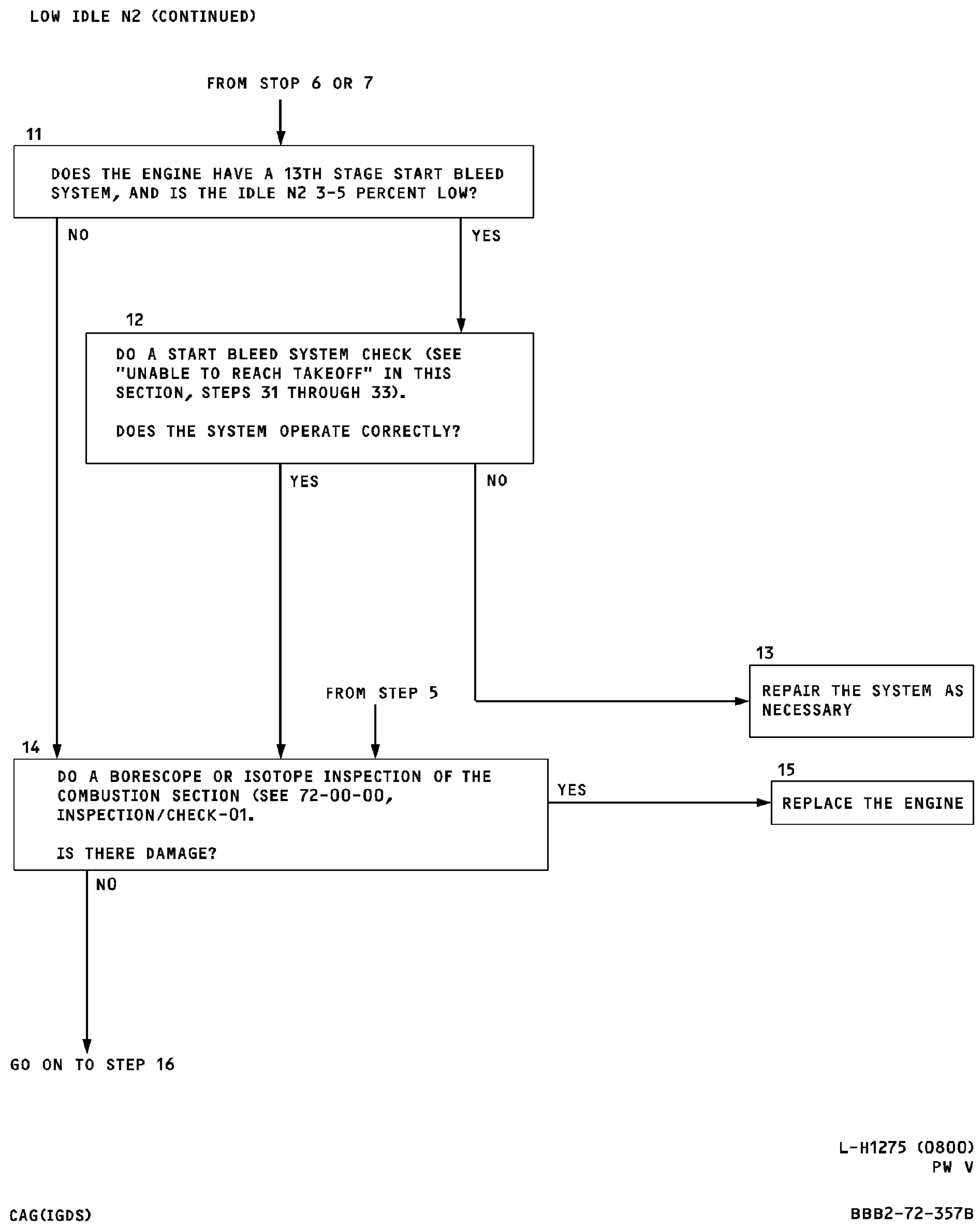
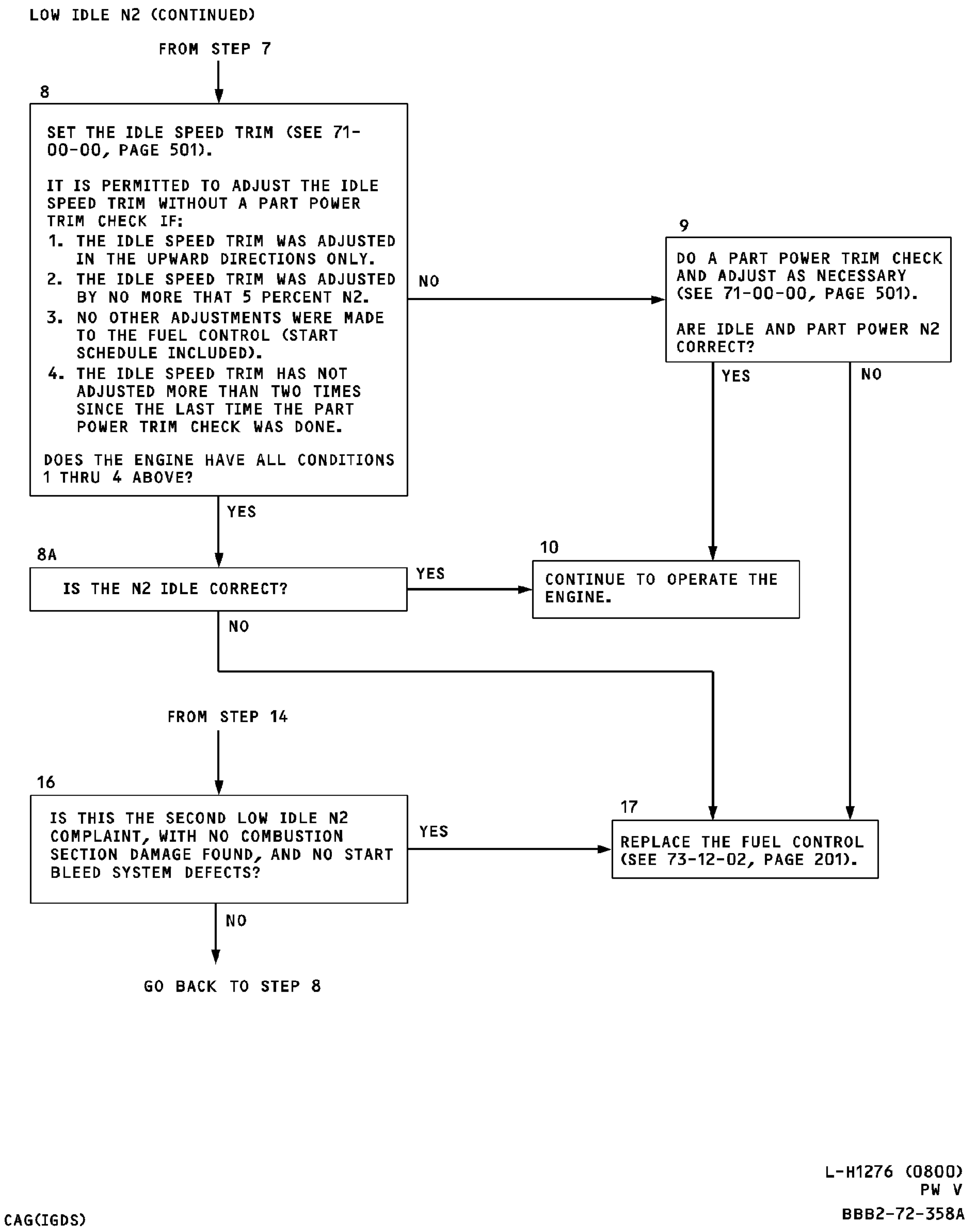
Low Idle N2 Troubleshooting
Figure 101/72-00-04-990-801 (Sheet 1 of 3)



Low Idle N2 Troubleshooting
Figure 101/72-00-04-990-801 (Sheet 2 of 3)



Low Idle N2 Troubleshooting
Figure 101/72-00-04-990-801 (Sheet 3 of 3)

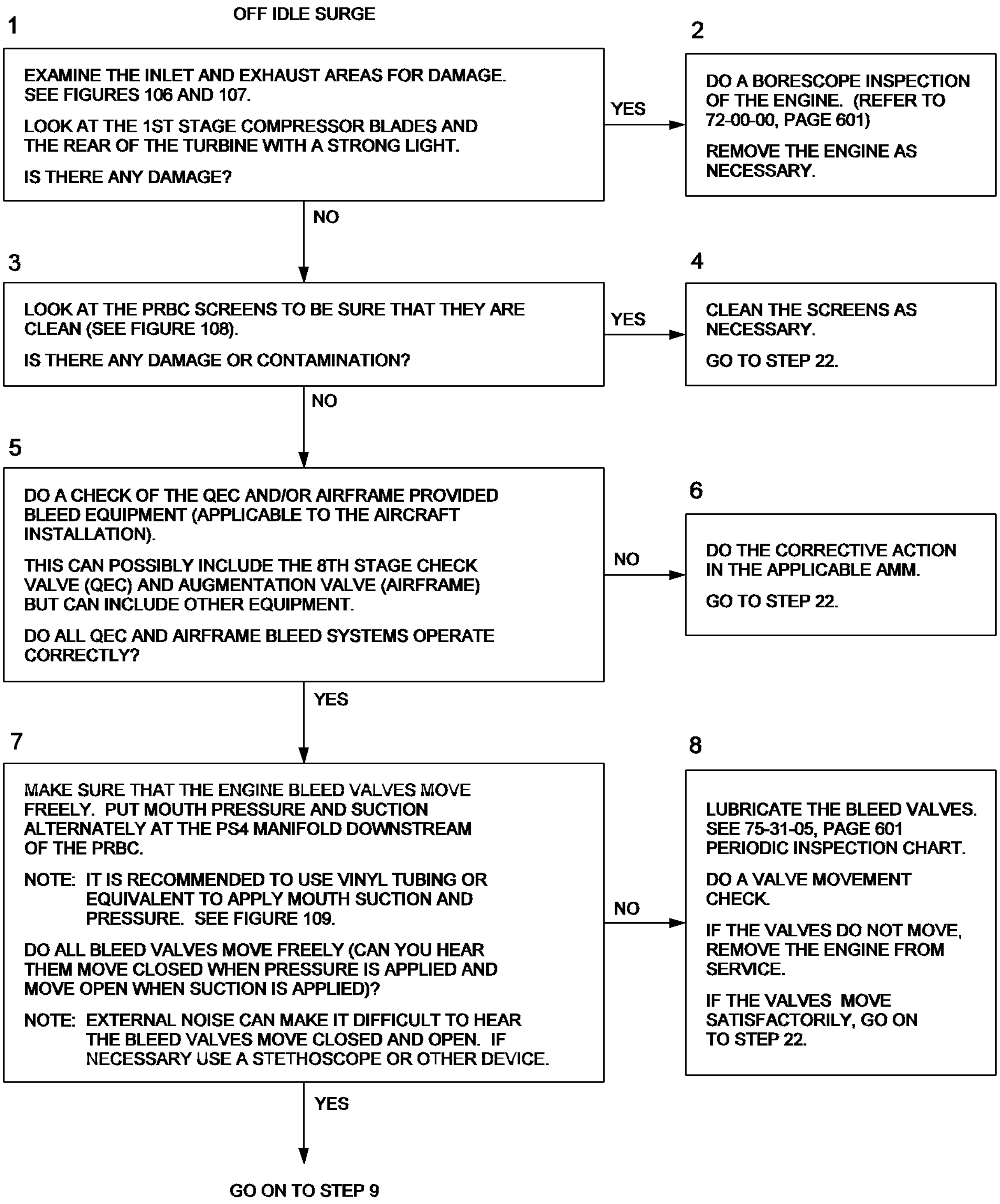
3. Surge

A. General (Figure 102) (Figure 103) (Figure 104Figure 105) (Figure 106) (Figure 107) (Figure 108) (Figure 109) (Figure 110) (Figure 111) (Figure 112) (Figure 113)

(1) When a jet engine is operated, a number of different types of compressor surge can occur. These surges can show as compressor pulsations in the aircraft structure or when an engine has too high an EGT; it is possible to hear some surges, or to see that the engine speed does not go higher when the power lever is moved forward, or that the engine speed decreases when the power lever is not moved. Surges can therefore be of many types, from a weak type which has no sound, motion, or other indication that the pilot can find, to stronger surges which make loud noises or which quickly make the engine temperature too high.

(2) Sometimes things other than a surge can cause the effects described above. If something goes into an engine, or if an airfoil breaks, this can cause a loud noise. Different things can cause the temperature to be too high or can cause engine limits to change too quickly.

(3) Many things can cause surges: The condition of the engine gaspath, how the engine systems are operated, things external to the engine, or some of these things together. If the cause of the surge is external to the engine (such as inlet blockage by snow or soft objects, water or ice that gets into the inlet, or hot or turbulent air in the inlet), it is possible that there will be no damage to the engine after the surge, and no repair will be necessary. If a surge caused by external forces made the engine temperature too high or caused vibration, it will be necessary to inspect the engine as shown in Adjustment/Test or Inspection/Check in this manual. How the engine is operated can also make an engine surge. If the thrust reverser is used incorrectly, or if the power lever is moved forward and back too quickly, this can cause a surge. During an engine test for surge it is important to obey the time limits in this manual to prevent surges from incorrect operation. For example, it is necessary to complete a specified time at Idle after Takeoff power is used, before the engine is operated at a higher level or is given a shutdown procedure.



OFF IDLE SURGE

1

EXAMINE THE INLET AND EXHAUST AREAS FOR DAMAGE. SEE FIGURES 106 AND 107.

LOOK AT THE 1ST STAGE COMPRESSOR BLADES AND THE REAR OF THE TURBINE WITH A STRONG LIGHT.

IS THERE ANY DAMAGE?

2

DO A BORESCOPE INSPECTION OF THE ENGINE. (REFER TO 72-00-00, PAGE 601)

REMOVE THE ENGINE AS NECESSARY.

3

LOOK AT THE PRBC SCREENS TO BE SURE THAT THEY ARE CLEAN (SEE FIGURE 108).

IS THERE ANY DAMAGE OR CONTAMINATION?

4

CLEAN THE SCREENS AS NECESSARY.

GO TO STEP 22.

5

DO A CHECK OF THE QEC AND/OR AIRFRAME PROVIDED BLEED EQUIPMENT (APPLICABLE TO THE AIRCRAFT INSTALLATION).

THIS CAN POSSIBLY INCLUDE THE 8TH STAGE CHECK VALVE (QEC) AND AUGMENTATION VALVE (AIRFRAME) BUT CAN INCLUDE OTHER EQUIPMENT.

DO ALL QEC AND AIRFRAME BLEED SYSTEMS OPERATE CORRECTLY?

6

DO THE CORRECTIVE ACTION IN THE APPLICABLE AMM.

GO TO STEP 22.

7

MAKE SURE THAT THE ENGINE BLEED VALVES MOVE FREELY. PUT MOUTH PRESSURE AND SUCTION ALTERNATELY AT THE PS4 MANIFOLD DOWNSTREAM OF THE PRBC.

NOTE: IT IS RECOMMENDED TO USE VINYL TUBING OR EQUIVALENT TO APPLY MOUTH SUCTION AND PRESSURE. SEE FIGURE 109.

DO ALL BLEED VALVES MOVE FREELY (CAN YOU HEAR THEM MOVE CLOSED WHEN PRESSURE IS APPLIED AND MOVE OPEN WHEN SUCTION IS APPLIED)?

NOTE: EXTERNAL NOISE CAN MAKE IT DIFFICULT TO HEAR THE BLEED VALVES MOVE CLOSED AND OPEN. IF NECESSARY USE A STETHOSCOPE OR OTHER DEVICE.

8

LUBRICATE THE BLEED VALVES. SEE 75-31-05, PAGE 601 PERIODIC INSPECTION CHART.

DO A VALVE MOVEMENT CHECK.

IF THE VALVES DO NOT MOVE, REMOVE THE ENGINE FROM SERVICE.

IF THE VALVES MOVE SATISFACTORILY, GO ON TO STEP 22.

GO ON TO STEP 9

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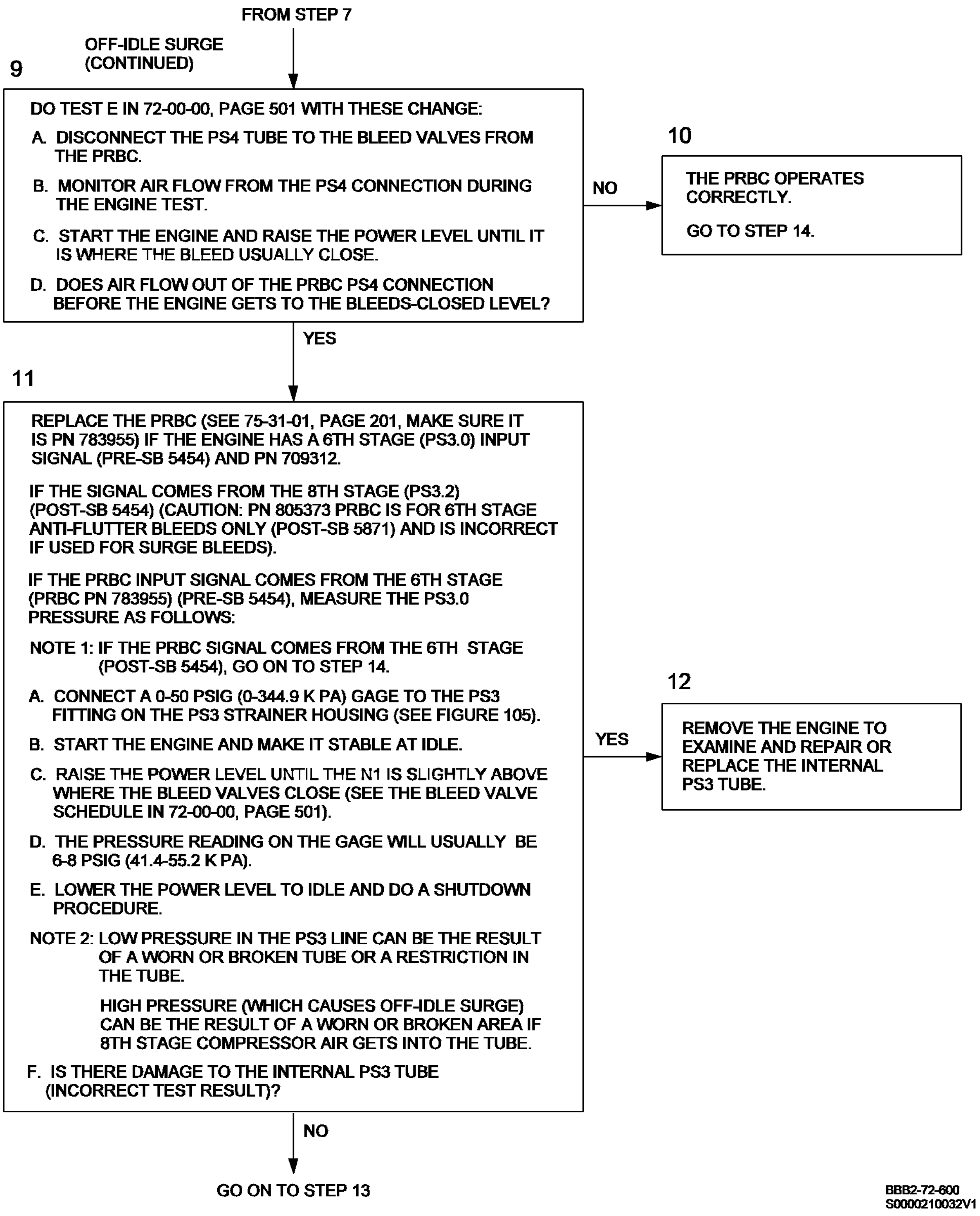
Off-Idle Surge Troubleshooting
Figure 102/72-00-04-990-802 (Sheet 1 of 5)



9

DO TEST E IN 72-00-00, PAGE 501 WITH THESE CHANGE:

A. DISCONNECT THE PS4 TUBE TO THE BLEED VALVES FROM THE PRBC.

B. MONITOR AIR FLOW FROM THE PS4 CONNECTION DURING THE ENGINE TEST.

C. START THE ENGINE AND RAISE THE POWER LEVEL UNTIL IT IS WHERE THE BLEED USUALLY CLOSE.

D. DOES AIR FLOW OUT OF THE PRBC PS4 CONNECTION BEFORE THE ENGINE GETS TO THE BLEEDS-CLOSED LEVEL?

10

THE PRBC OPERATES CORRECTLY.

GO TO STEP 14.

11

REPLACE THE PRBC (SEE 75-31-01, PAGE 201, MAKE SURE IT IS PN 783955) IF THE ENGINE HAS A 6TH STAGE (PS3.0) INPUT SIGNAL (PRE-SB 5454) AND PN 709312.

IF THE SIGNAL COMES FROM THE 8TH STAGE (PS3.2) (POST-SB 5454) (CAUTION: PN 805373 PRBC IS FOR 6TH STAGE ANTI-FLUTTER BLEEDS ONLY (POST-SB 5871) AND IS INCORRECT IF USED FOR SURGE BLEEDS).

IF THE PRBC INPUT SIGNAL COMES FROM THE 6TH STAGE (PRBC PN 783955) (PRE-SB 5454), MEASURE THE PS3.0 PRESSURE AS FOLLOWS:

NOTE 1: IF THE PRBC SIGNAL COMES FROM THE 6TH STAGE (POST-SB 5454), GO ON TO STEP 14.

A. CONNECT A 0-50 PSIG (0-344.9 K PA) GAGE TO THE PS3 FITTING ON THE PS3 STRAINER HOUSING (SEE FIGURE 105).

B. START THE ENGINE AND MAKE IT STABLE AT IDLE.

C. RAISE THE POWER LEVEL UNTIL THE N1 IS SLIGHTLY ABOVE WHERE THE BLEED VALVES CLOSE (SEE THE BLEED VALVE SCHEDULE IN 72-00-00, PAGE 501).

D. THE PRESSURE READING ON THE GAGE WILL USUALLY BE 6-8 PSIG (41.4-55.2 K PA).

E. LOWER THE POWER LEVEL TO IDLE AND DO A SHUTDOWN PROCEDURE.

NOTE 2: LOW PRESSURE IN THE PS3 LINE CAN BE THE RESULT OF A WORN OR BROKEN TUBE OR A RESTRICTION IN THE TUBE.

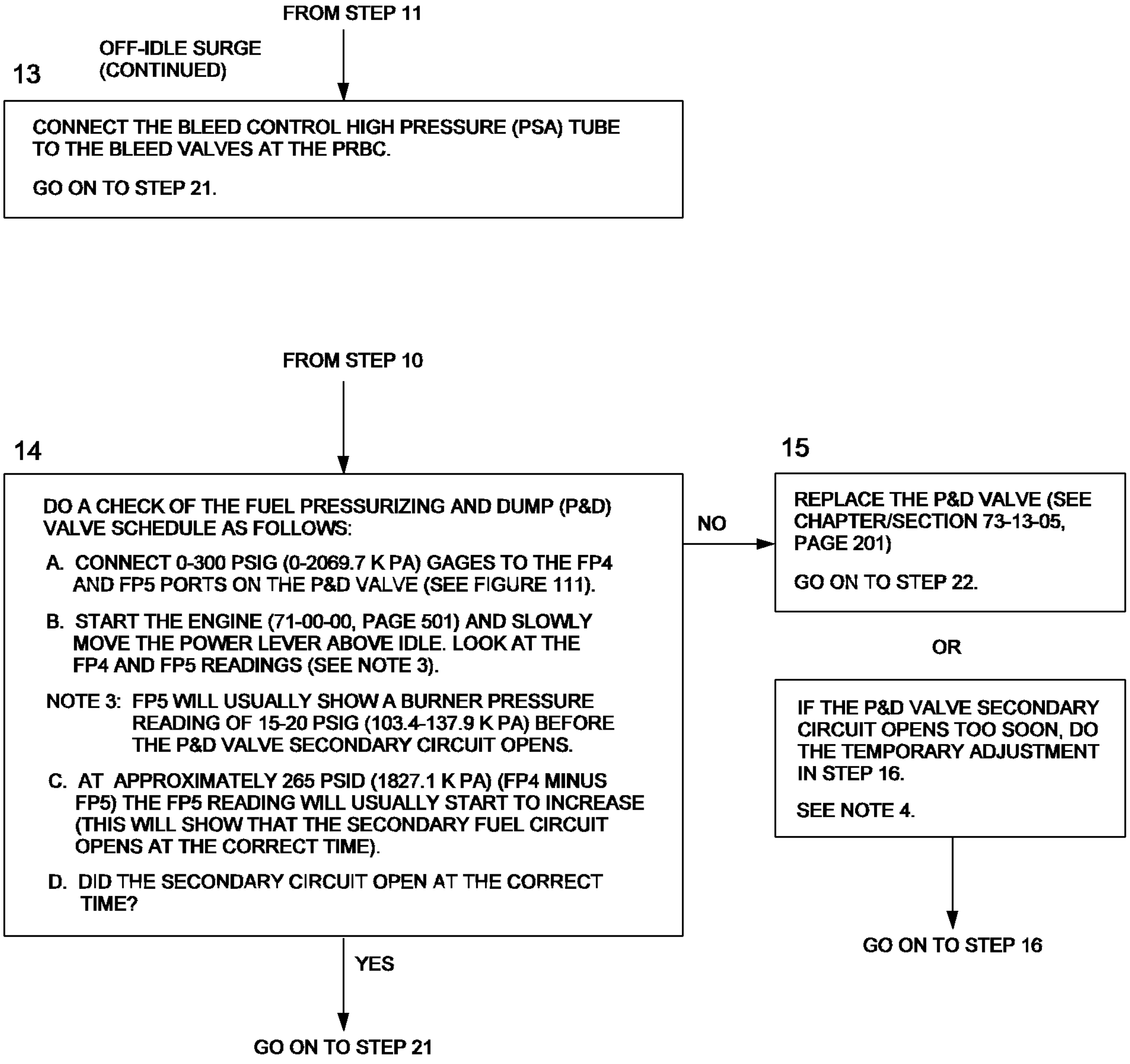
HIGH PRESSURE (WHICH CAUSES OFF-IDLE SURGE) CAN BE THE RESULT OF A WORN OR BROKEN AREA IF 8TH STAGE COMPRESSOR AIR GETS INTO THE TUBE.

F. IS THERE DAMAGE TO THE INTERNAL PS3 TUBE (INCORRECT TEST RESULT)?

12

REMOVE THE ENGINE TO EXAMINE AND REPAIR OR REPLACE THE INTERNAL PS3 TUBE.

Off-Idle Surge Troubleshooting
Figure 102/72-00-04-990-802 (Sheet 2 of 5)



CONNECT THE BLEED CONTROL HIGH PRESSURE (PSA) TUBE TO THE BLEED VALVES AT THE PRBC.

GO ON TO STEP 21.

DO A CHECK OF THE FUEL PRESSURIZING AND DUMP (P&D) VALVE SCHEDULE AS FOLLOWS:

A. CONNECT 0-300 PSIG (0-2069.7 K PA) GAGES TO THE FP4 AND FP5 PORTS ON THE P&D VALVE (SEE FIGURE 111).

B. START THE ENGINE (71-00-00, PAGE 501) AND SLOWLY MOVE THE POWER LEVER ABOVE IDLE. LOOK AT THE FP4 AND FP5 READINGS (SEE NOTE 3).

NOTE 3: FP5 WILL USUALLY SHOW A BURNER PRESSURE READING OF 15-20 PSIG (103.4-137.9 K PA) BEFORE THE P&D VALVE SECONDARY CIRCUIT OPENS.

C. AT APPROXIMATELY 265 PSID (1827.1 K PA) (FP4 MINUS FP5) THE FP5 READING WILL USUALLY START TO INCREASE (THIS WILL SHOW THAT THE SECONDARY FUEL CIRCUIT OPENS AT THE CORRECT TIME).

D. DID THE SECONDARY CIRCUIT OPEN AT THE CORRECT TIME?

REPLACE THE P&D VALVE (SEE CHAPTER/SECTION 73-13-05, PAGE 201)

GO ON TO STEP 22.

IF THE P&D VALVE SECONDARY CIRCUIT OPENS TOO SOON, DO THE TEMPORARY ADJUSTMENT IN STEP 16.

SEE NOTE 4.

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Off-Idle Surge Troubleshooting
Figure 102/72-00-04-990-802 (Sheet 3 of 5)

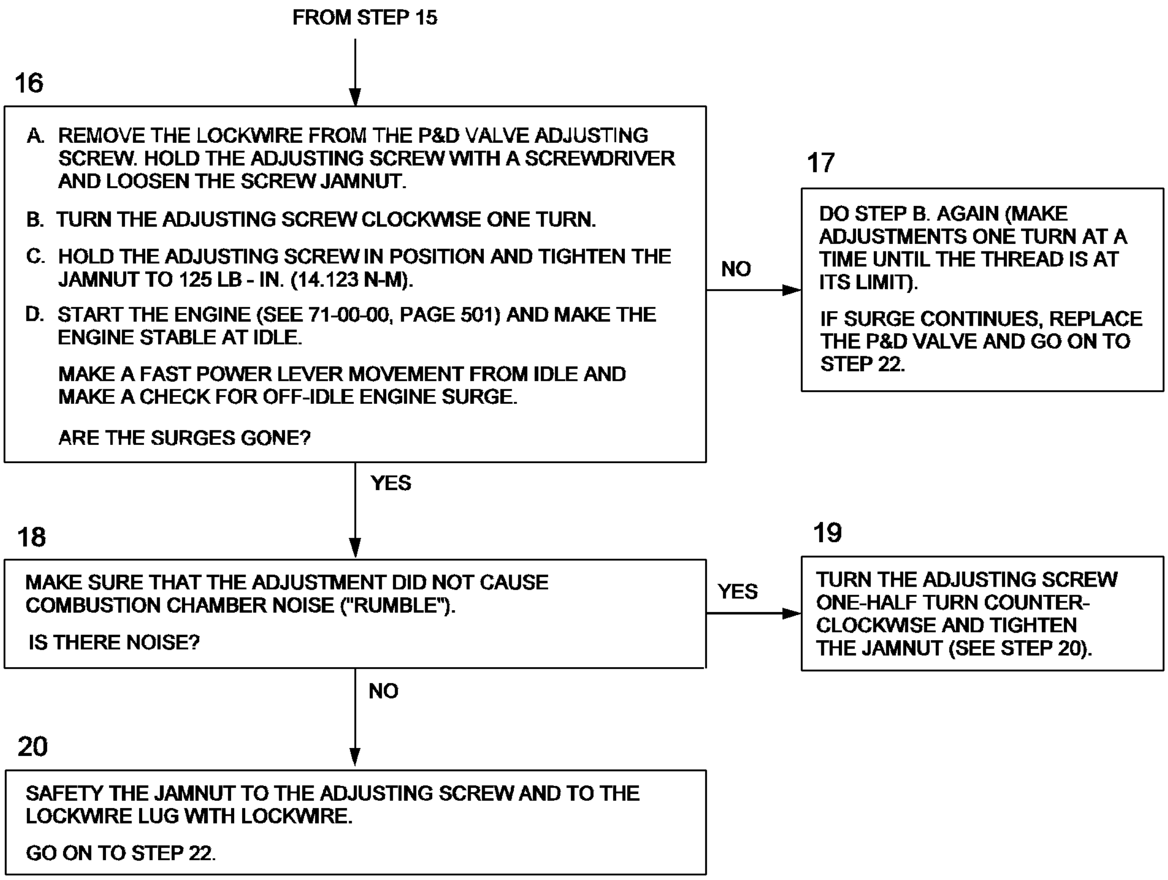
OFF-IDLE SURGE
(CONTINUED)

NOTE 4: THE FUEL P&D VALVE ADJUSTMENT IN STEP 16 WILL PERMIT A SMALL CHANGE IN THE P&D VALVE SECONDARY OPENING POSITION.

THIS CAN PREVENT AN INTERRUPTION OF AN AIRCRAFT'S SCHEDULE BECAUSE OF ENGINE COMPRESSOR SURGE.

THIS PROCEDURE IS ONLY TEMPORARY UNTIL THE OPERATOR CAN REPAIR THE ENGINE FULLY.

YOU CAN ONLY MAKE THIS ADJUSTMENT TO THE P&D VALVE SCREW IN THE CLOCKWISE DIRECTION, AND THE END THREAD OF THE SCREW MUST BE FLUSH WITH OR ABOVE THE FACE OF THE JAMNUT WITH THE NUT TIGHTENED.



16

A. REMOVE THE LOCKWIRE FROM THE P&D VALVE ADJUSTING SCREW. HOLD THE ADJUSTING SCREW WITH A SCREWDRIVER AND LOOSEN THE SCREW JAMNUT.

B. TURN THE ADJUSTING SCREW CLOCKWISE ONE TURN.

C. HOLD THE ADJUSTING SCREW IN POSITION AND TIGHTEN THE JAMNUT TO 125 LB - IN. (14.123 N-M).

D. START THE ENGINE (SEE 71-00-00, PAGE 501) AND MAKE THE ENGINE STABLE AT IDLE.

MAKE A FAST POWER LEVER MOVEMENT FROM IDLE AND MAKE A CHECK FOR OFF-IDLE ENGINE SURGE.

ARE THE SURGES GONE?

17

DO STEP B. AGAIN (MAKE ADJUSTMENTS ONE TURN AT A TIME UNTIL THE THREAD IS AT ITS LIMIT).

IF SURGE CONTINUES, REPLACE THE P&D VALVE AND GO ON TO STEP 22.

18

MAKE SURE THAT THE ADJUSTMENT DID NOT CAUSE COMBUSTION CHAMBER NOISE ("RUMBLE").

IS THERE NOISE?

19

TURN THE ADJUSTING SCREW ONE-HALF TURN COUNTER-CLOCKWISE AND TIGHTEN THE JAMNUT (SEE STEP 20).

20

SAFETY THE JAMNUT TO THE ADJUSTING SCREW AND TO THE LOCKWIRE LUG WITH LOCKWIRE.

GO ON TO STEP 22.

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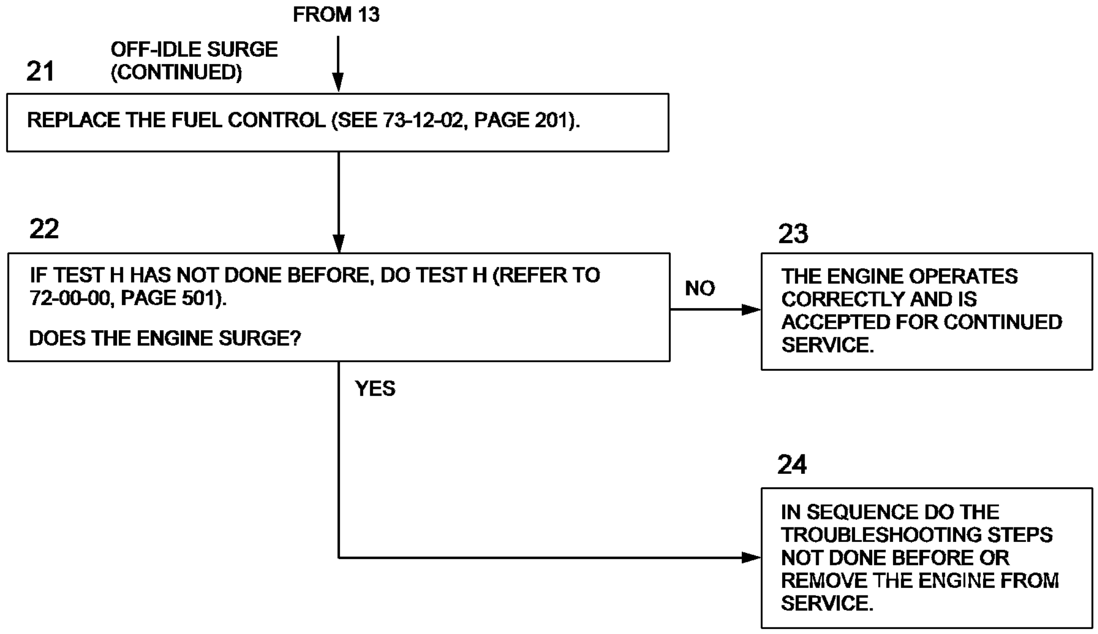
Off-Idle Surge Troubleshooting
Figure 102/72-00-04-990-802 (Sheet 4 of 5)



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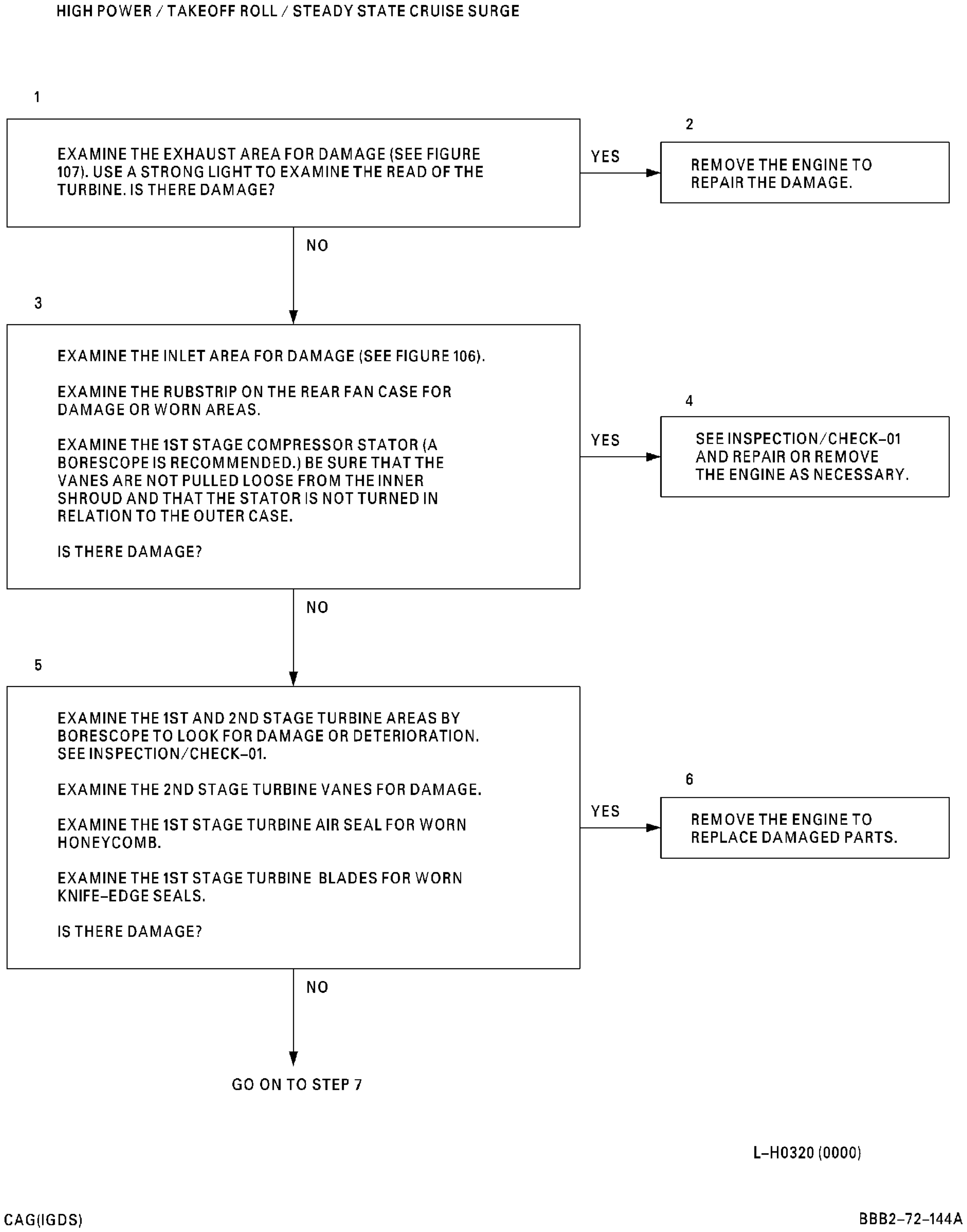
Off-Idle Surge Troubleshooting
Figure 102/72-00-04-990-802 (Sheet 5 of 5)



HIGH POWER / TAKEOFF ROLL / STEADY STATE CRUISE SURGE

1 EXAMINE THE EXHAUST AREA FOR DAMAGE (SEE FIGURE 107). USE A STRONG LIGHT TO EXAMINE THE READ OF THE TURBINE. IS THERE DAMAGE?

2 REMOVE THE ENGINE TO REPAIR THE DAMAGE.

3 EXAMINE THE INLET AREA FOR DAMAGE (SEE FIGURE 106).

EXAMINE THE RUBSTRIP ON THE REAR FAN CASE FOR DAMAGE OR WORN AREAS.

EXAMINE THE 1ST STAGE COMPRESSOR STATOR (A BORESCOPE IS RECOMMENDED.) BE SURE THAT THE VANES ARE NOT PULLED LOOSE FROM THE INNER SHROUD AND THAT THE STATOR IS NOT TURNED IN RELATION TO THE OUTER CASE.

IS THERE DAMAGE?

4 SEE INSPECTION/CHECK–01 AND REPAIR OR REMOVE THE ENGINE AS NECESSARY.

5 EXAMINE THE 1ST AND 2ND STAGE TURBINE AREAS BY BORESCOPE TO LOOK FOR DAMAGE OR DETERIORATION. SEE INSPECTION/CHECK–01.

EXAMINE THE 2ND STAGE TURBINE VANES FOR DAMAGE.

EXAMINE THE 1ST STAGE TURBINE AIR SEAL FOR WORN HONEYCOMB.

EXAMINE THE 1ST STAGE TURBINE BLADES FOR WORN KNIFE–EDGE SEALS.

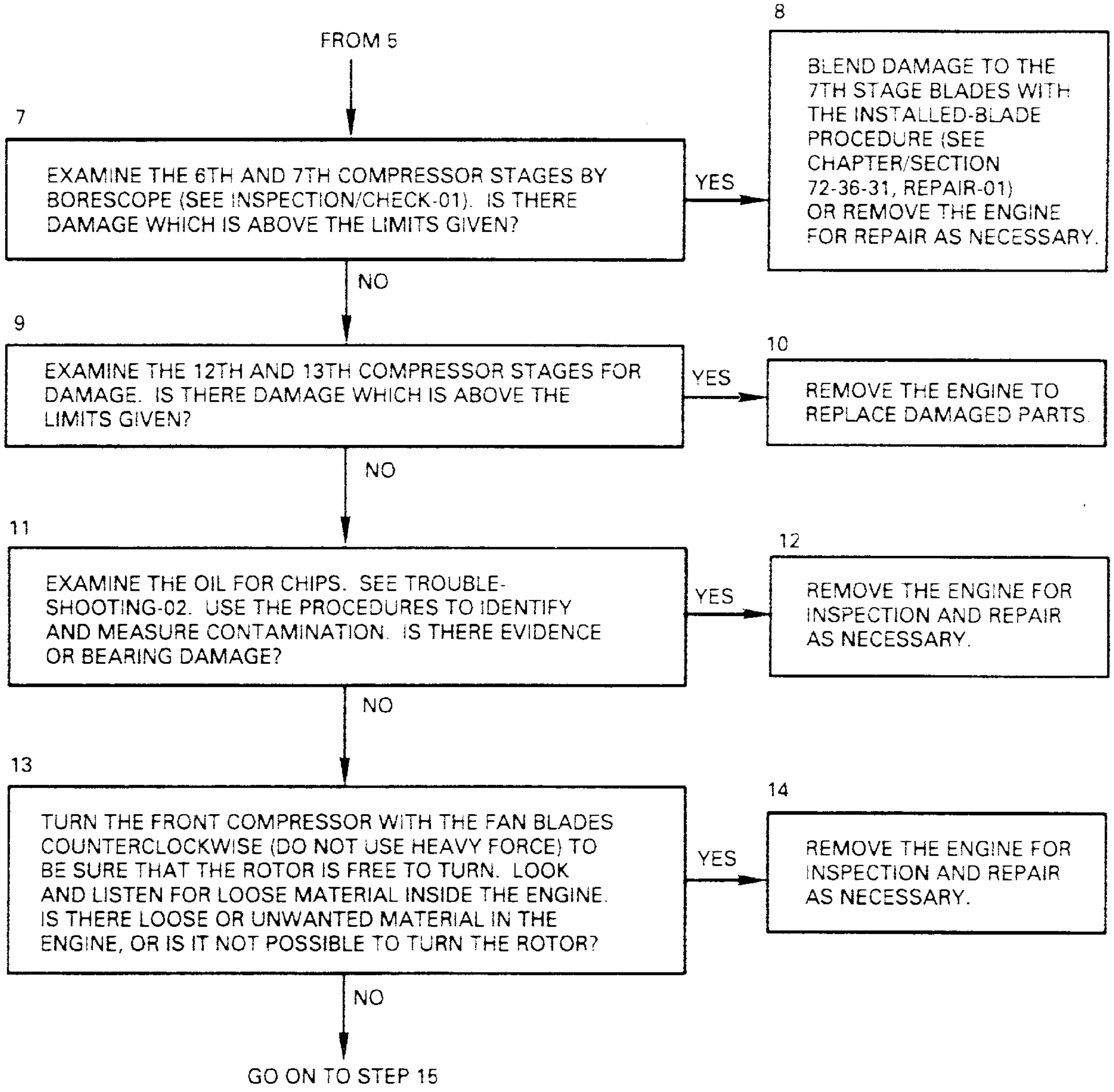
IS THERE DAMAGE?

6 REMOVE THE ENGINE TO REPLACE DAMAGED PARTS.

GO ON TO STEP 7

High Power/Takeoff Roll/Steady State Surge Troubleshooting
Figure 103/72-00-04-990-803 (Sheet 1 of 3)

HIGH POWER / TAKEOFF ROLL / STEADY STATE CRUISE SURGE (CONTINUED)



7 EXAMINE THE 6TH AND 7TH COMPRESSOR STAGES BY BORESCOPE (SEE INSPECTION/CHECK-01). IS THERE DAMAGE WHICH IS ABOVE THE LIMITS GIVEN?

8 BLEND DAMAGE TO THE 7TH STAGE BLADES WITH THE INSTALLED-BLADE PROCEDURE (SEE CHAPTER/SECTION 72-36-31, REPAIR-01) OR REMOVE THE ENGINE FOR REPAIR AS NECESSARY.

9 EXAMINE THE 12TH AND 13TH COMPRESSOR STAGES FOR DAMAGE. IS THERE DAMAGE WHICH IS ABOVE THE LIMITS GIVEN?

10 REMOVE THE ENGINE TO REPLACE DAMAGED PARTS.

11 EXAMINE THE OIL FOR CHIPS. SEE TROUBLESHOOTING-02. USE THE PROCEDURES TO IDENTIFY AND MEASURE CONTAMINATION. IS THERE EVIDENCE OR BEARING DAMAGE?

12 REMOVE THE ENGINE FOR INSPECTION AND REPAIR AS NECESSARY.

13 TURN THE FRONT COMPRESSOR WITH THE FAN BLADES COUNTERCLOCKWISE (DO NOT USE HEAVY FORCE) TO BE SURE THAT THE ROTOR IS FREE TO TURN. LOOK AND LISTEN FOR LOOSE MATERIAL INSIDE THE ENGINE. IS THERE LOOSE OR UNWANTED MATERIAL IN THE ENGINE, OR IS IT NOT POSSIBLE TO TURN THE ROTOR?

14 REMOVE THE ENGINE FOR INSPECTION AND REPAIR AS NECESSARY.

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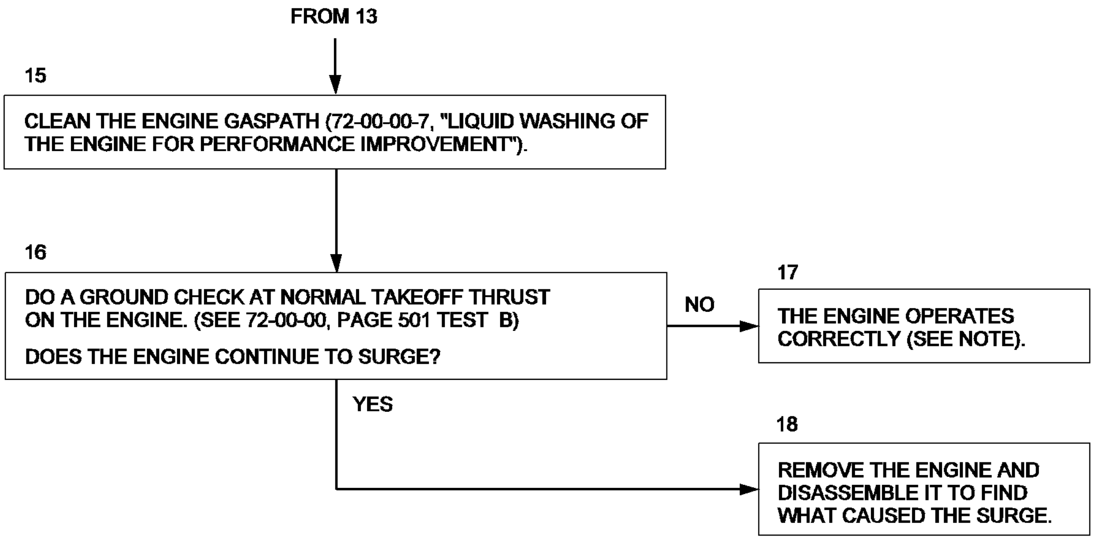
High Power/Takeoff Roll/Steady State Surge Troubleshooting
Figure 103/72-00-04-990-803 (Sheet 2 of 3)

HIGH POWER / TAKEOFF ROLL / STEADY STATE CRUISE SURGE (CONTINUED)



15 CLEAN THE ENGINE GASPATH (72-00-00-7, "LIQUID WASHING OF THE ENGINE FOR PERFORMANCE IMPROVEMENT").

16 DO A GROUND CHECK AT NORMAL TAKEOFF THRUST ON THE ENGINE. (SEE 72-00-00, PAGE 501 TEST B)

DOES THE ENGINE CONTINUE TO SURGE?

17 THE ENGINE OPERATES CORRECTLY (SEE NOTE).

18 REMOVE THE ENGINE AND DISASSEMBLE IT TO FIND WHAT CAUSED THE SURGE.

NOTE: IF SOFT OBJECTS GO INTO THE ENGINE, THIS CAN CAUSE A SURGE WITHOUT DAMAGE TO THE ENGINE. THIS OCCURS WHEN THE MATERIAL (PAPER, PLASTIC SHEETS, SNOW, OR ICE) STAYS ON THE INLET CASE VANES AND CAUSES INLET AIRFLOW DISTORTION. THIS ALSO OCCURS WHEN WATER OR SNOW GOES INTO THE ENGINE. CLEAR AIR TURBULENCE, OR DIRT ON THE BLADES AND VANES CAN ALSO CAUSE THIS TYPE OF SURGE.

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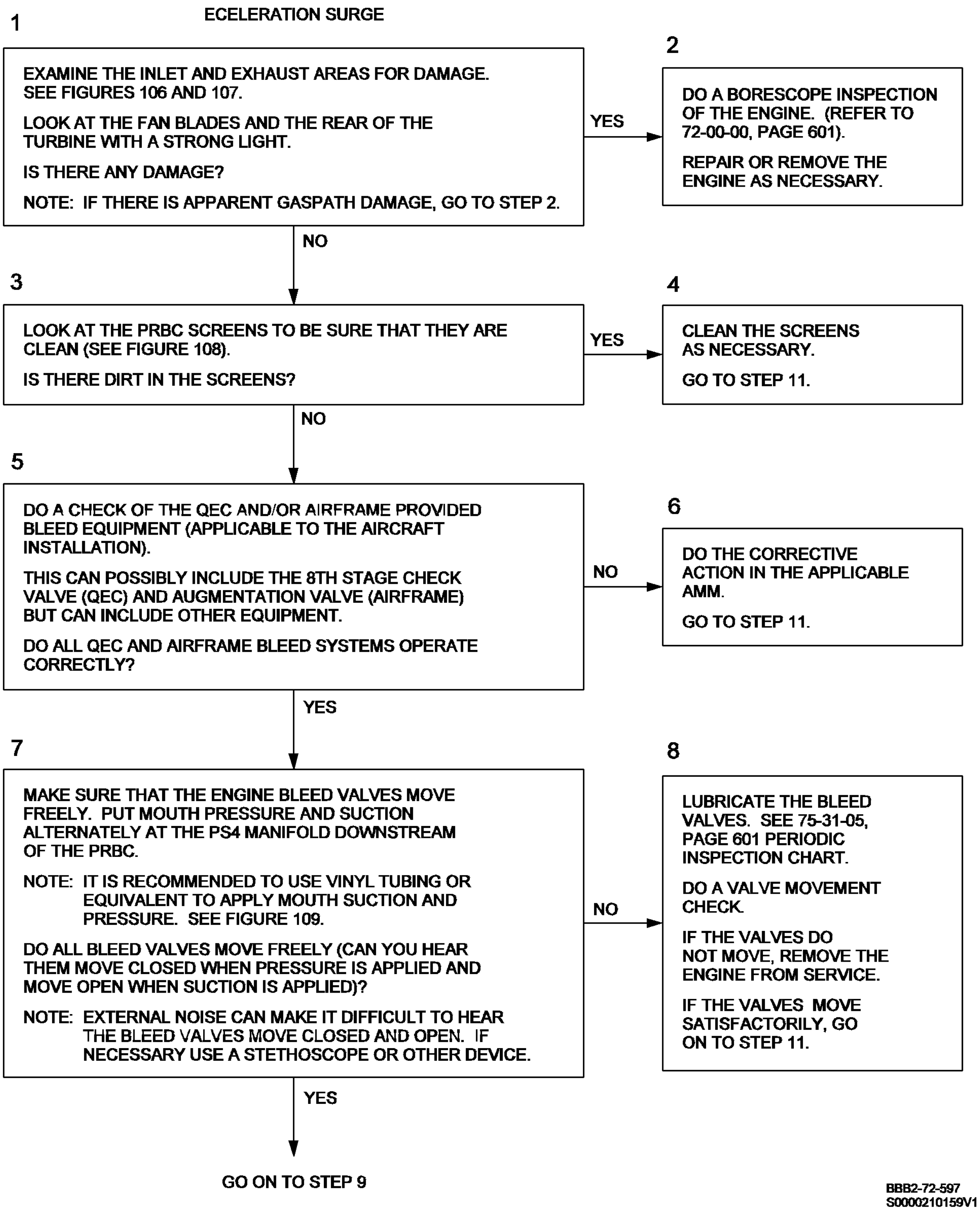
High Power/Takeoff Roll/Steady State Surge Troubleshooting
Figure 103/72-00-04-990-803 (Sheet 3 of 3)



1 EXAMINE THE INLET AND EXHAUST AREAS FOR DAMAGE. SEE FIGURES 106 AND 107.

LOOK AT THE FAN BLADES AND THE REAR OF THE TURBINE WITH A STRONG LIGHT.

IS THERE ANY DAMAGE?

NOTE: IF THERE IS APPARENT GASPATH DAMAGE, GO TO STEP 2.

2 DO A BORESCOPE INSPECTION OF THE ENGINE. (REFER TO 72-00-00, PAGE 601).

REPAIR OR REMOVE THE ENGINE AS NECESSARY.

3 LOOK AT THE PRBC SCREENS TO BE SURE THAT THEY ARE CLEAN (SEE FIGURE 108).

IS THERE DIRT IN THE SCREENS?

4 CLEAN THE SCREENS AS NECESSARY.

GO TO STEP 11.

5 DO A CHECK OF THE QEC AND/OR AIRFRAME PROVIDED BLEED EQUIPMENT (APPLICABLE TO THE AIRCRAFT INSTALLATION).

THIS CAN POSSIBLY INCLUDE THE 8TH STAGE CHECK VALVE (QEC) AND AUGMENTATION VALVE (AIRFRAME) BUT CAN INCLUDE OTHER EQUIPMENT.

DO ALL QEC AND AIRFRAME BLEED SYSTEMS OPERATE CORRECTLY?

6 DO THE CORRECTIVE ACTION IN THE APPLICABLE AMM.

GO TO STEP 11.

7 MAKE SURE THAT THE ENGINE BLEED VALVES MOVE FREELY. PUT MOUTH PRESSURE AND SUCTION ALTERNATELY AT THE PS4 MANIFOLD DOWNSTREAM OF THE PRBC.

NOTE: IT IS RECOMMENDED TO USE VINYL TUBING OR EQUIVALENT TO APPLY MOUTH SUCTION AND PRESSURE. SEE FIGURE 109.

DO ALL BLEED VALVES MOVE FREELY (CAN YOU HEAR THEM MOVE CLOSED WHEN PRESSURE IS APPLIED AND MOVE OPEN WHEN SUCTION IS APPLIED)?

NOTE: EXTERNAL NOISE CAN MAKE IT DIFFICULT TO HEAR THE BLEED VALVES MOVE CLOSED AND OPEN. IF NECESSARY USE A STETHOSCOPE OR OTHER DEVICE.

8 LUBRICATE THE BLEED VALVES. SEE 75-31-05, PAGE 601 PERIODIC INSPECTION CHART.

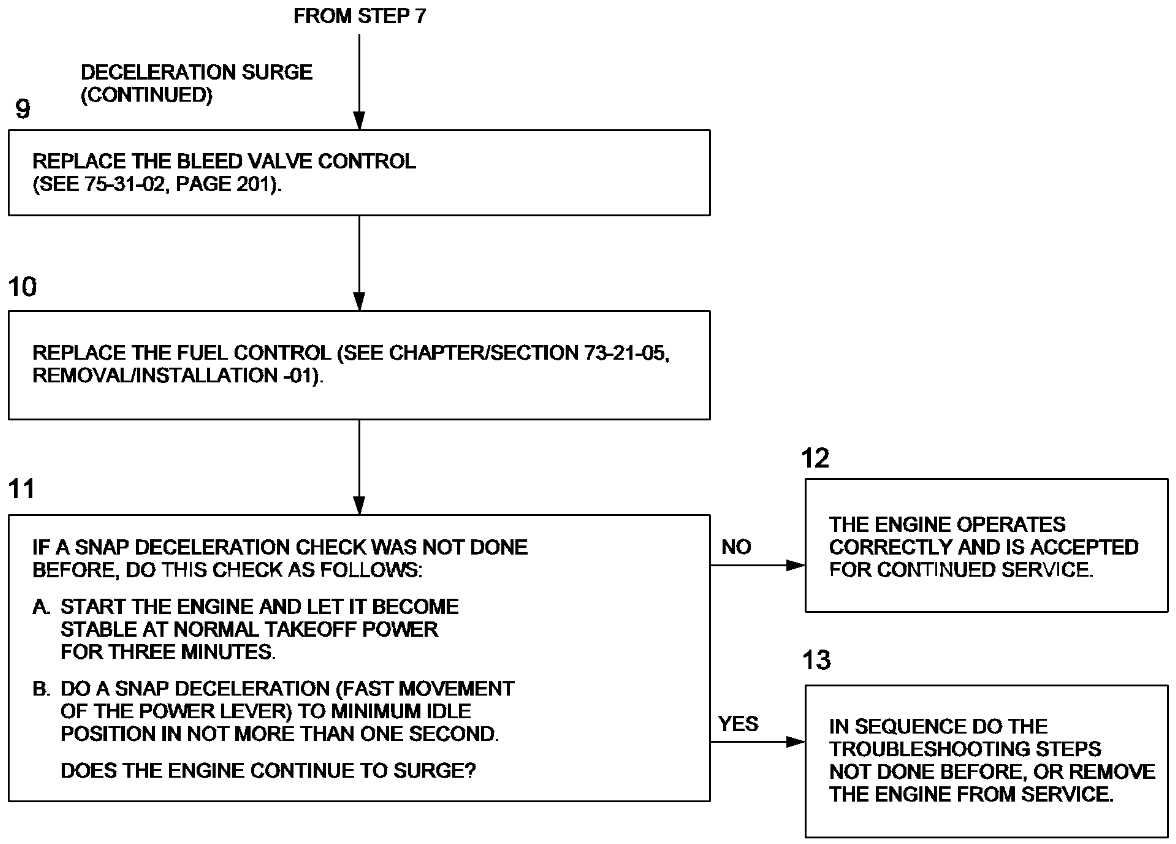
DO A VALVE MOVEMENT CHECK.

IF THE VALVES DO NOT MOVE, REMOVE THE ENGINE FROM SERVICE.

IF THE VALVES MOVE SATISFACTORILY, GO ON TO STEP 11.

GO ON TO STEP 9

Deceleration Surge Troubleshooting
Figure 104/72-00-04-990-804 (Sheet 1 of 2)



9 REPLACE THE BLEED VALVE CONTROL (SEE 75-31-02, PAGE 201).

10 REPLACE THE FUEL CONTROL (SEE CHAPTER/SECTION 73-21-05, REMOVAL/INSTALLATION -01).

11 IF A SNAP DECELERATION CHECK WAS NOT DONE BEFORE, DO THIS CHECK AS FOLLOWS:

A. START THE ENGINE AND LET IT BECOME STABLE AT NORMAL TAKEOFF POWER FOR THREE MINUTES.

B. DO A SNAP DECELERATION (FAST MOVEMENT OF THE POWER LEVER) TO MINIMUM IDLE POSITION IN NOT MORE THAN ONE SECOND.

DOES THE ENGINE CONTINUE TO SURGE?

12 THE ENGINE OPERATES CORRECTLY AND IS ACCEPTED FOR CONTINUED SERVICE.

13 IN SEQUENCE DO THE TROUBLESHOOTING STEPS NOT DONE BEFORE, OR REMOVE THE ENGINE FROM SERVICE.

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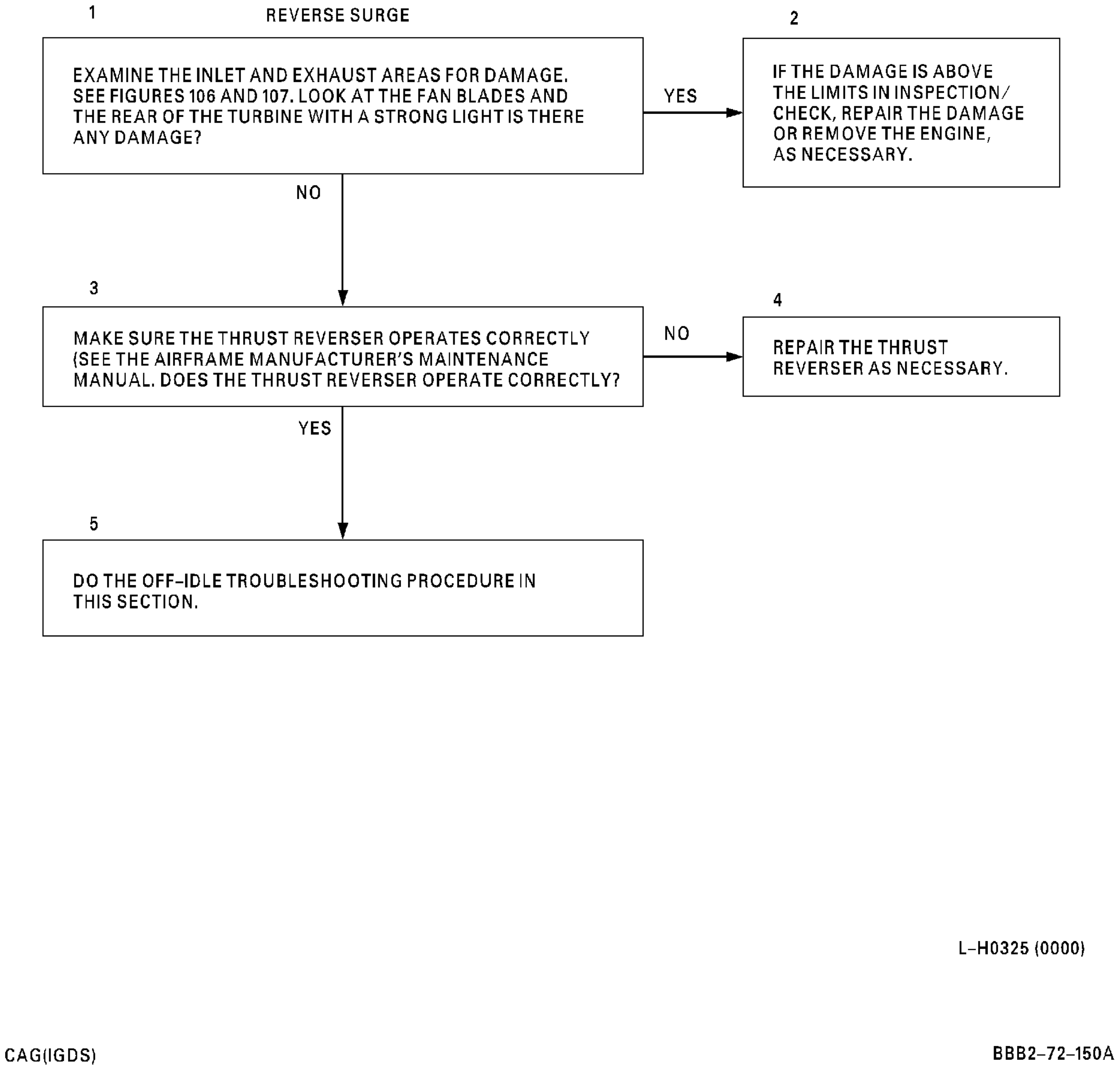
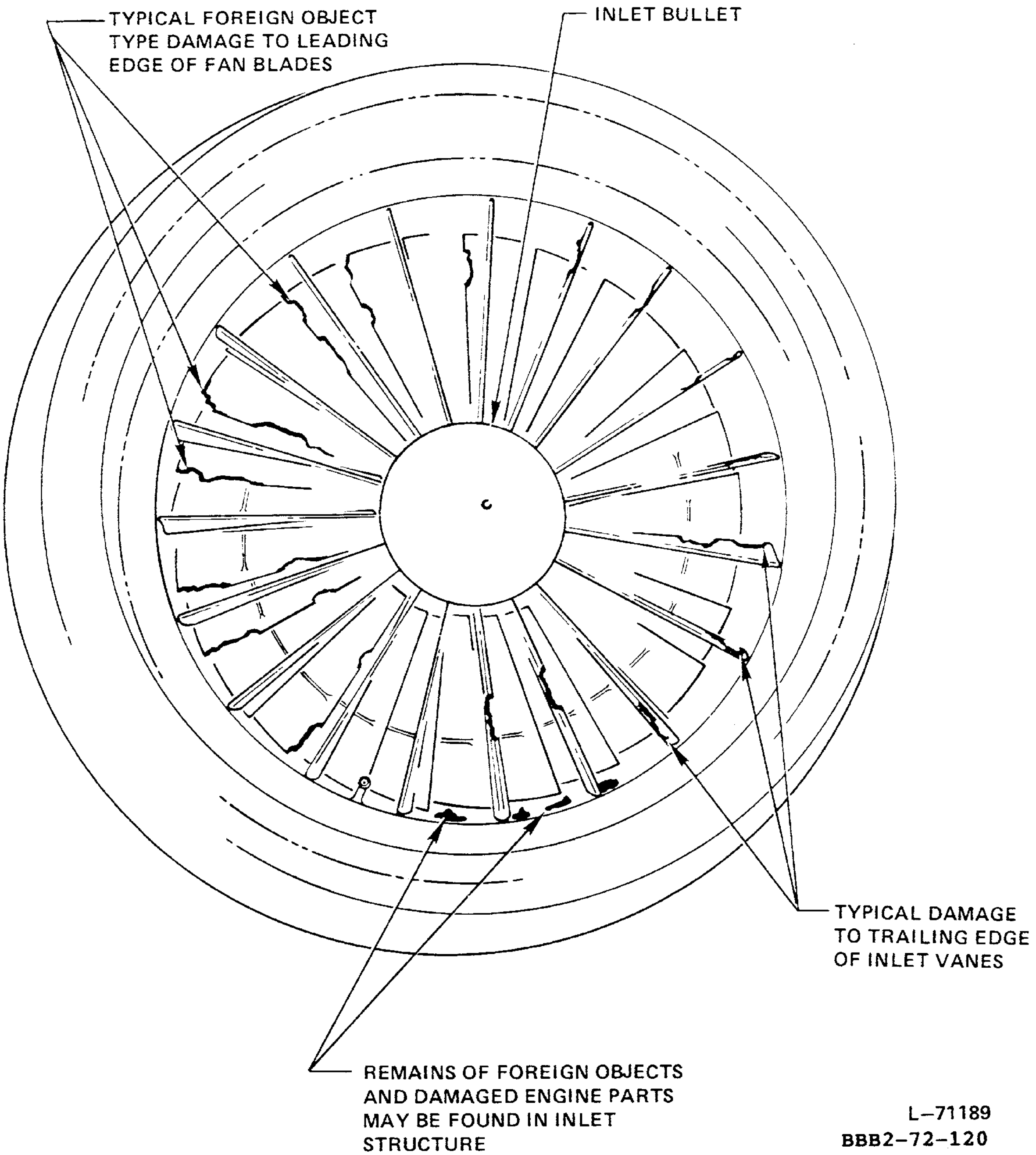
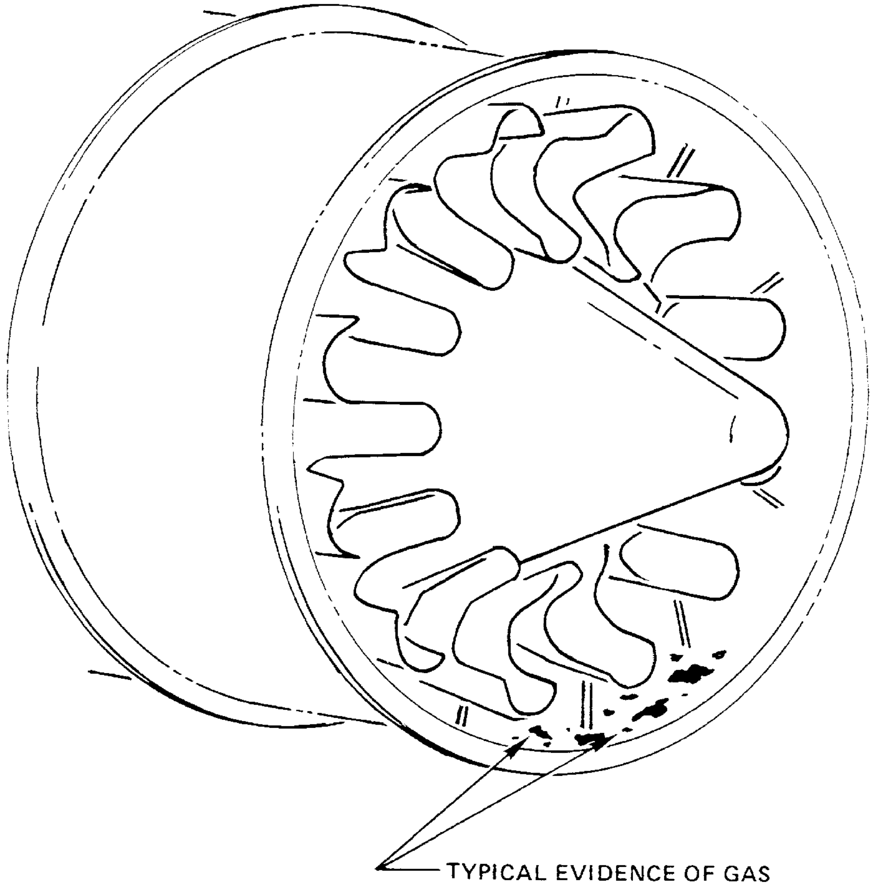
Deceleration Surge Troubleshooting
Figure 104/72-00-04-990-804 (Sheet 2 of 2)



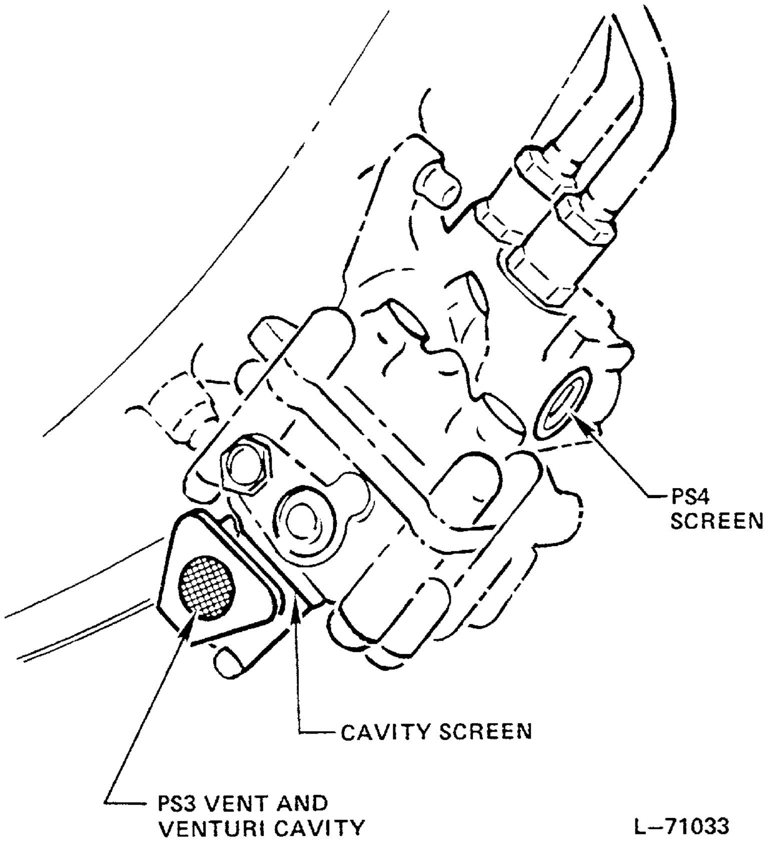
Reverse Surge Troubleshooting
Figure 105/72-00-04-990-805



Inlet Area Check
Figure 106/72-00-04-990-806



Exhaust Area Check
Figure 107/72-00-04-990-807



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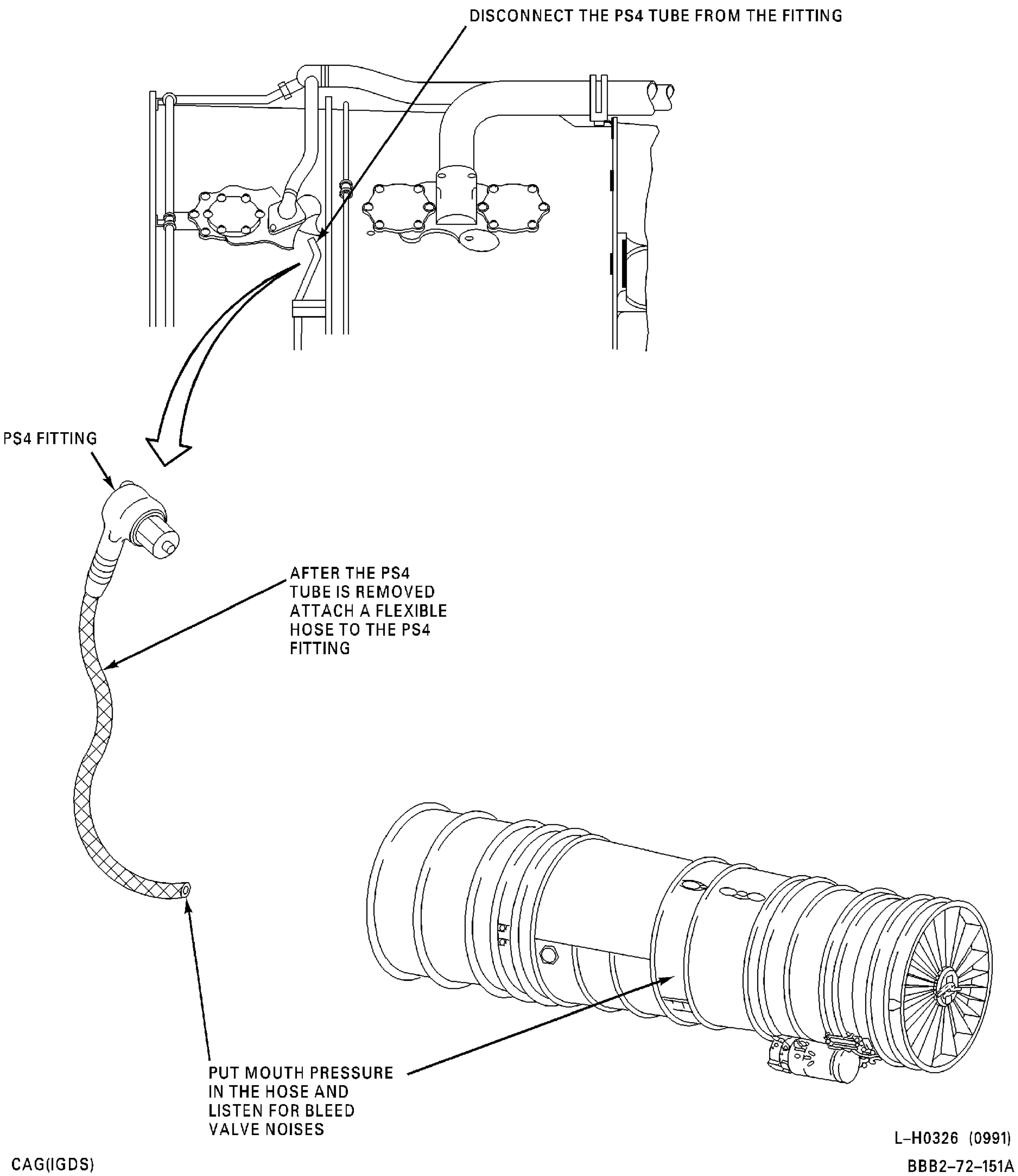
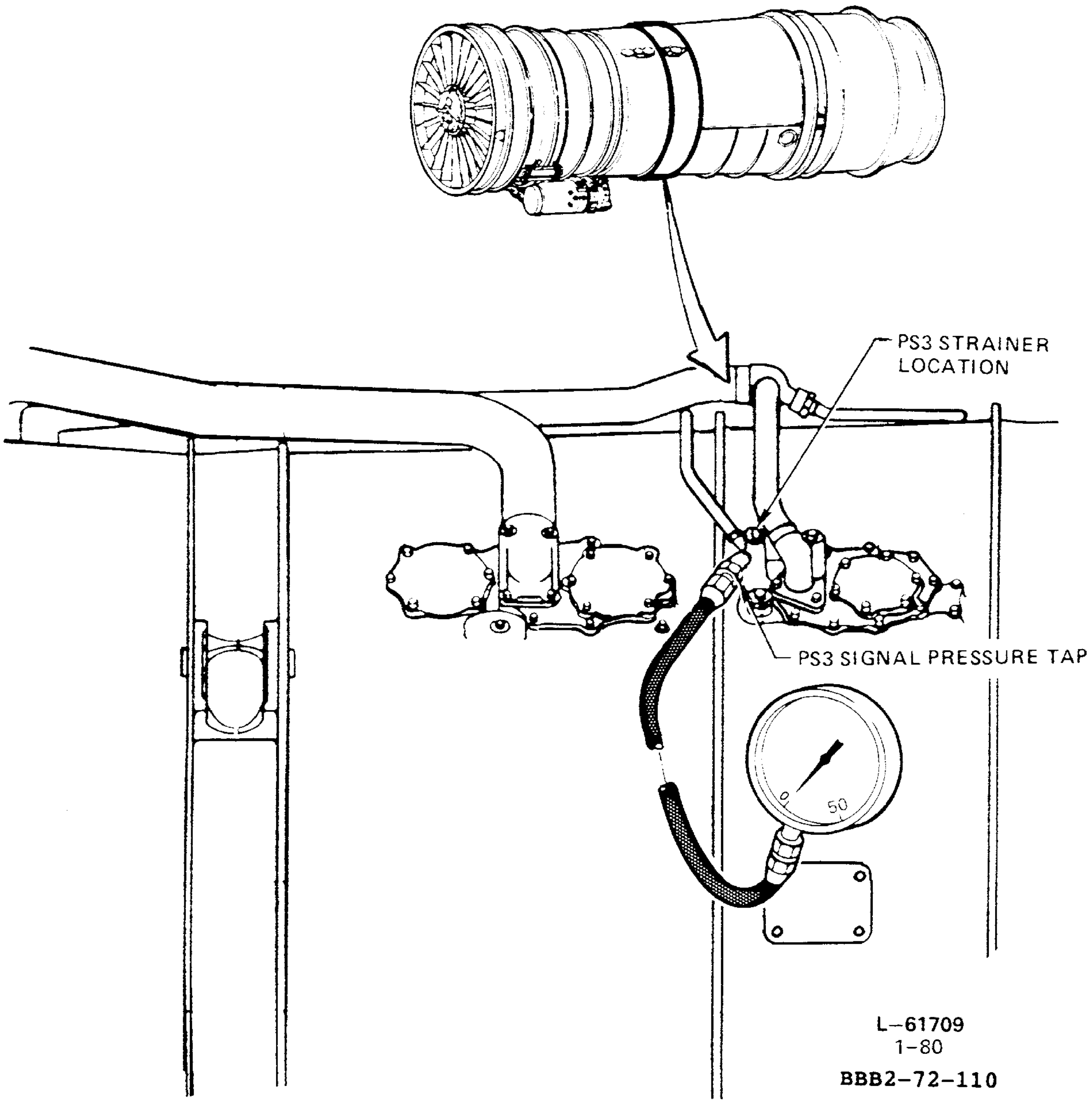
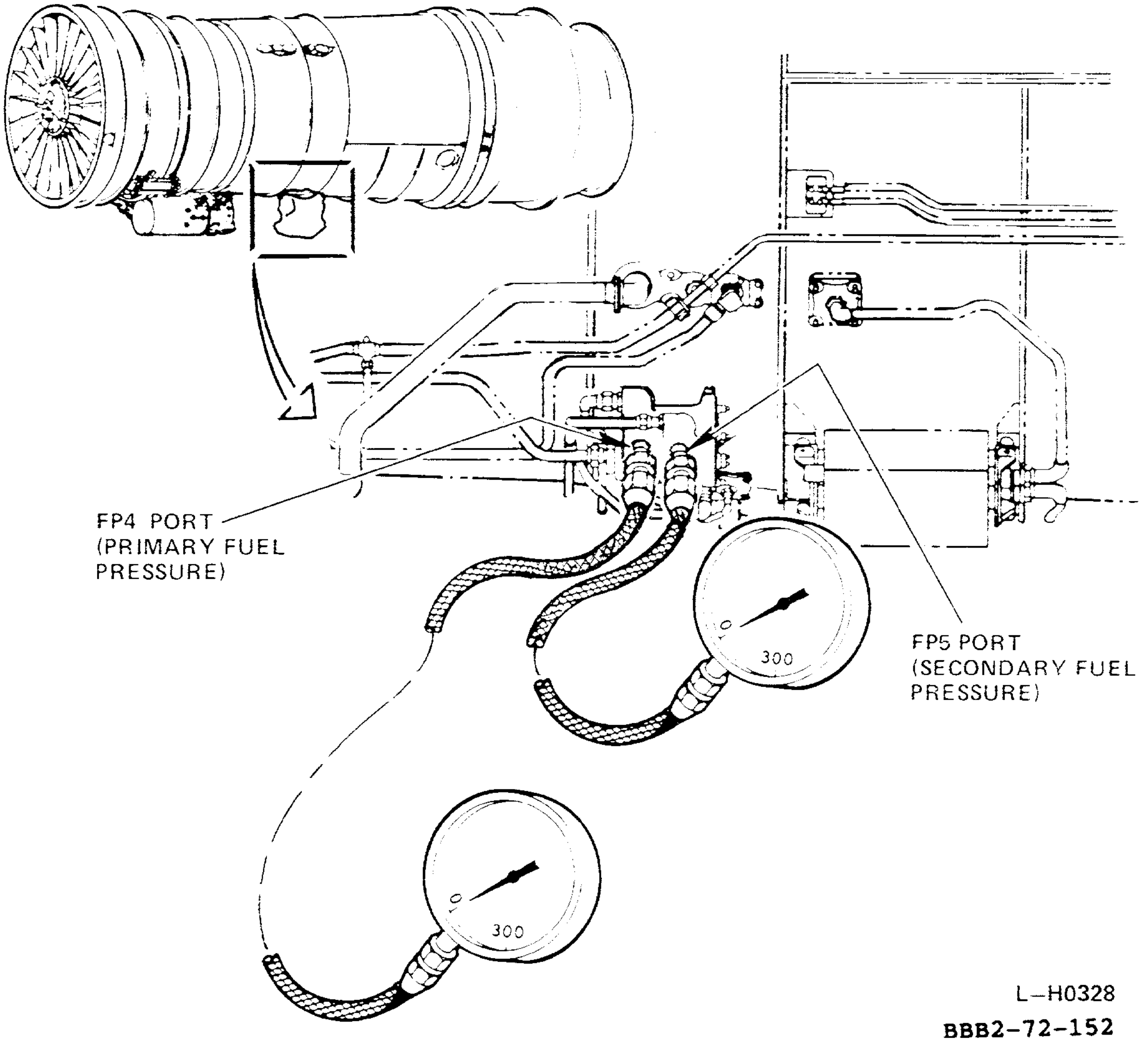
Pressure Ratio Bleed Control Screens
Figure 108/72-00-04-990-808



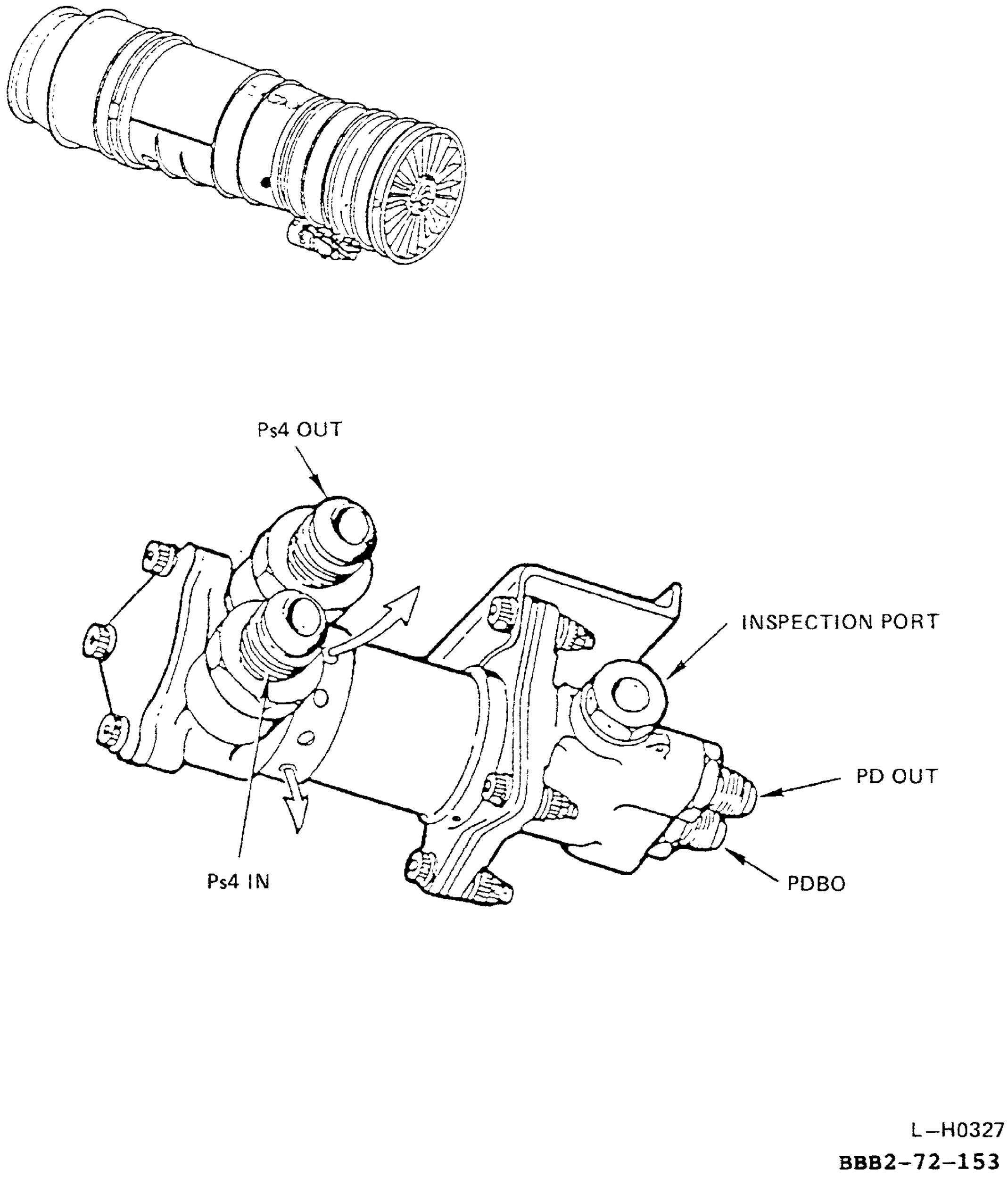
Bleed Valve Noise Check
Figure 109/72-00-04-990-809



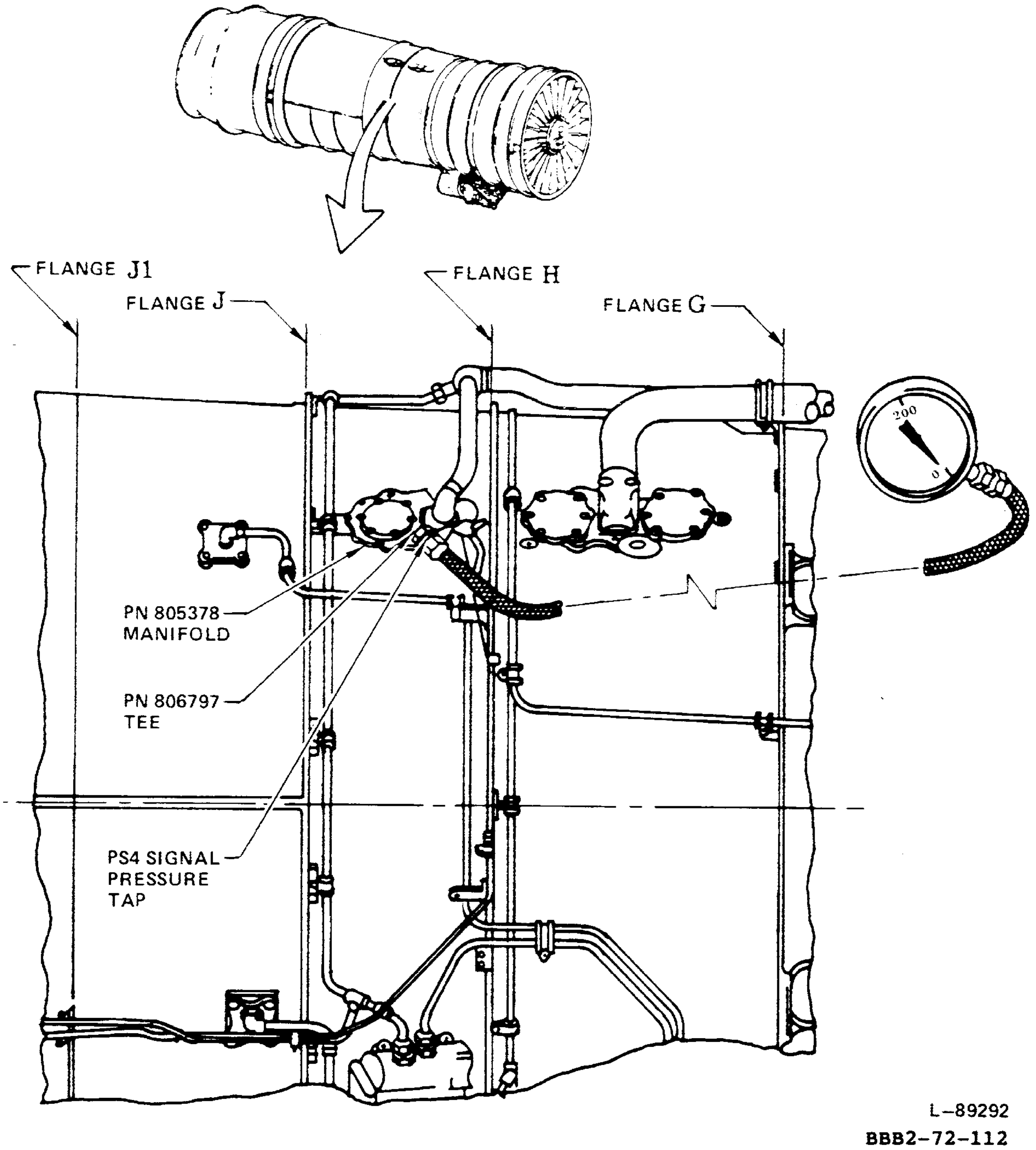
PS3 Pressure Measurement
Figure 110/72-00-04-990-810



Fuel Pressurizing And Dump Valve Check
Figure 111/72-00-04-990-811



Bleed Valve Control Check
Figure 112/72-00-04-990-812



PS4 Pressure Measurement (Engine With 6th Stage Bleed System)
Figure 113/72-00-04-990-813

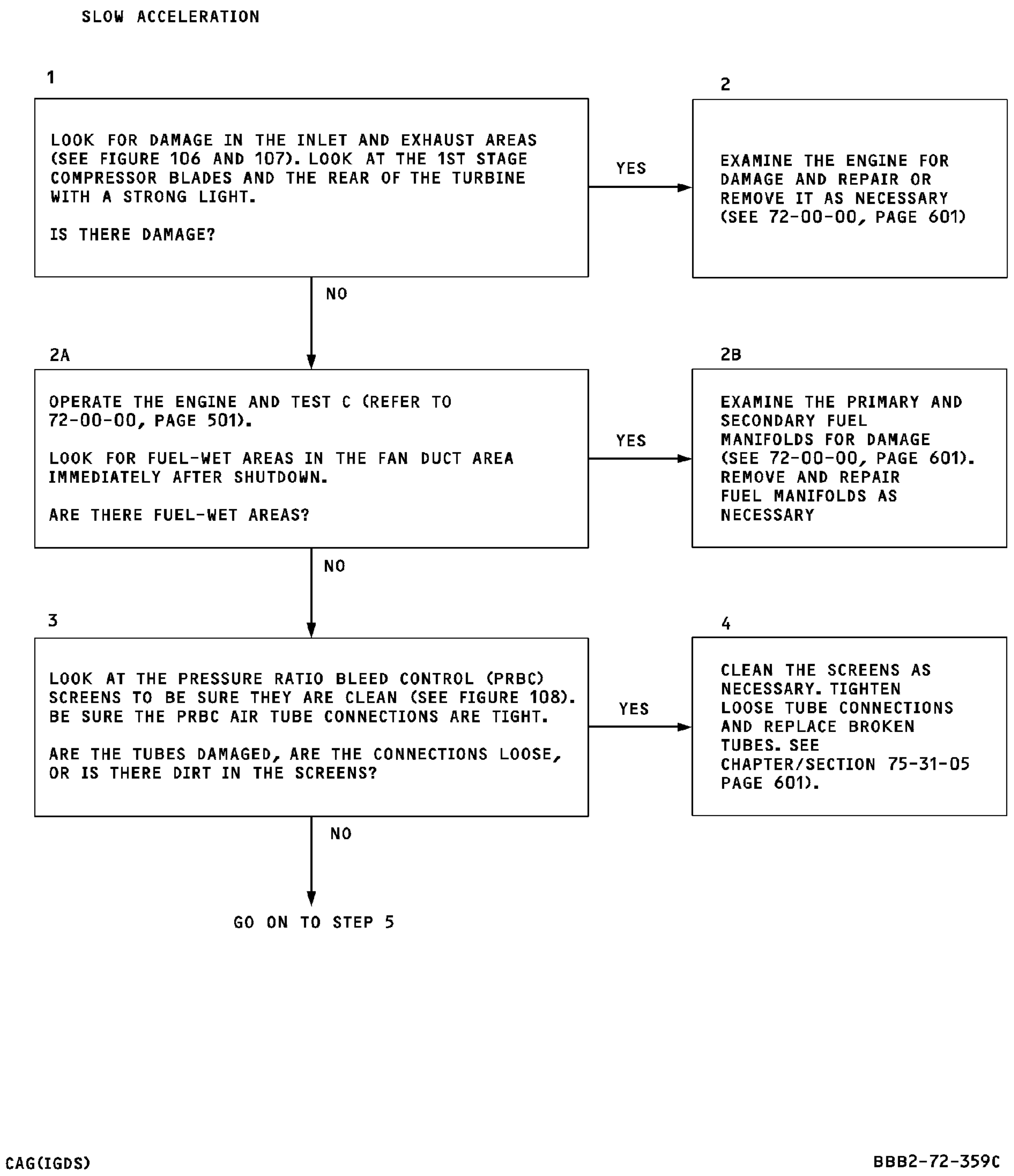
4. Slow Acceleration

A. General (Figure 114) (Figure 115) (Figure 116) (Figure 117) (Figure 118)

(1) Slow acceleration can be dangerous to flight safety. Sufficient engine response time must be available for emergency go-around if necessary. There can be many causes of slow acceleration, such as minor engine fuel control adjustments which are necessary, or combustion chamber failures (which can be dangerous), or fuel leaks which are a result of primary or secondary fuel manifold fractures.

(2) The flight crew's estimate of slow acceleration can be subjective and can be the result of the response time of one engine compared to that of the other engines on the aircraft. Line maintenance actions must be as specified by the airframe manufacturer, or airline engineering department. Thus flight crew reports which occur again and again, or reports of unusually large changes in engine parameters can show that more troubleshooting procedures are necessary.

(3) It is important to make sure that the engine has become stable at the correct idle speed as given in the applicable flight manual, before you apply external loads (especially air conditioning) to the engine, and before you accelerate the engine. This will give optimal engine acceleration.



SLOW ACCELERATION

1 LOOK FOR DAMAGE IN THE INLET AND EXHAUST AREAS (SEE FIGURE 106 AND 107). LOOK AT THE 1ST STAGE COMPRESSOR BLADES AND THE REAR OF THE TURBINE WITH A STRONG LIGHT.

IS THERE DAMAGE?

2 EXAMINE THE ENGINE FOR DAMAGE AND REPAIR OR REMOVE IT AS NECESSARY (SEE 72-00-00, PAGE 601)

2A OPERATE THE ENGINE AND TEST C (REFER TO 72-00-00, PAGE 501).

LOOK FOR FUEL-WET AREAS IN THE FAN DUCT AREA IMMEDIATELY AFTER SHUTDOWN.

ARE THERE FUEL-WET AREAS?

2B EXAMINE THE PRIMARY AND SECONDARY FUEL MANIFOLDS FOR DAMAGE (SEE 72-00-00, PAGE 601). REMOVE AND REPAIR FUEL MANIFOLDS AS NECESSARY

3 LOOK AT THE PRESSURE RATIO BLEED CONTROL (PRBC) SCREENS TO BE SURE THEY ARE CLEAN (SEE FIGURE 108). BE SURE THE PRBC AIR TUBE CONNECTIONS ARE TIGHT.

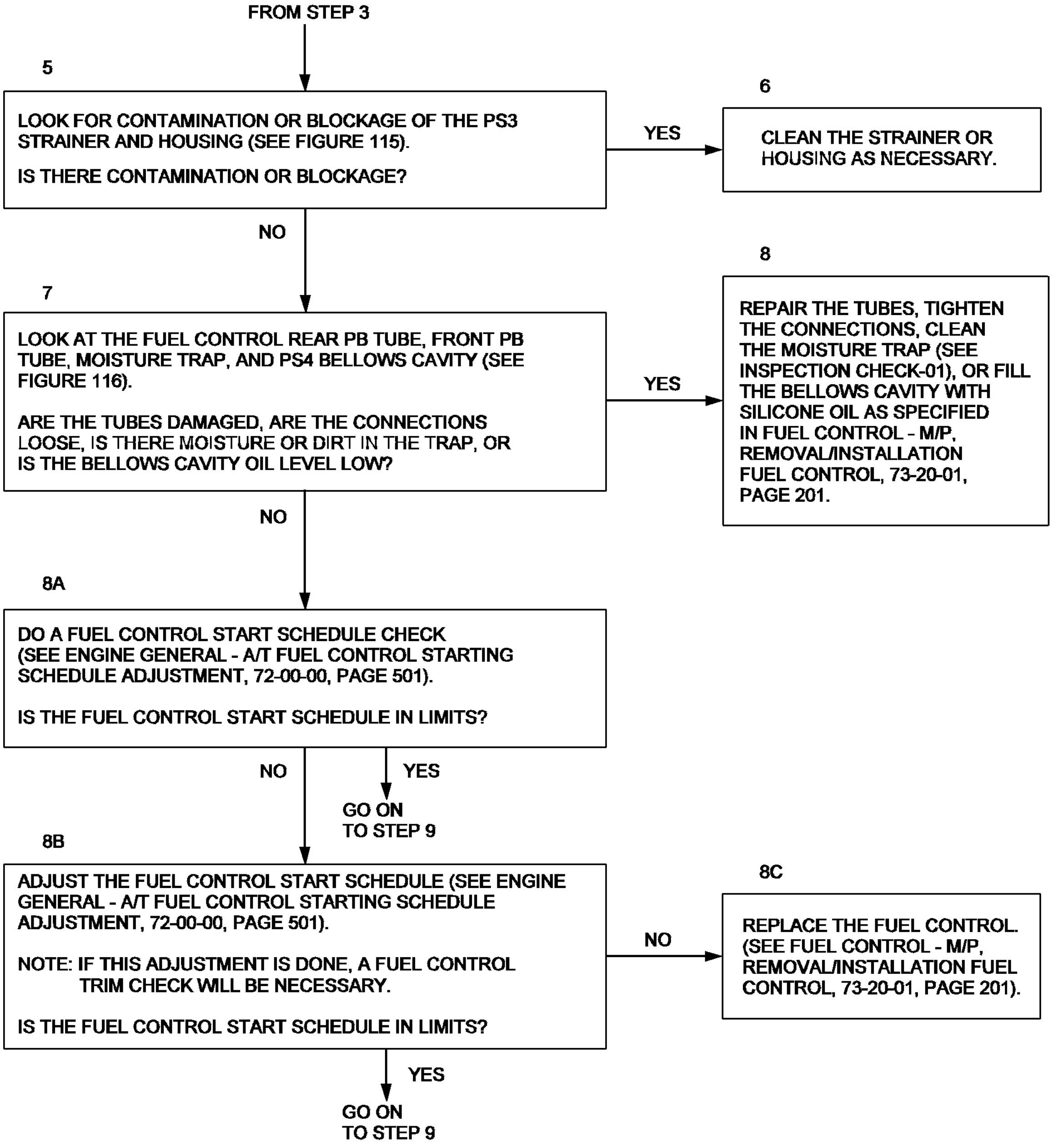
ARE THE TUBES DAMAGED, ARE THE CONNECTIONS LOOSE, OR IS THERE DIRT IN THE SCREENS?

4 CLEAN THE SCREENS AS NECESSARY. TIGHTEN LOOSE TUBE CONNECTIONS AND REPLACE BROKEN TUBES. SEE CHAPTER/SECTION 75-31-05 PAGE 601).

GO ON TO STEP 5

Slow Acceleration Troubleshooting
Figure 114/72-00-04-990-814 (Sheet 1 of 7)

SLOW ACCELERATION (CONTINUED)



5 LOOK FOR CONTAMINATION OR BLOCKAGE OF THE PS3 STRAINER AND HOUSING (SEE FIGURE 115).

IS THERE CONTAMINATION OR BLOCKAGE?

6 CLEAN THE STRAINER OR HOUSING AS NECESSARY.

7 LOOK AT THE FUEL CONTROL REAR PB TUBE, FRONT PB TUBE, MOISTURE TRAP, AND PS4 BELLOWS CAVITY (SEE FIGURE 116).

ARE THE TUBES DAMAGED, ARE THE CONNECTIONS LOOSE, IS THERE MOISTURE OR DIRT IN THE TRAP, OR IS THE BELLOWS CAVITY OIL LEVEL LOW?

8 REPAIR THE TUBES, TIGHTEN THE CONNECTIONS, CLEAN THE MOISTURE TRAP (SEE INSPECTION CHECK-01), OR FILL THE BELLOWS CAVITY WITH SILICONE OIL AS SPECIFIED IN FUEL CONTROL - M/P, REMOVAL/INSTALLATION FUEL CONTROL, 73-20-01, PAGE 201.

8A DO A FUEL CONTROL START SCHEDULE CHECK (SEE ENGINE GENERAL - A/T FUEL CONTROL STARTING SCHEDULE ADJUSTMENT, 72-00-00, PAGE 501).

IS THE FUEL CONTROL START SCHEDULE IN LIMITS?

8B ADJUST THE FUEL CONTROL START SCHEDULE (SEE ENGINE GENERAL - A/T FUEL CONTROL STARTING SCHEDULE ADJUSTMENT, 72-00-00, PAGE 501).

NOTE: IF THIS ADJUSTMENT IS DONE, A FUEL CONTROL TRIM CHECK WILL BE NECESSARY.

IS THE FUEL CONTROL START SCHEDULE IN LIMITS?

8C REPLACE THE FUEL CONTROL. (SEE FUEL CONTROL - M/P, REMOVAL/INSTALLATION FUEL CONTROL, 73-20-01, PAGE 201).

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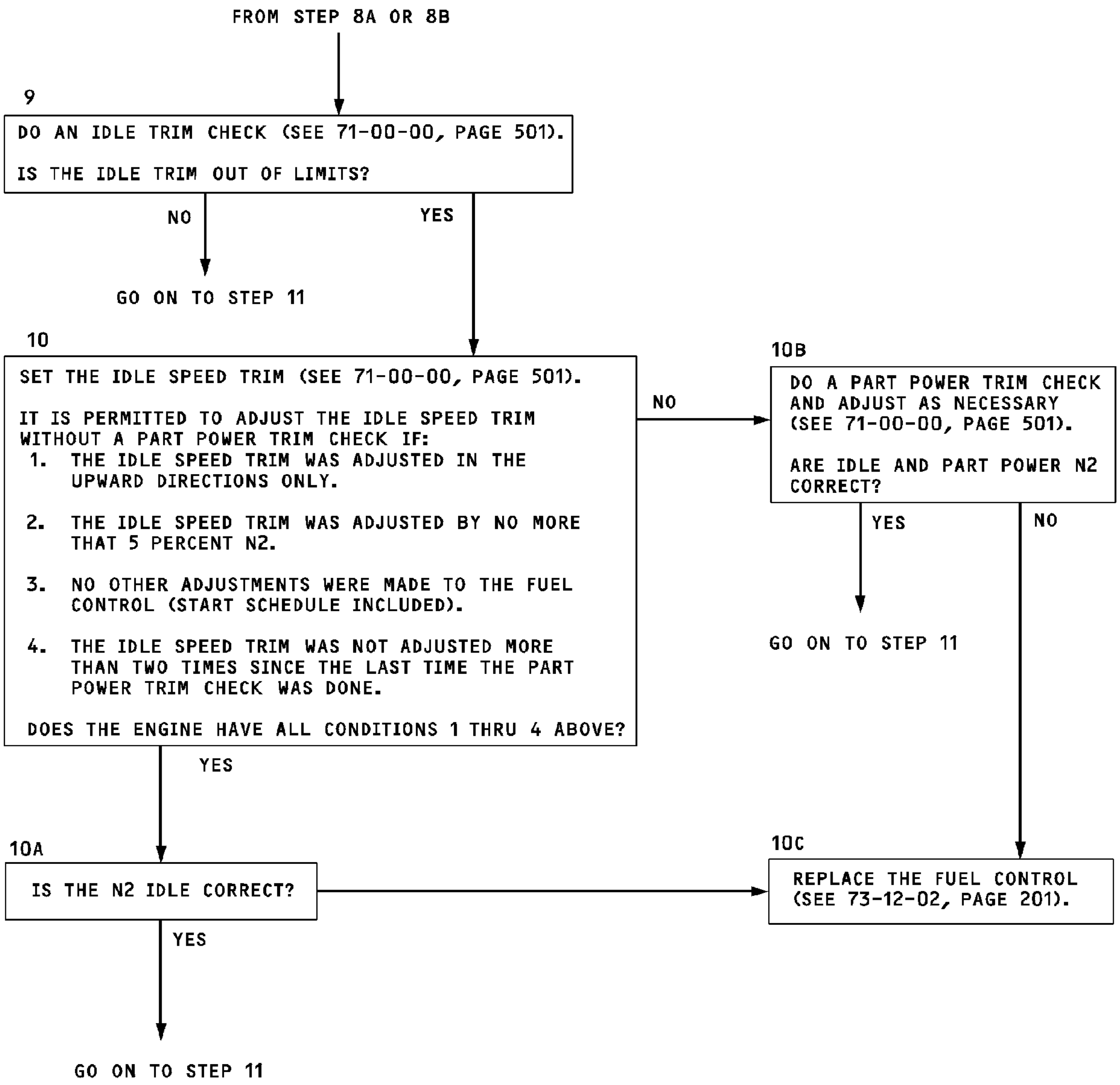
Slow Acceleration Troubleshooting
Figure 114/72-00-04-990-814 (Sheet 2 of 7)

SLOW ACCELERATION (CONTINUED)



9 DO AN IDLE TRIM CHECK (SEE 71-00-00, PAGE 501).

IS THE IDLE TRIM OUT OF LIMITS?

10 SET THE IDLE SPEED TRIM (SEE 71-00-00, PAGE 501).

IT IS PERMITTED TO ADJUST THE IDLE SPEED TRIM WITHOUT A PART POWER TRIM CHECK IF:

1. THE IDLE SPEED TRIM WAS ADJUSTED IN THE UPWARD DIRECTIONS ONLY.
2. THE IDLE SPEED TRIM WAS ADJUSTED BY NO MORE THAT 5 PERCENT N2.
3. NO OTHER ADJUSTMENTS WERE MADE TO THE FUEL CONTROL (START SCHEDULE INCLUDED).
4. THE IDLE SPEED TRIM WAS NOT ADJUSTED MORE THAN TWO TIMES SINCE THE LAST TIME THE PART POWER TRIM CHECK WAS DONE.

DOES THE ENGINE HAVE ALL CONDITIONS 1 THRU 4 ABOVE?

10A IS THE N2 IDLE CORRECT?

10B DO A PART POWER TRIM CHECK AND ADJUST AS NECESSARY (SEE 71-00-00, PAGE 501).

ARE IDLE AND PART POWER N2 CORRECT?

10C REPLACE THE FUEL CONTROL (SEE 73-12-02, PAGE 201).

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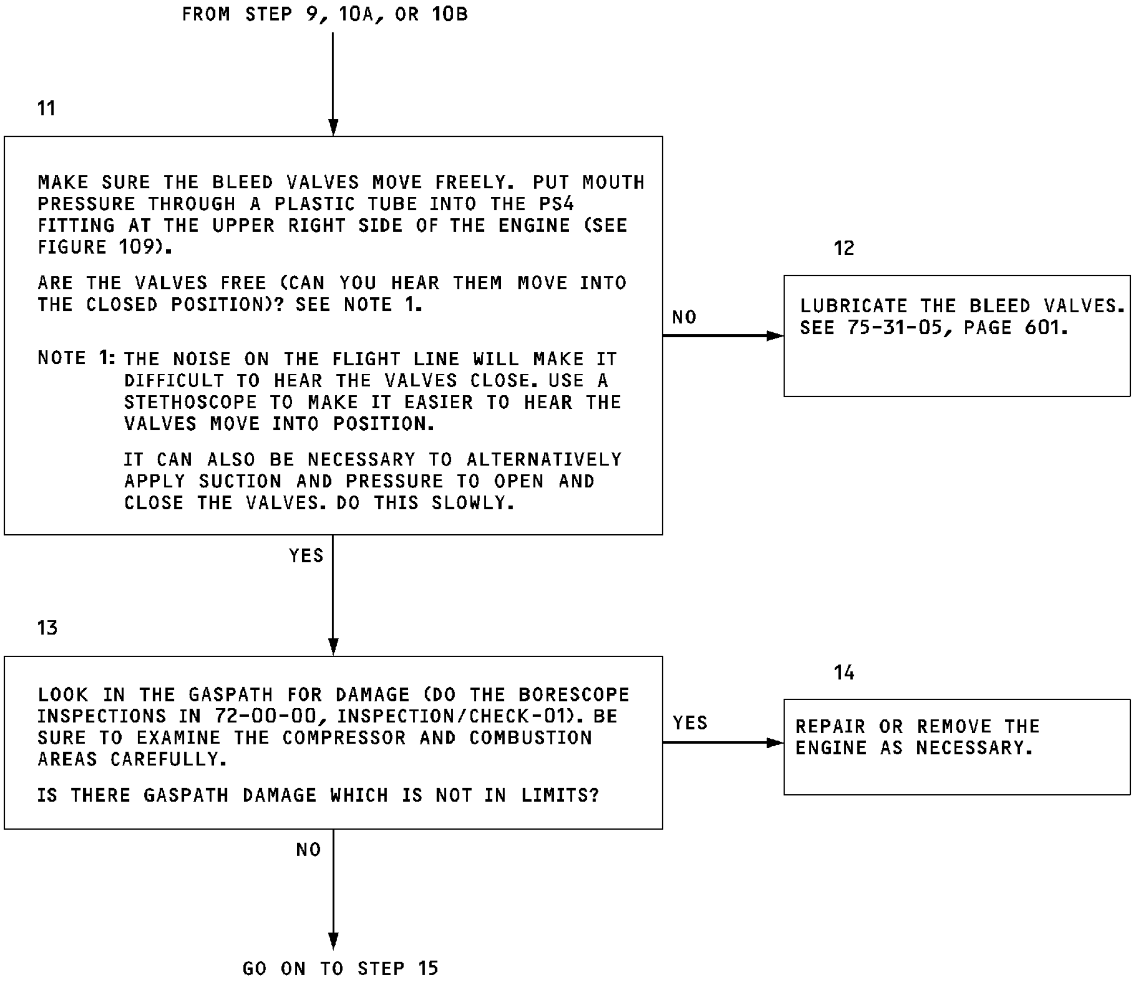
Slow Acceleration Troubleshooting
Figure 114/72-00-04-990-814 (Sheet 3 of 7)

SLOW ACCELERATION (CONTINUED)



FROM STEP 9, 10A, OR 10B

11

MAKE SURE THE BLEED VALVES MOVE FREELY. PUT MOUTH PRESSURE THROUGH A PLASTIC TUBE INTO THE PS4 FITTING AT THE UPPER RIGHT SIDE OF THE ENGINE (SEE FIGURE 109).

ARE THE VALVES FREE (CAN YOU HEAR THEM MOVE INTO THE CLOSED POSITION)? SEE NOTE 1.

NOTE 1: THE NOISE ON THE FLIGHT LINE WILL MAKE IT DIFFICULT TO HEAR THE VALVES CLOSE. USE A STETHOSCOPE TO MAKE IT EASIER TO HEAR THE VALVES MOVE INTO POSITION.

IT CAN ALSO BE NECESSARY TO ALTERNATIVELY APPLY SUCTION AND PRESSURE TO OPEN AND CLOSE THE VALVES. DO THIS SLOWLY.

NO

12

LUBRICATE THE BLEED VALVES. SEE 75-31-05, PAGE 601.

YES

13

LOOK IN THE GASPATH FOR DAMAGE (DO THE BORESCOPE INSPECTIONS IN 72-00-00, INSPECTION/CHECK-01). BE SURE TO EXAMINE THE COMPRESSOR AND COMBUSTION AREAS CAREFULLY.

IS THERE GASPATH DAMAGE WHICH IS NOT IN LIMITS?

YES

14

REPAIR OR REMOVE THE ENGINE AS NECESSARY.

NO

GO ON TO STEP 15

L-H1295 (0199)

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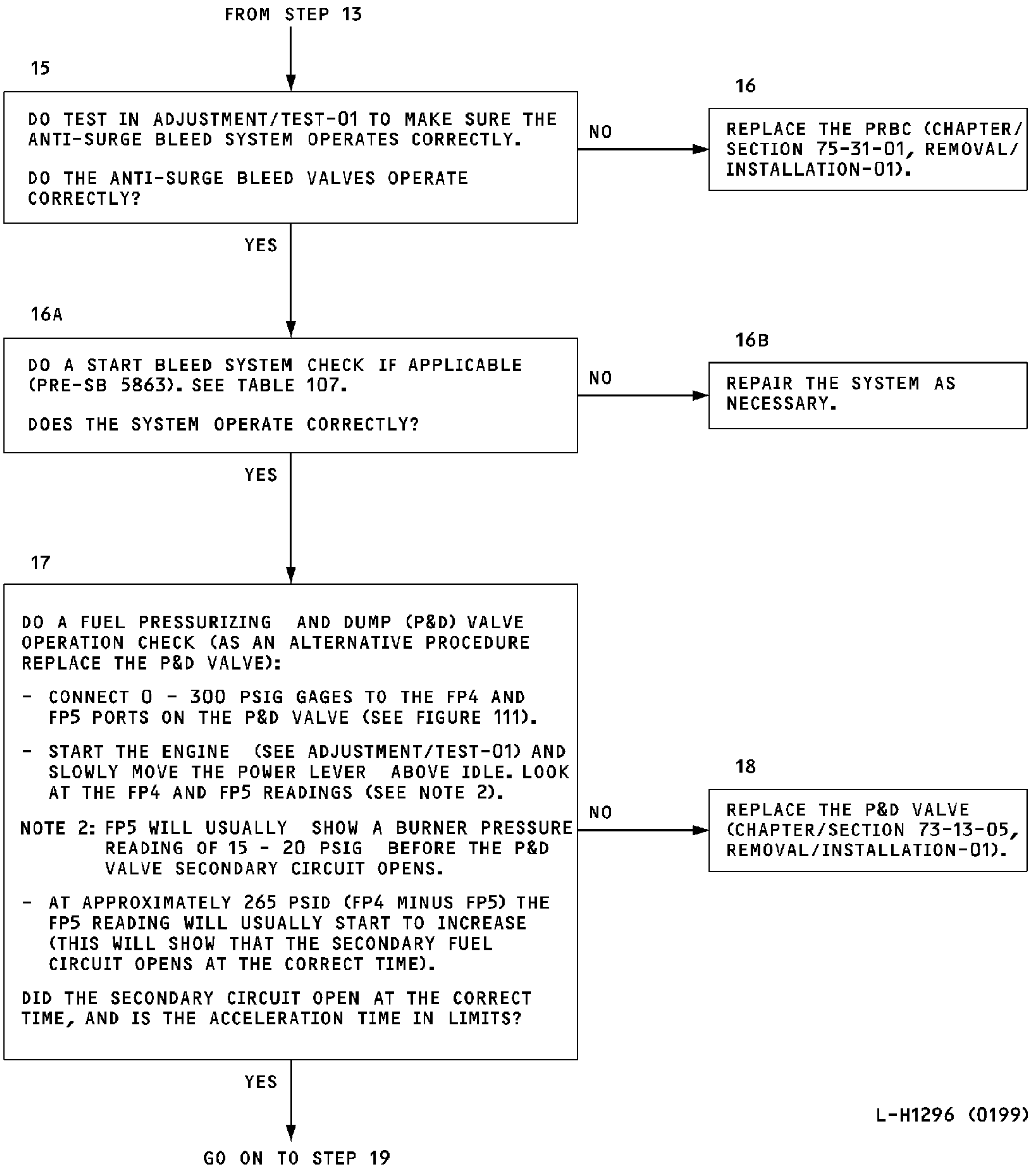
Slow Acceleration Troubleshooting
Figure 114/72-00-04-990-814 (Sheet 4 of 7)

SLOW ACCELERATION (CONTINUED)



15

DO TEST IN ADJUSTMENT/TEST-01 TO MAKE SURE THE ANTI-SURGE BLEED SYSTEM OPERATES CORRECTLY.

DO THE ANTI-SURGE BLEED VALVES OPERATE CORRECTLY?

16

REPLACE THE PRBC (CHAPTER/SECTION 75-31-01, REMOVAL/INSTALLATION-01).

16A

DO A START BLEED SYSTEM CHECK IF APPLICABLE (PRE-SB 5863). SEE TABLE 107.

DOES THE SYSTEM OPERATE CORRECTLY?

16B

REPAIR THE SYSTEM AS NECESSARY.

17

DO A FUEL PRESSURIZING AND DUMP (P&D) VALVE OPERATION CHECK (AS AN ALTERNATIVE PROCEDURE REPLACE THE P&D VALVE):

- CONNECT 0 - 300 PSIG GAGES TO THE FP4 AND FP5 PORTS ON THE P&D VALVE (SEE FIGURE 111).
- START THE ENGINE (SEE ADJUSTMENT/TEST-01) AND SLOWLY MOVE THE POWER LEVER ABOVE IDLE. LOOK AT THE FP4 AND FP5 READINGS (SEE NOTE 2).

NOTE 2: FP5 WILL USUALLY SHOW A BURNER PRESSURE READING OF 15 - 20 PSIG BEFORE THE P&D VALVE SECONDARY CIRCUIT OPENS.

- AT APPROXIMATELY 265 PSID (FP4 MINUS FP5) THE FP5 READING WILL USUALLY START TO INCREASE (THIS WILL SHOW THAT THE SECONDARY FUEL CIRCUIT OPENS AT THE CORRECT TIME).

DID THE SECONDARY CIRCUIT OPEN AT THE CORRECT TIME, AND IS THE ACCELERATION TIME IN LIMITS?

18

REPLACE THE P&D VALVE (CHAPTER/SECTION 73-13-05, REMOVAL/INSTALLATION-01).

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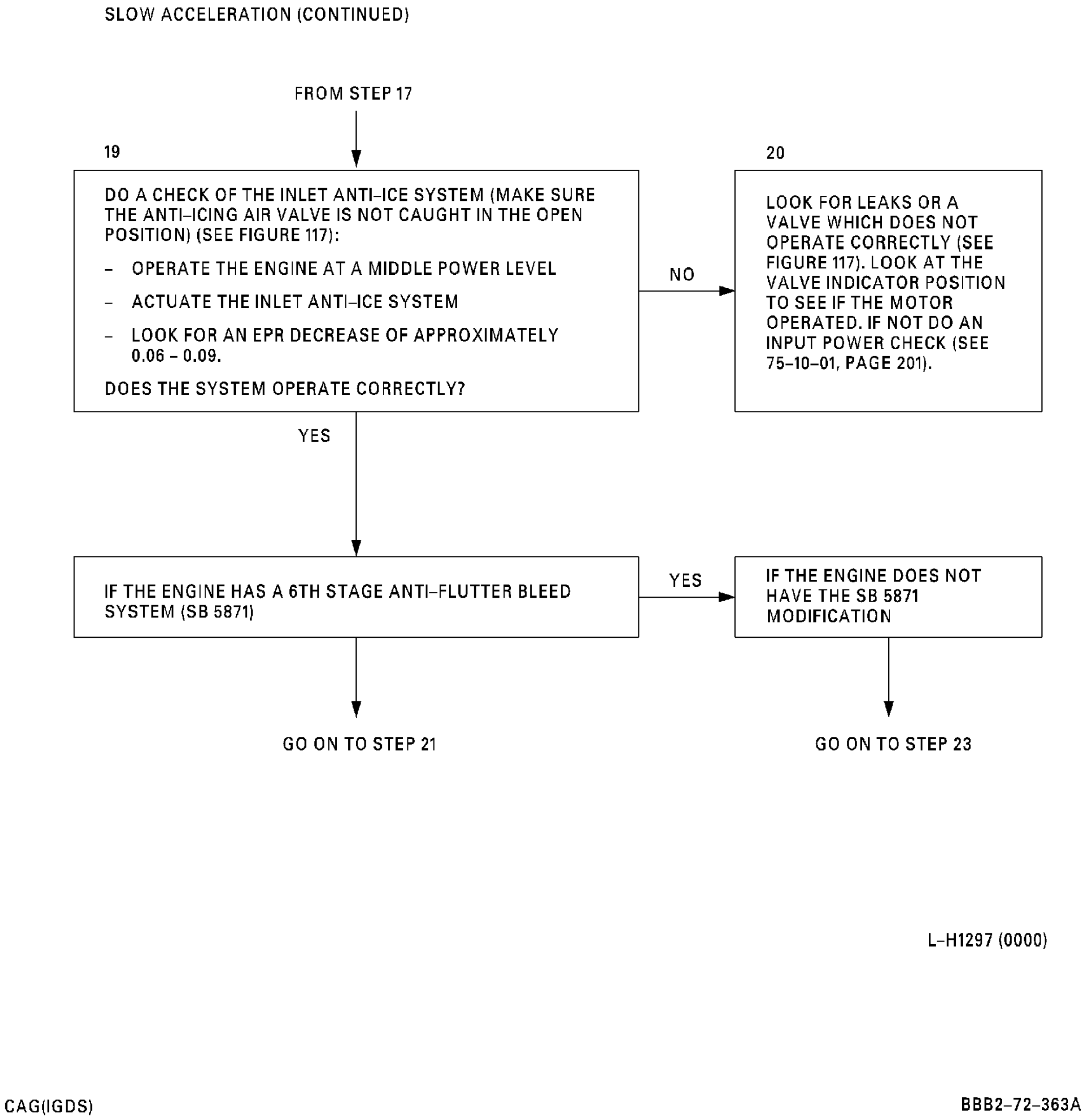
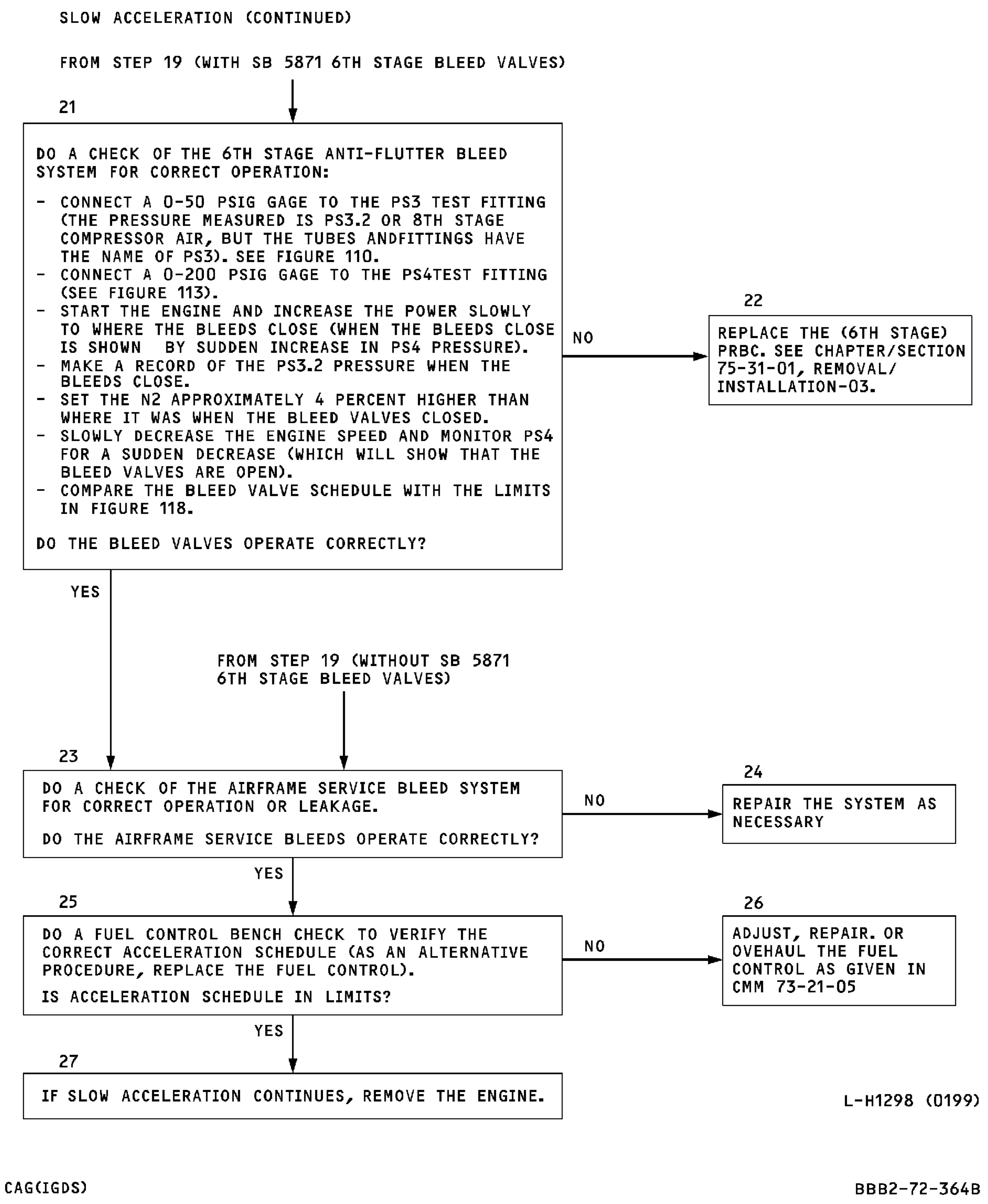
Slow Acceleration Troubleshooting
Figure 114/72-00-04-990-814 (Sheet 5 of 7)



Slow Acceleration Troubleshooting
Figure 114/72-00-04-990-814 (Sheet 6 of 7)



SLOW ACCELERATION (CONTINUED)

FROM STEP 19 (WITH SB 5871 6TH STAGE BLEED VALVES)

21

DO A CHECK OF THE 6TH STAGE ANTI-FLUTTER BLEED SYSTEM FOR CORRECT OPERATION:

- CONNECT A 0-50 PSIG GAGE TO THE PS3 TEST FITTING (THE PRESSURE MEASURED IS PS3.2 OR 8TH STAGE COMPRESSOR AIR, BUT THE TUBES ANDFITTINGS HAVE THE NAME OF PS3). SEE FIGURE 110.
- CONNECT A 0-200 PSIG GAGE TO THE PS4TEST FITTING (SEE FIGURE 113).
- START THE ENGINE AND INCREASE THE POWER SLOWLY TO WHERE THE BLEEDS CLOSE (WHEN THE BLEEDS CLOSE IS SHOWN BY SUDDEN INCREASE IN PS4 PRESSURE).
- MAKE A RECORD OF THE PS3.2 PRESSURE WHEN THE BLEEDS CLOSE.
- SET THE N2 APPROXIMATELY 4 PERCENT HIGHER THAN WHERE IT WAS WHEN THE BLEED VALVES CLOSED.
- SLOWLY DECREASE THE ENGINE SPEED AND MONITOR PS4 FOR A SUDDEN DECREASE (WHICH WILL SHOW THAT THE BLEED VALVES ARE OPEN).
- COMPARE THE BLEED VALVE SCHEDULE WITH THE LIMITS IN FIGURE 118.

DO THE BLEED VALVES OPERATE CORRECTLY?

22

REPLACE THE (6TH STAGE) PRBC. SEE CHAPTER/SECTION 75-31-01, REMOVAL/ INSTALLATION-03.

FROM STEP 19 (WITHOUT SB 5871 6TH STAGE BLEED VALVES)

23

DO A CHECK OF THE AIRFRAME SERVICE BLEED SYSTEM FOR CORRECT OPERATION OR LEAKAGE.

DO THE AIRFRAME SERVICE BLEEDS OPERATE CORRECTLY?

24

REPAIR THE SYSTEM AS NECESSARY

25

DO A FUEL CONTROL BENCH CHECK TO VERIFY THE CORRECT ACCELERATION SCHEDULE (AS AN ALTERNATIVE PROCEDURE, REPLACE THE FUEL CONTROL).

IS ACCELERATION SCHEDULE IN LIMITS?

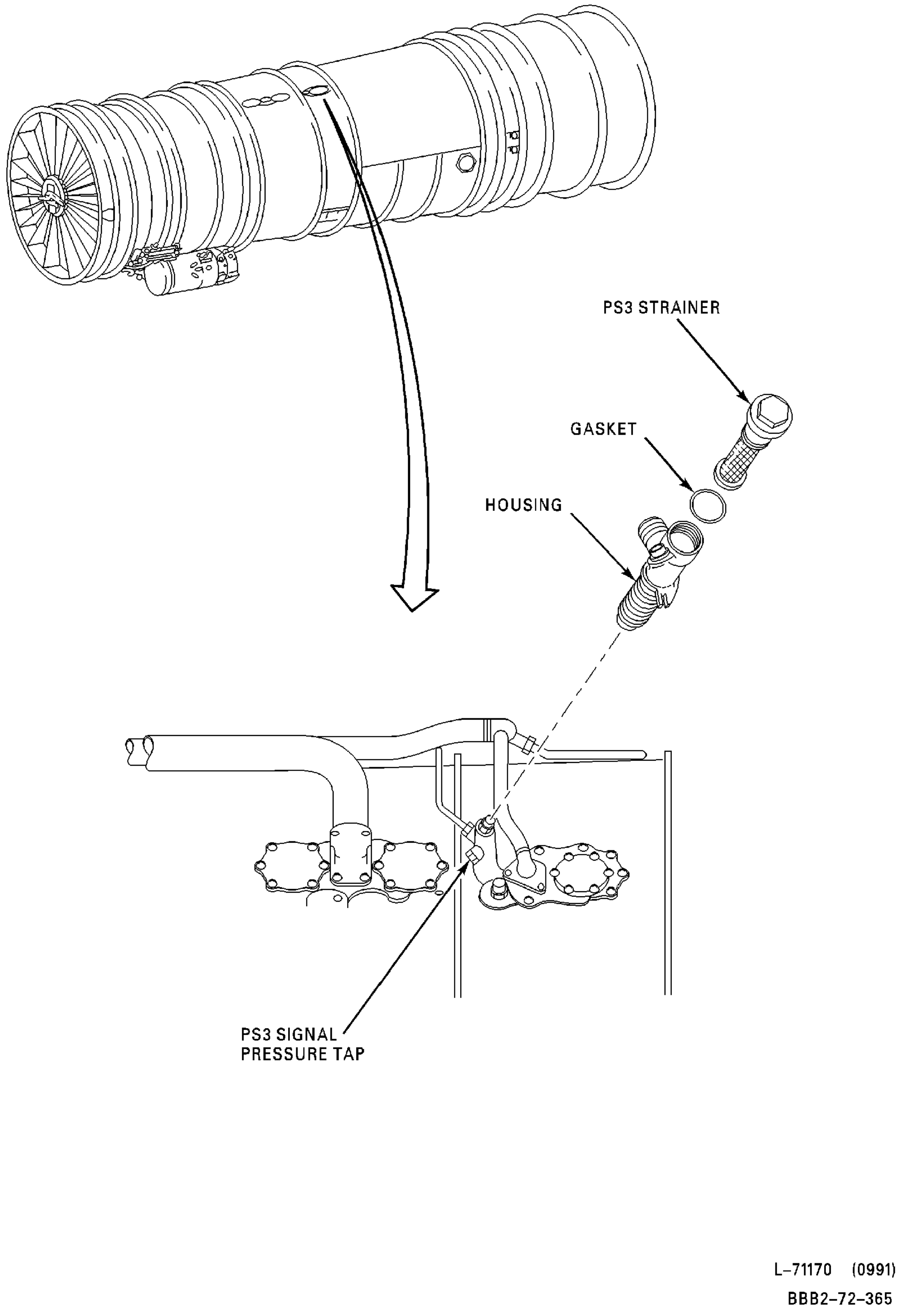
26

ADJUST, REPAIR. OR OVEHAUL THE FUEL CONTROL AS GIVEN IN CMM 73-21-05

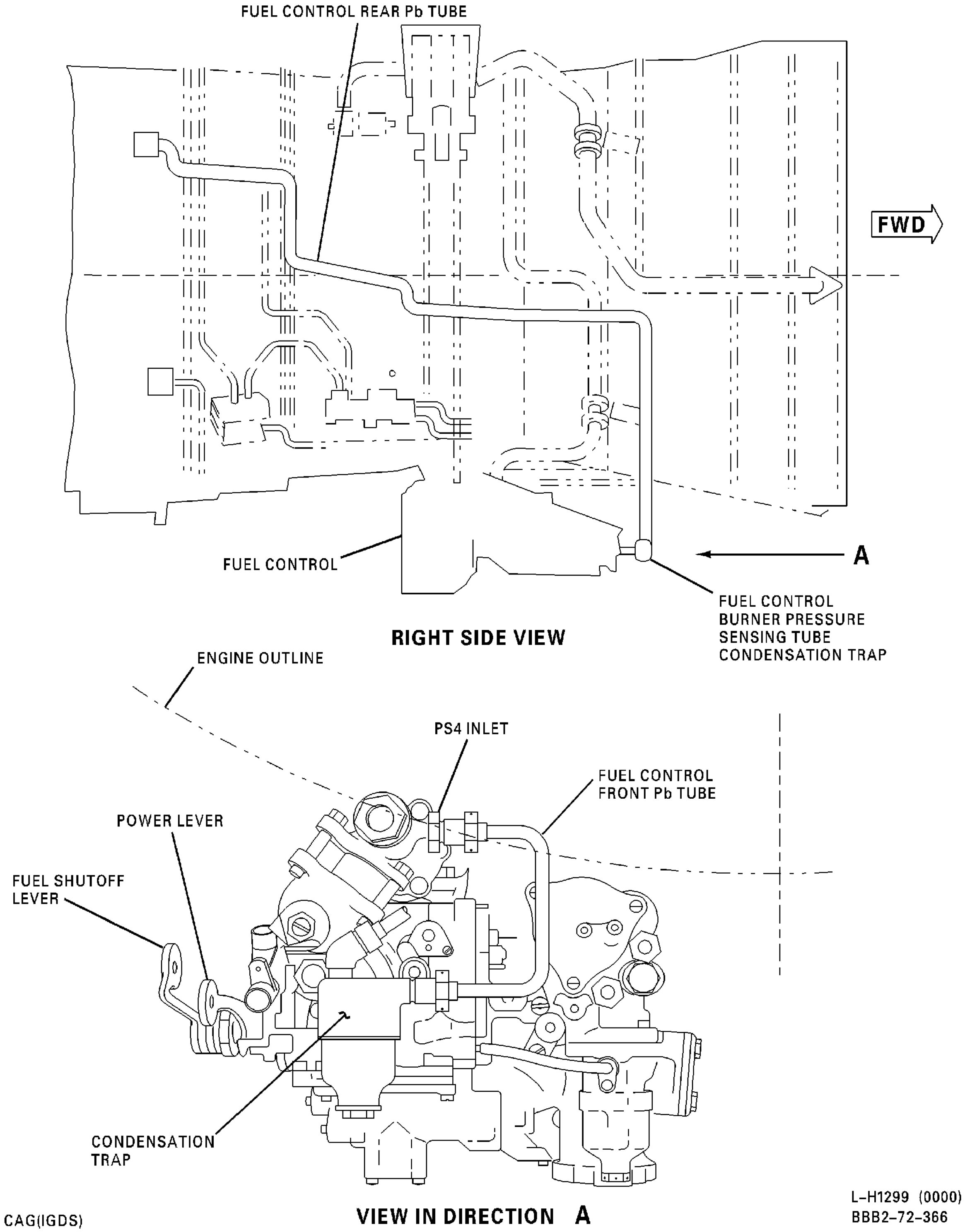
27

IF SLOW ACCELERATION CONTINUES, REMOVE THE ENGINE.

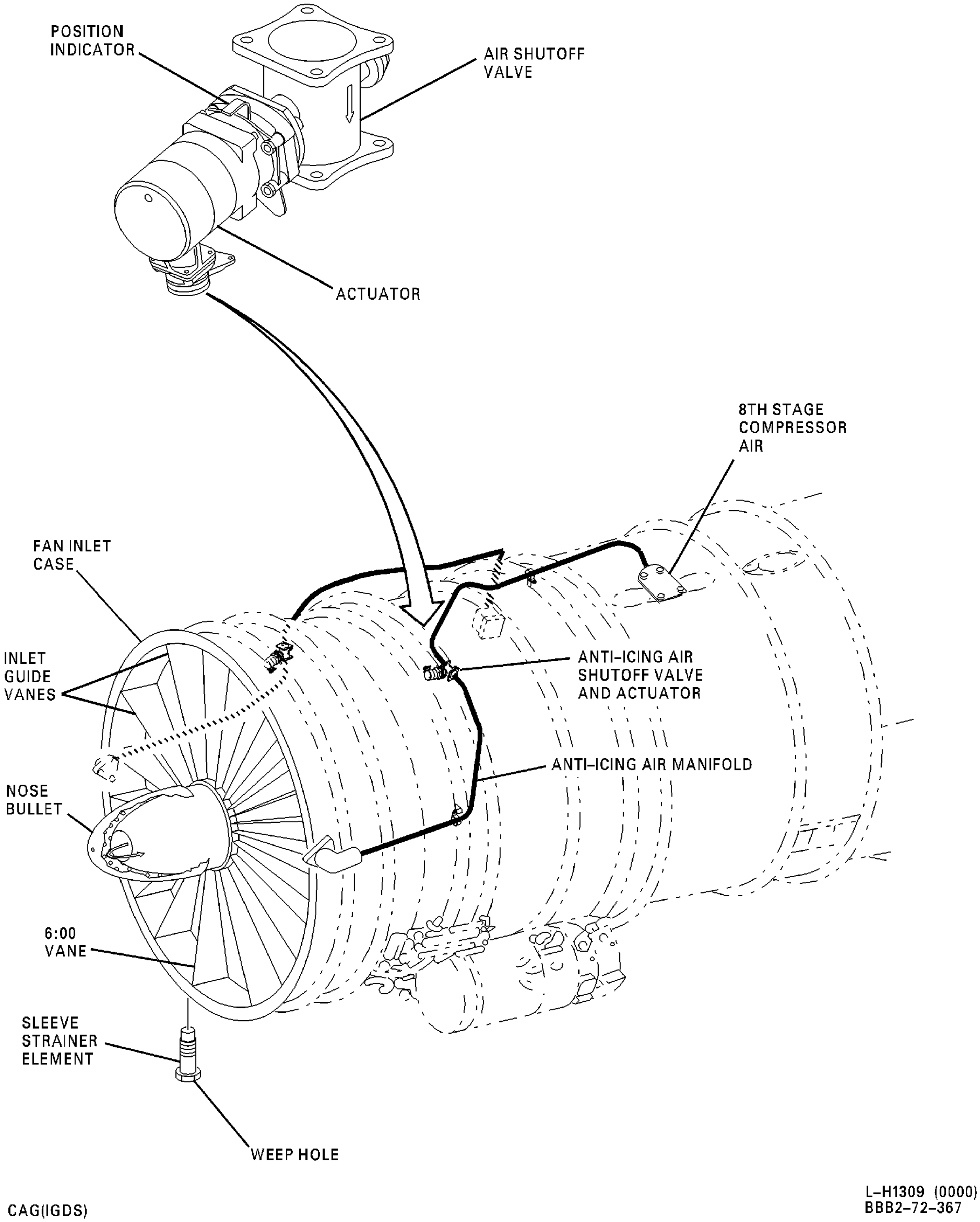
Slow Acceleration Troubleshooting
Figure 114/72-00-04-990-814 (Sheet 7 of 7)



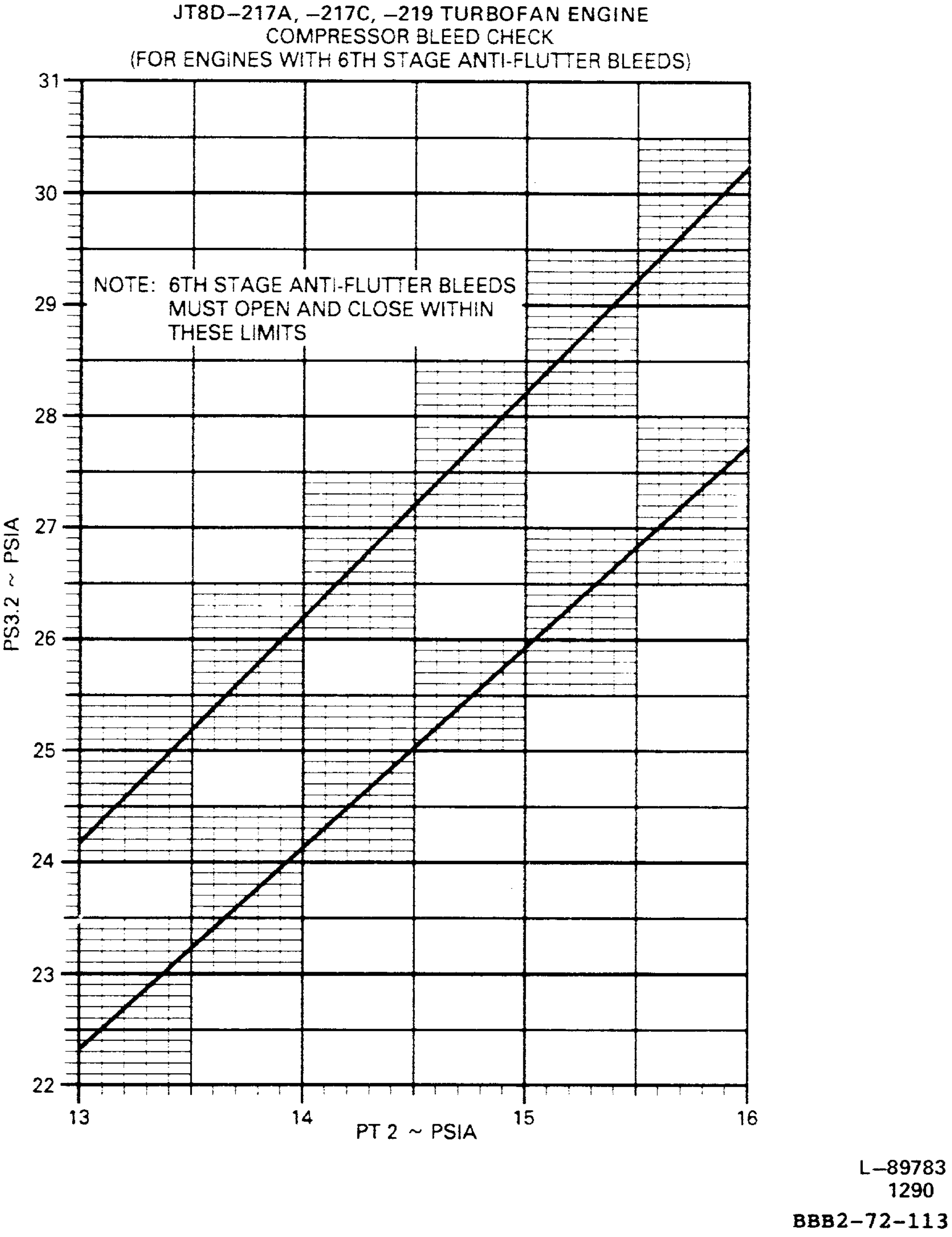
PS3 Strainer Check
Figure 115/72-00-04-990-815



Burner Pressure (Pb) Tubes and Moisture Trap
Figure 116/72-00-04-990-816



Inlet Anti-Icing System Operation Check
Figure 117/72-00-04-990-817



Sixth Stage Anti-Flutter Bleed Check Curve
Figure 118/72-00-04-990-818

5. Unable To Reach Takeoff Power

A. General (Figure 119) (Figure 120) (Figure 121) (Figure 122)

(1) When an engine cannot go to Takeoff power, this can be because of:

- Redline limits
- Throttle position limits
- Unusual engine response.

(2) The cause of this complaint can be problems with:

- Indication (EPR, EGT, N_1/N_2)
- Anti-surge bleed (Ps3 pressure, strainer, pressure ratio bleed control, bleed valve control, start bleed control valve, engine compressor bleed valves)
- Aircraft air system (leaks)
- Anti-ice system (leaks)
- Gaspath (damage to the inlet, compressor, combustion section, turbine, exhaust)
- Fuel (supply, fuel pressure, fuel control, primary or secondary fuel manifold, Ps4 signal, pressurizing and dump valve)

(3) Fuel: The most frequent fuel cause is fuel flow which is not sufficient (the fuel flow and EGT for the engine will be low compared to other engines).

(4) Fuel flow can change during engine operation. These are the limits for fuel flow change (in pounds per hour):

NOTE: Monitor fuel flow for change at Climb or Cruise power level. Monitor EPR and N_2 at the same time (if EPR and N_2 change with the fuel flow, a defect in the fuel control is very possible).

Table 101

LIMIT	ACTION
0 - 150 pph	Continued engine operation is permitted.
150 - 300 pph	Continued engine operation is permitted but:
	1. Get information from the outbound crew about the fuel flow difference.
	2. If the difference occurs again on two or more flights, start troubleshooting and actions to correct the problem.
300 pph or more	Continued engine operation is not permitted. Replace the fuel control unless some other defect is found.

(5) Indication: (ENGINE GENERAL - TROUBLESHOOTING-03 (INDICATION SYSTEM), PAGEBLOCK 72-00-03/101)

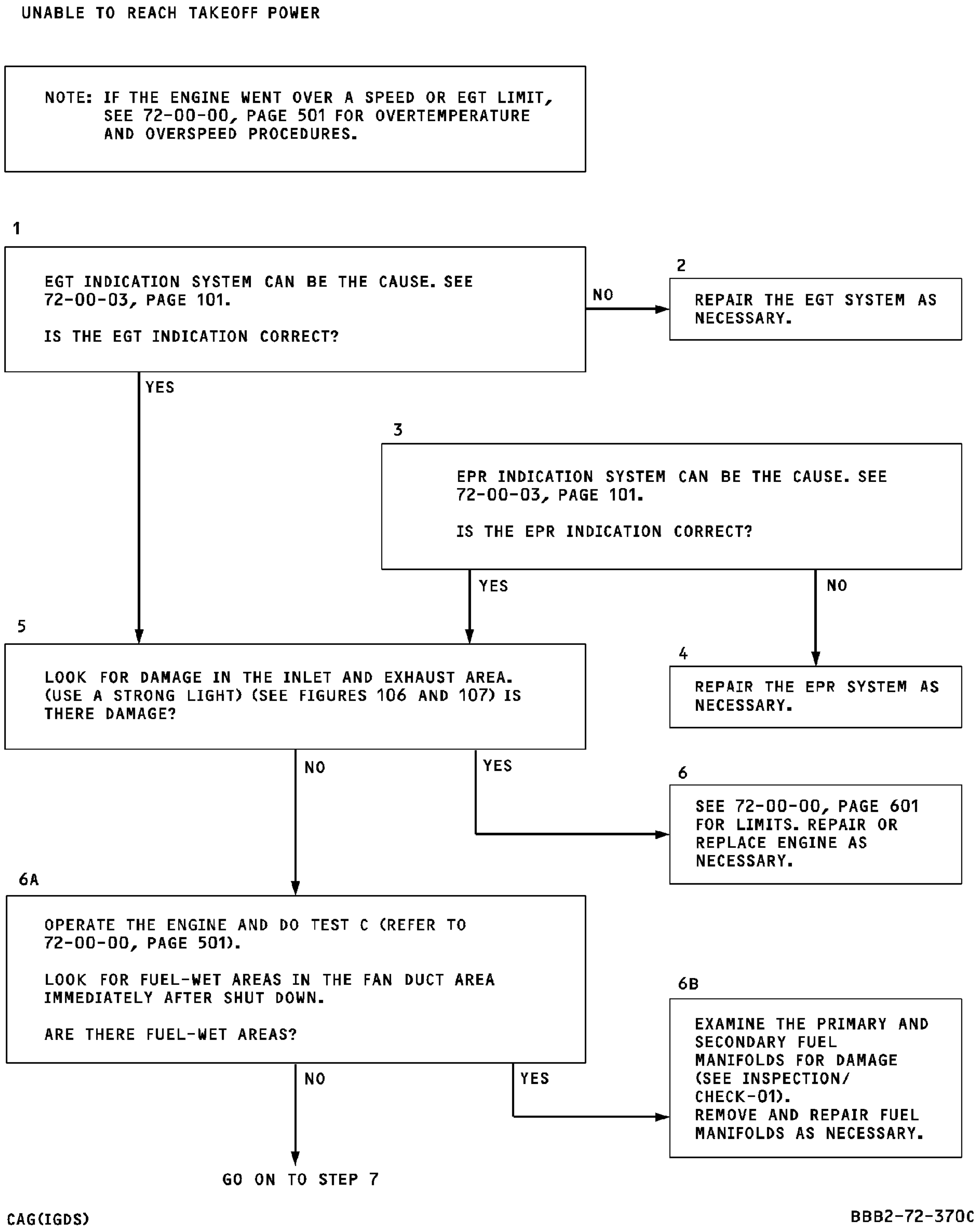
(6) Anti-surge bleed: If bleed valves do not close correctly, this can cause a large fuel flow and EGT increase but only a small engine speed decrease. Idle power will be apparently normal.

(7) Anti-ice and aircraft air systems: Defects in these systems can cause overheat or fire warnings. If engine power decreases, it is easy for the flight crew to increase the power (with higher fuel flow and EGT); it is possible that engine speed limits will prevent Takeoff power operation.

(8) Gaspath: A damaged gaspath will cause high EGT and fuel flow, but engine speed can be high or low. It is possible that there will be slow acceleration, difficult starts, surge, or throttle handles at different positions ("throttle stagger").

(9) The steps in the troubleshooting diagrams are about engine complaints (compared to another engine in the aircraft) in this sequence:

- Step 1: EGT (only)
- Step 3: All parameters
- Step 5: Fuel flow and EGT high
- Step 33: No throttle response, or unusual engine response
- Step 39: Power lever "throttle limited", with other parameters high but in limits



UNABLE TO REACH TAKEOFF POWER

NOTE: IF THE ENGINE WENT OVER A SPEED OR EGT LIMIT, SEE 72-00-00, PAGE 501 FOR OVERTEMPERATURE AND OVERSPEED PROCEDURES.

1 EGT INDICATION SYSTEM CAN BE THE CAUSE. SEE 72-00-03, PAGE 101.

IS THE EGT INDICATION CORRECT?

2 REPAIR THE EGT SYSTEM AS NECESSARY.

3 EPR INDICATION SYSTEM CAN BE THE CAUSE. SEE 72-00-03, PAGE 101.

IS THE EPR INDICATION CORRECT?

4 REPAIR THE EPR SYSTEM AS NECESSARY.

5 LOOK FOR DAMAGE IN THE INLET AND EXHAUST AREA. (USE A STRONG LIGHT) (SEE FIGURES 106 AND 107) IS THERE DAMAGE?

6 SEE 72-00-00, PAGE 601 FOR LIMITS. REPAIR OR REPLACE ENGINE AS NECESSARY.

6A OPERATE THE ENGINE AND DO TEST C (REFER TO 72-00-00, PAGE 501).

LOOK FOR FUEL-WET AREAS IN THE FAN DUCT AREA IMMEDIATELY AFTER SHUT DOWN.

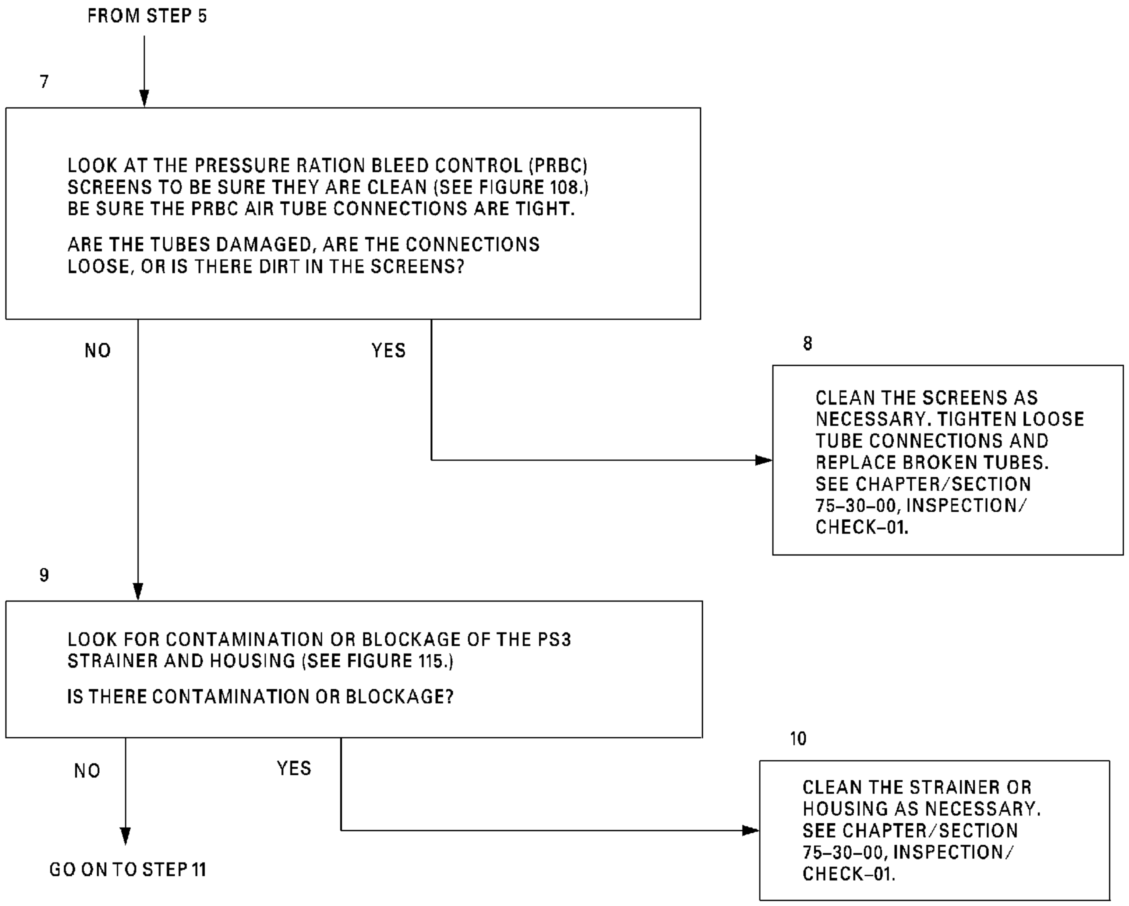
ARE THERE FUEL-WET AREAS?

6B EXAMINE THE PRIMARY AND SECONDARY FUEL MANIFOLDS FOR DAMAGE (SEE INSPECTION/CHECK-01). REMOVE AND REPAIR FUEL MANIFOLDS AS NECESSARY.

GO ON TO STEP 7

Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 1 of 11)

UNABLE TO REACH TAKEOFF POWER (CONTINUED)



LOOK AT THE PRESSURE RATION BLEED CONTROL (PRBC) SCREENS TO BE SURE THEY ARE CLEAN (SEE FIGURE 108.) BE SURE THE PRBC AIR TUBE CONNECTIONS ARE TIGHT.

ARE THE TUBES DAMAGED, ARE THE CONNECTIONS LOOSE, OR IS THERE DIRT IN THE SCREENS?

CLEAN THE SCREENS AS NECESSARY. TIGHTEN LOOSE TUBE CONNECTIONS AND REPLACE BROKEN TUBES. SEE CHAPTER/SECTION 75-30-00, INSPECTION/CHECK-01.

LOOK FOR CONTAMINATION OR BLOCKAGE OF THE PS3 STRAINER AND HOUSING (SEE FIGURE 115.)

IS THERE CONTAMINATION OR BLOCKAGE?

CLEAN THE STRAINER OR HOUSING AS NECESSARY. SEE CHAPTER/SECTION 75-30-00, INSPECTION/CHECK-01.

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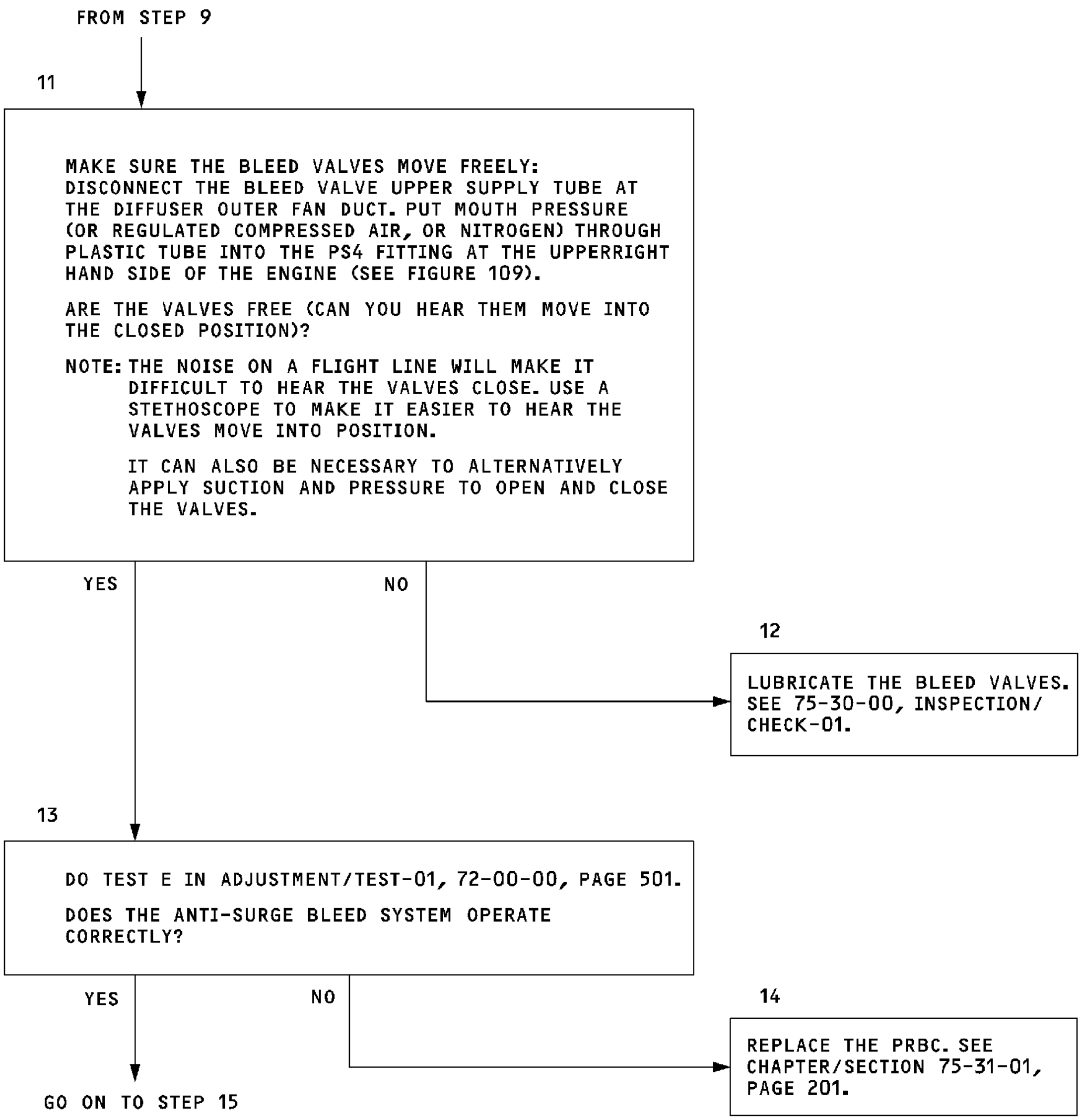
Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 2 of 11)

UNABLE TO REACH TAKE OFF POWER (CONTINUED)



11

MAKE SURE THE BLEED VALVES MOVE FREELY: DISCONNECT THE BLEED VALVE UPPER SUPPLY TUBE AT THE DIFFUSER OUTER FAN DUCT. PUT MOUTH PRESSURE (OR REGULATED COMPRESSED AIR, OR NITROGEN) THROUGH PLASTIC TUBE INTO THE PS4 FITTING AT THE UPPERRIGHT HAND SIDE OF THE ENGINE (SEE FIGURE 109).

ARE THE VALVES FREE (CAN YOU HEAR THEM MOVE INTO THE CLOSED POSITION)?

NOTE: THE NOISE ON A FLIGHT LINE WILL MAKE IT DIFFICULT TO HEAR THE VALVES CLOSE. USE A STETHOSCOPE TO MAKE IT EASIER TO HEAR THE VALVES MOVE INTO POSITION.

IT CAN ALSO BE NECESSARY TO ALTERNATIVELY APPLY SUCTION AND PRESSURE TO OPEN AND CLOSE THE VALVES.

12

LUBRICATE THE BLEED VALVES. SEE 75-30-00, INSPECTION/CHECK-01.

13

DO TEST E IN ADJUSTMENT/TEST-01, 72-00-00, PAGE 501.

DOES THE ANTI-SURGE BLEED SYSTEM OPERATE CORRECTLY?

14

REPLACE THE PRBC. SEE CHAPTER/SECTION 75-31-01, PAGE 201.

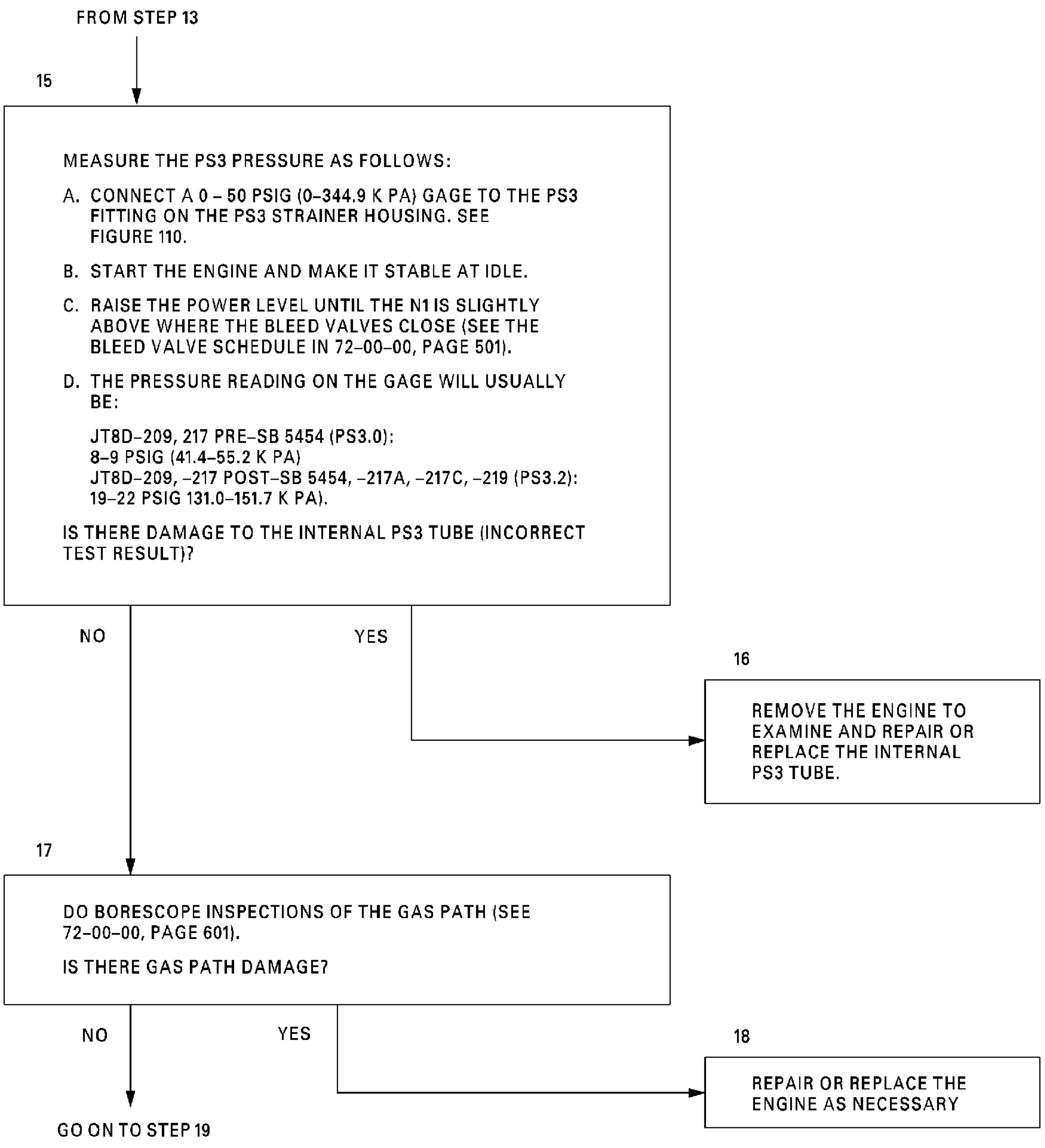
L-H1428 (0000)

CAG(IGDS)

BBB2-72-372B

Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 3 of 11)

UNABLE TO REACH TAKEOFF POWER (CONTINUED)



15

MEASURE THE PS3 PRESSURE AS FOLLOWS:

A. CONNECT A 0 – 50 PSIG (0–344.9 K PA) GAGE TO THE PS3 FITTING ON THE PS3 STRAINER HOUSING. SEE FIGURE 110.

B. START THE ENGINE AND MAKE IT STABLE AT IDLE.

C. RAISE THE POWER LEVEL UNTIL THE N1 IS SLIGHTLY ABOVE WHERE THE BLEED VALVES CLOSE (SEE THE BLEED VALVE SCHEDULE IN 72–00–00, PAGE 501).

D. THE PRESSURE READING ON THE GAGE WILL USUALLY BE:

JT8D–209, 217 PRE–SB 5454 (PS3.0):
8–9 PSIG (41.4–55.2 K PA)
JT8D–209, –217 POST–SB 5454, –217A, –217C, –219 (PS3.2):
19–22 PSIG 131.0–151.7 K PA).

IS THERE DAMAGE TO THE INTERNAL PS3 TUBE (INCORRECT TEST RESULT)?

16

REMOVE THE ENGINE TO EXAMINE AND REPAIR OR REPLACE THE INTERNAL PS3 TUBE.

17

DO BORESCOPE INSPECTIONS OF THE GAS PATH (SEE 72–00–00, PAGE 601).

IS THERE GAS PATH DAMAGE?

18

REPAIR OR REPLACE THE ENGINE AS NECESSARY

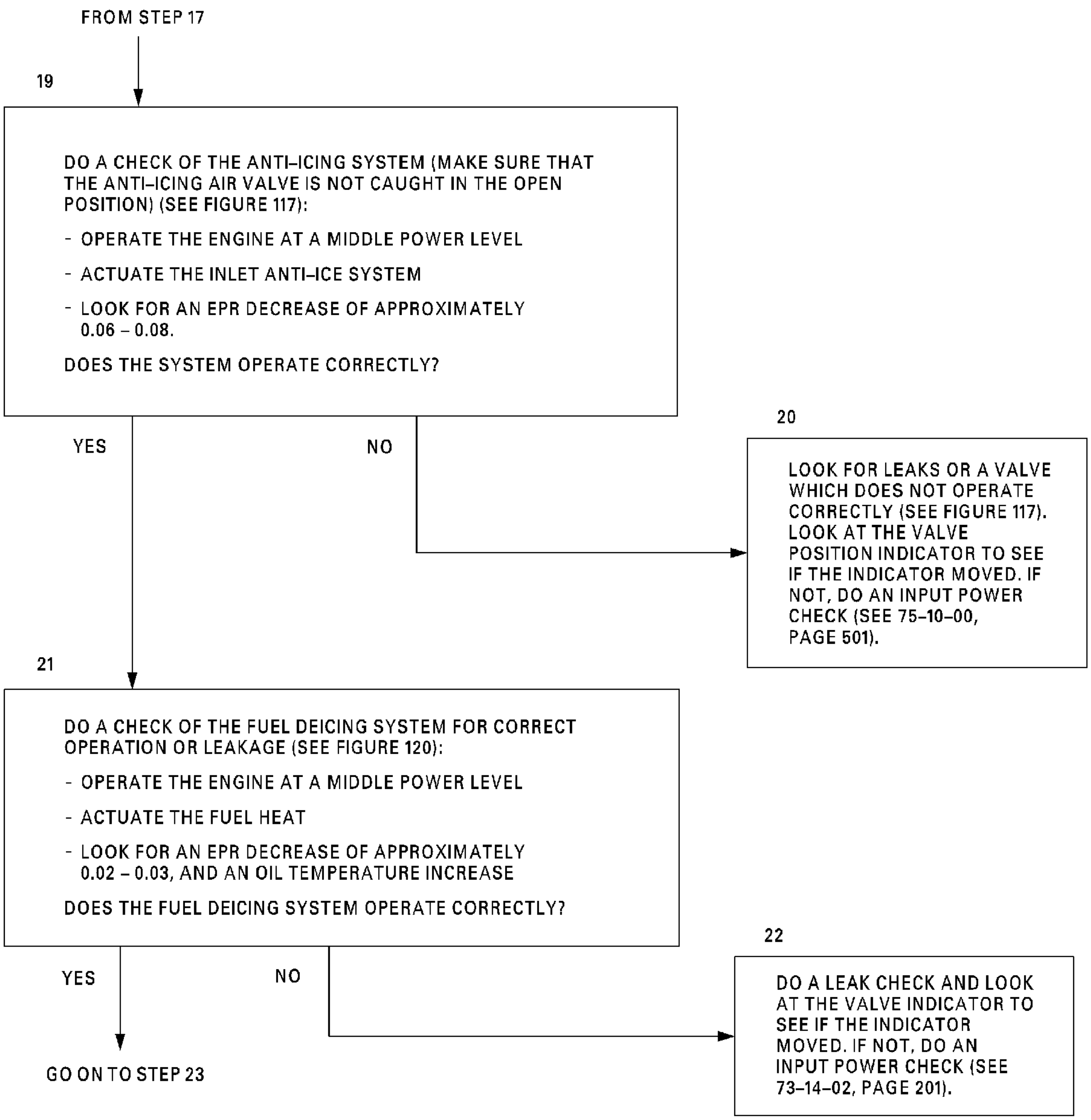
L–H1429 (0000)

CAG(IGDS)

BBB2–72–373A

Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 4 of 11)

UNABLE TO REACH TAKEOFF POWER (CONTINUED)



19

DO A CHECK OF THE ANTI-ICING SYSTEM (MAKE SURE THAT THE ANTI-ICING AIR VALVE IS NOT CAUGHT IN THE OPEN POSITION) (SEE FIGURE 117):

- OPERATE THE ENGINE AT A MIDDLE POWER LEVEL
- ACTUATE THE INLET ANTI-ICE SYSTEM
- LOOK FOR AN EPR DECREASE OF APPROXIMATELY 0.06 – 0.08.

DOES THE SYSTEM OPERATE CORRECTLY?

20

LOOK FOR LEAKS OR A VALVE WHICH DOES NOT OPERATE CORRECTLY (SEE FIGURE 117). LOOK AT THE VALVE POSITION INDICATOR TO SEE IF THE INDICATOR MOVED. IF NOT, DO AN INPUT POWER CHECK (SEE 75-10-00, PAGE 501).

21

DO A CHECK OF THE FUEL DEICING SYSTEM FOR CORRECT OPERATION OR LEAKAGE (SEE FIGURE 120):

- OPERATE THE ENGINE AT A MIDDLE POWER LEVEL
- ACTUATE THE FUEL HEAT
- LOOK FOR AN EPR DECREASE OF APPROXIMATELY 0.02 – 0.03, AND AN OIL TEMPERATURE INCREASE

DOES THE FUEL DEICING SYSTEM OPERATE CORRECTLY?

22

DO A LEAK CHECK AND LOOK AT THE VALVE INDICATOR TO SEE IF THE INDICATOR MOVED. IF NOT, DO AN INPUT POWER CHECK (SEE 73-14-02, PAGE 201).

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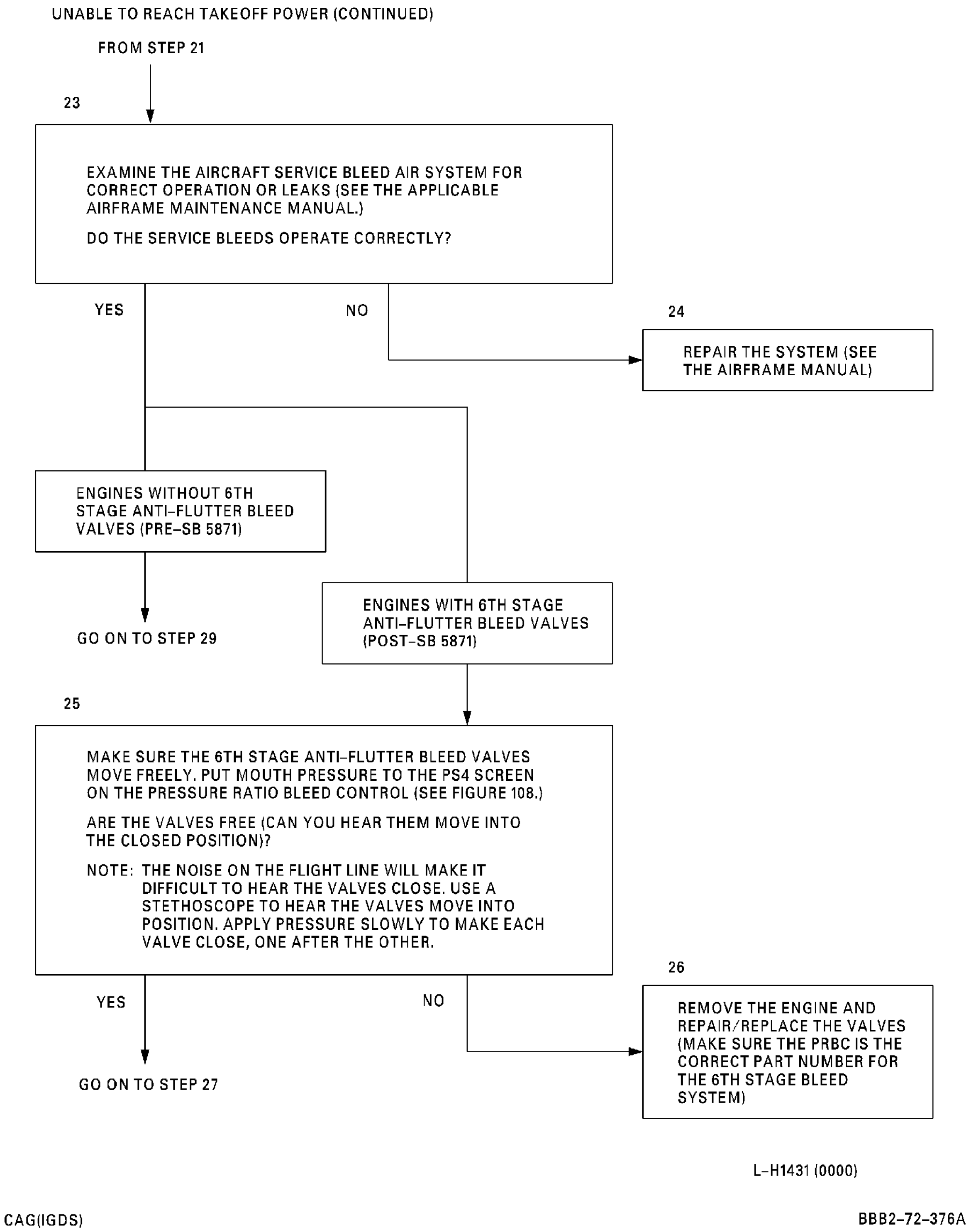
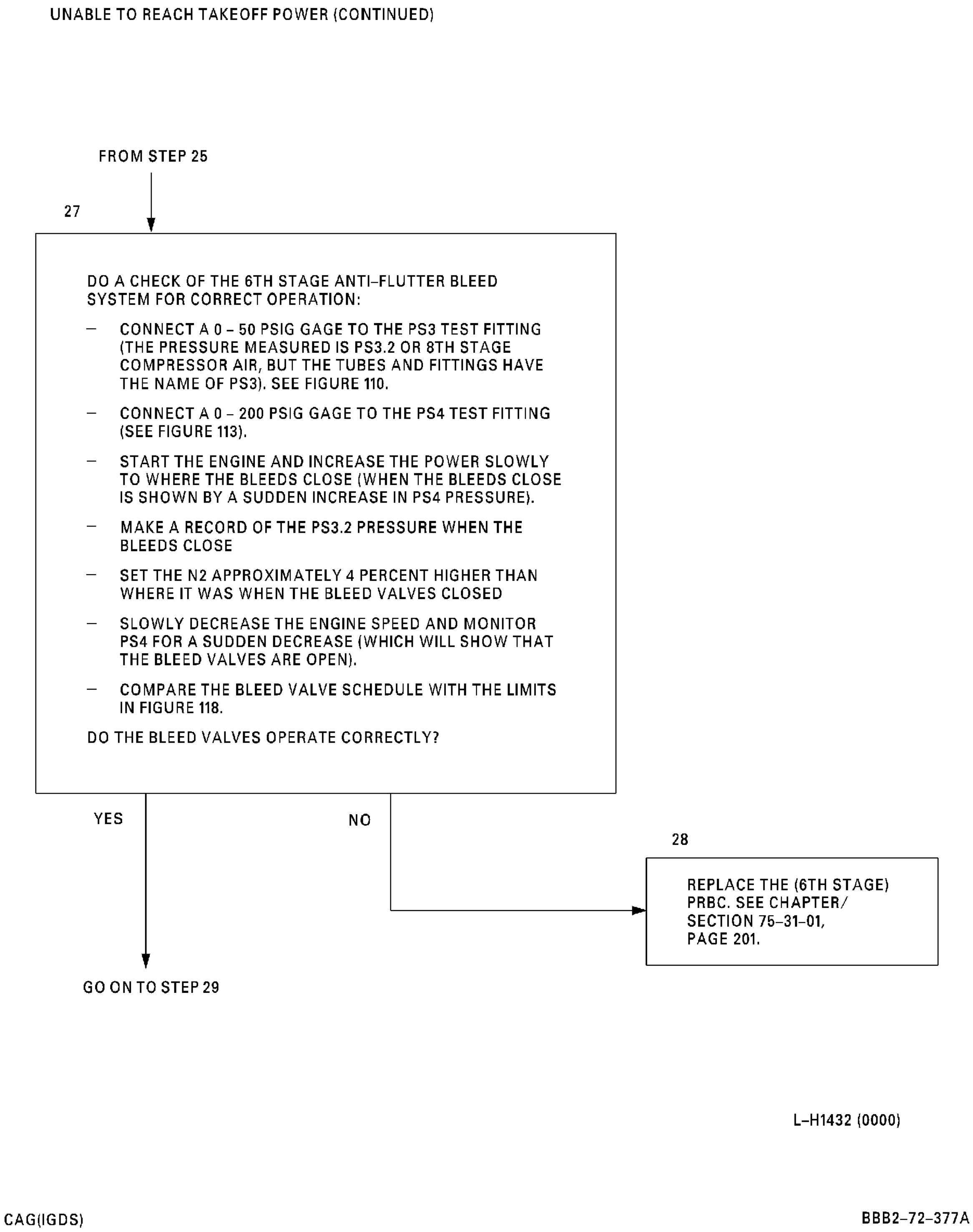
Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 5 of 11)



Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 6 of 11)



UNABLE TO REACH TAKEOFF POWER (CONTINUED)

DO A CHECK OF THE 6TH STAGE ANTI–FLUTTER BLEED SYSTEM FOR CORRECT OPERATION:

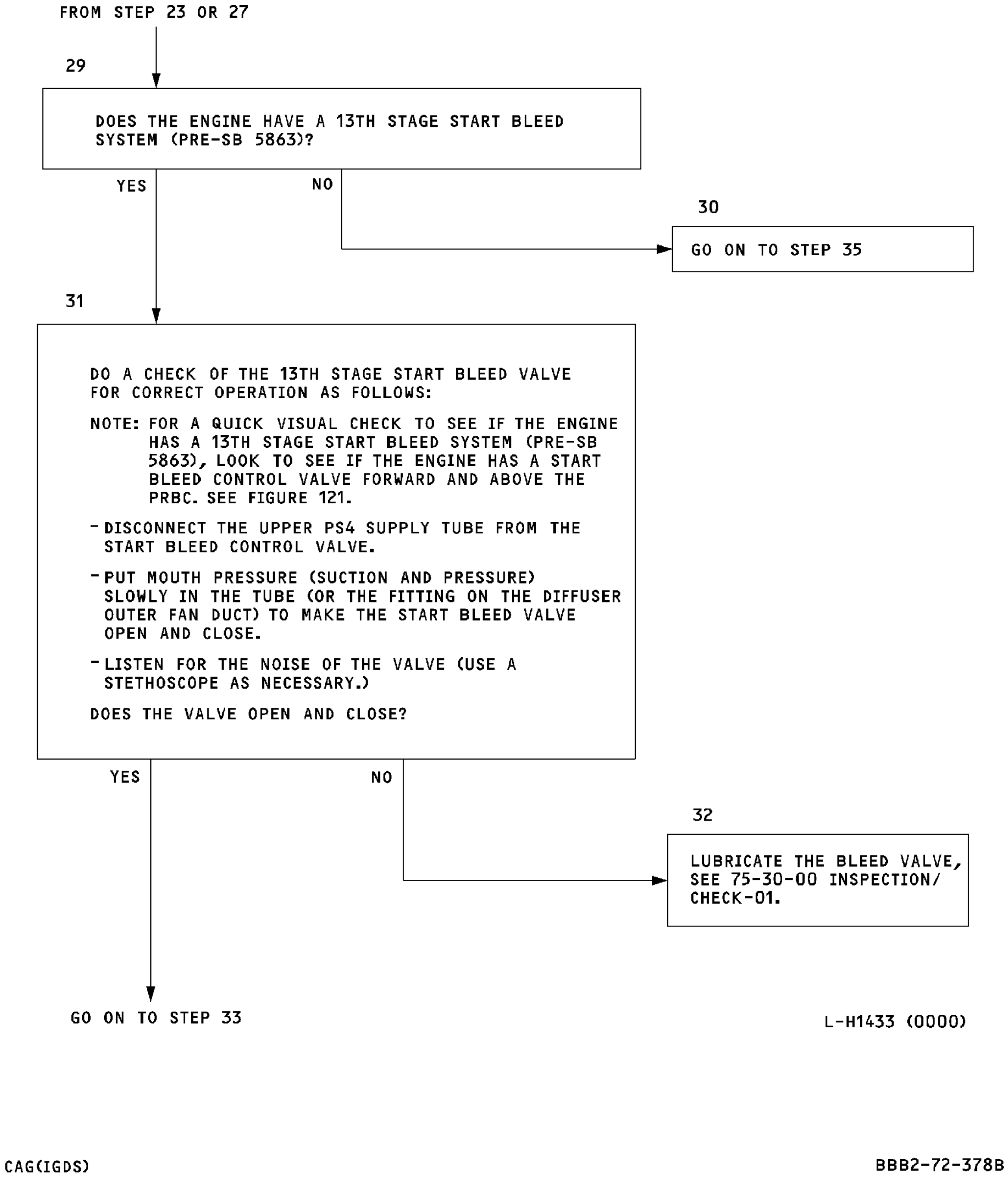
- CONNECT A 0 – 50 PSIG GAGE TO THE PS3 TEST FITTING (THE PRESSURE MEASURED IS PS3.2 OR 8TH STAGE COMPRESSOR AIR, BUT THE TUBES AND FITTINGS HAVE THE NAME OF PS3). SEE FIGURE 110.
- CONNECT A 0 – 200 PSIG GAGE TO THE PS4 TEST FITTING (SEE FIGURE 113).
- START THE ENGINE AND INCREASE THE POWER SLOWLY TO WHERE THE BLEEDS CLOSE (WHEN THE BLEEDS CLOSE IS SHOWN BY A SUDDEN INCREASE IN PS4 PRESSURE).
- MAKE A RECORD OF THE PS3.2 PRESSURE WHEN THE BLEEDS CLOSE
- SET THE N2 APPROXIMATELY 4 PERCENT HIGHER THAN WHERE IT WAS WHEN THE BLEED VALVES CLOSED
- SLOWLY DECREASE THE ENGINE SPEED AND MONITOR PS4 FOR A SUDDEN DECREASE (WHICH WILL SHOW THAT THE BLEED VALVES ARE OPEN).
- COMPARE THE BLEED VALVE SCHEDULE WITH THE LIMITS IN FIGURE 118.

DO THE BLEED VALVES OPERATE CORRECTLY?

REPLACE THE (6TH STAGE) PRBC. SEE CHAPTER/ SECTION 75–31–01, PAGE 201.

Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 7 of 11)

UNABLE TO REACH TAKEOFF POWER (CONTINUED)



FROM STEP 23 OR 27

29

DOES THE ENGINE HAVE A 13TH STAGE START BLEED SYSTEM (PRE-SB 5863)?

YES

NO

30

GO ON TO STEP 35

31

DO A CHECK OF THE 13TH STAGE START BLEED VALVE FOR CORRECT OPERATION AS FOLLOWS:

NOTE: FOR A QUICK VISUAL CHECK TO SEE IF THE ENGINE HAS A 13TH STAGE START BLEED SYSTEM (PRE-SB 5863), LOOK TO SEE IF THE ENGINE HAS A START BLEED CONTROL VALVE FORWARD AND ABOVE THE PRBC. SEE FIGURE 121.

- DISCONNECT THE UPPER PS4 SUPPLY TUBE FROM THE START BLEED CONTROL VALVE.
- PUT MOUTH PRESSURE (SUCTION AND PRESSURE) SLOWLY IN THE TUBE (OR THE FITTING ON THE DIFFUSER OUTER FAN DUCT) TO MAKE THE START BLEED VALVE OPEN AND CLOSE.
- LISTEN FOR THE NOISE OF THE VALVE (USE A STETHOSCOPE AS NECESSARY.)

DOES THE VALVE OPEN AND CLOSE?

YES

NO

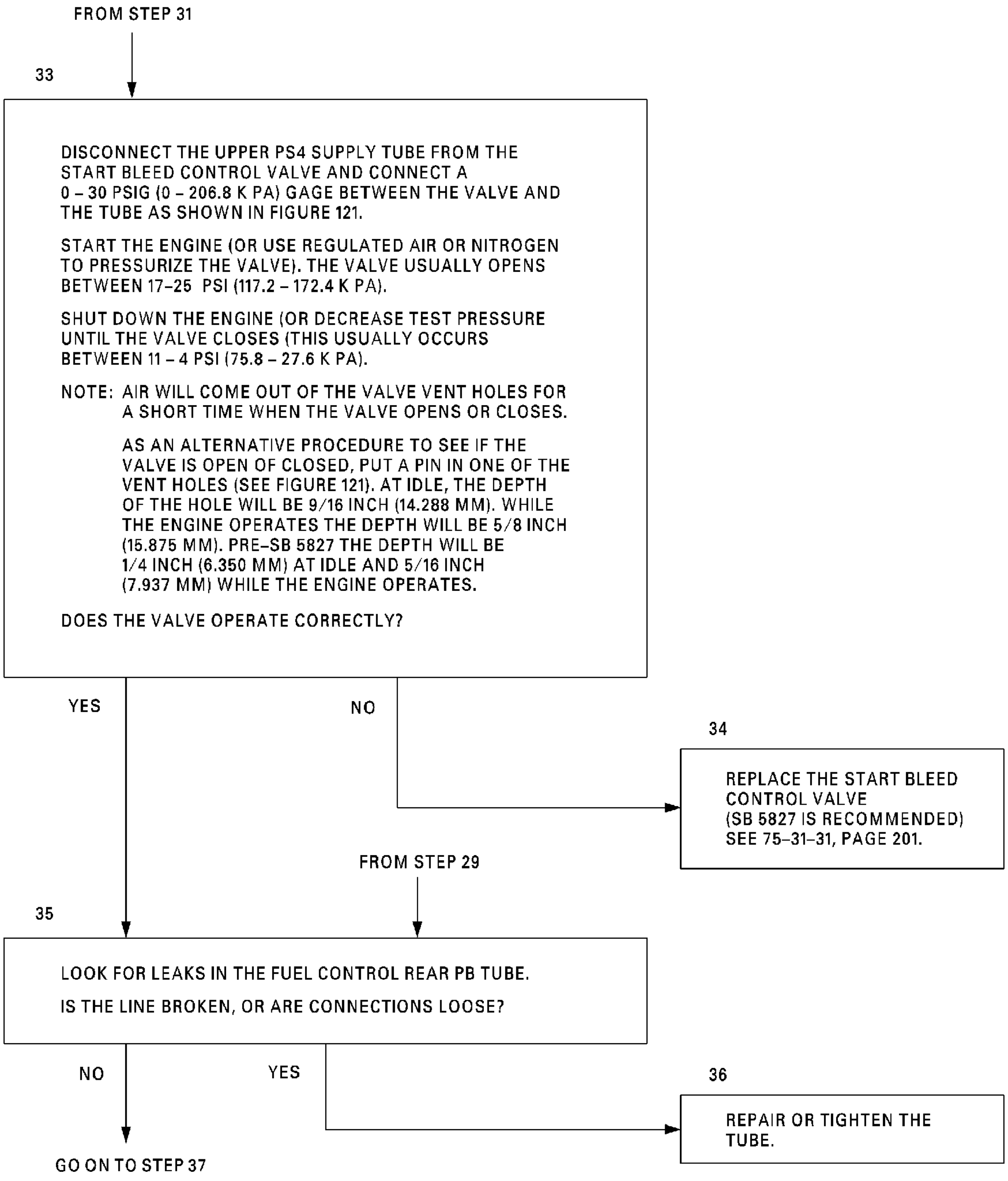
32

LUBRICATE THE BLEED VALVE, SEE 75-30-00 INSPECTION/CHECK-01.

GO ON TO STEP 33

Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 8 of 11)

UNABLE TO REACH TAKEOFF POWER (CONTINUED)



33: DISCONNECT THE UPPER PS4 SUPPLY TUBE FROM THE START BLEED CONTROL VALVE AND CONNECT A 0 – 30 PSIG (0 – 206.8 K PA) GAGE BETWEEN THE VALVE AND THE TUBE AS SHOWN IN FIGURE 121.

START THE ENGINE (OR USE REGULATED AIR OR NITROGEN TO PRESSURIZE THE VALVE). THE VALVE USUALLY OPENS BETWEEN 17–25 PSI (117.2 – 172.4 K PA).

SHUT DOWN THE ENGINE (OR DECREASE TEST PRESSURE UNTIL THE VALVE CLOSES (THIS USUALLY OCCURS BETWEEN 11 – 4 PSI (75.8 – 27.6 K PA).

NOTE: AIR WILL COME OUT OF THE VALVE VENT HOLES FOR A SHORT TIME WHEN THE VALVE OPENS OR CLOSES.

AS AN ALTERNATIVE PROCEDURE TO SEE IF THE VALVE IS OPEN OF CLOSED, PUT A PIN IN ONE OF THE VENT HOLES (SEE FIGURE 121). AT IDLE, THE DEPTH OF THE HOLE WILL BE 9/16 INCH (14.288 MM). WHILE THE ENGINE OPERATES THE DEPTH WILL BE 5/8 INCH (15.875 MM). PRE–SB 5827 THE DEPTH WILL BE 1/4 INCH (6.350 MM) AT IDLE AND 5/16 INCH (7.937 MM) WHILE THE ENGINE OPERATES.

DOES THE VALVE OPERATE CORRECTLY?

34: REPLACE THE START BLEED CONTROL VALVE (SB 5827 IS RECOMMENDED) SEE 75–31–31, PAGE 201.

35: LOOK FOR LEAKS IN THE FUEL CONTROL REAR PB TUBE.

IS THE LINE BROKEN, OR ARE CONNECTIONS LOOSE?

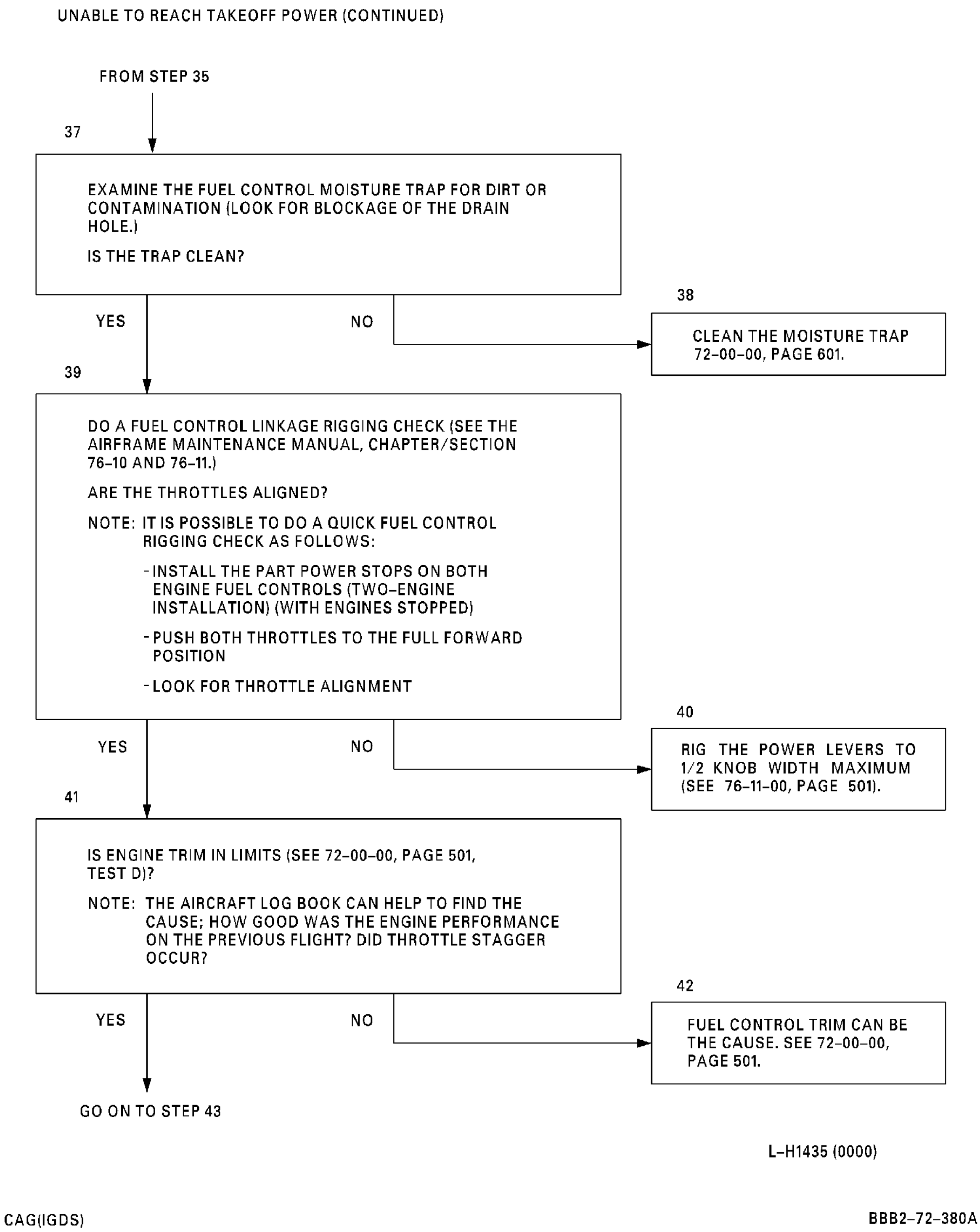
36: REPAIR OR TIGHTEN THE TUBE.

L–H1434 (0000)

CAG(IGDS)

BBB2–72–379A

Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 9 of 11)



UNABLE TO REACH TAKEOFF POWER (CONTINUED)

FROM STEP 35

37 EXAMINE THE FUEL CONTROL MOISTURE TRAP FOR DIRT OR CONTAMINATION (LOOK FOR BLOCKAGE OF THE DRAIN HOLE.)

IS THE TRAP CLEAN?

YES → 39; NO → 38

38 CLEAN THE MOISTURE TRAP 72-00-00, PAGE 601.

39 DO A FUEL CONTROL LINKAGE RIGGING CHECK (SEE THE AIRFRAME MAINTENANCE MANUAL, CHAPTER/SECTION 76-10 AND 76-11.)

ARE THE THROTTLES ALIGNED?

NOTE: IT IS POSSIBLE TO DO A QUICK FUEL CONTROL RIGGING CHECK AS FOLLOWS:

- INSTALL THE PART POWER STOPS ON BOTH ENGINE FUEL CONTROLS (TWO-ENGINE INSTALLATION) (WITH ENGINES STOPPED)
- PUSH BOTH THROTTLES TO THE FULL FORWARD POSITION
- LOOK FOR THROTTLE ALIGNMENT

YES → 41; NO → 40

40 RIG THE POWER LEVERS TO 1/2 KNOB WIDTH MAXIMUM (SEE 76-11-00, PAGE 501).

41 IS ENGINE TRIM IN LIMITS (SEE 72-00-00, PAGE 501, TEST D)?

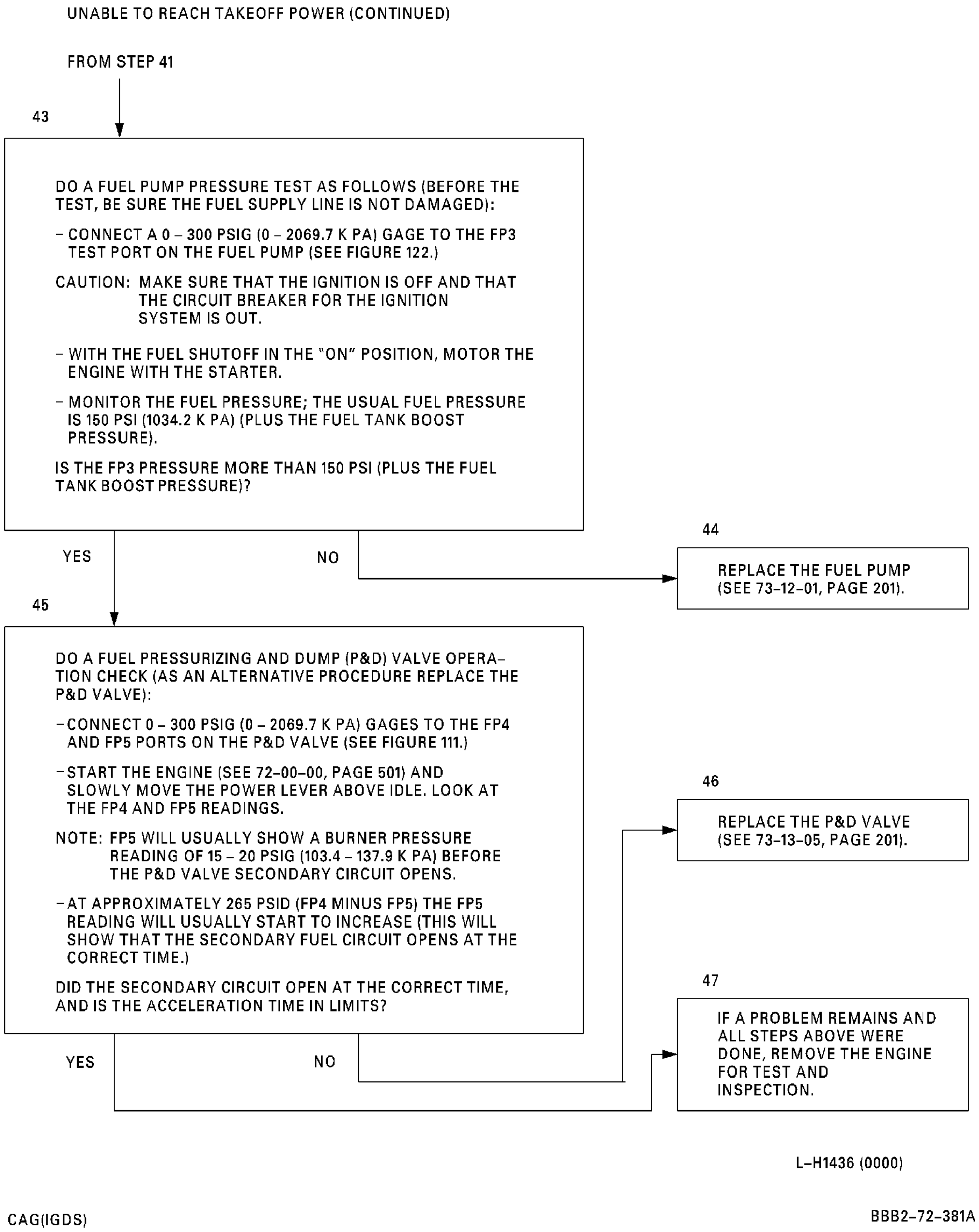
NOTE: THE AIRCRAFT LOG BOOK CAN HELP TO FIND THE CAUSE; HOW GOOD WAS THE ENGINE PERFORMANCE ON THE PREVIOUS FLIGHT? DID THROTTLE STAGGER OCCUR?

YES → GO ON TO STEP 43; NO → 42

42 FUEL CONTROL TRIM CAN BE THE CAUSE. SEE 72-00-00, PAGE 501.

GO ON TO STEP 43

Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 10 of 11)



UNABLE TO REACH TAKEOFF POWER (CONTINUED)

FROM STEP 41

43

DO A FUEL PUMP PRESSURE TEST AS FOLLOWS (BEFORE THE TEST, BE SURE THE FUEL SUPPLY LINE IS NOT DAMAGED):

- CONNECT A 0 – 300 PSIG (0 – 2069.7 K PA) GAGE TO THE FP3 TEST PORT ON THE FUEL PUMP (SEE FIGURE 122.)

CAUTION: MAKE SURE THAT THE IGNITION IS OFF AND THAT THE CIRCUIT BREAKER FOR THE IGNITION SYSTEM IS OUT.

- WITH THE FUEL SHUTOFF IN THE "ON" POSITION, MOTOR THE ENGINE WITH THE STARTER.
- MONITOR THE FUEL PRESSURE; THE USUAL FUEL PRESSURE IS 150 PSI (1034.2 K PA) (PLUS THE FUEL TANK BOOST PRESSURE).

IS THE FP3 PRESSURE MORE THAN 150 PSI (PLUS THE FUEL TANK BOOST PRESSURE)?

YES → 45

NO → 44

44

REPLACE THE FUEL PUMP (SEE 73–12–01, PAGE 201).

45

DO A FUEL PRESSURIZING AND DUMP (P&D) VALVE OPERATION CHECK (AS AN ALTERNATIVE PROCEDURE REPLACE THE P&D VALVE):

- CONNECT 0 – 300 PSIG (0 – 2069.7 K PA) GAGES TO THE FP4 AND FP5 PORTS ON THE P&D VALVE (SEE FIGURE 111.)
- START THE ENGINE (SEE 72–00–00, PAGE 501) AND SLOWLY MOVE THE POWER LEVER ABOVE IDLE. LOOK AT THE FP4 AND FP5 READINGS.

NOTE: FP5 WILL USUALLY SHOW A BURNER PRESSURE READING OF 15 – 20 PSIG (103.4 – 137.9 K PA) BEFORE THE P&D VALVE SECONDARY CIRCUIT OPENS.

- AT APPROXIMATELY 265 PSID (FP4 MINUS FP5) THE FP5 READING WILL USUALLY START TO INCREASE (THIS WILL SHOW THAT THE SECONDARY FUEL CIRCUIT OPENS AT THE CORRECT TIME.)

DID THE SECONDARY CIRCUIT OPEN AT THE CORRECT TIME, AND IS THE ACCELERATION TIME IN LIMITS?

YES → 47

NO → 46

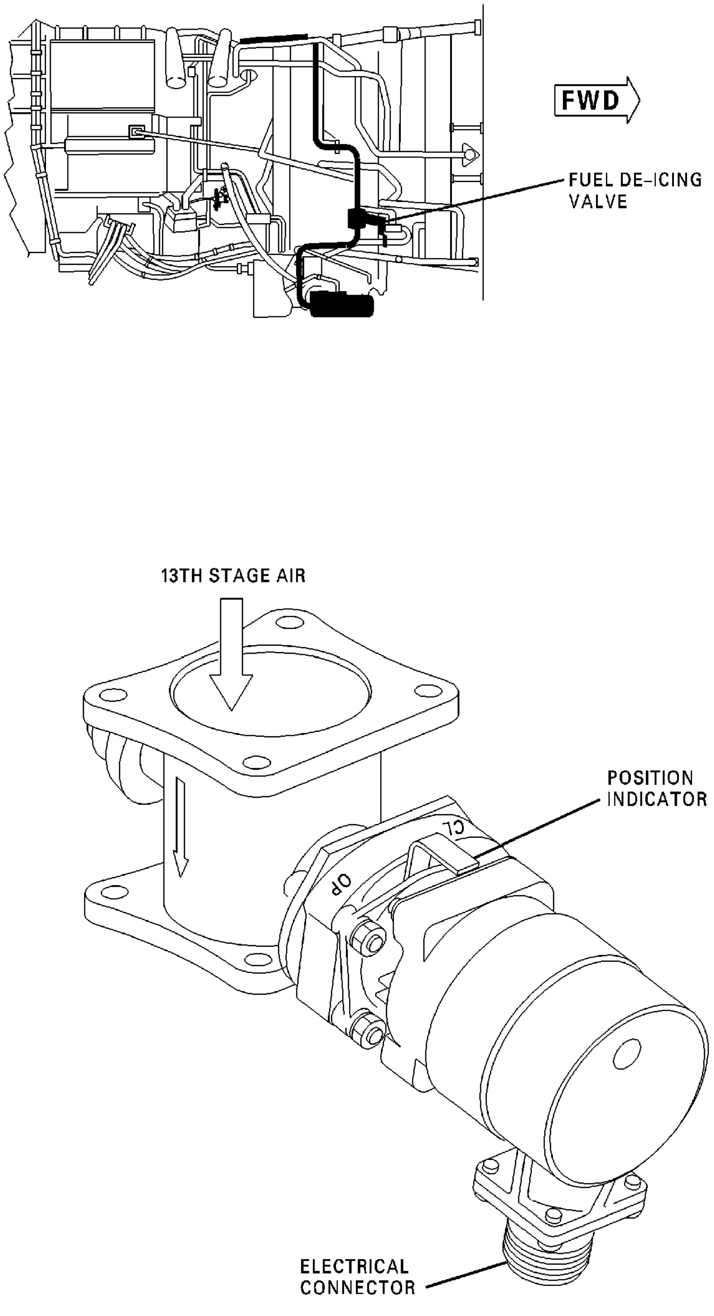
46

REPLACE THE P&D VALVE (SEE 73–13–05, PAGE 201).

47

IF A PROBLEM REMAINS AND ALL STEPS ABOVE WERE DONE, REMOVE THE ENGINE FOR TEST AND INSPECTION.

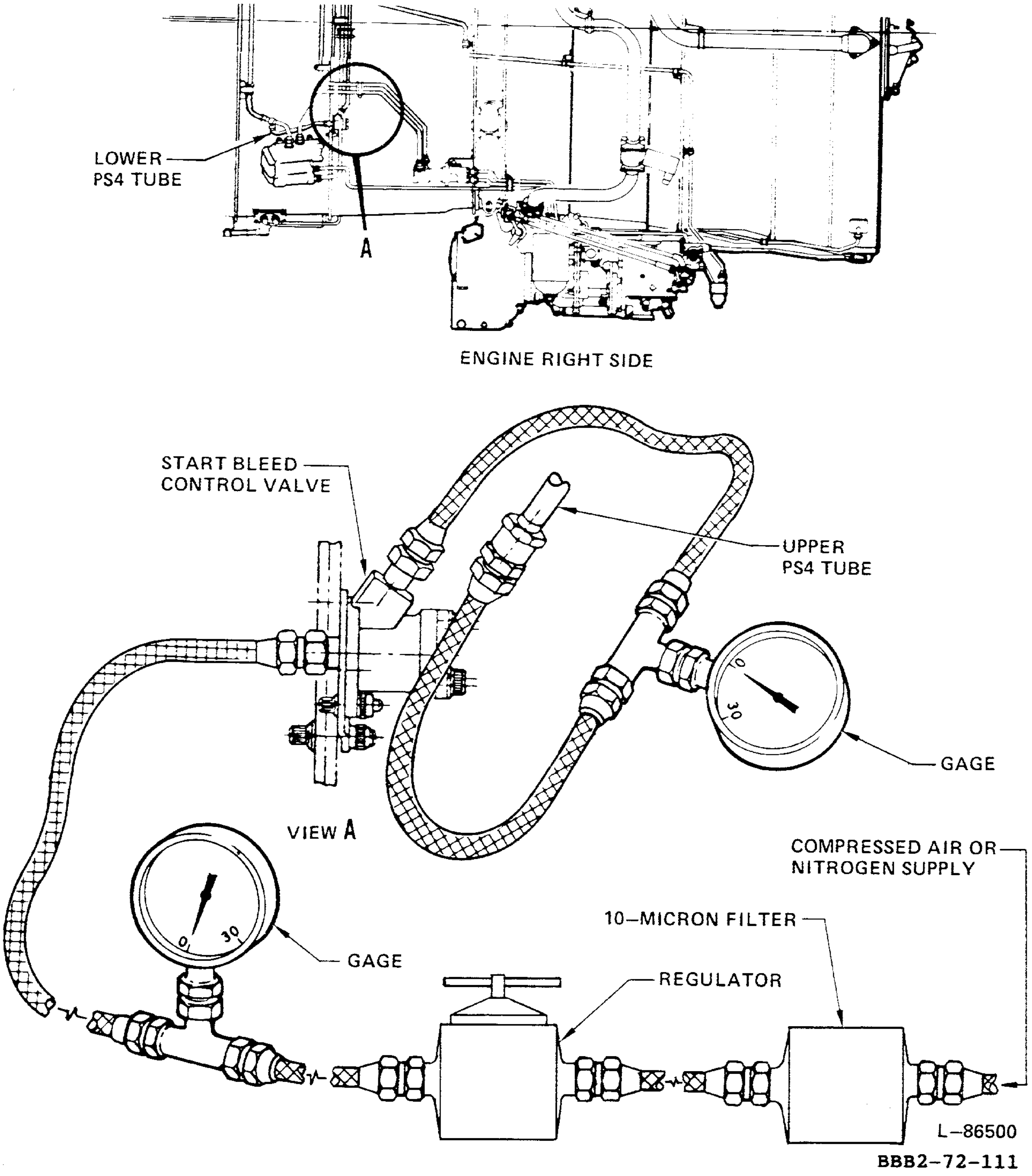
Unable To Reach Takeoff Power Troubleshooting
Figure 119/72-00-04-990-819 (Sheet 11 of 11)



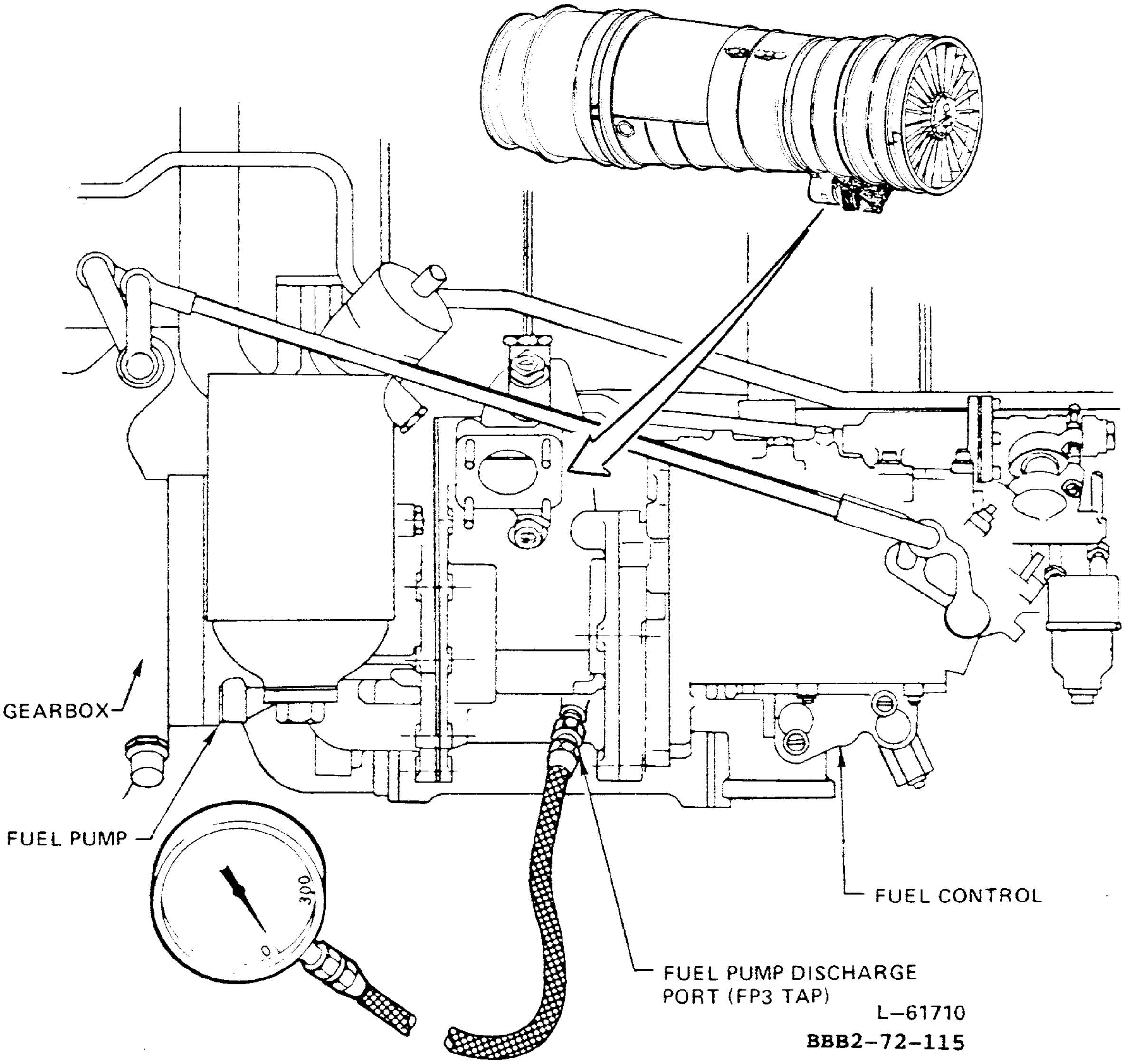
L-H0870 (0000)
BBB2-72-327

CAG(IGDS)

Fuel De-Icing Valve Check
Figure 120/72-00-04-990-820



Start Bleed Control Valve Check
Figure 121/72-00-04-990-821



Fuel Pump Pressure Check
Figure 122/72-00-04-990-822

6. Start Problems

A. General

(1) No Start (Figure 123) (Figure 124)

(a) An engine will start if the rotors turn, the gas path is in good condition, and there is fuel and ignition.

(b) When an engine does not start, it is important to know as much as possible about what occurred when the start was tried. For example:

- Did the rotors turn (was it possible to hear the N_1 or N_2 rotors turn, or see the N_1 move)?

NOTE: There can be too much friction between the rotor airseals and the mating stator lands (or between the blade tips and the outer airseals) if the engine was stopped too fast without a sufficient cool-down period to make the internal temperature lower. When this occurs it can be difficult to turn one or both rotors until the internal temperatures get sufficiently low to release the rotors. Do not put too much force on a rotor to try to turn it, because it is possible to damage the blades and airseals. Let an engine get down to a lower temperature before you either start it or try to turn the rotors.

- Was there indication of fuel flow or EGT increase?
- Was the ignition system on?

(2) Hot Start (Figure 125)

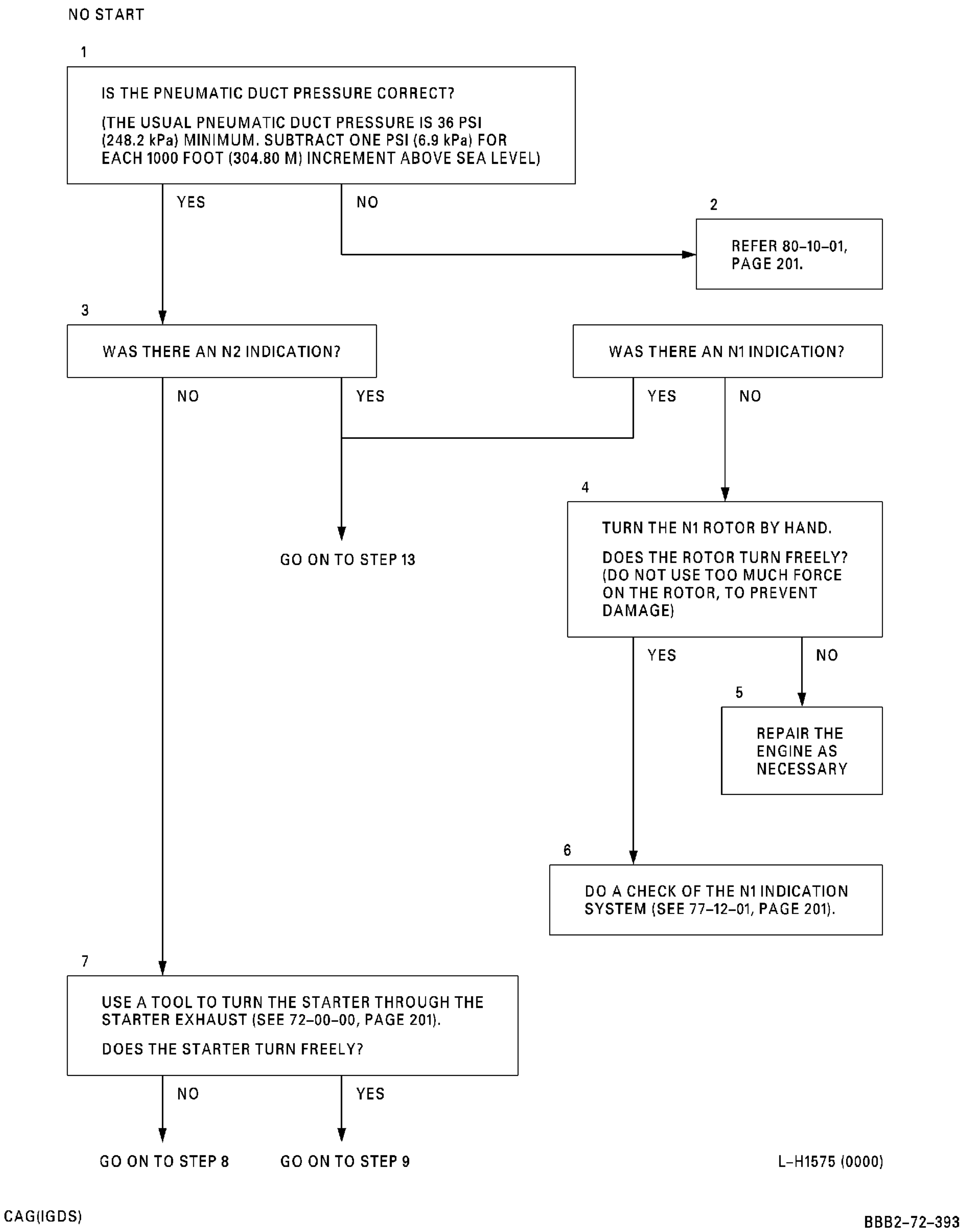
(a) An engine has a "hot start" when the EGT is high during the start (or when the EGT will become high if the engine is not stopped).

(b) "Hot start" condition can occur if:

- Fuel flow is too high
- There is a high ambient temperature
- N_2 is low during the start
- Starter air pressure is low
- There is gas path damage.

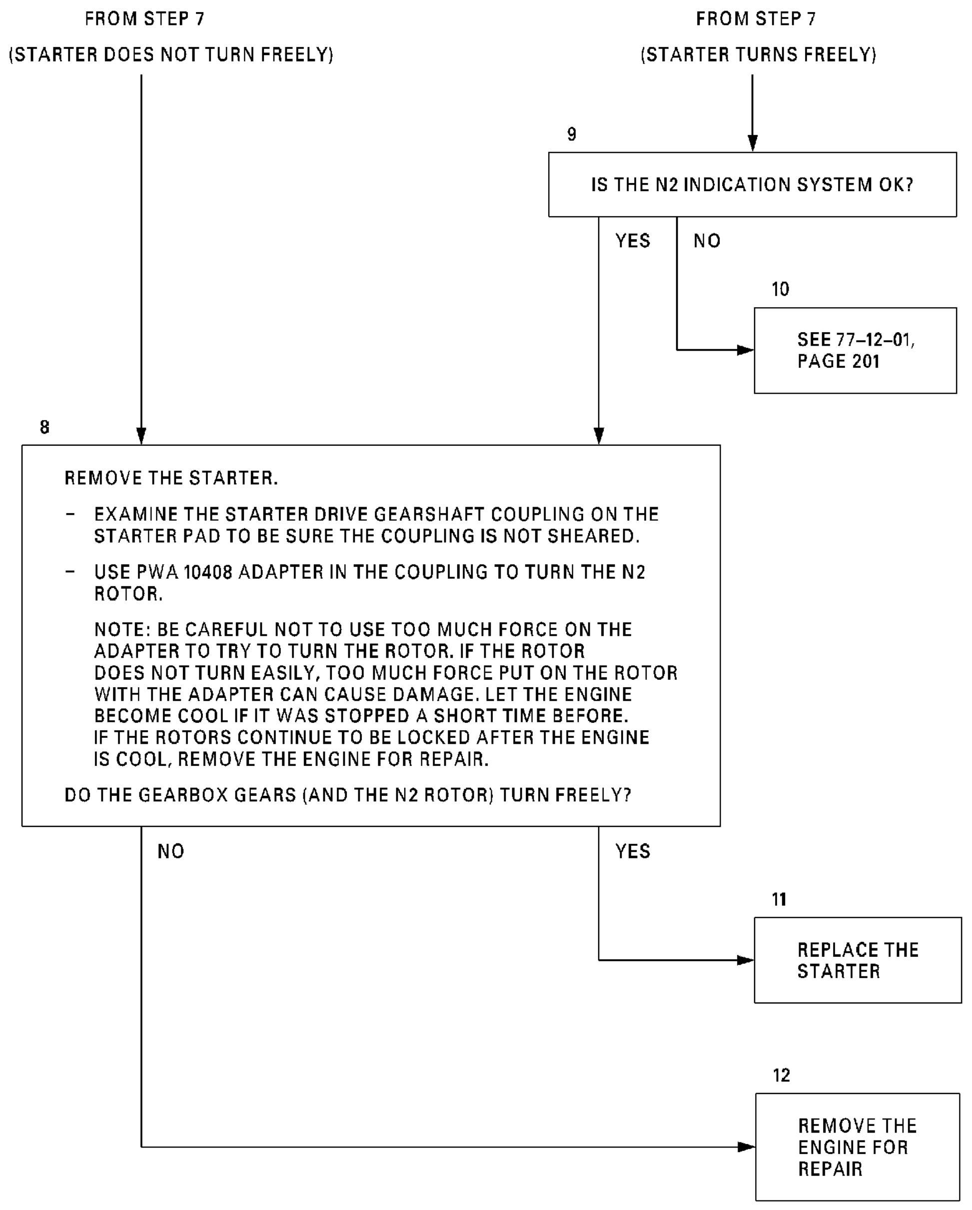
(3) Hung Start (Figure 126) (Figure 127) (Figure 128)

(a) An engine has a "hung start" when the engine starts, N_2 and EGT are stable, but the power level does not increase to idle.



No Start Troubleshooting
Figure 123/72-00-04-990-823 (Sheet 1 of 8)

NO START (CONTINUED)



REMOVE THE STARTER.

- EXAMINE THE STARTER DRIVE GEARSHAFT COUPLING ON THE STARTER PAD TO BE SURE THE COUPLING IS NOT SHEARED.
- USE PWA 10408 ADAPTER IN THE COUPLING TO TURN THE N2 ROTOR.

  NOTE: BE CAREFUL NOT TO USE TOO MUCH FORCE ON THE ADAPTER TO TRY TO TURN THE ROTOR. IF THE ROTOR DOES NOT TURN EASILY, TOO MUCH FORCE PUT ON THE ROTOR WITH THE ADAPTER CAN CAUSE DAMAGE. LET THE ENGINE BECOME COOL IF IT WAS STOPPED A SHORT TIME BEFORE. IF THE ROTORS CONTINUE TO BE LOCKED AFTER THE ENGINE IS COOL, REMOVE THE ENGINE FOR REPAIR.

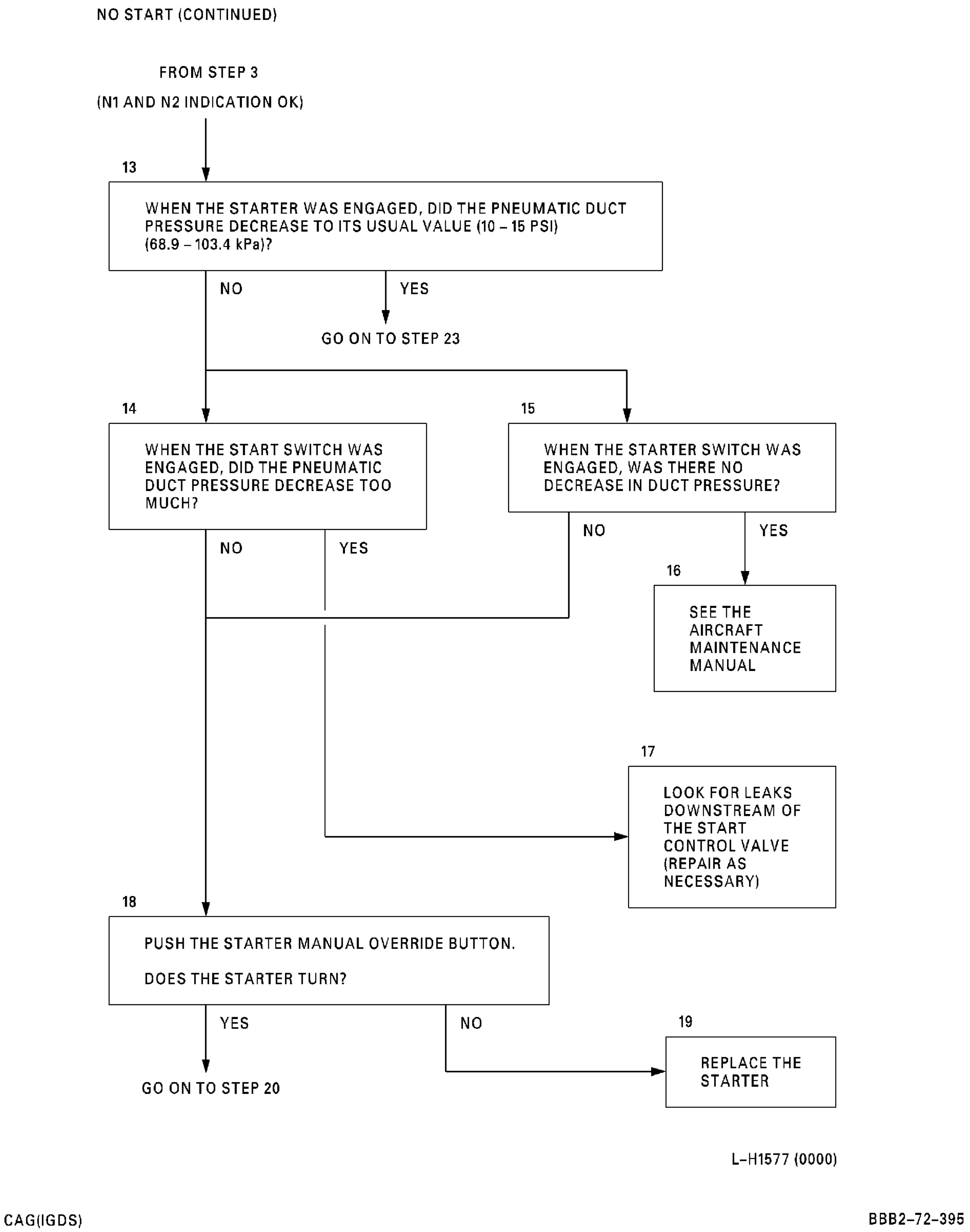
DO THE GEARBOX GEARS (AND THE N2 ROTOR) TURN FREELY?

L–H1576 (0000)

CAG(IGDS)

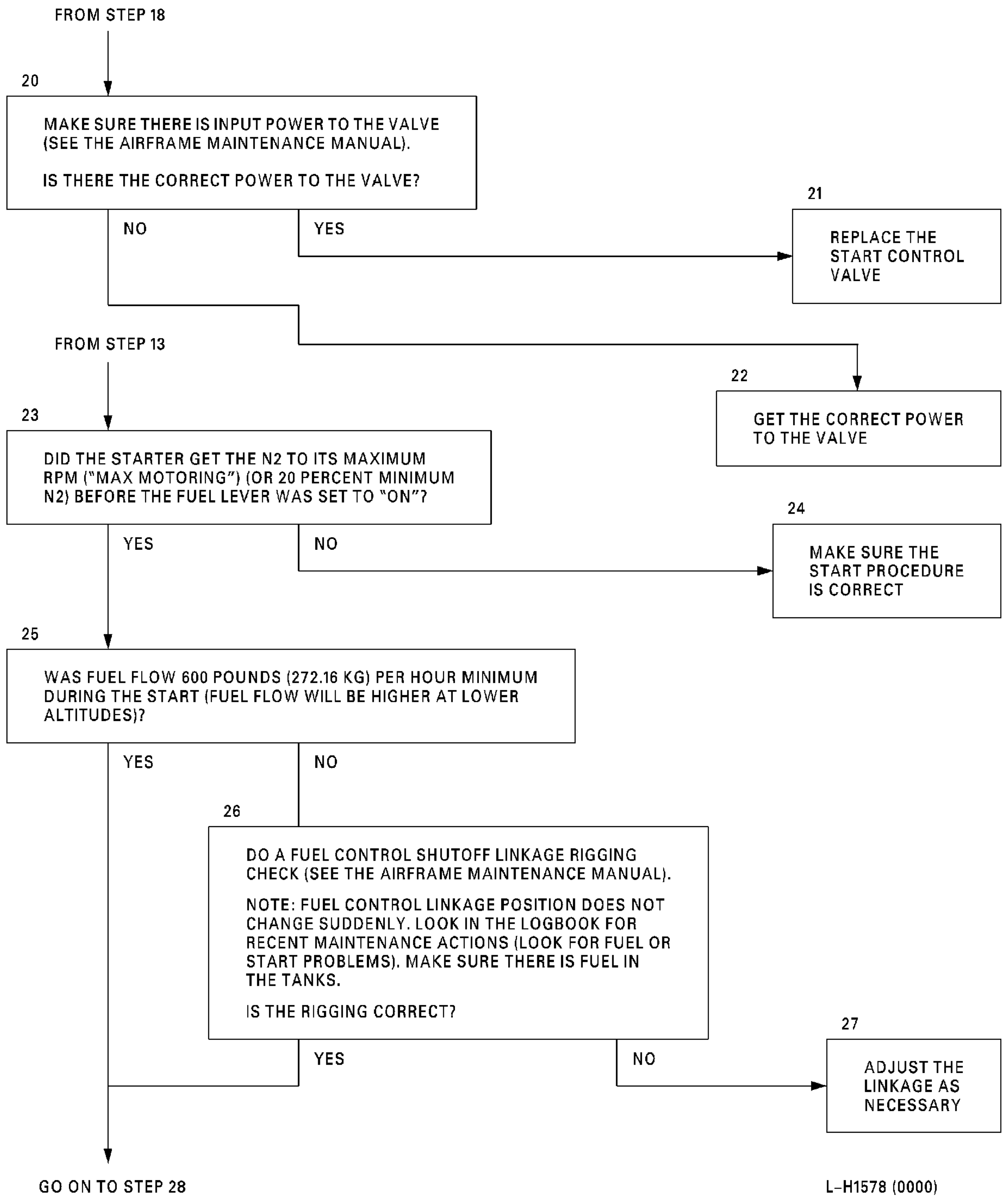
BBB2–72–394

No Start Troubleshooting
Figure 123/72-00-04-990-823 (Sheet 2 of 8)



No Start Troubleshooting
Figure 123/72-00-04-990-823 (Sheet 3 of 8)

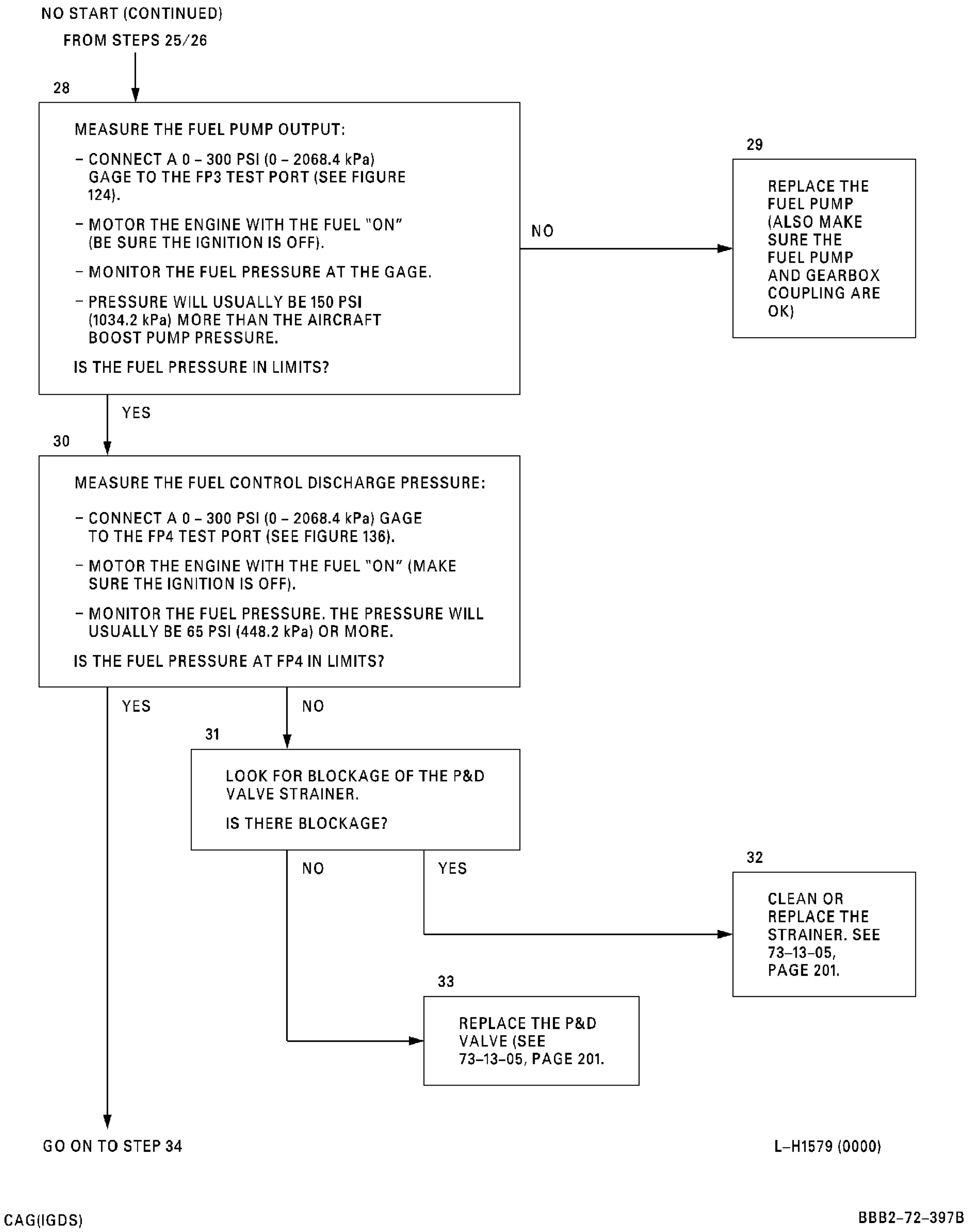
NO START (CONTINUED)



CAG(IGDS)

BBB2-72-396

No Start Troubleshooting
Figure 123/72-00-04-990-823 (Sheet 4 of 8)



NO START (CONTINUED)

FROM STEPS 25/26

28

MEASURE THE FUEL PUMP OUTPUT:

- CONNECT A 0 – 300 PSI (0 – 2068.4 kPa) GAGE TO THE FP3 TEST PORT (SEE FIGURE 124).
- MOTOR THE ENGINE WITH THE FUEL "ON" (BE SURE THE IGNITION IS OFF).
- MONITOR THE FUEL PRESSURE AT THE GAGE.
- PRESSURE WILL USUALLY BE 150 PSI (1034.2 kPa) MORE THAN THE AIRCRAFT BOOST PUMP PRESSURE.

IS THE FUEL PRESSURE IN LIMITS?

29

REPLACE THE FUEL PUMP (ALSO MAKE SURE THE FUEL PUMP AND GEARBOX COUPLING ARE OK)

30

MEASURE THE FUEL CONTROL DISCHARGE PRESSURE:

- CONNECT A 0 – 300 PSI (0 – 2068.4 kPa) GAGE TO THE FP4 TEST PORT (SEE FIGURE 136).
- MOTOR THE ENGINE WITH THE FUEL "ON" (MAKE SURE THE IGNITION IS OFF).
- MONITOR THE FUEL PRESSURE. THE PRESSURE WILL USUALLY BE 65 PSI (448.2 kPa) OR MORE.

IS THE FUEL PRESSURE AT FP4 IN LIMITS?

31

LOOK FOR BLOCKAGE OF THE P&D VALVE STRAINER.

IS THERE BLOCKAGE?

32

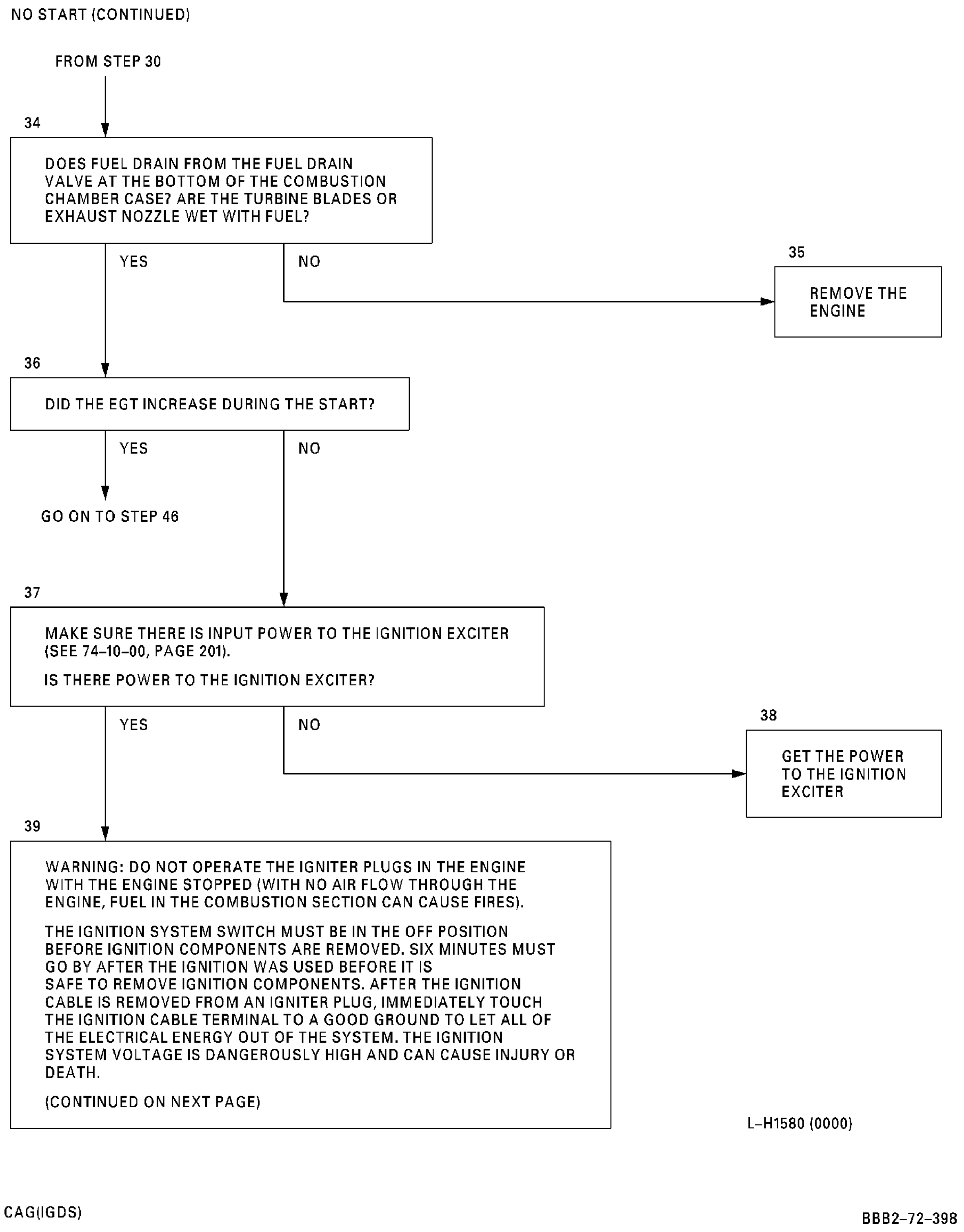
CLEAN OR REPLACE THE STRAINER. SEE 73–13–05, PAGE 201.

33

REPLACE THE P&D VALVE (SEE 73–13–05, PAGE 201.

GO ON TO STEP 34

No Start Troubleshooting
Figure 123/72-00-04-990-823 (Sheet 5 of 8)



34 DOES FUEL DRAIN FROM THE FUEL DRAIN VALVE AT THE BOTTOM OF THE COMBUSTION CHAMBER CASE? ARE THE TURBINE BLADES OR EXHAUST NOZZLE WET WITH FUEL?

35 REMOVE THE ENGINE

36 DID THE EGT INCREASE DURING THE START?

37 MAKE SURE THERE IS INPUT POWER TO THE IGNITION EXCITER (SEE 74–10–00, PAGE 201).

IS THERE POWER TO THE IGNITION EXCITER?

38 GET THE POWER TO THE IGNITION EXCITER

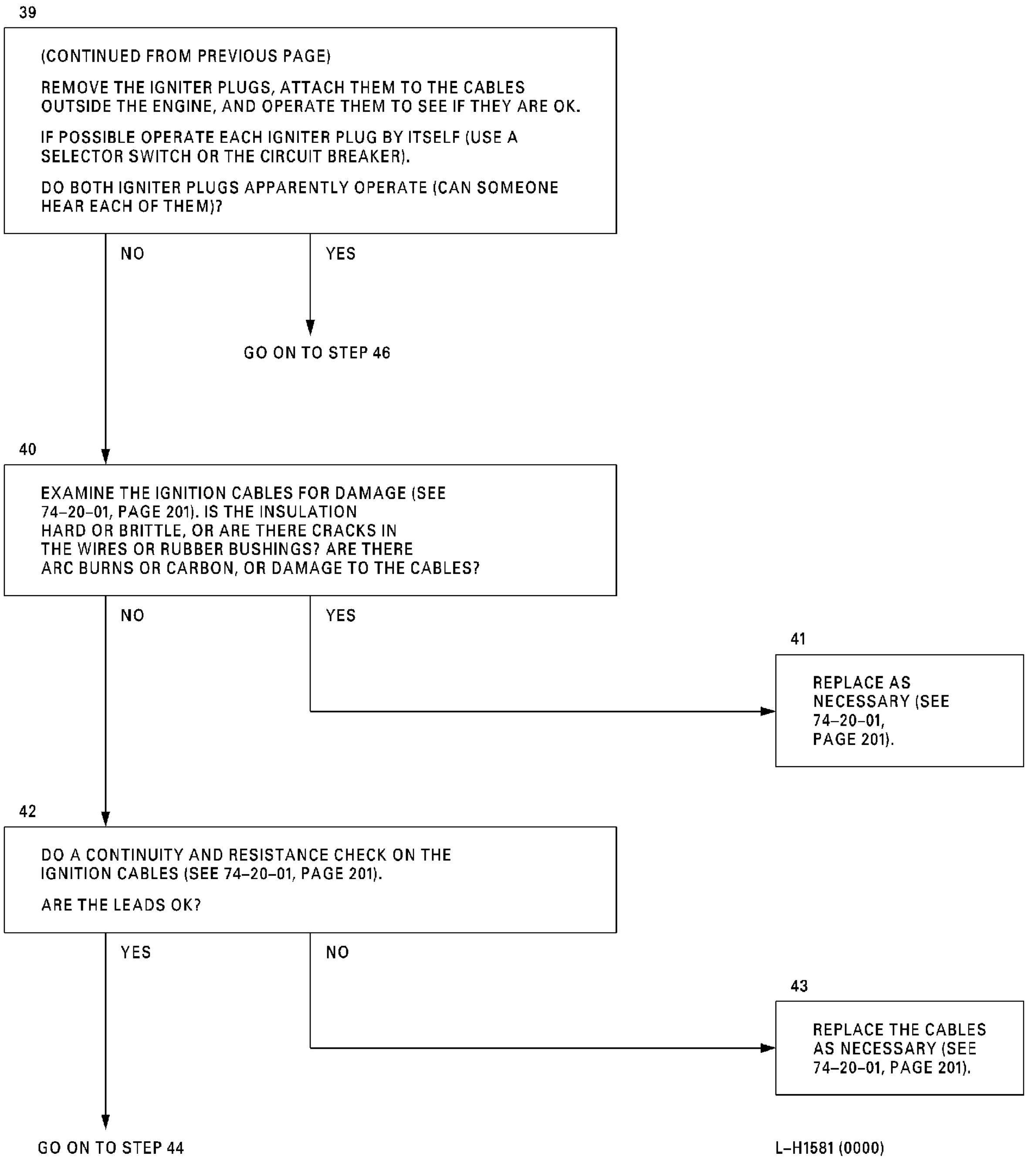
39 WARNING: DO NOT OPERATE THE IGNITER PLUGS IN THE ENGINE WITH THE ENGINE STOPPED (WITH NO AIR FLOW THROUGH THE ENGINE, FUEL IN THE COMBUSTION SECTION CAN CAUSE FIRES).

THE IGNITION SYSTEM SWITCH MUST BE IN THE OFF POSITION BEFORE IGNITION COMPONENTS ARE REMOVED. SIX MINUTES MUST GO BY AFTER THE IGNITION WAS USED BEFORE IT IS SAFE TO REMOVE IGNITION COMPONENTS. AFTER THE IGNITION CABLE IS REMOVED FROM AN IGNITER PLUG, IMMEDIATELY TOUCH THE IGNITION CABLE TERMINAL TO A GOOD GROUND TO LET ALL OF THE ELECTRICAL ENERGY OUT OF THE SYSTEM. THE IGNITION SYSTEM VOLTAGE IS DANGEROUSLY HIGH AND CAN CAUSE INJURY OR DEATH.

(CONTINUED ON NEXT PAGE)

No Start Troubleshooting
Figure 123/72-00-04-990-823 (Sheet 6 of 8)

NO START (CONTINUED)



39

(CONTINUED FROM PREVIOUS PAGE)

REMOVE THE IGNITER PLUGS, ATTACH THEM TO THE CABLES OUTSIDE THE ENGINE, AND OPERATE THEM TO SEE IF THEY ARE OK.

IF POSSIBLE OPERATE EACH IGNITER PLUG BY ITSELF (USE A SELECTOR SWITCH OR THE CIRCUIT BREAKER).

DO BOTH IGNITER PLUGS APPARENTLY OPERATE (CAN SOMEONE HEAR EACH OF THEM)?

GO ON TO STEP 46

40

EXAMINE THE IGNITION CABLES FOR DAMAGE (SEE 74–20–01, PAGE 201). IS THE INSULATION HARD OR BRITTLE, OR ARE THERE CRACKS IN THE WIRES OR RUBBER BUSHINGS? ARE THERE ARC BURNS OR CARBON, OR DAMAGE TO THE CABLES?

41

REPLACE AS NECESSARY (SEE 74–20–01, PAGE 201).

42

DO A CONTINUITY AND RESISTANCE CHECK ON THE IGNITION CABLES (SEE 74–20–01, PAGE 201).

ARE THE LEADS OK?

43

REPLACE THE CABLES AS NECESSARY (SEE 74–20–01, PAGE 201).

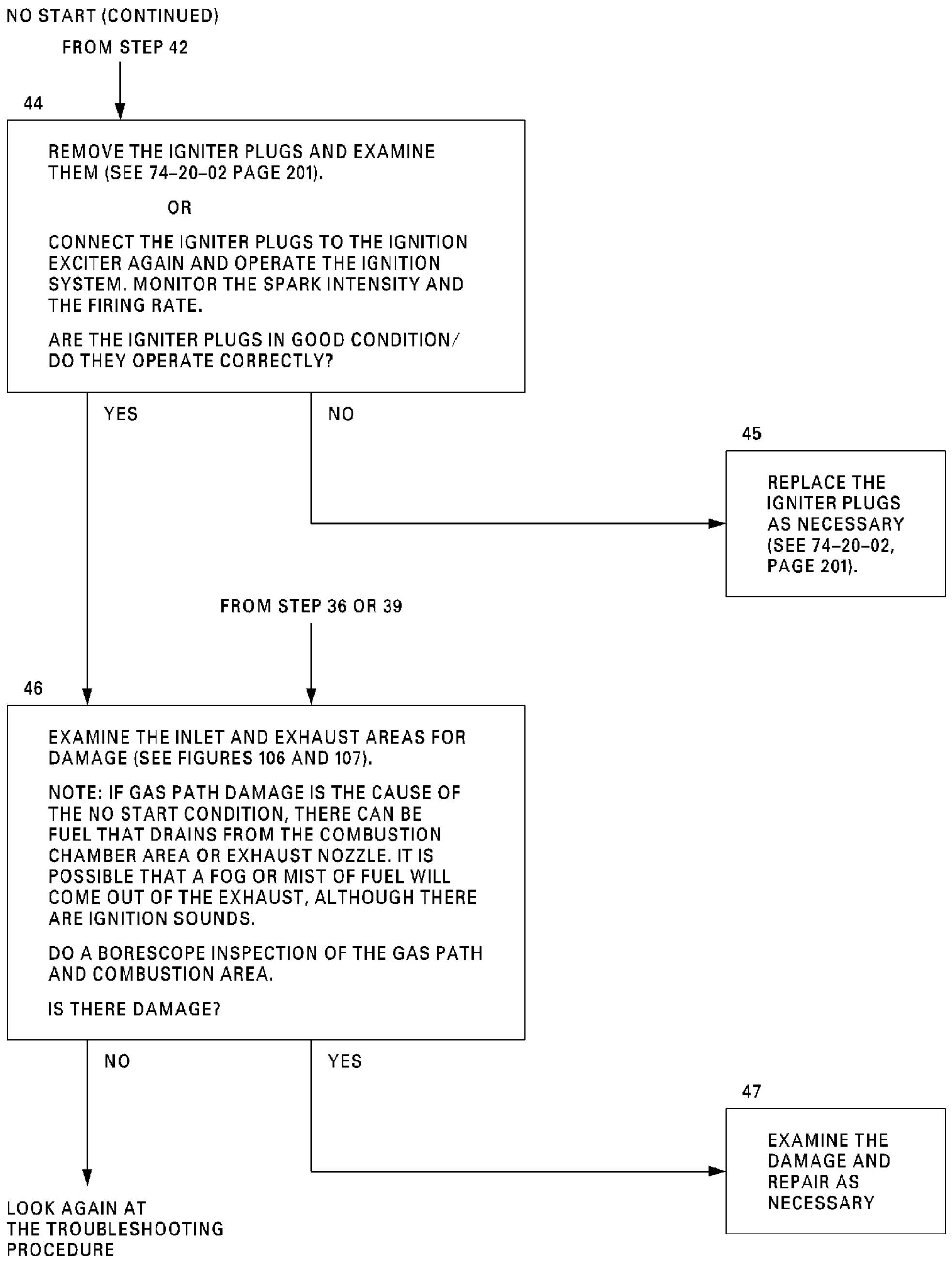
GO ON TO STEP 44

L–H1581 (0000)

CAG(IGDS)

BBB2–72–399

No Start Troubleshooting
Figure 123/72-00-04-990-823 (Sheet 7 of 8)



44

REMOVE THE IGNITER PLUGS AND EXAMINE THEM (SEE 74-20-02 PAGE 201).

OR

CONNECT THE IGNITER PLUGS TO THE IGNITION EXCITER AGAIN AND OPERATE THE IGNITION SYSTEM. MONITOR THE SPARK INTENSITY AND THE FIRING RATE.

ARE THE IGNITER PLUGS IN GOOD CONDITION/ DO THEY OPERATE CORRECTLY?

45

REPLACE THE IGNITER PLUGS AS NECESSARY (SEE 74-20-02, PAGE 201).

46

EXAMINE THE INLET AND EXHAUST AREAS FOR DAMAGE (SEE FIGURES 106 AND 107).

NOTE: IF GAS PATH DAMAGE IS THE CAUSE OF THE NO START CONDITION, THERE CAN BE FUEL THAT DRAINS FROM THE COMBUSTION CHAMBER AREA OR EXHAUST NOZZLE. IT IS POSSIBLE THAT A FOG OR MIST OF FUEL WILL COME OUT OF THE EXHAUST, ALTHOUGH THERE ARE IGNITION SOUNDS.

DO A BORESCOPE INSPECTION OF THE GAS PATH AND COMBUSTION AREA.

IS THERE DAMAGE?

47

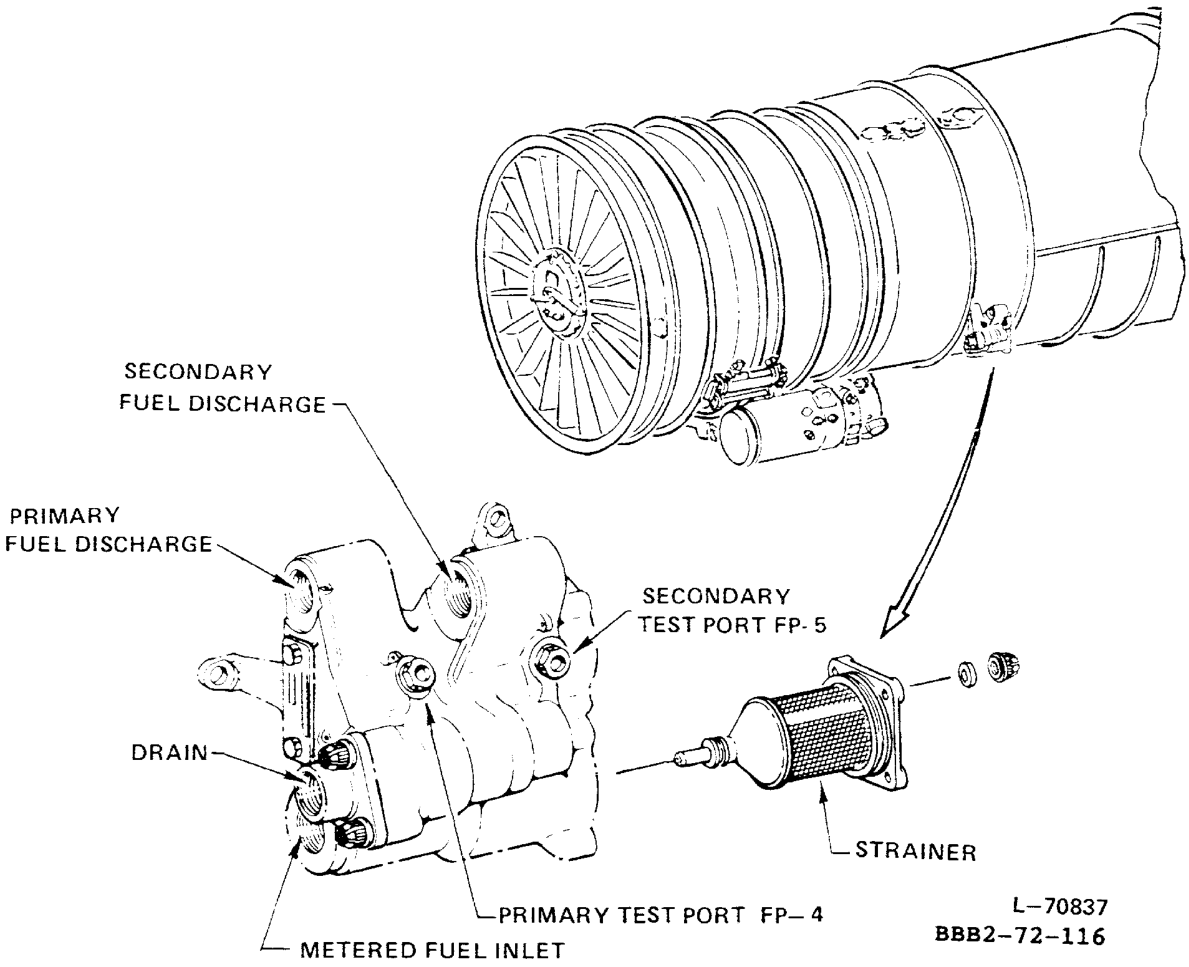
EXAMINE THE DAMAGE AND REPAIR AS NECESSARY

LOOK AGAIN AT THE TROUBLESHOOTING PROCEDURE

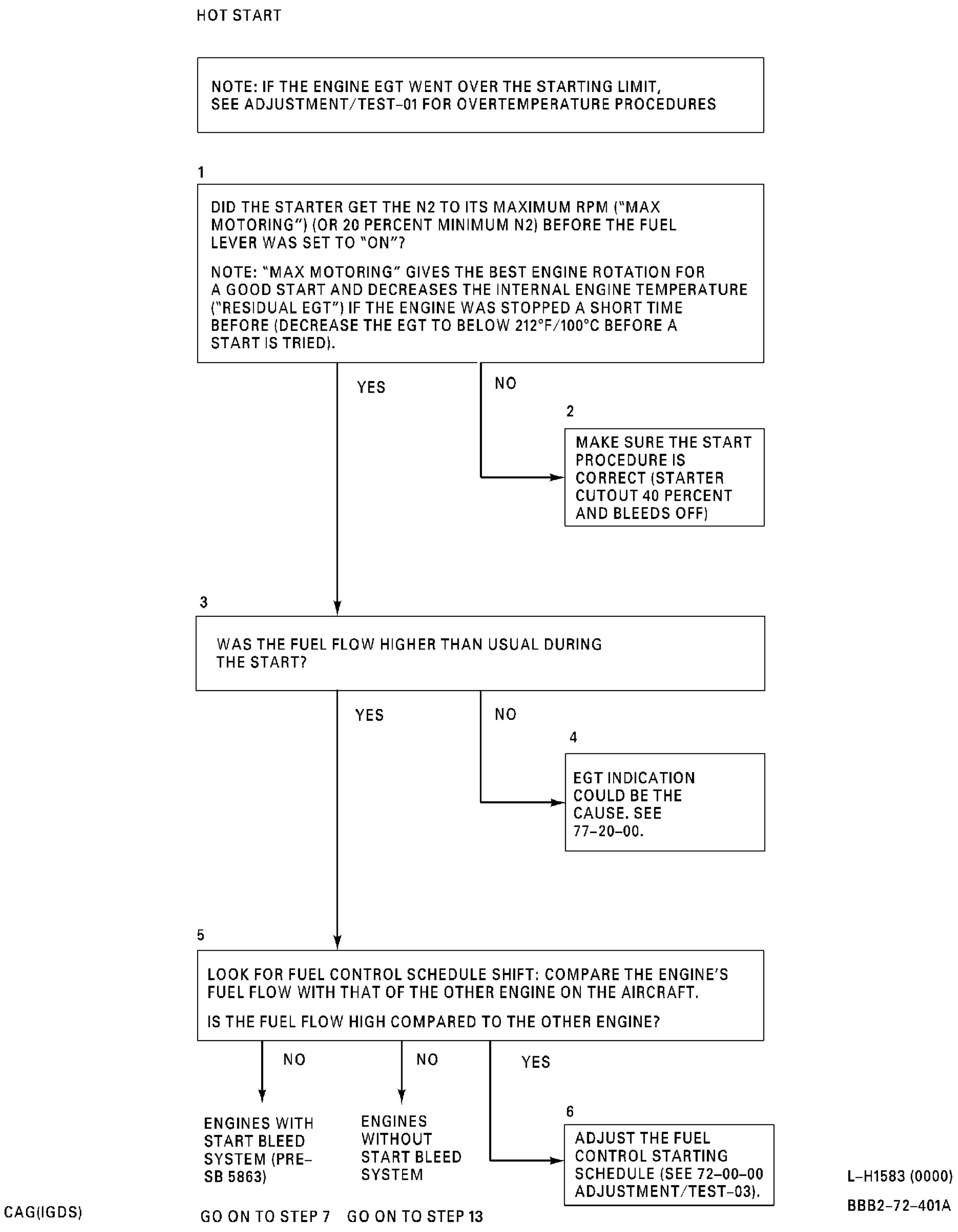
CAG(IGDS)

BBB2-72-400A

No Start Troubleshooting
Figure 123/72-00-04-990-823 (Sheet 8 of 8)



Fuel Pressurizing and Dump Valve Pressure Check
Figure 124/72-00-04-990-824



HOT START

NOTE: IF THE ENGINE EGT WENT OVER THE STARTING LIMIT, SEE ADJUSTMENT/TEST-01 FOR OVERTEMPERATURE PROCEDURES

1 DID THE STARTER GET THE N2 TO ITS MAXIMUM RPM ("MAX MOTORING") (OR 20 PERCENT MINIMUM N2) BEFORE THE FUEL LEVER WAS SET TO "ON"?

NOTE: "MAX MOTORING" GIVES THE BEST ENGINE ROTATION FOR A GOOD START AND DECREASES THE INTERNAL ENGINE TEMPERATURE ("RESIDUAL EGT") IF THE ENGINE WAS STOPPED A SHORT TIME BEFORE (DECREASE THE EGT TO BELOW 212°F/100°C BEFORE A START IS TRIED).

2 MAKE SURE THE START PROCEDURE IS CORRECT (STARTER CUTOUT 40 PERCENT AND BLEEDS OFF)

3 WAS THE FUEL FLOW HIGHER THAN USUAL DURING THE START?

4 EGT INDICATION COULD BE THE CAUSE. SEE 77-20-00.

5 LOOK FOR FUEL CONTROL SCHEDULE SHIFT: COMPARE THE ENGINE'S FUEL FLOW WITH THAT OF THE OTHER ENGINE ON THE AIRCRAFT.

IS THE FUEL FLOW HIGH COMPARED TO THE OTHER ENGINE?

ENGINES WITH START BLEED SYSTEM (PRE-SB 5863)

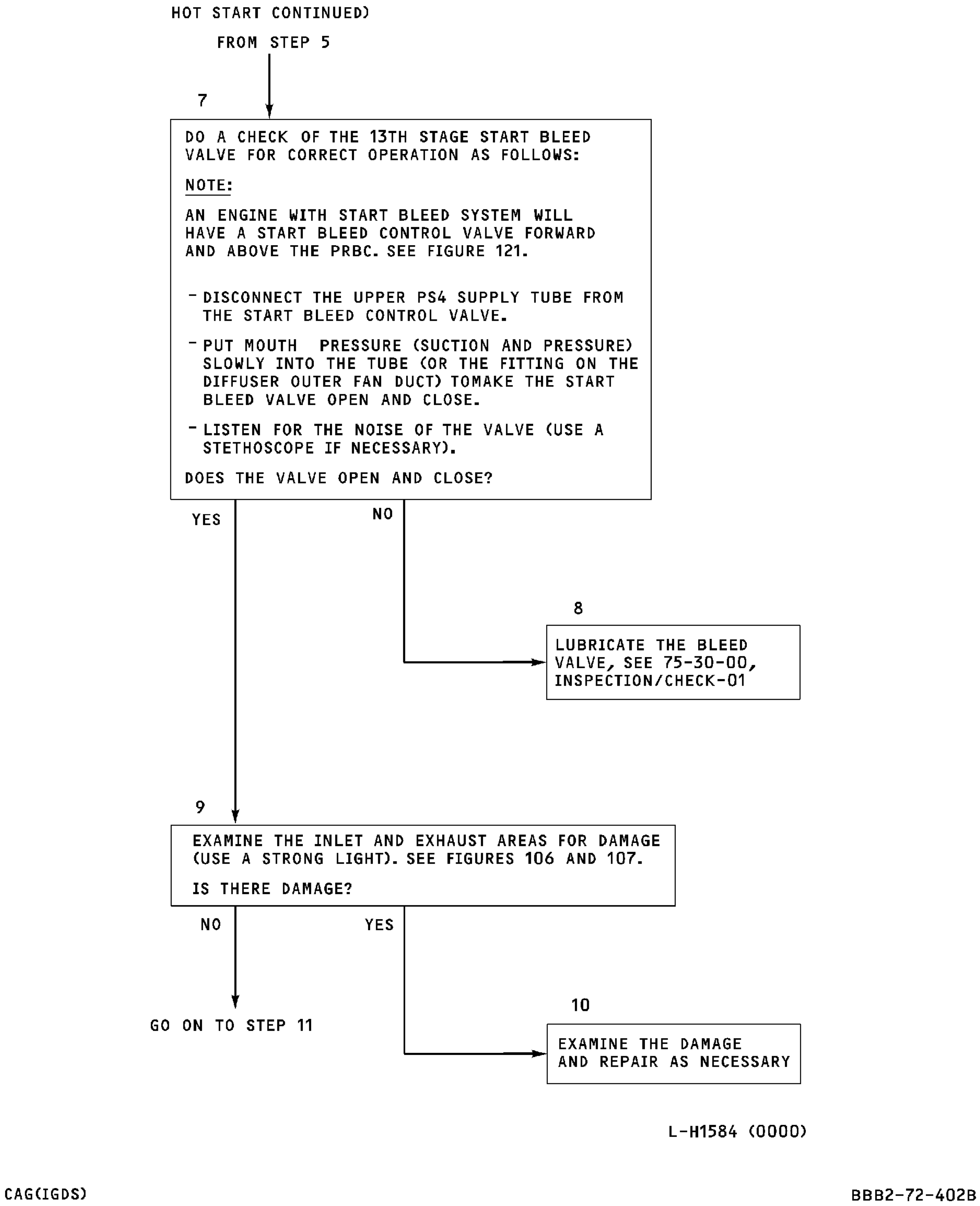
GO ON TO STEP 7

ENGINES WITHOUT START BLEED SYSTEM

GO ON TO STEP 13

6 ADJUST THE FUEL CONTROL STARTING SCHEDULE (SEE 72-00-00 ADJUSTMENT/TEST-03).

Hot Start Troubleshooting
Figure 125/72-00-04-990-825 (Sheet 1 of 4)



7

DO A CHECK OF THE 13TH STAGE START BLEED VALVE FOR CORRECT OPERATION AS FOLLOWS:

NOTE:

AN ENGINE WITH START BLEED SYSTEM WILL HAVE A START BLEED CONTROL VALVE FORWARD AND ABOVE THE PRBC. SEE FIGURE 121.

- DISCONNECT THE UPPER PS4 SUPPLY TUBE FROM THE START BLEED CONTROL VALVE.
- PUT MOUTH PRESSURE (SUCTION AND PRESSURE) SLOWLY INTO THE TUBE (OR THE FITTING ON THE DIFFUSER OUTER FAN DUCT) TOMAKE THE START BLEED VALVE OPEN AND CLOSE.
- LISTEN FOR THE NOISE OF THE VALVE (USE A STETHOSCOPE IF NECESSARY).

DOES THE VALVE OPEN AND CLOSE?

8

LUBRICATE THE BLEED VALVE, SEE 75-30-00, INSPECTION/CHECK-01

9

EXAMINE THE INLET AND EXHAUST AREAS FOR DAMAGE (USE A STRONG LIGHT). SEE FIGURES 106 AND 107.

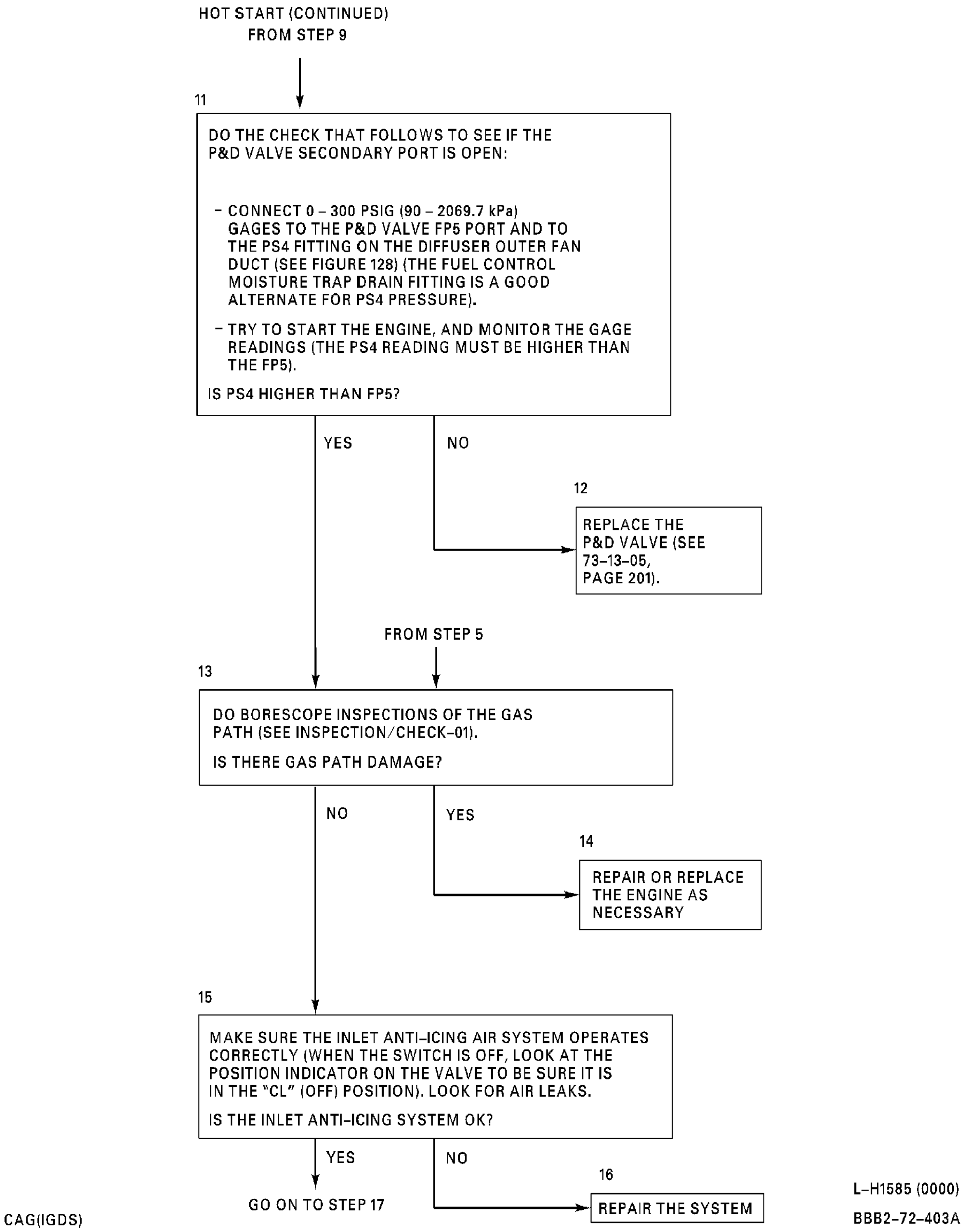
IS THERE DAMAGE?

GO ON TO STEP 11

10

EXAMINE THE DAMAGE AND REPAIR AS NECESSARY

Hot Start Troubleshooting
Figure 125/72-00-04-990-825 (Sheet 2 of 4)



HOT START (CONTINUED)
FROM STEP 9

11 DO THE CHECK THAT FOLLOWS TO SEE IF THE P&D VALVE SECONDARY PORT IS OPEN:

- CONNECT 0 – 300 PSIG (90 – 2069.7 kPa) GAGES TO THE P&D VALVE FP5 PORT AND TO THE PS4 FITTING ON THE DIFFUSER OUTER FAN DUCT (SEE FIGURE 128) (THE FUEL CONTROL MOISTURE TRAP DRAIN FITTING IS A GOOD ALTERNATE FOR PS4 PRESSURE).
- TRY TO START THE ENGINE, AND MONITOR THE GAGE READINGS (THE PS4 READING MUST BE HIGHER THAN THE FP5).

IS PS4 HIGHER THAN FP5?

12 REPLACE THE P&D VALVE (SEE 73-13-05, PAGE 201).

FROM STEP 5

13 DO BORESCOPE INSPECTIONS OF THE GAS PATH (SEE INSPECTION/CHECK-01).

IS THERE GAS PATH DAMAGE?

14 REPAIR OR REPLACE THE ENGINE AS NECESSARY

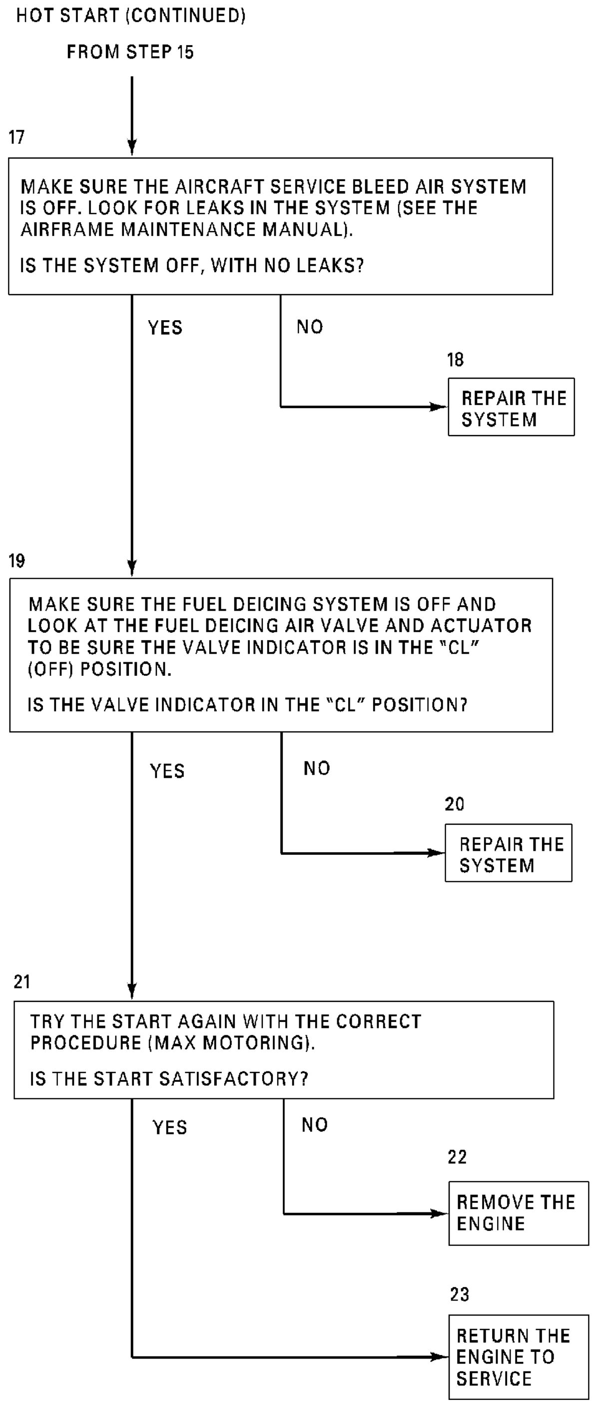
15 MAKE SURE THE INLET ANTI-ICING AIR SYSTEM OPERATES CORRECTLY (WHEN THE SWITCH IS OFF, LOOK AT THE POSITION INDICATOR ON THE VALVE TO BE SURE IT IS IN THE "CL" (OFF) POSITION). LOOK FOR AIR LEAKS.

IS THE INLET ANTI-ICING SYSTEM OK?

GO ON TO STEP 17

16 REPAIR THE SYSTEM

Hot Start Troubleshooting
Figure 125/72-00-04-990-825 (Sheet 3 of 4)



17 MAKE SURE THE AIRCRAFT SERVICE BLEED AIR SYSTEM IS OFF. LOOK FOR LEAKS IN THE SYSTEM (SEE THE AIRFRAME MAINTENANCE MANUAL).

IS THE SYSTEM OFF, WITH NO LEAKS?

18 REPAIR THE SYSTEM

19 MAKE SURE THE FUEL DEICING SYSTEM IS OFF AND LOOK AT THE FUEL DEICING AIR VALVE AND ACTUATOR TO BE SURE THE VALVE INDICATOR IS IN THE "CL" (OFF) POSITION.

IS THE VALVE INDICATOR IN THE "CL" POSITION?

20 REPAIR THE SYSTEM

21 TRY THE START AGAIN WITH THE CORRECT PROCEDURE (MAX MOTORING).

IS THE START SATISFACTORY?

22 REMOVE THE ENGINE

23 RETURN THE ENGINE TO SERVICE

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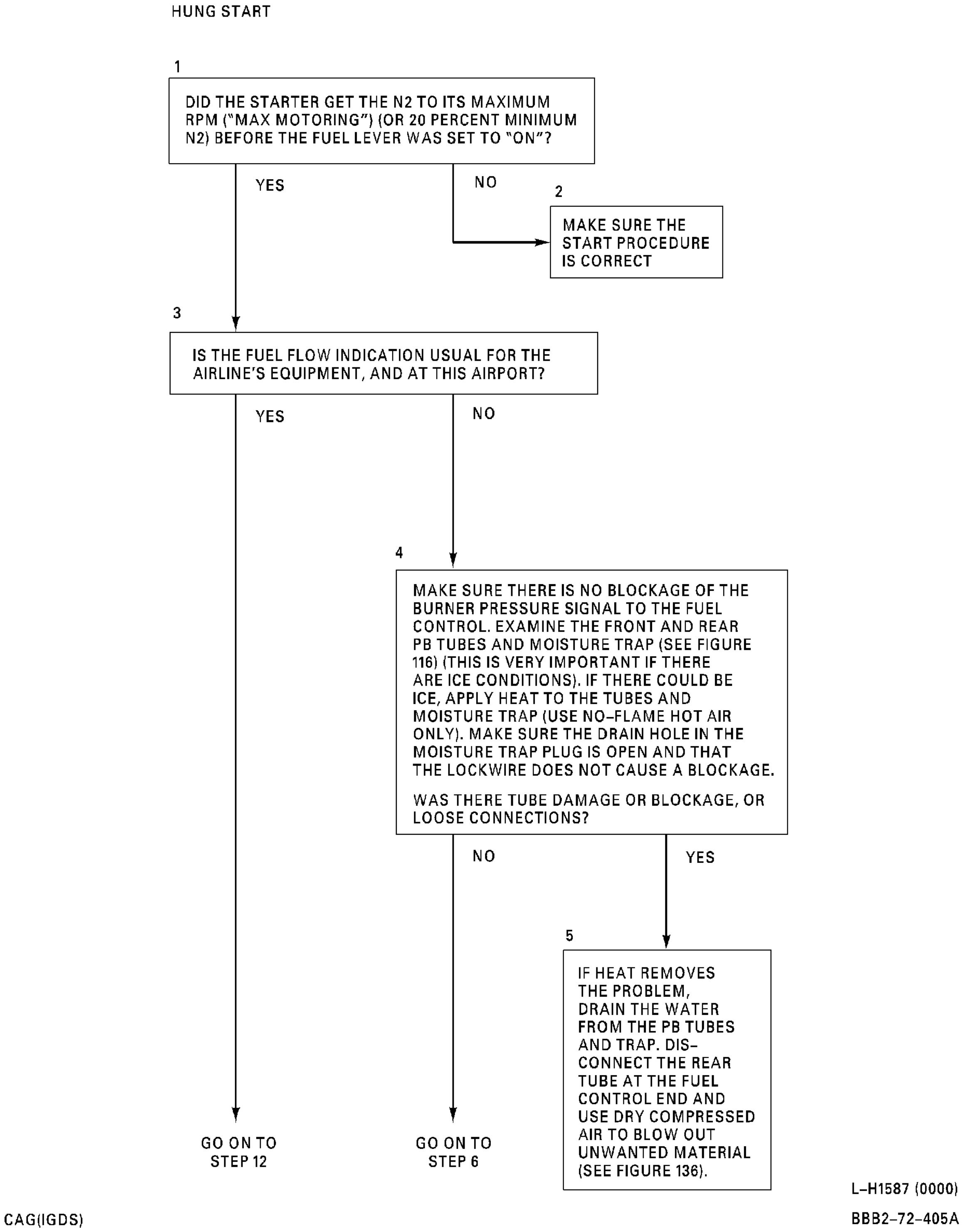
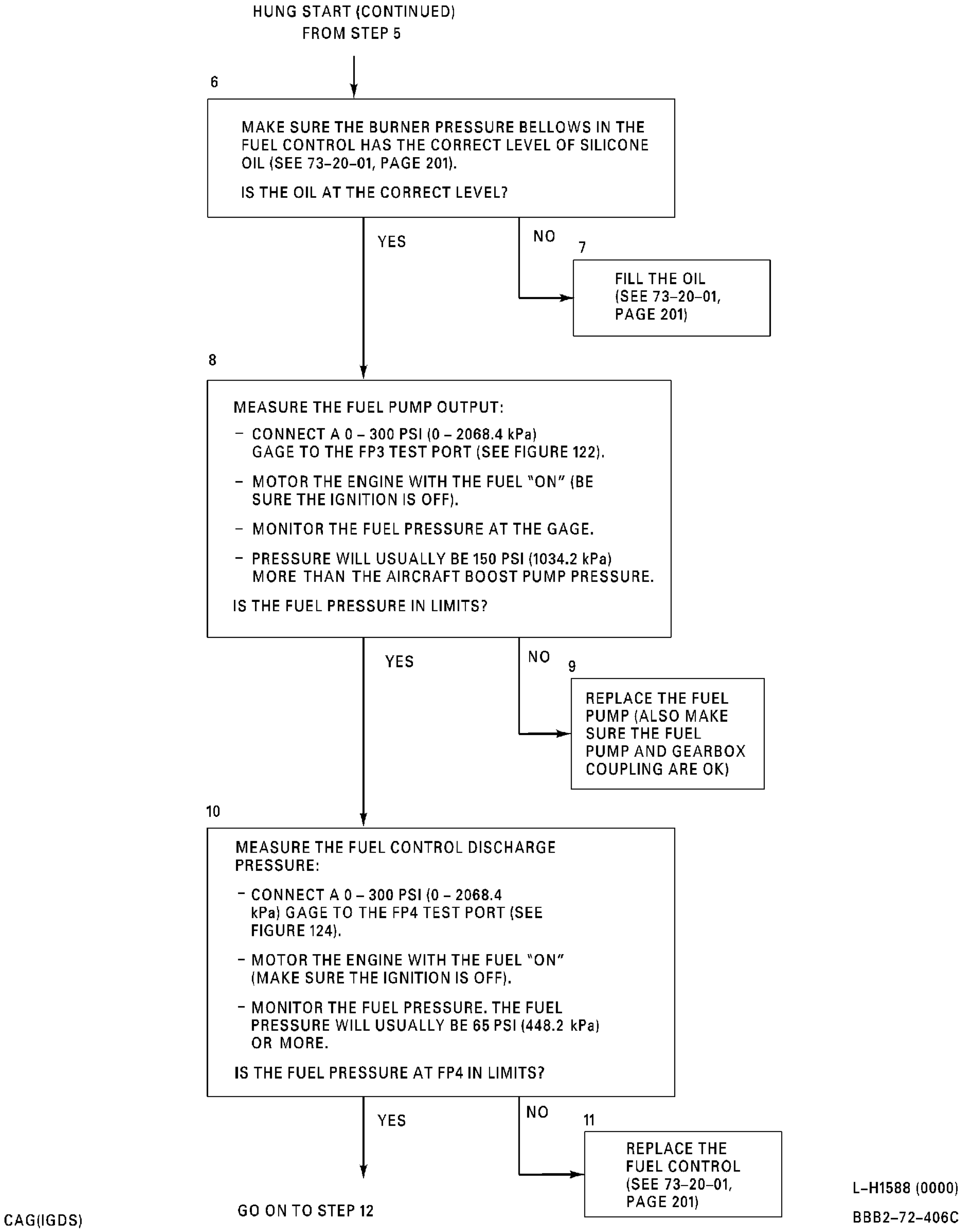
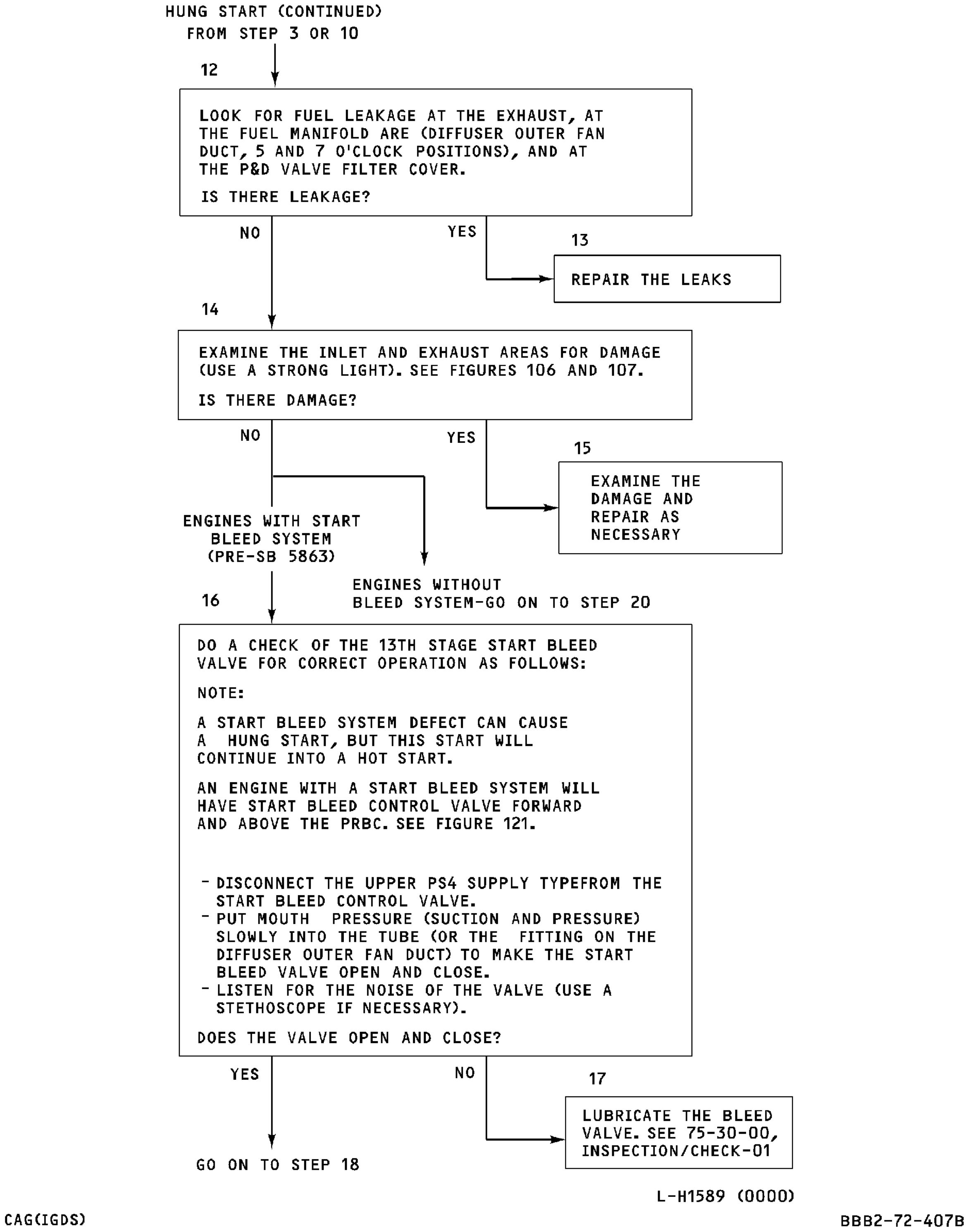
Hot Start Troubleshooting
Figure 125/72-00-04-990-825 (Sheet 4 of 4)



Hung Start Troubleshooting
Figure 126/72-00-04-990-826 (Sheet 1 of 5)



Hung Start Troubleshooting
Figure 126/72-00-04-990-826 (Sheet 2 of 5)



HUNG START (CONTINUED)
FROM STEP 3 OR 10

12 LOOK FOR FUEL LEAKAGE AT THE EXHAUST, AT THE FUEL MANIFOLD ARE (DIFFUSER OUTER FAN DUCT, 5 AND 7 O'CLOCK POSITIONS), AND AT THE P&D VALVE FILTER COVER.

IS THERE LEAKAGE?

13 REPAIR THE LEAKS

14 EXAMINE THE INLET AND EXHAUST AREAS FOR DAMAGE (USE A STRONG LIGHT). SEE FIGURES 106 AND 107.

IS THERE DAMAGE?

15 EXAMINE THE DAMAGE AND REPAIR AS NECESSARY

ENGINES WITH START BLEED SYSTEM (PRE-SB 5863)

ENGINES WITHOUT BLEED SYSTEM-GO ON TO STEP 20

16 DO A CHECK OF THE 13TH STAGE START BLEED VALVE FOR CORRECT OPERATION AS FOLLOWS:

NOTE:

A START BLEED SYSTEM DEFECT CAN CAUSE A HUNG START, BUT THIS START WILL CONTINUE INTO A HOT START.

AN ENGINE WITH A START BLEED SYSTEM WILL HAVE START BLEED CONTROL VALVE FORWARD AND ABOVE THE PRBC. SEE FIGURE 121.

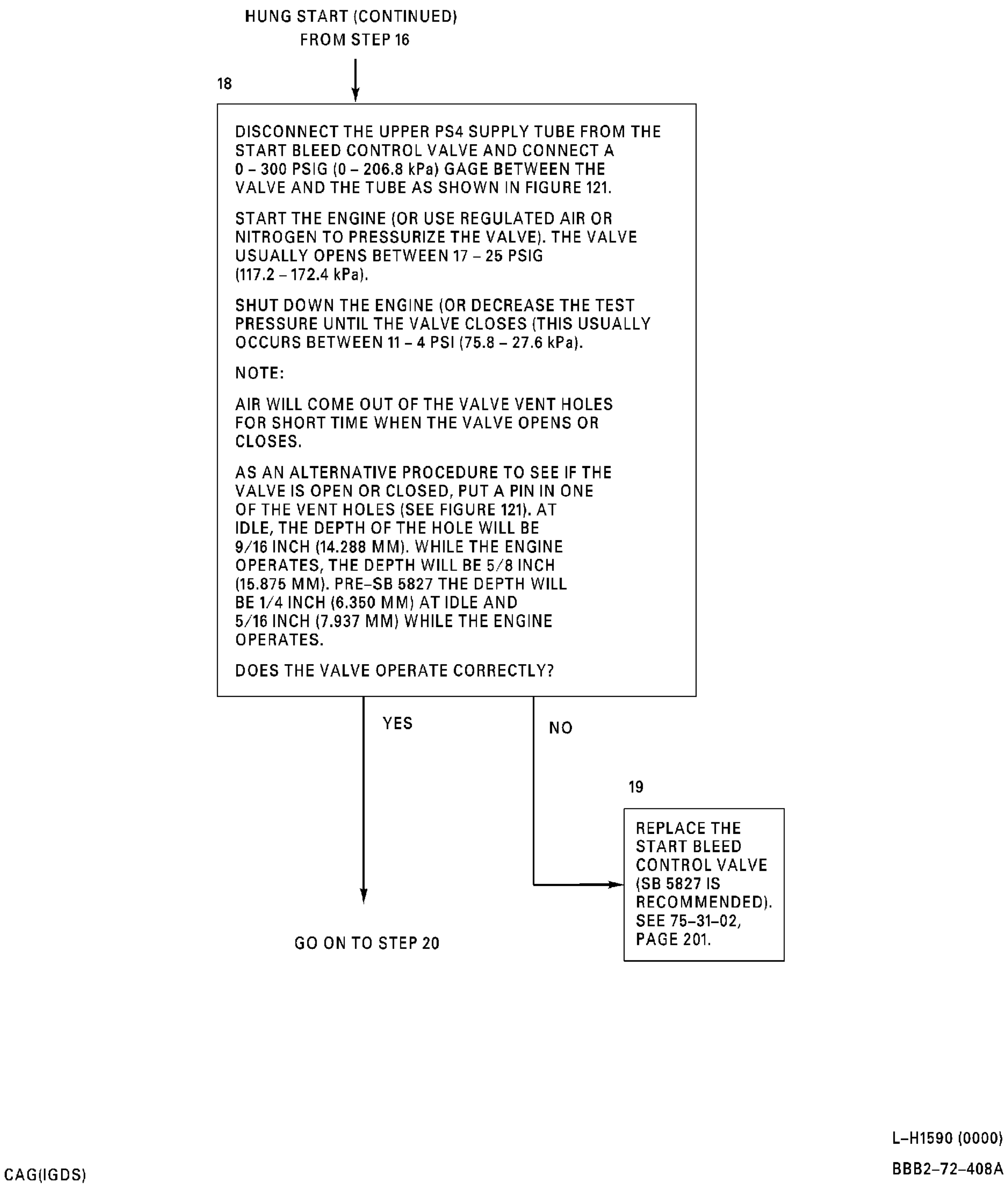
- DISCONNECT THE UPPER PS4 SUPPLY TYPEFROM THE START BLEED CONTROL VALVE.
- PUT MOUTH PRESSURE (SUCTION AND PRESSURE) SLOWLY INTO THE TUBE (OR THE FITTING ON THE DIFFUSER OUTER FAN DUCT) TO MAKE THE START BLEED VALVE OPEN AND CLOSE.
- LISTEN FOR THE NOISE OF THE VALVE (USE A STETHOSCOPE IF NECESSARY).

DOES THE VALVE OPEN AND CLOSE?

17 LUBRICATE THE BLEED VALVE. SEE 75-30-00, INSPECTION/CHECK-01

GO ON TO STEP 18

Hung Start Troubleshooting
Figure 126/72-00-04-990-826 (Sheet 3 of 5)



DISCONNECT THE UPPER PS4 SUPPLY TUBE FROM THE START BLEED CONTROL VALVE AND CONNECT A 0 – 300 PSIG (0 – 206.8 kPa) GAGE BETWEEN THE VALVE AND THE TUBE AS SHOWN IN FIGURE 121.

START THE ENGINE (OR USE REGULATED AIR OR NITROGEN TO PRESSURIZE THE VALVE). THE VALVE USUALLY OPENS BETWEEN 17 – 25 PSIG (117.2 – 172.4 kPa).

SHUT DOWN THE ENGINE (OR DECREASE THE TEST PRESSURE UNTIL THE VALVE CLOSES (THIS USUALLY OCCURS BETWEEN 11 – 4 PSI (75.8 – 27.6 kPa).

NOTE:

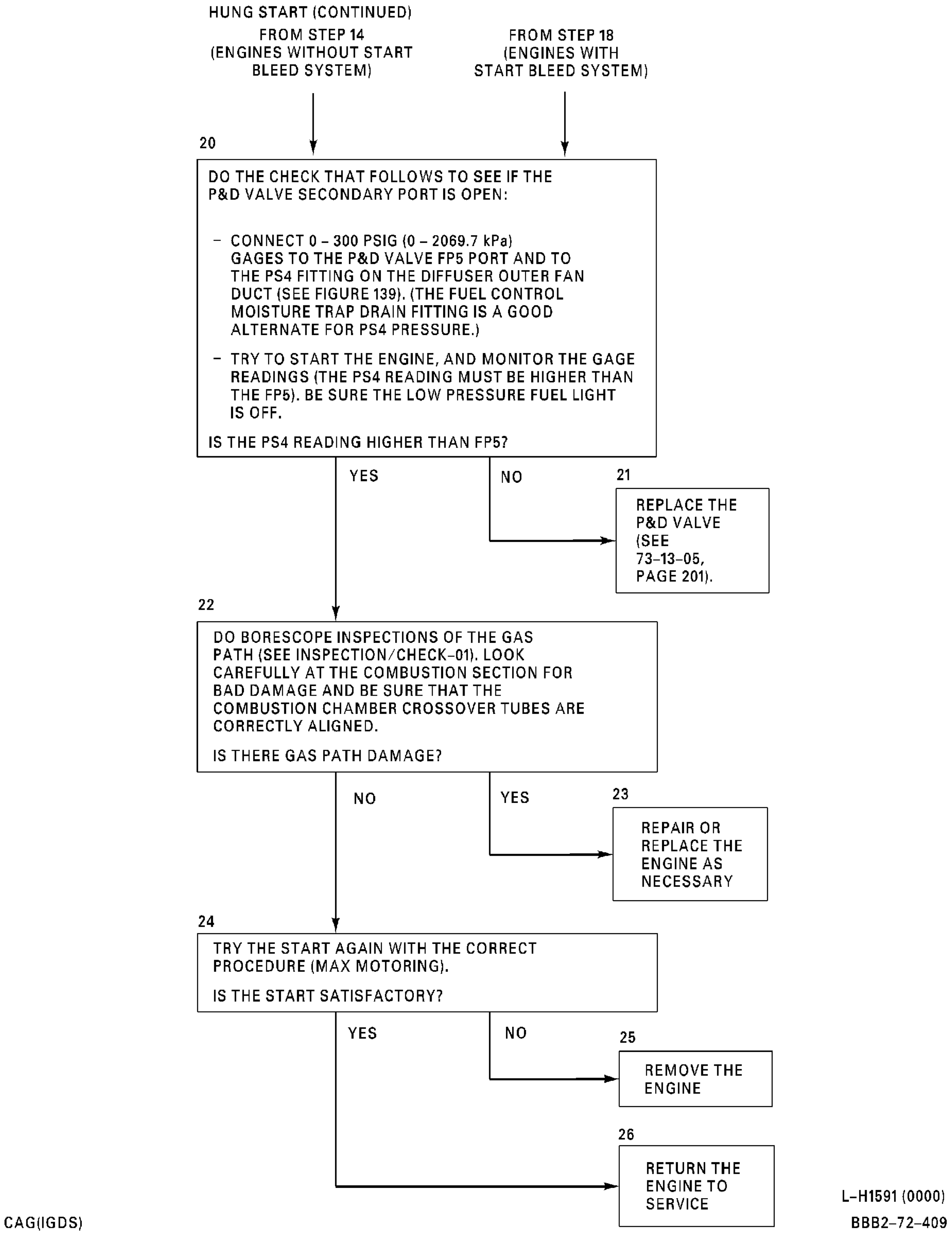
AIR WILL COME OUT OF THE VALVE VENT HOLES FOR SHORT TIME WHEN THE VALVE OPENS OR CLOSES.

AS AN ALTERNATIVE PROCEDURE TO SEE IF THE VALVE IS OPEN OR CLOSED, PUT A PIN IN ONE OF THE VENT HOLES (SEE FIGURE 121). AT IDLE, THE DEPTH OF THE HOLE WILL BE 9/16 INCH (14.288 MM). WHILE THE ENGINE OPERATES, THE DEPTH WILL BE 5/8 INCH (15.875 MM). PRE-SB 5827 THE DEPTH WILL BE 1/4 INCH (6.350 MM) AT IDLE AND 5/16 INCH (7.937 MM) WHILE THE ENGINE OPERATES.

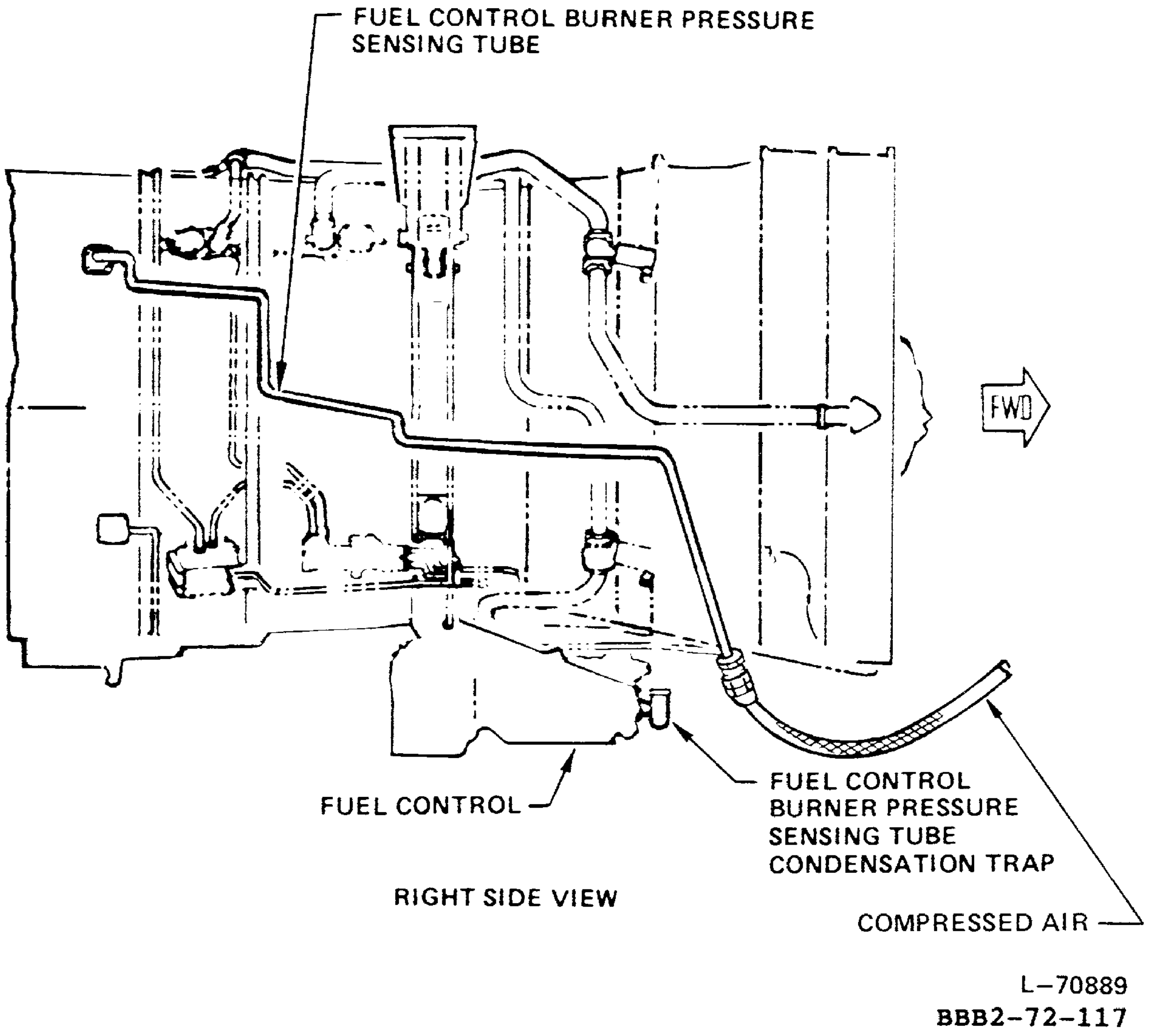
DOES THE VALVE OPERATE CORRECTLY?

REPLACE THE START BLEED CONTROL VALVE (SB 5827 IS RECOMMENDED). SEE 75-31-02, PAGE 201.

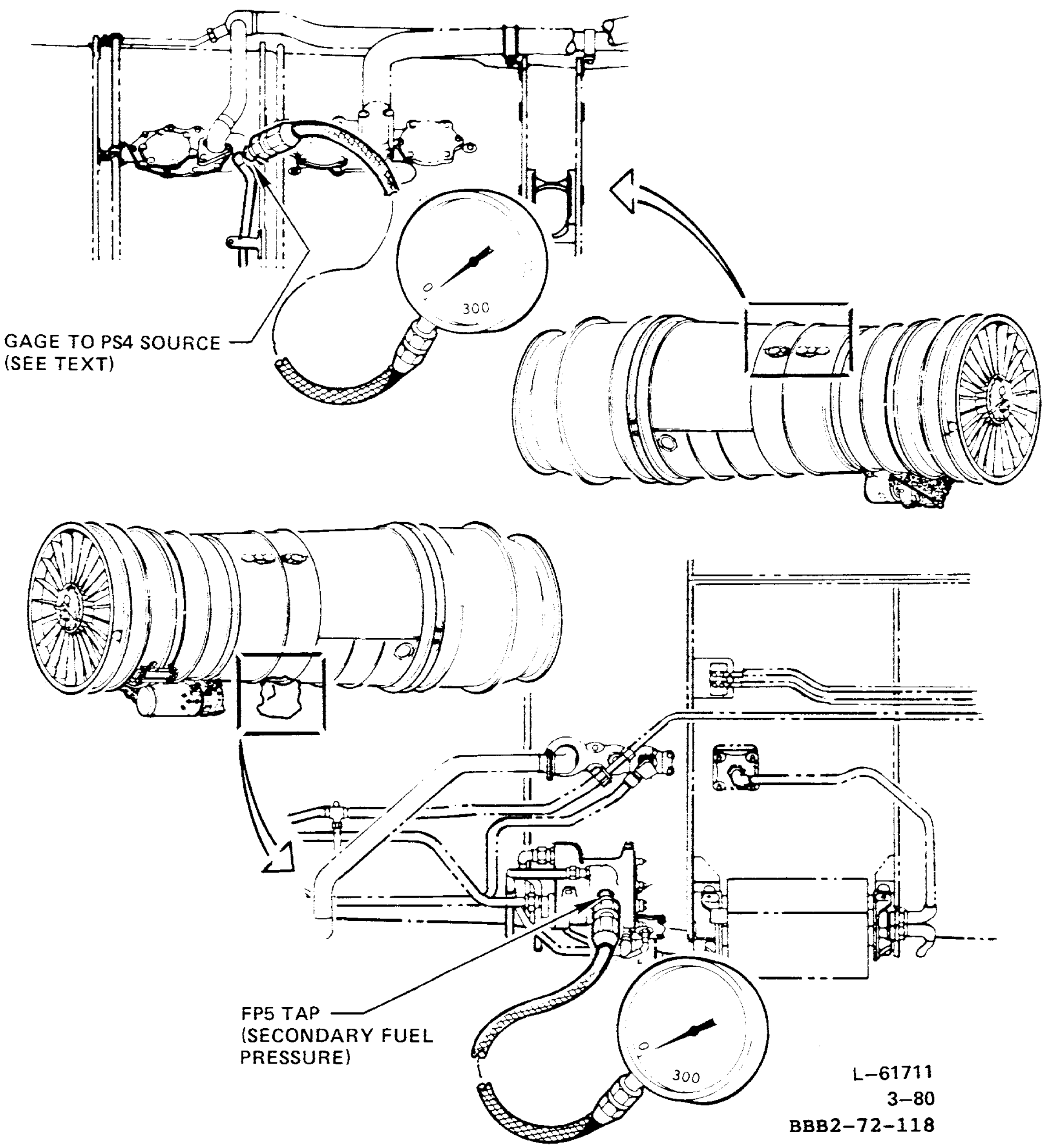
Hung Start Troubleshooting
Figure 126/72-00-04-990-826 (Sheet 4 of 5)



Hung Start Troubleshooting
Figure 126/72-00-04-990-826 (Sheet 5 of 5)



Fuel Control Sense Line Check
Figure 127/72-00-04-990-827



Fuel Pressurizing and Dump Valve Pressure Test
Figure 128/72-00-04-990-828

7. Engine Flameout

A. General (Figure 129) (Figure 130)

(1) If an engine has a flameout, there can be four causes:

- Irregular fuel supply
- Bad weather operation
- Engine gas path damage
- Engine component problem

(2) Irregular Fuel Supply

(a) If the fuel flow is stopped for a short time (this time can be as short as 0.1 second), an engine can have a flameout. If there was sufficient water in the fuel system to fill part of the engine fuel manifolds for a short time, this can cause a flameout. Blockage of the fuel system upstream of the engine can cause flameout. If the blockage or contamination goes away in a short time, it will usually be possible to get a satisfactory start.

(3) Bad Weather

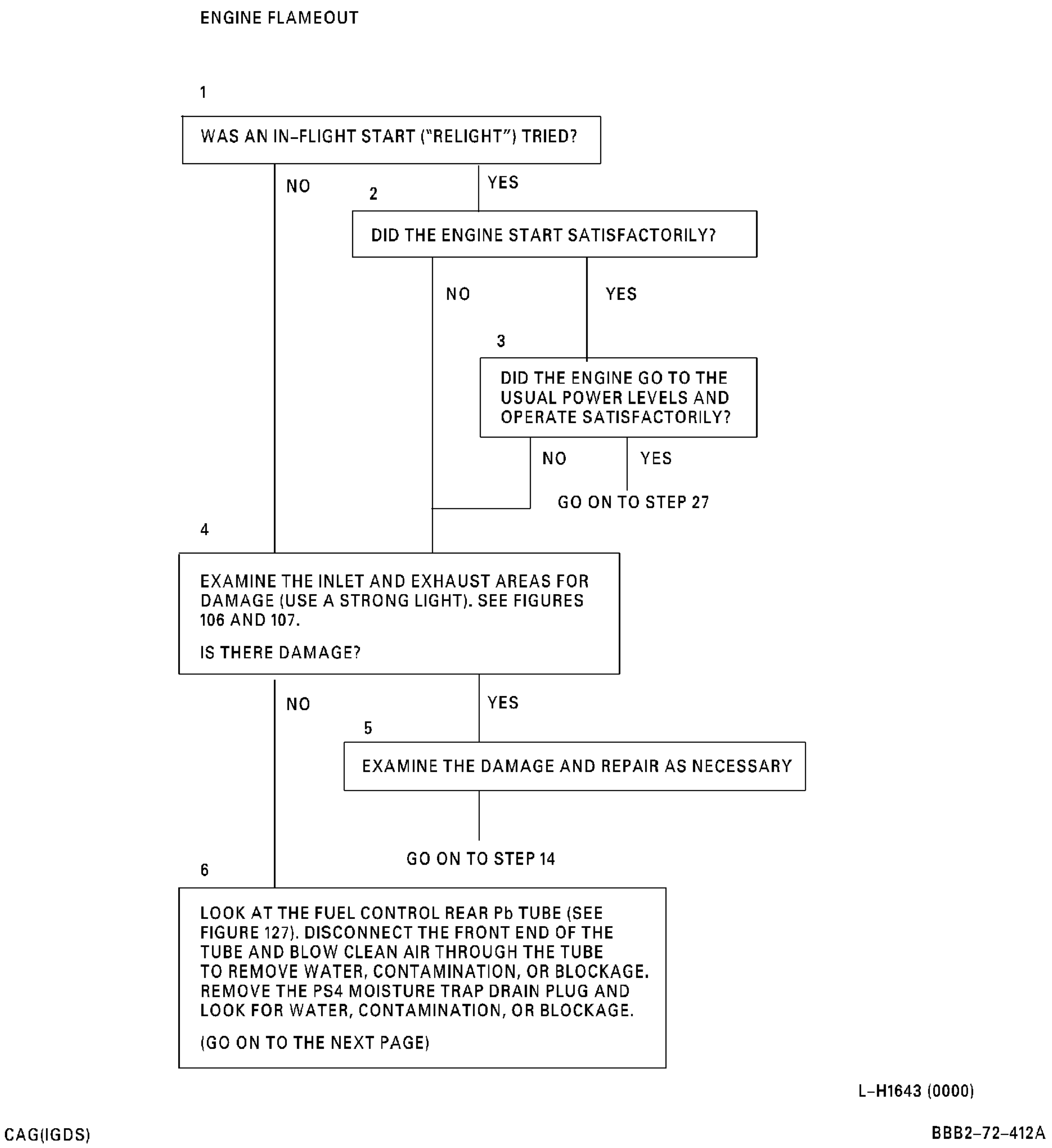
(a) During takeoff a large quantity of ground water (rain, snow, slush, etc.) in the engine can cause flameout (gas path damage can also occur from this). During flight operations in extreme weather conditions (rain, hail, etc.), at power levels lower than those recommended for these conditions, flameout can occur. If there is no damage to the engine, it is usually possible to get a satisfactory in-flight start.

(4) Gas Path Damage

(a) Engine gas path damage can occur from different causes, and the result can be engine flameout. If this occurs it is not usually possible to start the engine again.

(5) Engine Component Problem

(a) There are engine component problems that can cause engine flameout. Problems with the fuel pump, fuel control, and fuel pressurizing and dump valve can cause irregular or stopped fuel flow and cause a flameout (with these problems it is not usually possible to get the engine started again in-flight). Problems with the fuel control Pb tube or fuel deicing system can be a flameout cause, but with these causes an in-flight start is frequently possible.



ENGINE FLAMEOUT

1 WAS AN IN-FLIGHT START ("RELIGHT") TRIED?

2 DID THE ENGINE START SATISFACTORILY?

3 DID THE ENGINE GO TO THE USUAL POWER LEVELS AND OPERATE SATISFACTORILY?

GO ON TO STEP 27

4 EXAMINE THE INLET AND EXHAUST AREAS FOR DAMAGE (USE A STRONG LIGHT). SEE FIGURES 106 AND 107.

IS THERE DAMAGE?

5 EXAMINE THE DAMAGE AND REPAIR AS NECESSARY

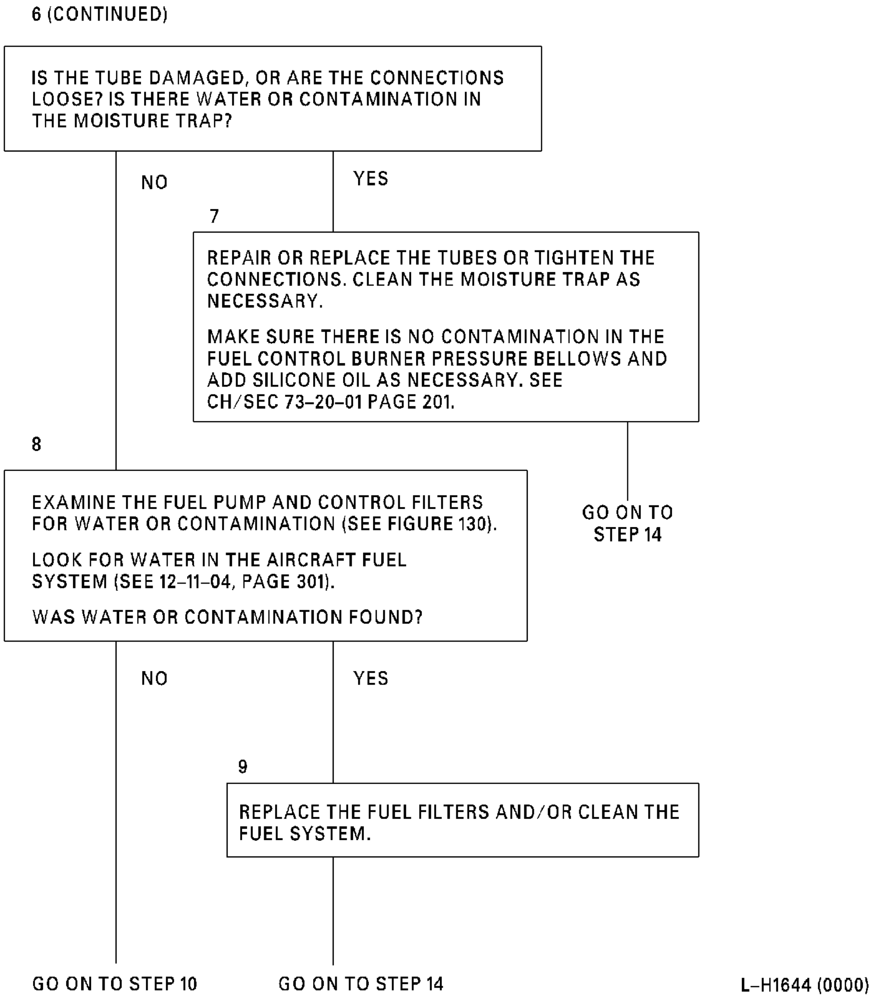
GO ON TO STEP 14

6 LOOK AT THE FUEL CONTROL REAR Pb TUBE (SEE FIGURE 127). DISCONNECT THE FRONT END OF THE TUBE AND BLOW CLEAN AIR THROUGH THE TUBE TO REMOVE WATER, CONTAMINATION, OR BLOCKAGE. REMOVE THE PS4 MOISTURE TRAP DRAIN PLUG AND LOOK FOR WATER, CONTAMINATION, OR BLOCKAGE.

(GO ON TO THE NEXT PAGE)

Engine Flameout Troubleshooting
Figure 129/72-00-04-990-829 (Sheet 1 of 7)

ENGINE FLAMEOUT (CONTINUED)



6 (CONTINUED)

IS THE TUBE DAMAGED, OR ARE THE CONNECTIONS LOOSE? IS THERE WATER OR CONTAMINATION IN THE MOISTURE TRAP?

7

REPAIR OR REPLACE THE TUBES OR TIGHTEN THE CONNECTIONS. CLEAN THE MOISTURE TRAP AS NECESSARY.

MAKE SURE THERE IS NO CONTAMINATION IN THE FUEL CONTROL BURNER PRESSURE BELLOWS AND ADD SILICONE OIL AS NECESSARY. SEE CH/SEC 73–20–01 PAGE 201.

8

EXAMINE THE FUEL PUMP AND CONTROL FILTERS FOR WATER OR CONTAMINATION (SEE FIGURE 130).

LOOK FOR WATER IN THE AIRCRAFT FUEL SYSTEM (SEE 12–11–04, PAGE 301).

WAS WATER OR CONTAMINATION FOUND?

9

REPLACE THE FUEL FILTERS AND/OR CLEAN THE FUEL SYSTEM.

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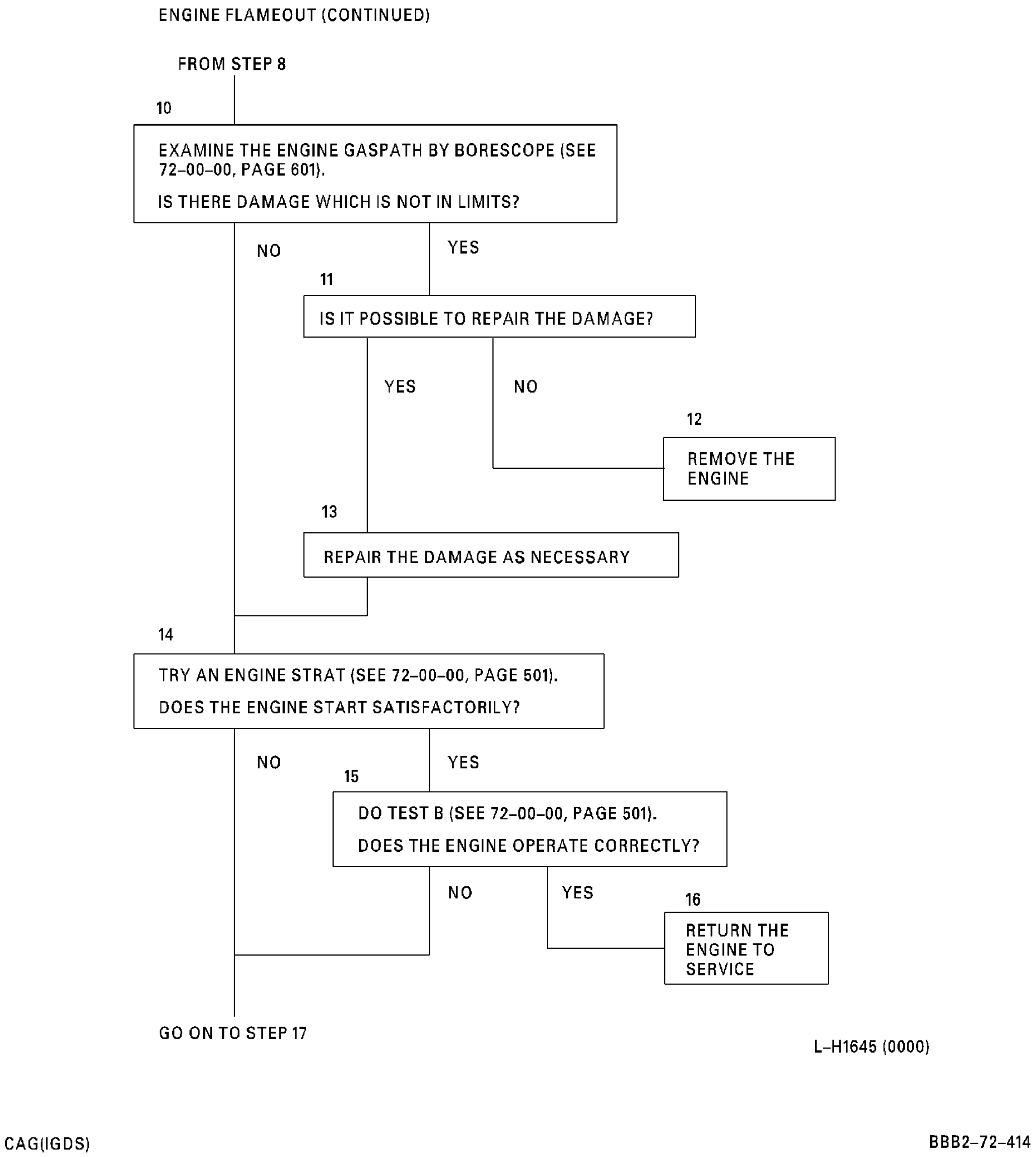
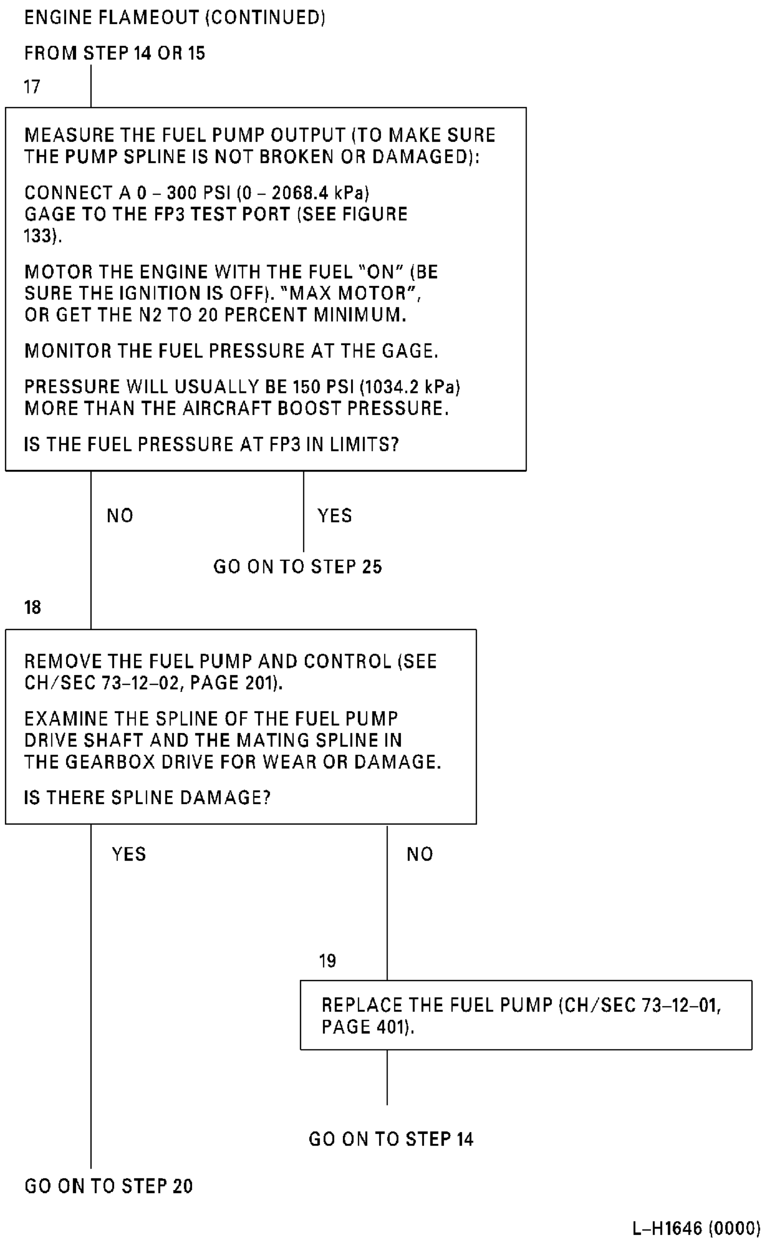
Engine Flameout Troubleshooting
Figure 129/72-00-04-990-829 (Sheet 2 of 7)



Engine Flameout Troubleshooting
Figure 129/72-00-04-990-829 (Sheet 3 of 7)



ENGINE FLAMEOUT (CONTINUED)

FROM STEP 14 OR 15

17

MEASURE THE FUEL PUMP OUTPUT (TO MAKE SURE THE PUMP SPLINE IS NOT BROKEN OR DAMAGED):

CONNECT A 0 – 300 PSI (0 – 2068.4 kPa) GAGE TO THE FP3 TEST PORT (SEE FIGURE 133).

MOTOR THE ENGINE WITH THE FUEL "ON" (BE SURE THE IGNITION IS OFF). "MAX MOTOR", OR GET THE N2 TO 20 PERCENT MINIMUM.

MONITOR THE FUEL PRESSURE AT THE GAGE.

PRESSURE WILL USUALLY BE 150 PSI (1034.2 kPa) MORE THAN THE AIRCRAFT BOOST PRESSURE.

IS THE FUEL PRESSURE AT FP3 IN LIMITS?

NO

YES

GO ON TO STEP 25

18

REMOVE THE FUEL PUMP AND CONTROL (SEE CH/SEC 73-12-02, PAGE 201).

EXAMINE THE SPLINE OF THE FUEL PUMP DRIVE SHAFT AND THE MATING SPLINE IN THE GEARBOX DRIVE FOR WEAR OR DAMAGE.

IS THERE SPLINE DAMAGE?

YES

NO

19

REPLACE THE FUEL PUMP (CH/SEC 73-12-01, PAGE 401).

GO ON TO STEP 14

GO ON TO STEP 20

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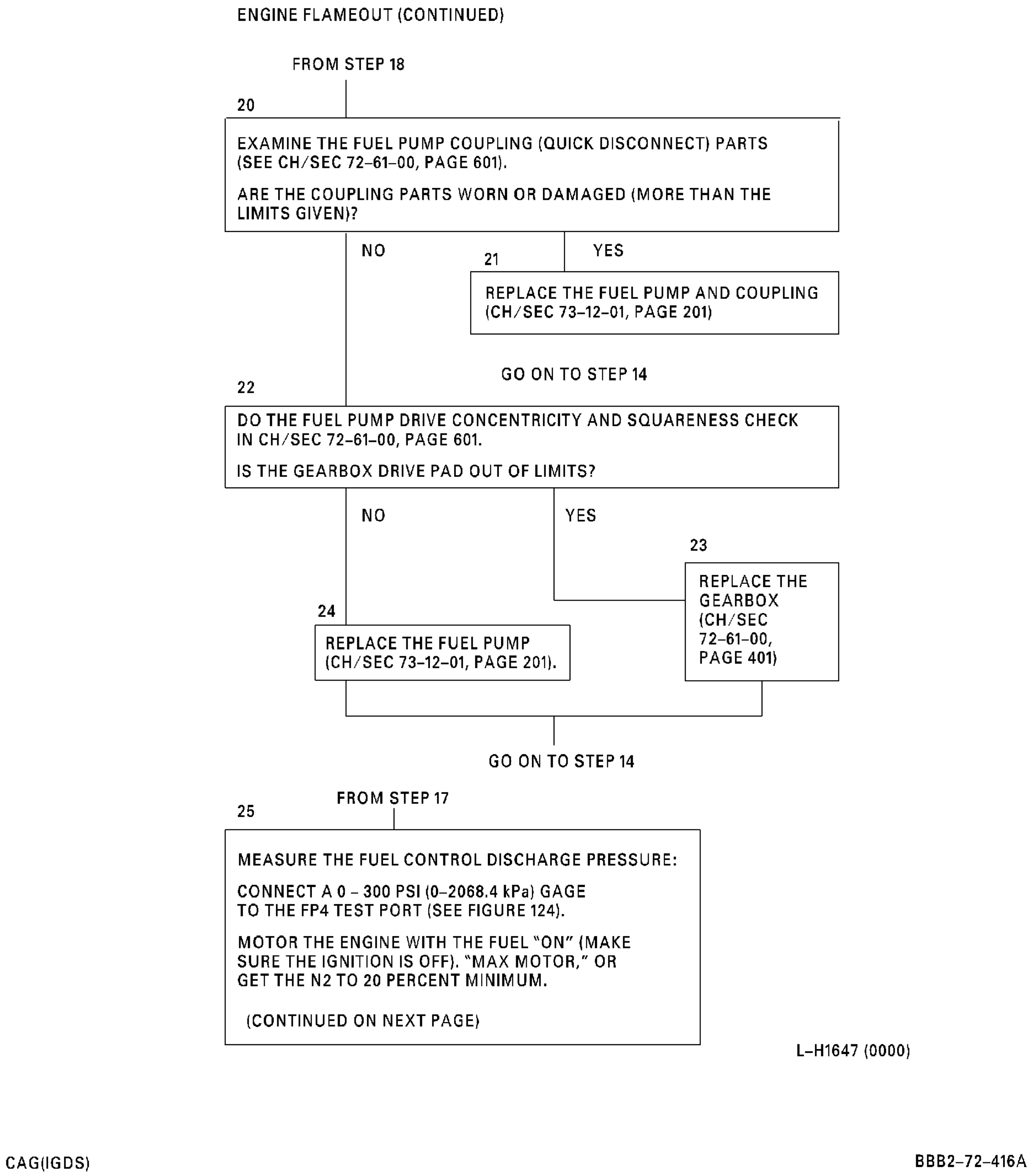
Engine Flameout Troubleshooting
Figure 129/72-00-04-990-829 (Sheet 4 of 7)



ENGINE FLAMEOUT (CONTINUED)

FROM STEP 18

20 EXAMINE THE FUEL PUMP COUPLING (QUICK DISCONNECT) PARTS (SEE CH/SEC 72-61-00, PAGE 601).

ARE THE COUPLING PARTS WORN OR DAMAGED (MORE THAN THE LIMITS GIVEN)?

21 REPLACE THE FUEL PUMP AND COUPLING (CH/SEC 73-12-01, PAGE 201)

GO ON TO STEP 14

22 DO THE FUEL PUMP DRIVE CONCENTRICITY AND SQUARENESS CHECK IN CH/SEC 72-61-00, PAGE 601.

IS THE GEARBOX DRIVE PAD OUT OF LIMITS?

23 REPLACE THE GEARBOX (CH/SEC 72-61-00, PAGE 401)

24 REPLACE THE FUEL PUMP (CH/SEC 73-12-01, PAGE 201).

GO ON TO STEP 14

FROM STEP 17

25 MEASURE THE FUEL CONTROL DISCHARGE PRESSURE:

CONNECT A 0 - 300 PSI (0-2068.4 kPa) GAGE TO THE FP4 TEST PORT (SEE FIGURE 124).

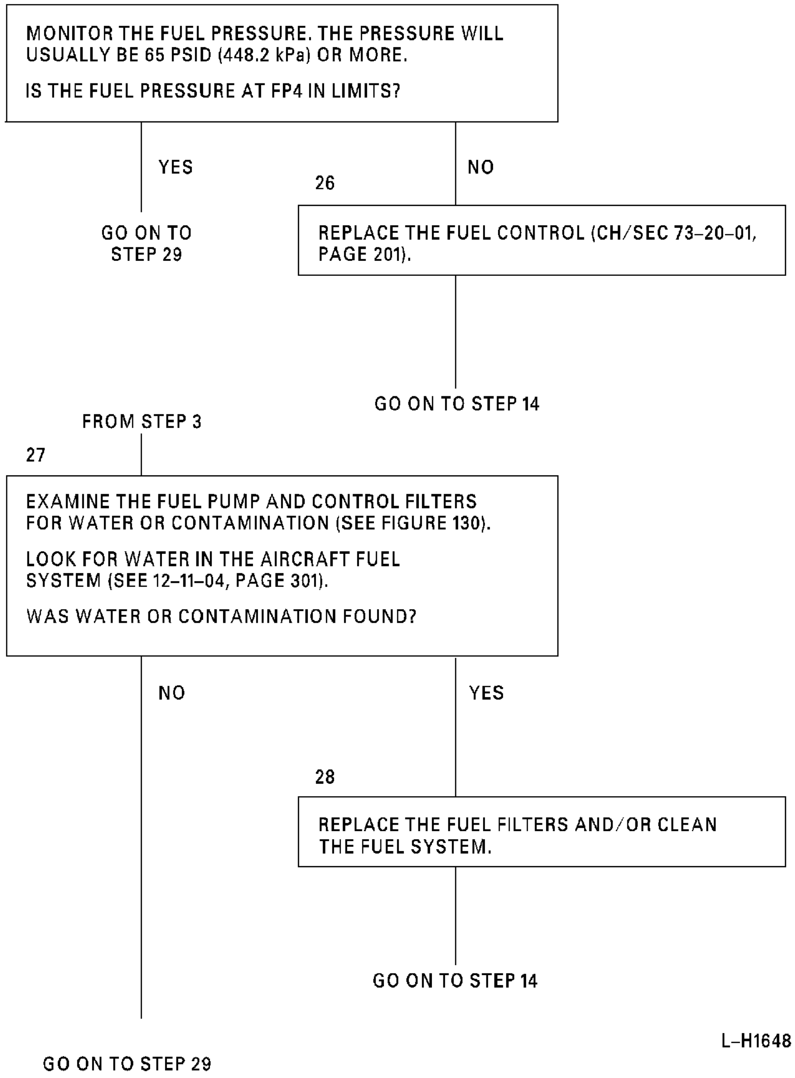
MOTOR THE ENGINE WITH THE FUEL "ON" (MAKE SURE THE IGNITION IS OFF). "MAX MOTOR," OR GET THE N2 TO 20 PERCENT MINIMUM.

(CONTINUED ON NEXT PAGE)

Engine Flameout Troubleshooting
Figure 129/72-00-04-990-829 (Sheet 5 of 7)

ENGINE FLAMEOUT (CONTINUED)

25 (CONTINUED)



MONITOR THE FUEL PRESSURE. THE PRESSURE WILL USUALLY BE 65 PSID (448.2 kPa) OR MORE.

IS THE FUEL PRESSURE AT FP4 IN LIMITS?

REPLACE THE FUEL CONTROL (CH/SEC 73-20-01, PAGE 201).

EXAMINE THE FUEL PUMP AND CONTROL FILTERS FOR WATER OR CONTAMINATION (SEE FIGURE 130).

LOOK FOR WATER IN THE AIRCRAFT FUEL SYSTEM (SEE 12-11-04, PAGE 301).

WAS WATER OR CONTAMINATION FOUND?

REPLACE THE FUEL FILTERS AND/OR CLEAN THE FUEL SYSTEM.

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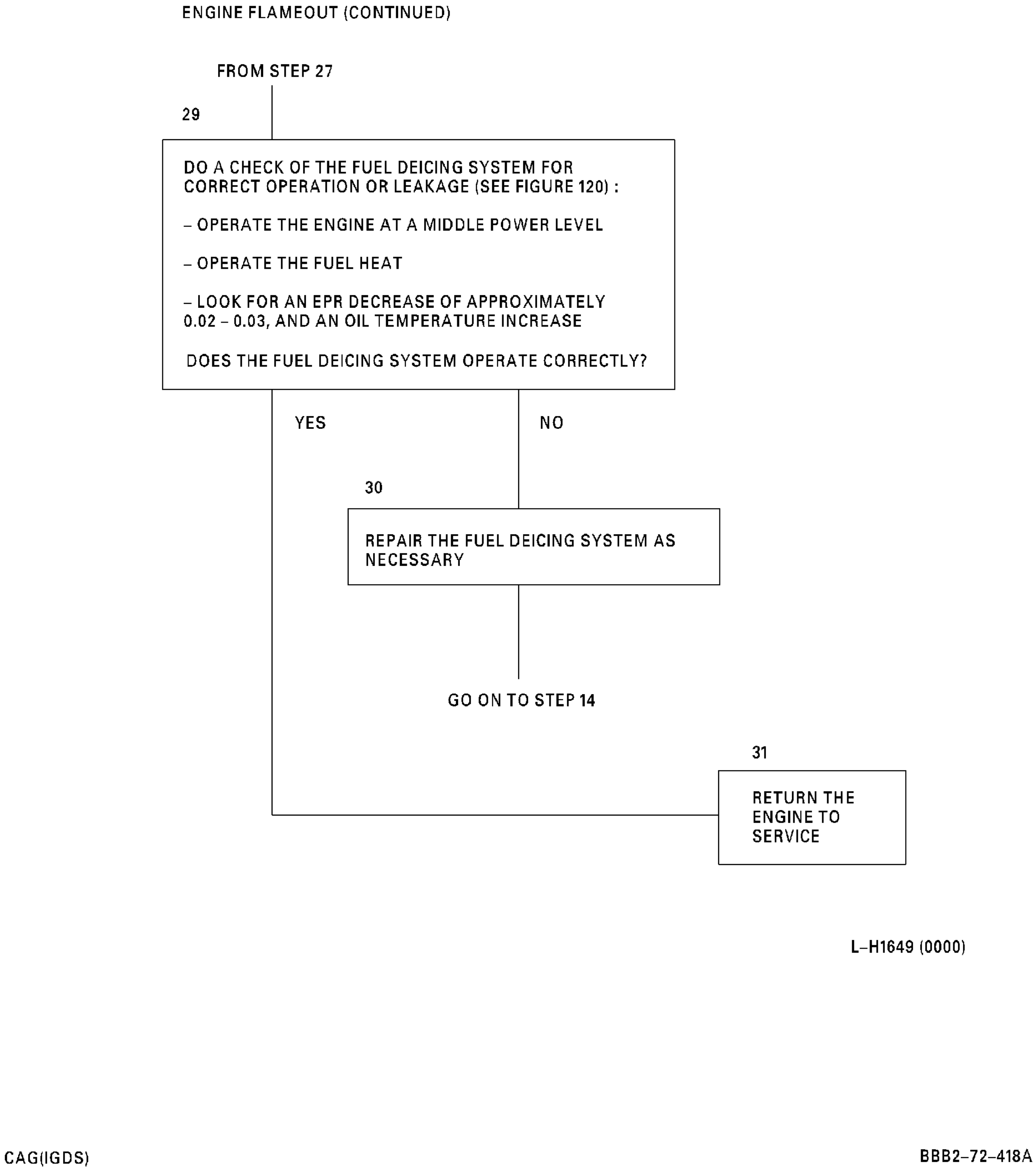
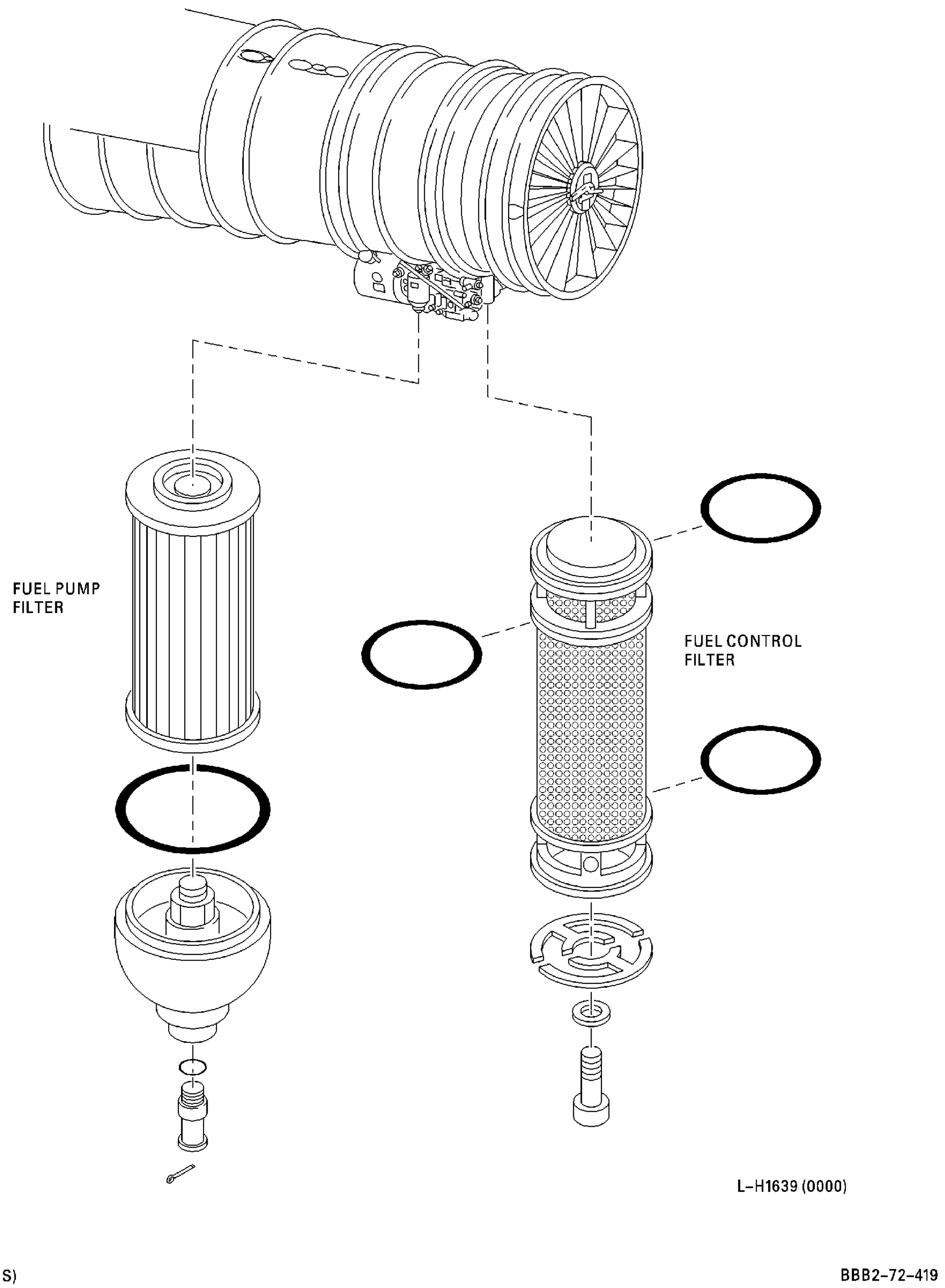
Engine Flameout Troubleshooting
Figure 129/72-00-04-990-829 (Sheet 6 of 7)



Engine Flameout Troubleshooting
Figure 129/72-00-04-990-829 (Sheet 7 of 7)



Fuel Filter Check
Figure 130/72-00-04-990-830

8. Auto-Acceleration

A. General (Figure 131)

(1) An engine has an auto-acceleration if the engine speed increases automatically. The cause of this can be:

(a) A defect in the fuel control or fuel pump.

(b) An aircraft auto throttle system that does not operate correctly.

(c) Incorrect operation of the auto throttle system.

(2) The first thing it is important to know is if engine operation went above the speed or temperature limits in ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 5 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 2 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 3 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 4 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 1, during the auto-acceleration. If engine operation went above these limits, it can be necessary to replace the engine. It will be necessary to find and correct the problem so that it does not occur again.

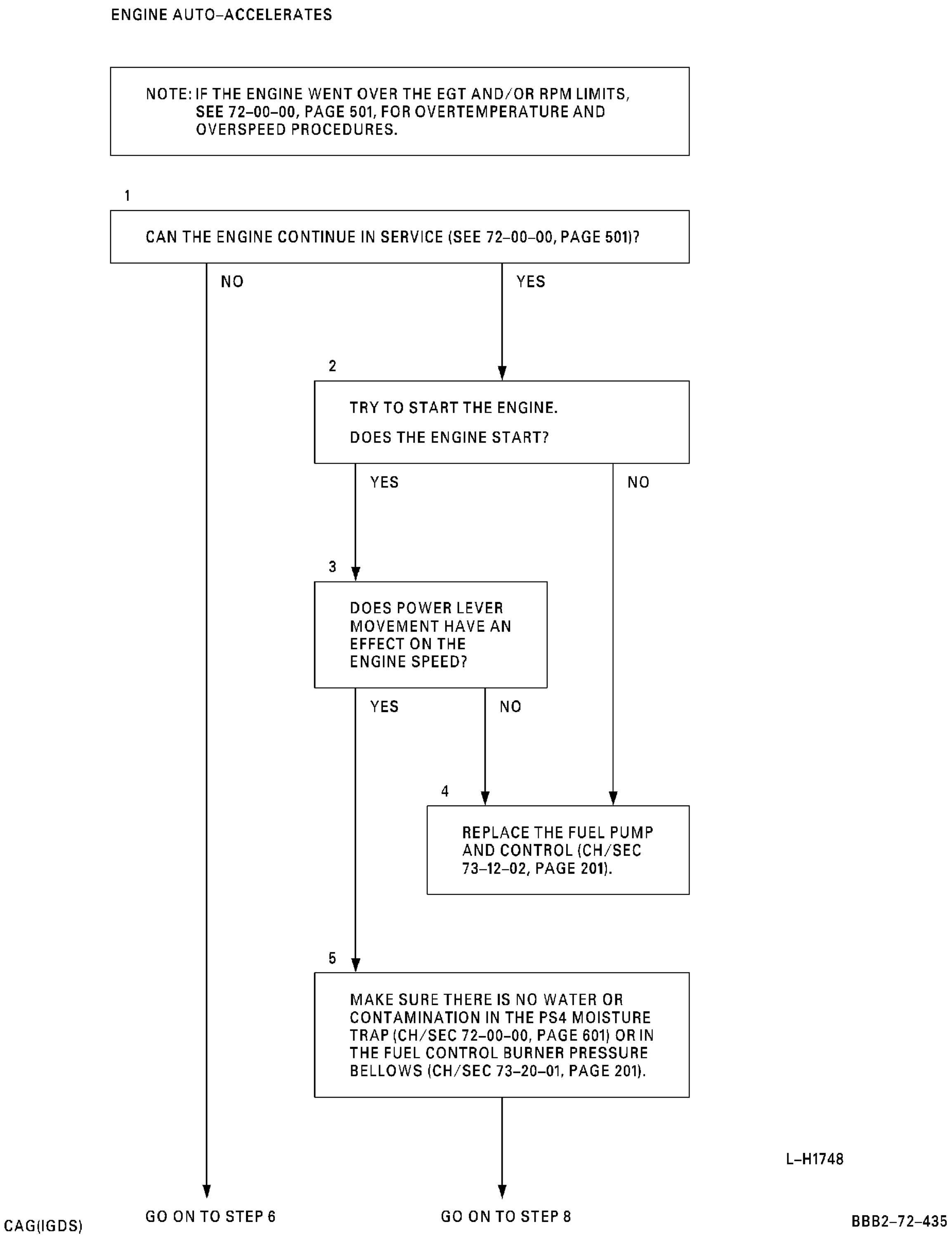
(3) Auto-acceleration of the engine can occur when some of the N_2 signal to the fuel control does not get to the control because the drive shaft between the fuel pump and the fuel control is damaged but is not fully disengaged from the control. When this occurs the fuel control gets a speed signal that is lower than N_2 , and the fuel control will schedule a high level of fuel flow. The result will be an auto-acceleration which the power lever will not control. Another cause of auto-acceleration can be an N_2 signal which does not get to the fuel control because the fuel pump drive shaft between the pump and control is broken (when this occurs the fuel pump will continue to pump fuel, but the fuel control will get a "Zero N_2 Level" signal). If the N_2 signal goes to zero at a sufficiently high power level, the engine will usually "auto-decelerate"; if the power level is lower when the N_2 signal goes to zero, the engine will usually auto-accelerate.

(4) If the fuel control does not get an N_2 signal, it will usually not be possible to start the engine again after it is stopped. However, if a start is possible, the engine will continue to accelerate slowly to a speed above idle. This engine could have a surge at an N_2 not to much above idle during its acceleration.

(5) If a Ps4 signal does not get to the fuel control, this can cause acceleration problems. Low temperatures at altitude can freeze water in a Ps4 moisture trap and in the burner pressure bellows of the fuel control. On the ground (when temperatures are higher), this ice is usually gone, and it can be difficult to find this contamination. Frequent check of the Ps4 moisture trap and servicing of the fuel control burner pressure bellows with silicone oil can prevent this contamination.

(6) It is possible that the aircraft auto throttle system caused the auto-acceleration; do not operate the engine until the cause of the auto-acceleration is known (or the defect can cause the engine or a replacement engine to go above limits). If it was necessary to replace the engine because it went above limits, make sure the auto throttle system of the aircraft did not cause the acceleration. If the aircraft auto throttle system has a defect, it can cause the engine auto throttle system has a defect, it can cause the engine power lever to go too far forward (look at the aircraft maintenance data for the auto throttle system to see if this occurred). Because it will not be possible to know of defects in the fuel pump and fuel control of the removed engine, do not use this pump and control on the replacement engine. It is recommended that the mechanic find as much as possible about how the auto-acceleration occurred.

(7) If the auto throttle system is used incorrectly, this can also cause the engine power lever to go too far forward. Make sure that the auto throttle system is operated only as permitted by the approved flight deck procedures.



ENGINE AUTO-ACCELERATES

NOTE: IF THE ENGINE WENT OVER THE EGT AND/OR RPM LIMITS, SEE 72-00-00, PAGE 501, FOR OVERTEMPERATURE AND OVERSPEED PROCEDURES.

1 CAN THE ENGINE CONTINUE IN SERVICE (SEE 72-00-00, PAGE 501)?

2 TRY TO START THE ENGINE.

DOES THE ENGINE START?

3 DOES POWER LEVER MOVEMENT HAVE AN EFFECT ON THE ENGINE SPEED?

4 REPLACE THE FUEL PUMP AND CONTROL (CH/SEC 73-12-02, PAGE 201).

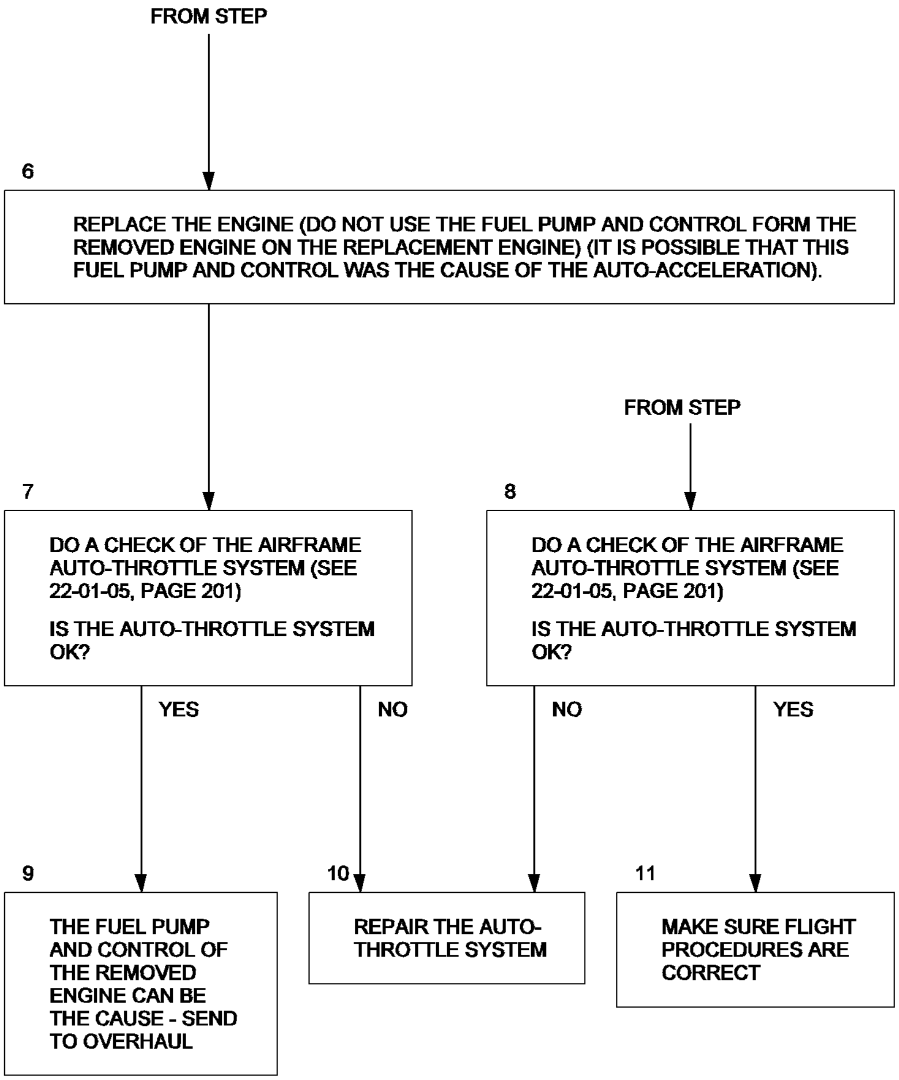
5 MAKE SURE THERE IS NO WATER OR CONTAMINATION IN THE PS4 MOISTURE TRAP (CH/SEC 72-00-00, PAGE 601) OR IN THE FUEL CONTROL BURNER PRESSURE BELLOWS (CH/SEC 73-20-01, PAGE 201).

GO ON TO STEP 6

GO ON TO STEP 8

Auto-Acceleration Troubleshooting
Figure 131/72-00-04-990-831 (Sheet 1 of 2)

ENGINE AUTO-ACCELERATES (CONTINUED)



6 REPLACE THE ENGINE (DO NOT USE THE FUEL PUMP AND CONTROL FORM THE REMOVED ENGINE ON THE REPLACEMENT ENGINE) (IT IS POSSIBLE THAT THIS FUEL PUMP AND CONTROL WAS THE CAUSE OF THE AUTO-ACCELERATION).

7 DO A CHECK OF THE AIRFRAME AUTO-THROTTLE SYSTEM (SEE 22-01-05, PAGE 201)

IS THE AUTO-THROTTLE SYSTEM OK?

8 DO A CHECK OF THE AIRFRAME AUTO-THROTTLE SYSTEM (SEE 22-01-05, PAGE 201)

IS THE AUTO-THROTTLE SYSTEM OK?

9 THE FUEL PUMP AND CONTROL OF THE REMOVED ENGINE CAN BE THE CAUSE - SEND TO OVERHAUL

10 REPAIR THE AUTO-THROTTLE SYSTEM

11 MAKE SURE FLIGHT PROCEDURES ARE CORRECT

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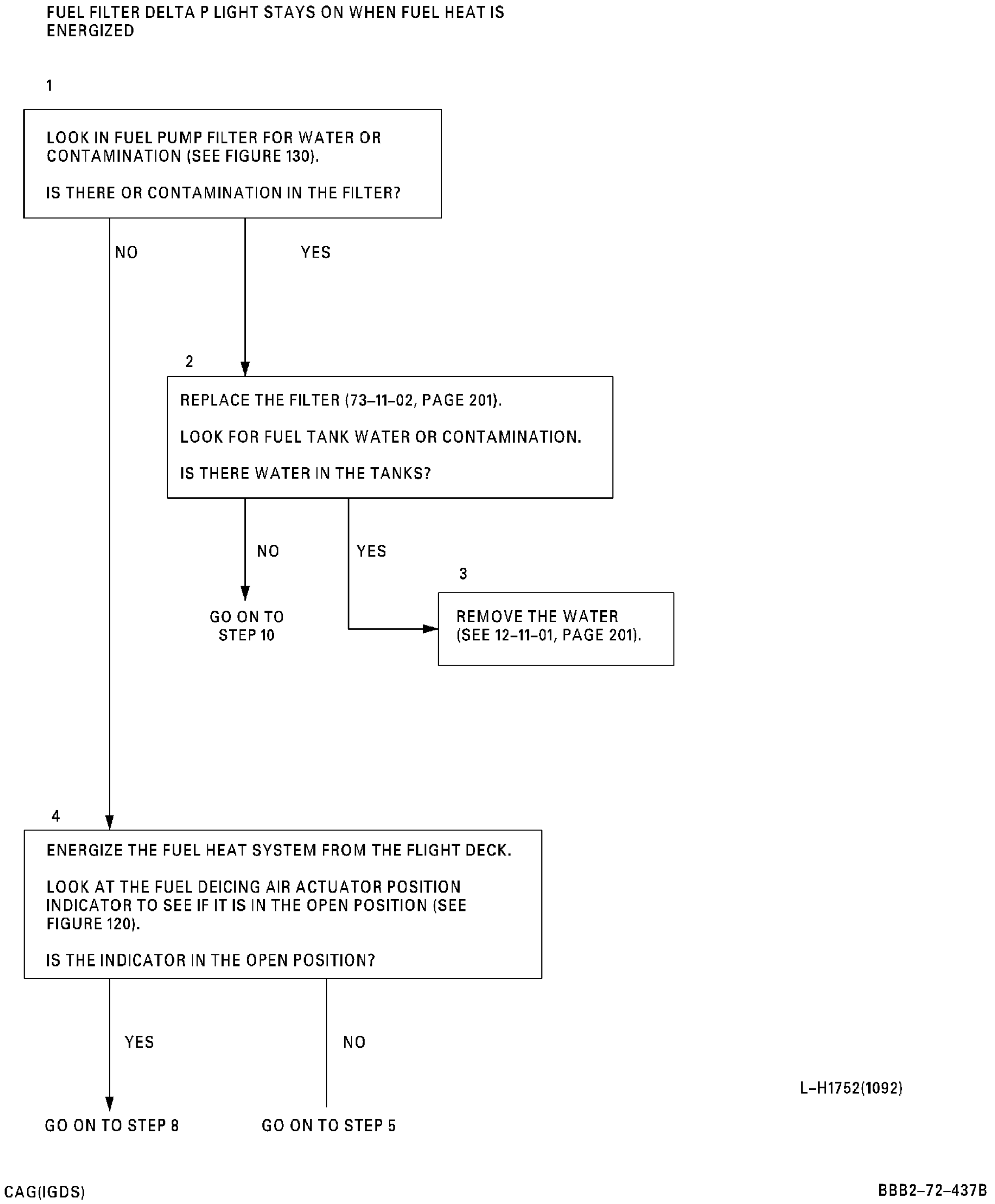
Auto-Acceleration Troubleshooting
Figure 131/72-00-04-990-831 (Sheet 2 of 2)

9. Fuel Filter Delta P Light Stays On When Fuel Heat Is Energized

A. General (Figure 132) (Figure 133)

(1) The fuel filter differential pressure warning ("Delta P Light") can come on when there is a blockage of the fuel pump filter. Water which freezes in the fuel filter (or other contamination) can cause this. Usually the flight crew energizes the fuel deicing system to correct this problem in flight. If there is a defect in the fuel deicing system, ice can collect in the filter in flight but will melt on the ground before maintenance operations can find it. If the fuel filter Delta P light stays on, look for water (or other contamination) in the filter. Look also at the engine and aircraft deicing systems (differential pressure switch, air actuator, and airframe circuit).



FUEL FILTER DELTA P LIGHT STAYS ON WHEN FUEL HEAT IS ENERGIZED

1 LOOK IN FUEL PUMP FILTER FOR WATER OR CONTAMINATION (SEE FIGURE 130).

IS THERE OR CONTAMINATION IN THE FILTER?

2 REPLACE THE FILTER (73-11-02, PAGE 201).

LOOK FOR FUEL TANK WATER OR CONTAMINATION.

IS THERE WATER IN THE TANKS?

3 REMOVE THE WATER (SEE 12-11-01, PAGE 201).

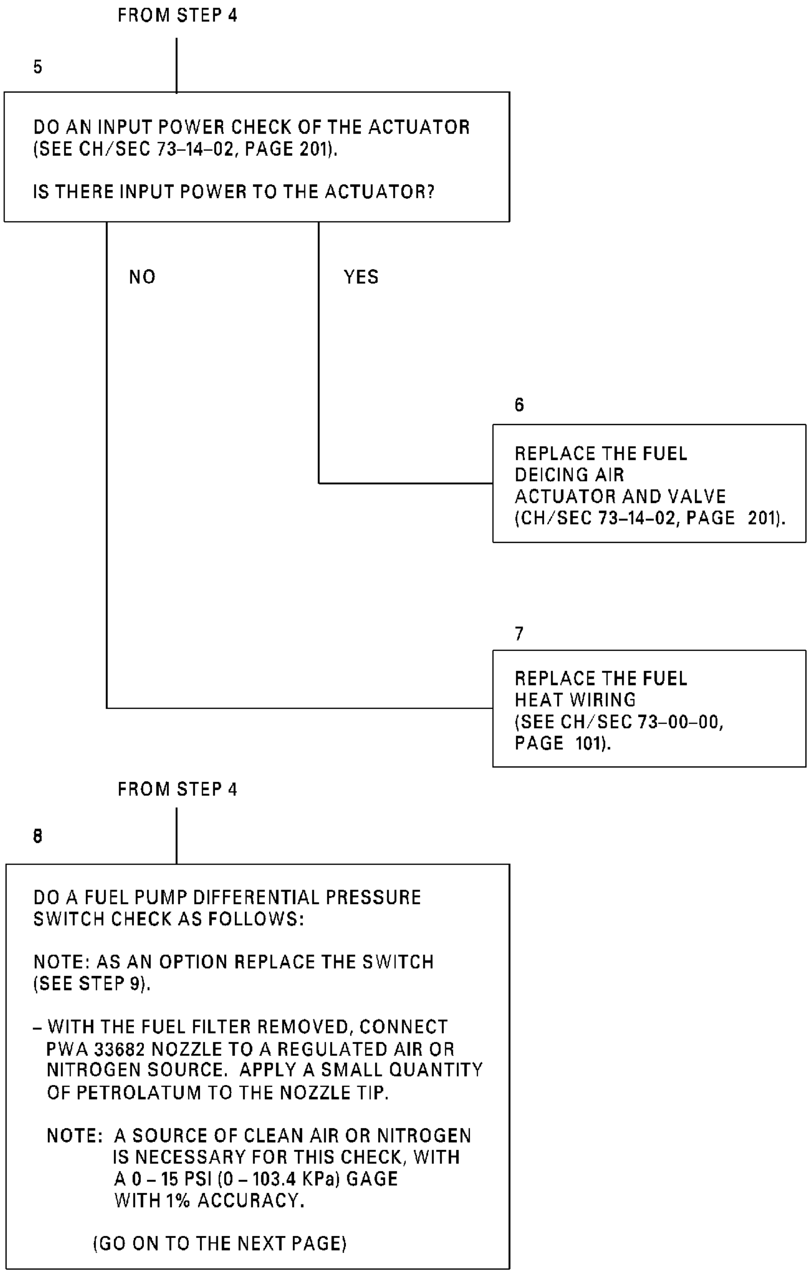
4 ENERGIZE THE FUEL HEAT SYSTEM FROM THE FLIGHT DECK.

LOOK AT THE FUEL DEICING AIR ACTUATOR POSITION INDICATOR TO SEE IF IT IS IN THE OPEN POSITION (SEE FIGURE 120).

IS THE INDICATOR IN THE OPEN POSITION?

Fuel Filter Delta P Light Troubleshooting
Figure 132/72-00-04-990-832 (Sheet 1 of 3)

FUEL FILTER DELTA P LIGHT STAYS ON WHEN FUEL HEAT IS ENERGIZED (CONTINUED)



5 DO AN INPUT POWER CHECK OF THE ACTUATOR (SEE CH/SEC 73-14-02, PAGE 201).

IS THERE INPUT POWER TO THE ACTUATOR?

6 REPLACE THE FUEL DEICING AIR ACTUATOR AND VALVE (CH/SEC 73-14-02, PAGE 201).

7 REPLACE THE FUEL HEAT WIRING (SEE CH/SEC 73-00-00, PAGE 101).

8 DO A FUEL PUMP DIFFERENTIAL PRESSURE SWITCH CHECK AS FOLLOWS:

NOTE: AS AN OPTION REPLACE THE SWITCH (SEE STEP 9).

- WITH THE FUEL FILTER REMOVED, CONNECT PWA 33682 NOZZLE TO A REGULATED AIR OR NITROGEN SOURCE. APPLY A SMALL QUANTITY OF PETROLATUM TO THE NOZZLE TIP.

  NOTE: A SOURCE OF CLEAN AIR OR NITROGEN IS NECESSARY FOR THIS CHECK, WITH A 0 – 15 PSI (0 – 103.4 KPa) GAGE WITH 1% ACCURACY.

(GO ON TO THE NEXT PAGE)

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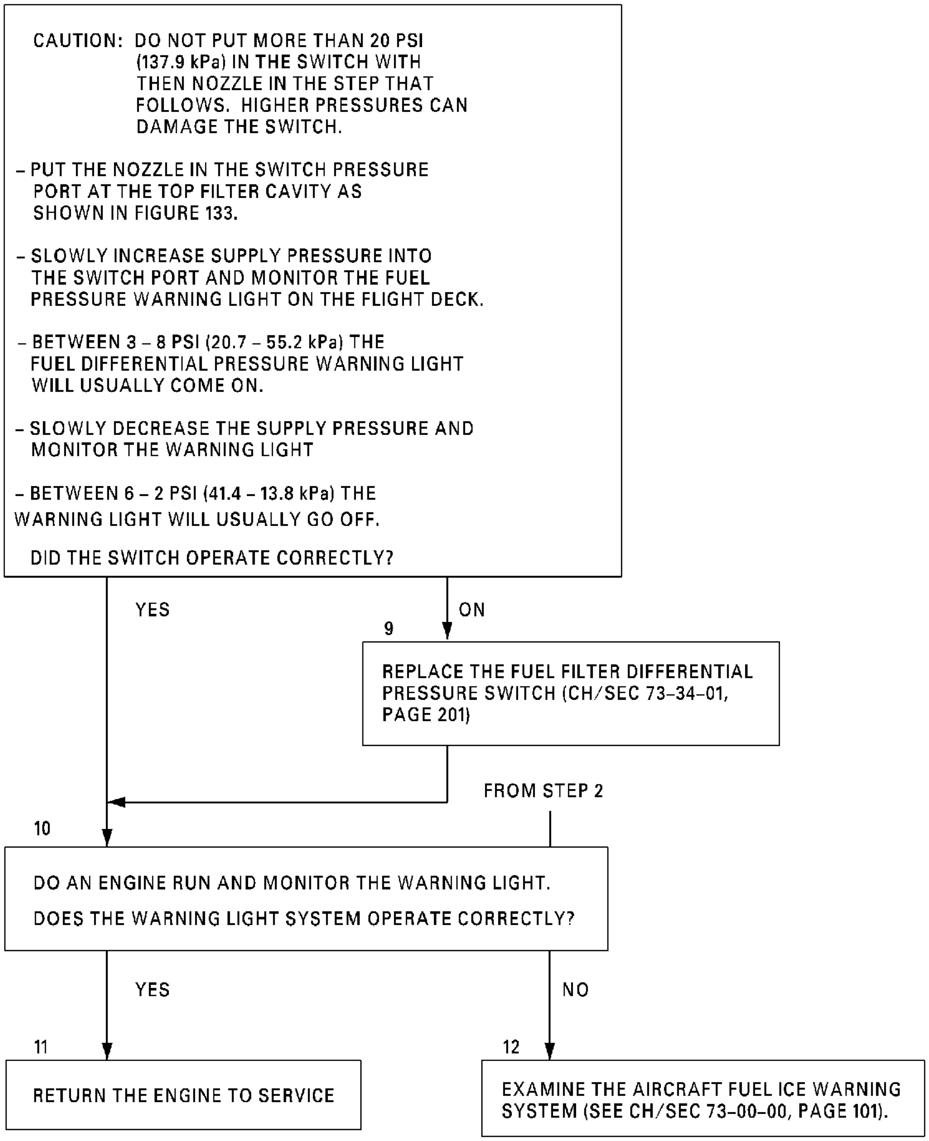
Fuel Filter Delta P Light Troubleshooting
Figure 132/72-00-04-990-832 (Sheet 2 of 3)

FUEL FILTER DELTA P LIGHT STAYS ON WHEN FUEL HEAT IS ENERGIZED (CONTINUED)

8 (CONTINUED)



CAUTION: DO NOT PUT MORE THAN 20 PSI (137.9 kPa) IN THE SWITCH WITH THEN NOZZLE IN THE STEP THAT FOLLOWS. HIGHER PRESSURES CAN DAMAGE THE SWITCH.

- PUT THE NOZZLE IN THE SWITCH PRESSURE PORT AT THE TOP FILTER CAVITY AS SHOWN IN FIGURE 133.
- SLOWLY INCREASE SUPPLY PRESSURE INTO THE SWITCH PORT AND MONITOR THE FUEL PRESSURE WARNING LIGHT ON THE FLIGHT DECK.
- BETWEEN 3 – 8 PSI (20.7 – 55.2 kPa) THE FUEL DIFFERENTIAL PRESSURE WARNING LIGHT WILL USUALLY COME ON.
- SLOWLY DECREASE THE SUPPLY PRESSURE AND MONITOR THE WARNING LIGHT
- BETWEEN 6 – 2 PSI (41.4 – 13.8 kPa) THE WARNING LIGHT WILL USUALLY GO OFF.

DID THE SWITCH OPERATE CORRECTLY?

REPLACE THE FUEL FILTER DIFFERENTIAL PRESSURE SWITCH (CH/SEC 73-34-01, PAGE 201)

DO AN ENGINE RUN AND MONITOR THE WARNING LIGHT.

DOES THE WARNING LIGHT SYSTEM OPERATE CORRECTLY?

RETURN THE ENGINE TO SERVICE

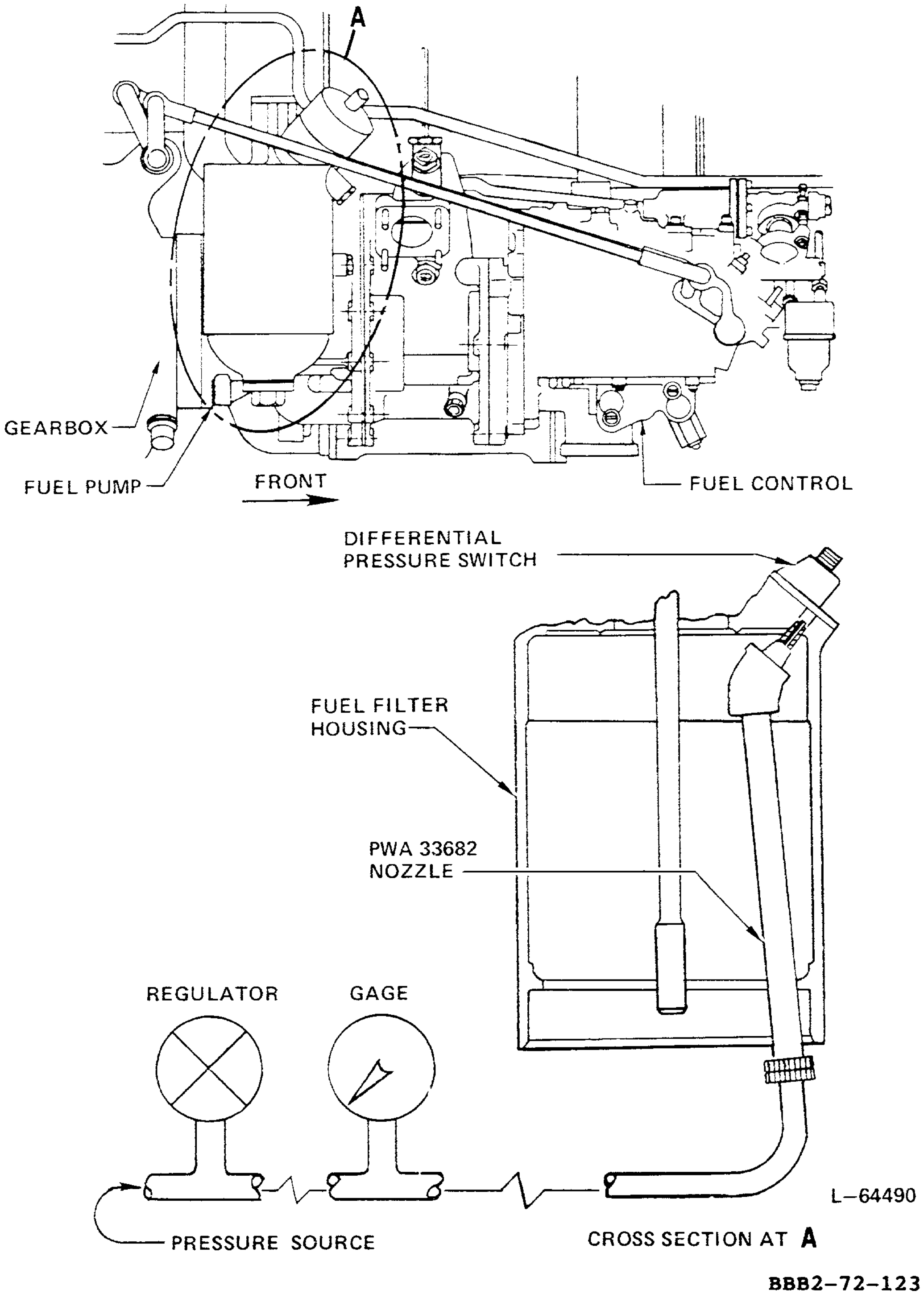
EXAMINE THE AIRCRAFT FUEL ICE WARNING SYSTEM (SEE CH/SEC 73-00-00, PAGE 101).

L–H1754 (1092)

CAG(IGDS)

BBB2–72–439B

Fuel Filter Delta P Light Troubleshooting
Figure 132/72-00-04-990-832 (Sheet 3 of 3)



Fuel Filter Differential Switch Check
Figure 133/72-00-04-990-833

10. Fuel Temperature Does Not Increase When Fuel Heat Is Energized

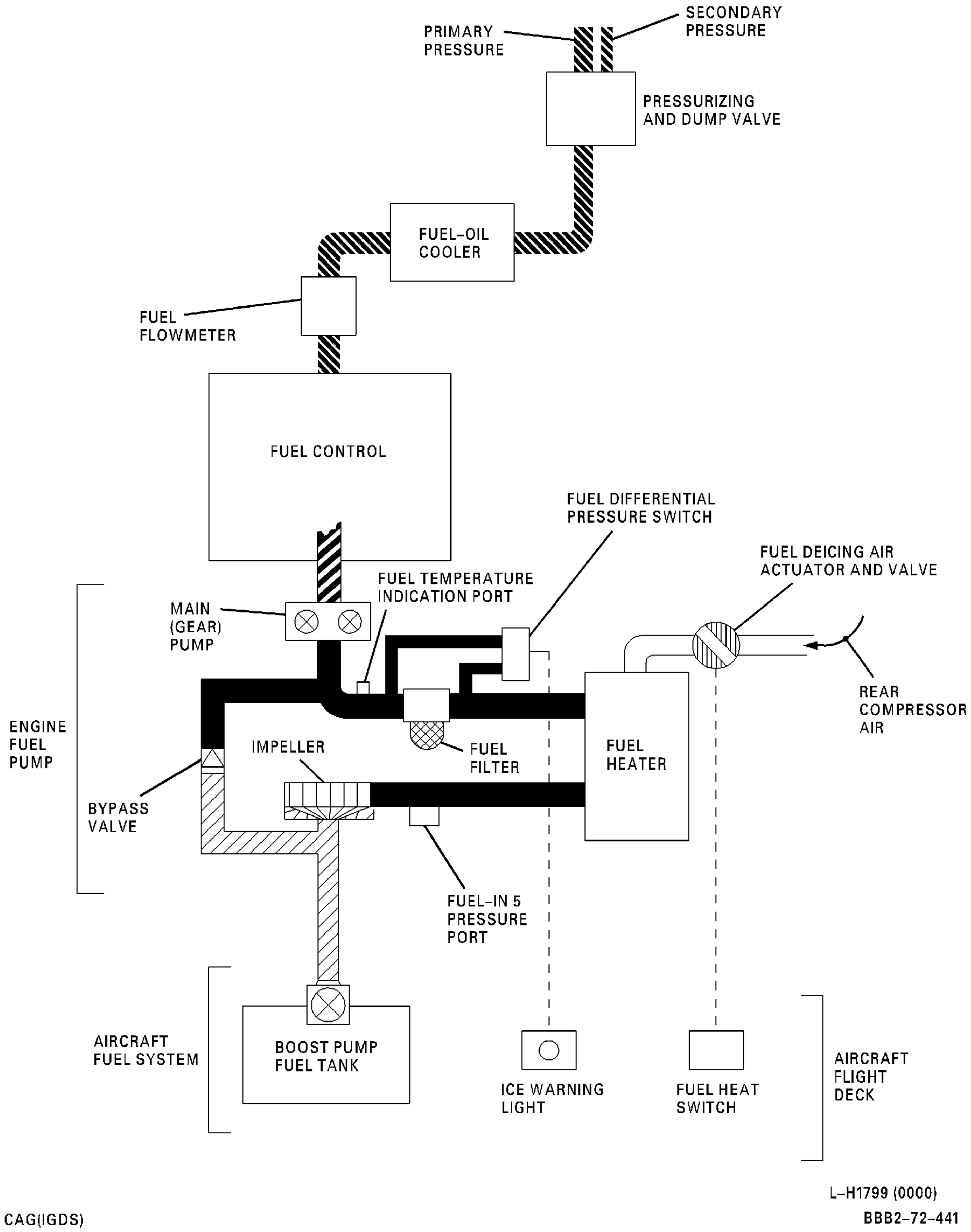
NOTE: Fuel temperature is measured at the fuel pump downstream of the fuel heater.

A. General (Fuel De-icing System Schematic/Figure 134) (Figure 135) (Figure 136)

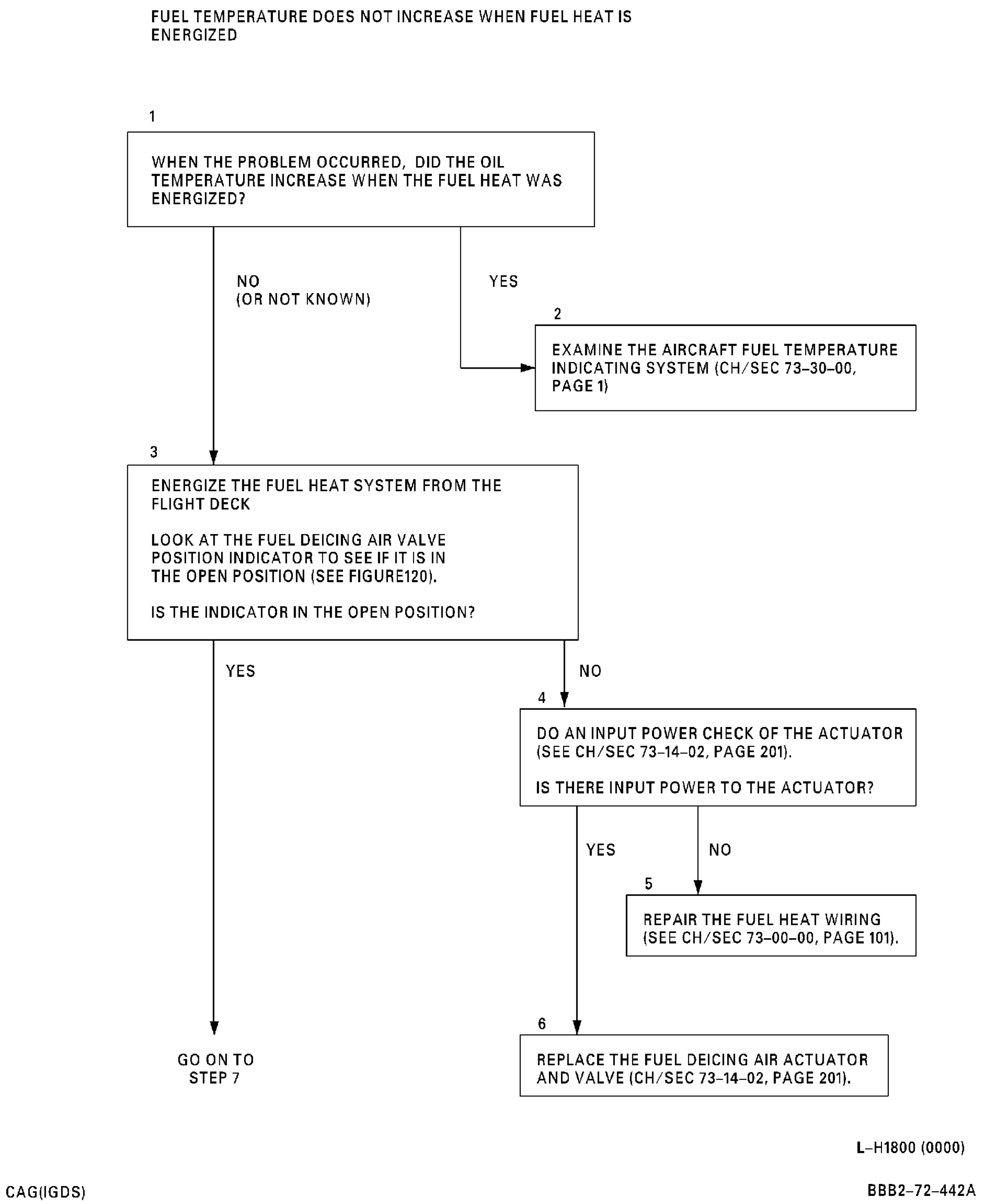
(1) The fuel de-icing system removes ice from fuel in the fuel filter with heat from the fuel heater. This fuel heater uses hot rear compressor air from the engine (controlled by a fuel de-icing air actuator and valve) to increase the fuel temperature when the fuel de-icing switch is operated on the flight deck.

(2) Fuel goes from the fuel heater through the fuel filter to the main stage of the fuel pump. From there the fuel goes to the cooler. The fuel is usually colder than the oil, with the result that the fuel keeps the oil temperature lower. If the fuel temperature increases, the oil temperature will increase also. Therefore when the fuel de-icing system operates correctly, there will be an increase in oil temperature when fuel heat is energized.

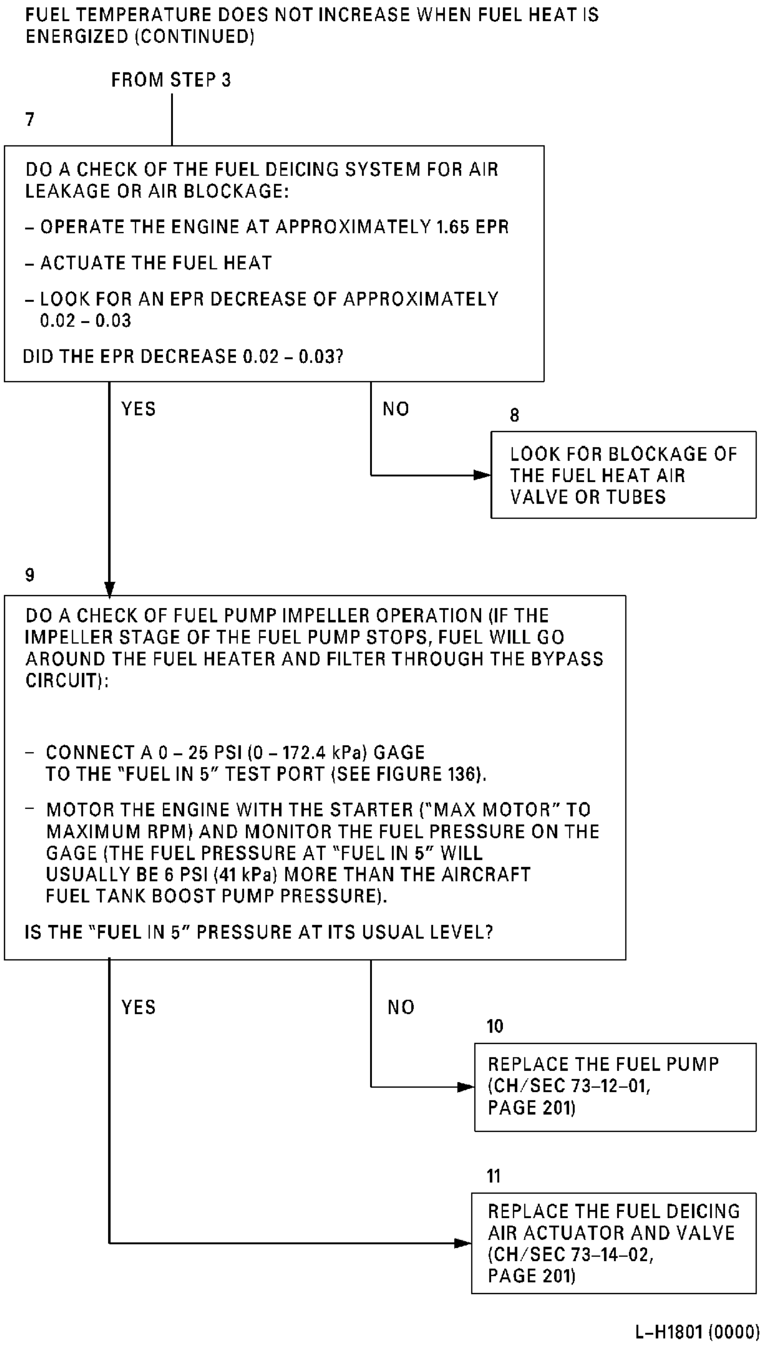
(3) If the selection of fuel heat has no effect on fuel temperature, look for an oil temperature increase or an indication that the actuator and valve operated. If these (or a check of the circuit from the aircraft flight deck to the actuator) do not show the cause, damage to the fuel pump is a possible cause. If something stops the impeller stage of the fuel pump, a bypass valve will cause fuel to go around the fuel heater and filter to the pump main stage (if this occurs the selection of fuel heat will have no effect on the fuel temperature). See Figure 134 for a schematic of this system.



Fuel De-icing System Schematic
Figure 134/72-00-04-990-834



Fuel Temperature Does Not Increase Troubleshooting
Figure 135/72-00-04-990-835 (Sheet 1 of 2)



FUEL TEMPERATURE DOES NOT INCREASE WHEN FUEL HEAT IS ENERGIZED (CONTINUED)

FROM STEP 3

7

DO A CHECK OF THE FUEL DEICING SYSTEM FOR AIR LEAKAGE OR AIR BLOCKAGE:

- OPERATE THE ENGINE AT APPROXIMATELY 1.65 EPR
- ACTUATE THE FUEL HEAT
- LOOK FOR AN EPR DECREASE OF APPROXIMATELY 0.02 – 0.03

DID THE EPR DECREASE 0.02 – 0.03?

8

LOOK FOR BLOCKAGE OF THE FUEL HEAT AIR VALVE OR TUBES

9

DO A CHECK OF FUEL PUMP IMPELLER OPERATION (IF THE IMPELLER STAGE OF THE FUEL PUMP STOPS, FUEL WILL GO AROUND THE FUEL HEATER AND FILTER THROUGH THE BYPASS CIRCUIT):

- CONNECT A 0 – 25 PSI (0 – 172.4 kPa) GAGE TO THE "FUEL IN 5" TEST PORT (SEE FIGURE 136).
- MOTOR THE ENGINE WITH THE STARTER ("MAX MOTOR" TO MAXIMUM RPM) AND MONITOR THE FUEL PRESSURE ON THE GAGE (THE FUEL PRESSURE AT "FUEL IN 5" WILL USUALLY BE 6 PSI (41 kPa) MORE THAN THE AIRCRAFT FUEL TANK BOOST PUMP PRESSURE).

IS THE "FUEL IN 5" PRESSURE AT ITS USUAL LEVEL?

10

REPLACE THE FUEL PUMP (CH/SEC 73–12–01, PAGE 201)

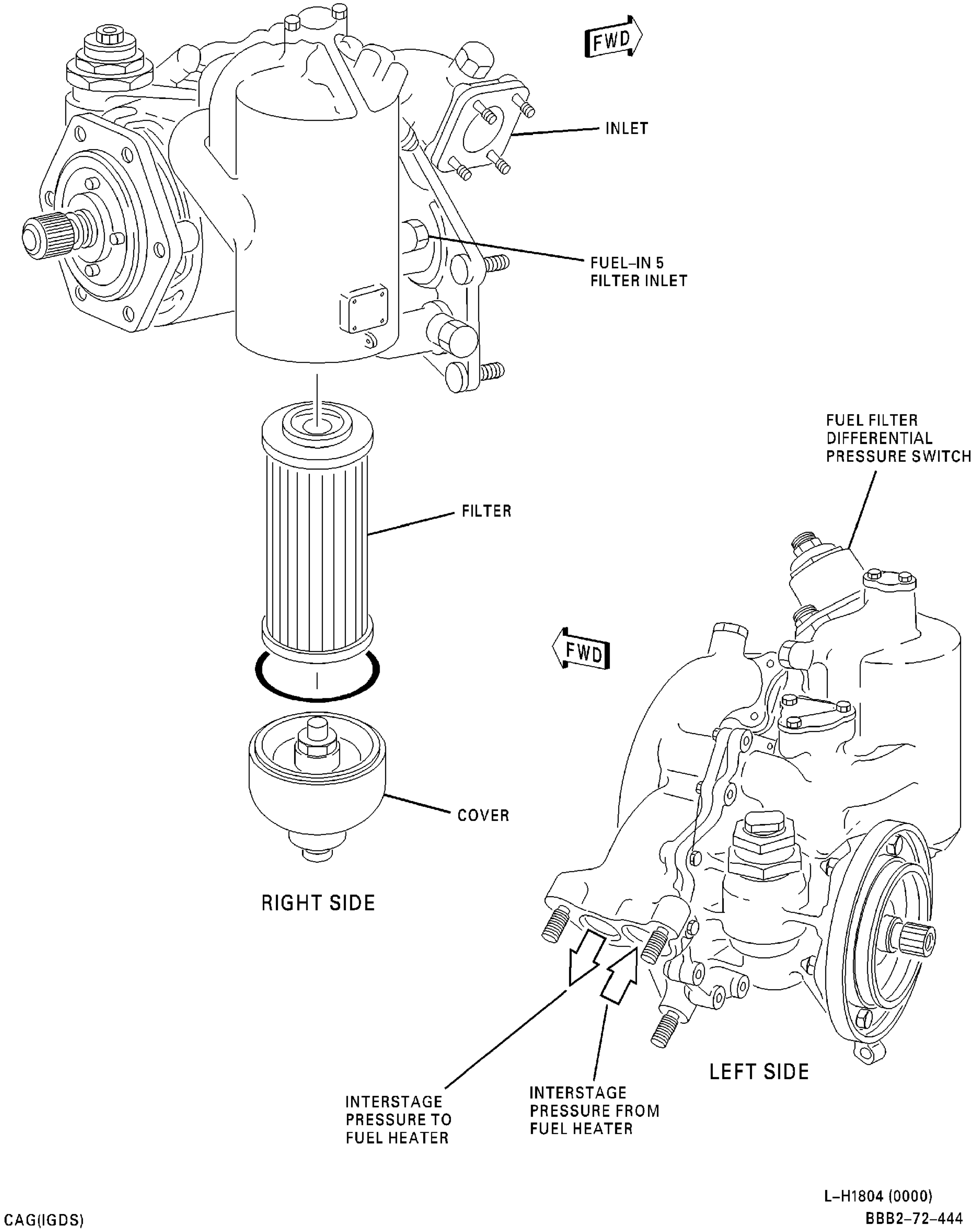
11

REPLACE THE FUEL DEICING AIR ACTUATOR AND VALVE (CH/SEC 73–14–02, PAGE 201)

CAG(IGDS)

BBB2–72–443A

Fuel Temperature Does Not Increase Troubleshooting
Figure 135/72-00-04-990-835 (Sheet 2 of 2)



Fuel Pump Impeller Pressure Measurement
Figure 136/72-00-04-990-836

11. High Fuel Flow (With No Increase in EGT)

A. Engines with damaged fuel manifolds can show an increased fuel flow indication without the usual related EGT increase because of fuel leakage. The increase in fuel flow indication on an engine with a fractured fuel manifold (compared to other engines) can be up to 2000 pounds per hour during Takeoff, 1500 pounds per hour during Climb, and 400-500 pounds per hour during Cruise, without a related increase in EGT.

B. To remove a fractured secondary fuel manifold as a cause of high fuel flow reading with no related increase in EGT, do Test C - Ground Check at 3000 lb/hr (Ref. Adjustment/Test-01). Immediately after engine shutdown, examine the fan duct area for collected fuel or duct areas wet with fuel. If fuel or fuel-wet areas are found, look for damaged fuel secondary manifolds and repair as necessary.

C. An engine with fractured secondary fuel manifolds can have other symptoms:

(1) Slow Acceleration (Paragraph 4.)

(2) Unable To Reach Takeoff Power (Paragraph 5.)

(3) Power Levers Not Aligned ("Throttle Stagger").

12. Power Levers Not Aligned ("Throttle Stagger")

A. Power levers not aligned ("throttle stagger") can be more than a nuisance flight crew complaint. If the power lever knobs are no more than one and a half knobs away from each other at Takeoff power, correct this at the immediately subsequent time when it is possible to do a trim procedure. If the power levers are more than one and one-half knobs away from each other, correct this before the immediately subsequent flight. (Measure power lever position from the rear surface of each knob). It is possible to correct "throttle stagger" with a trim procedure, but if "throttle stagger" occurs too many times, this is a symptom of changes in engine operation levels. These changes can be the result of:

(1) Bleed system defects.

(2) EPR system defects.

(3) Engine gaspath part damage.

(4) Combustion chambers not aligned.

(5) Fractured primary or secondary fuel manifolds.

B. The above conditions can cause EGT-limited or power-limited operation. To remove a fractured secondary fuel manifold as a cause of "throttle stagger," do Test - Ground Check at 3000 lb/hr (Ref. Adjustment/Test). Immediately after engine shutdown, examine the fan duct area with a bright light for collected fuel or duct areas wet with fuel. If fuel or fuel-wet areas are found, look for damaged fuel secondary manifolds and repair as necessary.

13. External Fuel Leaks

A. If fuel leaks found after engine shutdown come from known sources (for example connections or fittings), repair these leaks and test the engine as specified in the Repair Reference Table. (ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 5 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 2 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 3 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 4 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 1) If the source of fuel leakage is not known, use this troubleshooting procedure to find the leak:

(1) Clean all areas of the engine where the leak could be. It is permitted to use PMC 4356 fluorescent penetrant developer (for example Magnaflux ZP4) on all areas of the engine where the leak could be.

(2) Run the engine at Normal Takeoff Power for 5 minutes.

(3) Do an engine shutdown and keep fuel pressure to the main fuel pump inlet. Look for leaks on the engine.

NOTE: The color of dry developer becomes gray when it touches oil, fuel, hydraulic fluid, or other hydrocarbons.

(4) Repair the leak. When all leaks are repaired, refer to the Repair Reference Table for the necessary test. (ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 5 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 2 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 3 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 4 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 1)

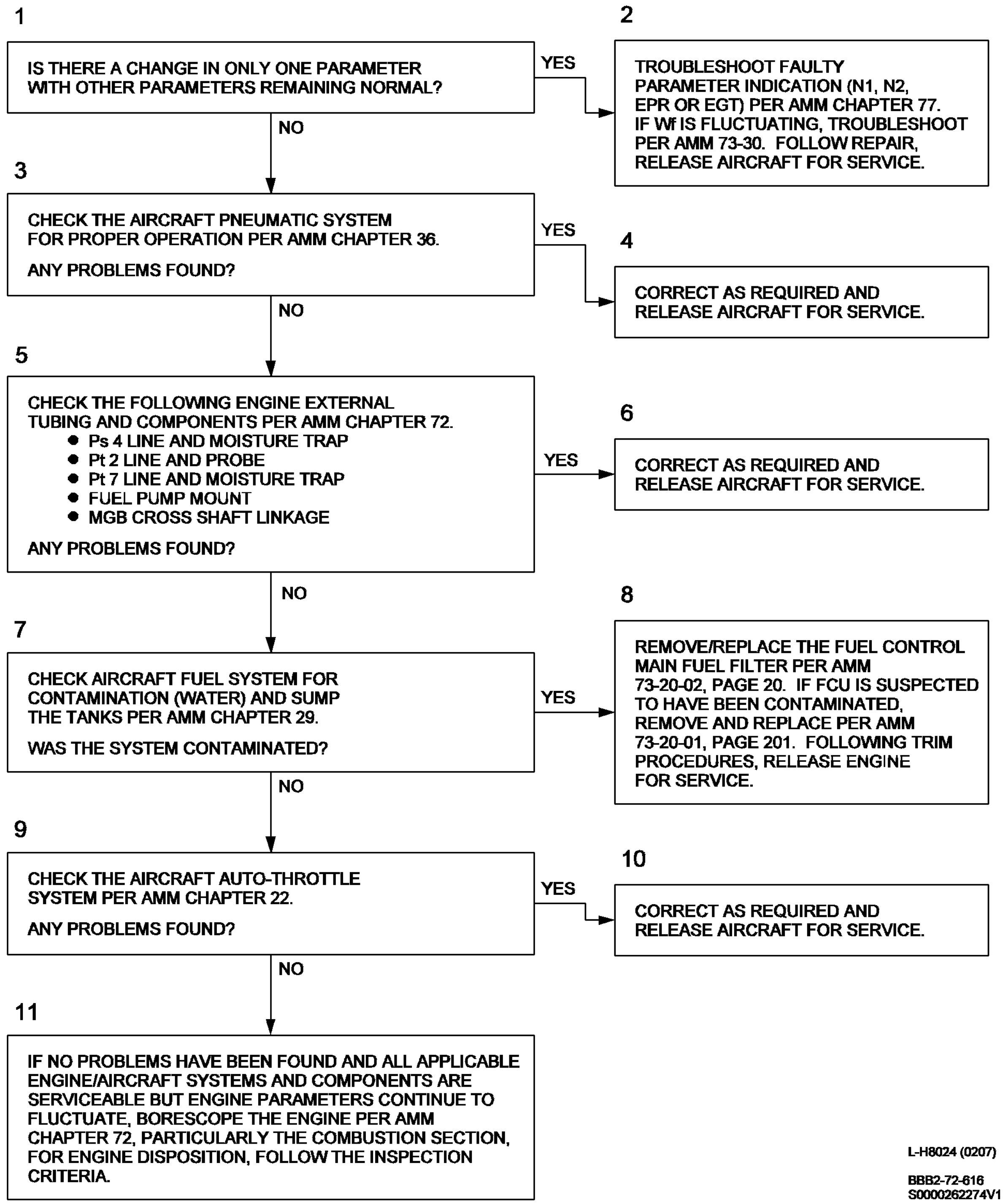
B. If there is leakage from the overboard drain which is not in limits, run the engine at Normal Takeoff Power for five minutes. Do a shutdown, then look for leaks. Repair the leak. When all leaks are repaired, refer to the Repair Reference Table for the necessary test. (ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 5 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 2 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 3 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 4 or ENGINE GENERAL - ADJUSTMENT/TEST, PAGEBLOCK 72-00-00/501 Config 1)

14. Engine Parameter Fluctuation

A. Engine parameter fluctuation is a periodic or random change of Wf, EPR, EGT, N1, or N2 which continues during steady state engine operation. The period between parameter changes can be from approximately three seconds to three minutes. Parameter fluctuation is a much slower change that low frequency vibration of engine “rumble”.

B. Parameter fluctuations may be caused by defects in the indicating system (ATA 77), fuel system (ATA 73), pneumatic system (ATA 36), controls system (ATA22), engine external hardware or, gas path (ATA 72).

C. To prevent engine component removals which are not necessary, it is necessary to use the procedure shown in Figure 137



ENGINE PARAMETER FLUCTUATION

1 IS THERE A CHANGE IN ONLY ONE PARAMETER WITH OTHER PARAMETERS REMAINING NORMAL?

2 TROUBLESHOOT FAULTY PARAMETER INDICATION (N1, N2, EPR OR EGT) PER AMM CHAPTER 77. IF Wf IS FLUCTUATING, TROUBLESHOOT PER AMM 73-30. FOLLOW REPAIR, RELEASE AIRCRAFT FOR SERVICE.

3 CHECK THE AIRCRAFT PNEUMATIC SYSTEM FOR PROPER OPERATION PER AMM CHAPTER 36.

ANY PROBLEMS FOUND?

4 CORRECT AS REQUIRED AND RELEASE AIRCRAFT FOR SERVICE.

5 CHECK THE FOLLOWING ENGINE EXTERNAL TUBING AND COMPONENTS PER AMM CHAPTER 72.

- Ps 4 LINE AND MOISTURE TRAP
- Pt 2 LINE AND PROBE
- Pt 7 LINE AND MOISTURE TRAP
- FUEL PUMP MOUNT
- MGB CROSS SHAFT LINKAGE

ANY PROBLEMS FOUND?

6 CORRECT AS REQUIRED AND RELEASE AIRCRAFT FOR SERVICE.

7 CHECK AIRCRAFT FUEL SYSTEM FOR CONTAMINATION (WATER) AND SUMP THE TANKS PER AMM CHAPTER 29.

WAS THE SYSTEM CONTAMINATED?

8 REMOVE/REPLACE THE FUEL CONTROL MAIN FUEL FILTER PER AMM 73-20-02, PAGE 20. IF FCU IS SUSPECTED TO HAVE BEEN CONTAMINATED, REMOVE AND REPLACE PER AMM 73-20-01, PAGE 201. FOLLOWING TRIM PROCEDURES, RELEASE ENGINE FOR SERVICE.

9 CHECK THE AIRCRAFT AUTO-THROTTLE SYSTEM PER AMM CHAPTER 22.

ANY PROBLEMS FOUND?

10 CORRECT AS REQUIRED AND RELEASE AIRCRAFT FOR SERVICE.

11 IF NO PROBLEMS HAVE BEEN FOUND AND ALL APPLICABLE ENGINE/AIRCRAFT SYSTEMS AND COMPONENTS ARE SERVICEABLE BUT ENGINE PARAMETERS CONTINUE TO FLUCTUATE, BORESCOPE THE ENGINE PER AMM CHAPTER 72, PARTICULARLY THE COMBUSTION SECTION, FOR ENGINE DISPOSITION, FOLLOW THE INSPECTION CRITERIA.

L-H8024 (0207)

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Engine Parameter Fluctuation
Figure 137/72-00-04-990-837

ENGINE GENERAL - TROUBLESHOOTING-05

1. Vibration Troubleshooting

A. General

Engine vibration can occur when engine parts are loose or when rotors or parts of rotors are not balanced. When vibration is found, it is important to know as much as possible about:

- How the vibration was measured
- Where the vibration is estimated to be (front compressor or rear compressor rotor)
- What the engine maintenance history is (what rotor parts were replaced, what type of parts or components were used).

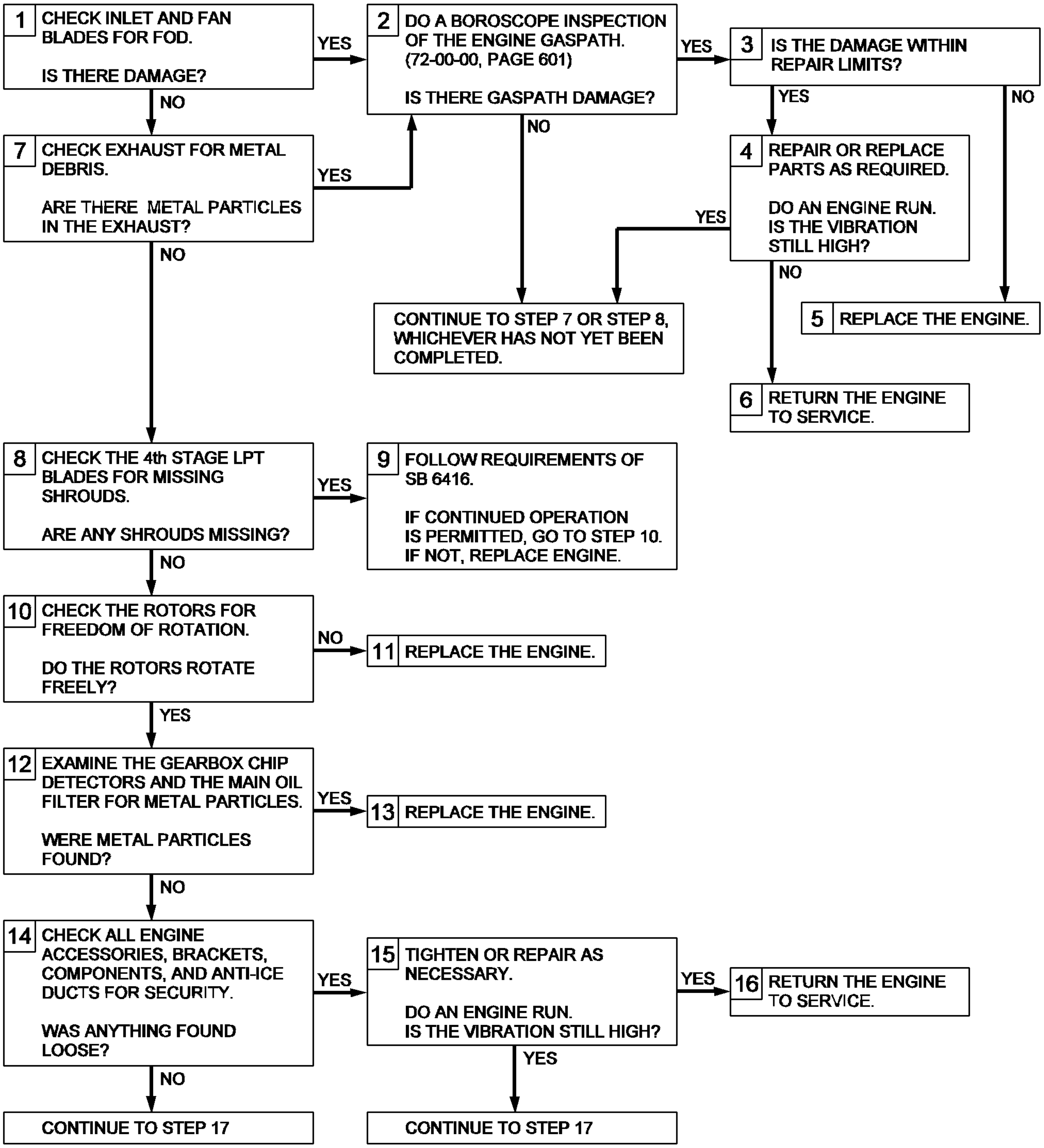
B. Certain engine/aircraft combinations may produce a sound frequency (resonance) in the cabin at certain engine speeds. This sound frequency can produce vibration that can be felt in the aircraft cabin or heard as a rumble or cabin noise and may not be due to excessive engine vibration or other engine problem.

C. Experience has shown the following conditions can cause the cabin sound frequency (resonance) and may not be due to an engine problem:

- High noise or vibration in the aft cabin at approximately 81% - 85% N2 or at idle and slightly above idle (53% - 63% N2), with no vibration in the cockpit
- High vibration during engine start or shutdown, with or without visible engine vibration displacement.

D. All unusual vibration should be diagnosed using the vibration troubleshooting shown in Figure 101 through Figure 102.

HIGH VIBRATION



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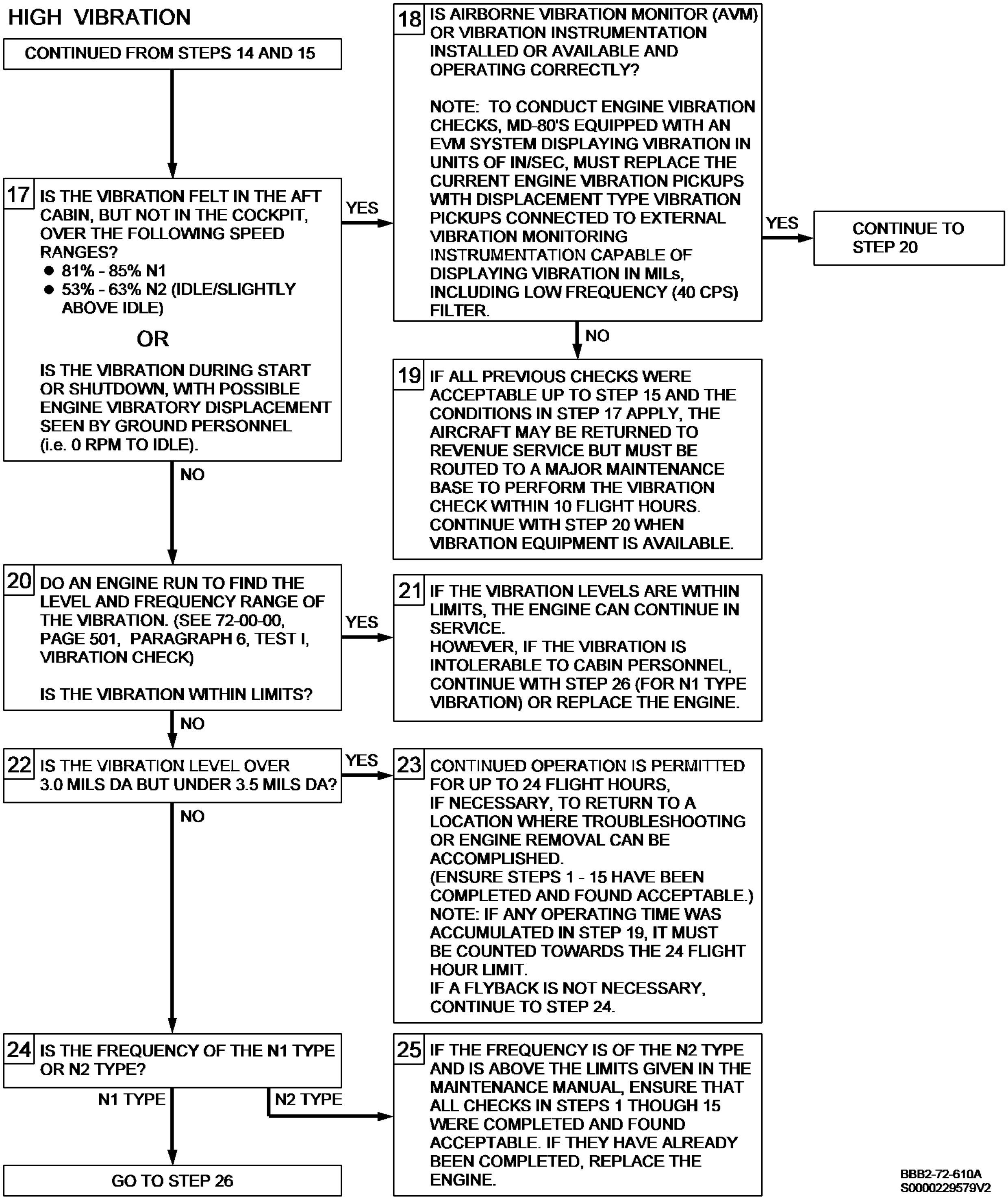
Vibration Troubleshooting
Figure 101/72-00-05-990-809 (Sheet 1 of 3)



HIGH VIBRATION

CONTINUED FROM STEPS 14 AND 15

17 IS THE VIBRATION FELT IN THE AFT CABIN, BUT NOT IN THE COCKPIT, OVER THE FOLLOWING SPEED RANGES?
- 81% - 85% N1
- 53% - 63% N2 (IDLE/SLIGHTLY ABOVE IDLE)

OR

IS THE VIBRATION DURING START OR SHUTDOWN, WITH POSSIBLE ENGINE VIBRATORY DISPLACEMENT SEEN BY GROUND PERSONNEL (i.e. 0 RPM TO IDLE).

18 IS AIRBORNE VIBRATION MONITOR (AVM) OR VIBRATION INSTRUMENTATION INSTALLED OR AVAILABLE AND OPERATING CORRECTLY?

NOTE: TO CONDUCT ENGINE VIBRATION CHECKS, MD-80'S EQUIPPED WITH AN EVM SYSTEM DISPLAYING VIBRATION IN UNITS OF IN/SEC, MUST REPLACE THE CURRENT ENGINE VIBRATION PICKUPS WITH DISPLACEMENT TYPE VIBRATION PICKUPS CONNECTED TO EXTERNAL VIBRATION MONITORING INSTRUMENTATION CAPABLE OF DISPLAYING VIBRATION IN MILs, INCLUDING LOW FREQUENCY (40 CPS) FILTER.

CONTINUE TO STEP 20

19 IF ALL PREVIOUS CHECKS WERE ACCEPTABLE UP TO STEP 15 AND THE CONDITIONS IN STEP 17 APPLY, THE AIRCRAFT MAY BE RETURNED TO REVENUE SERVICE BUT MUST BE ROUTED TO A MAJOR MAINTENANCE BASE TO PERFORM THE VIBRATION CHECK WITHIN 10 FLIGHT HOURS. CONTINUE WITH STEP 20 WHEN VIBRATION EQUIPMENT IS AVAILABLE.

20 DO AN ENGINE RUN TO FIND THE LEVEL AND FREQUENCY RANGE OF THE VIBRATION. (SEE 72-00-00, PAGE 501, PARAGRAPH 6, TEST I, VIBRATION CHECK)

IS THE VIBRATION WITHIN LIMITS?

21 IF THE VIBRATION LEVELS ARE WITHIN LIMITS, THE ENGINE CAN CONTINUE IN SERVICE.
HOWEVER, IF THE VIBRATION IS INTOLERABLE TO CABIN PERSONNEL, CONTINUE WITH STEP 26 (FOR N1 TYPE VIBRATION) OR REPLACE THE ENGINE.

22 IS THE VIBRATION LEVEL OVER 3.0 MILS DA BUT UNDER 3.5 MILS DA?

23 CONTINUED OPERATION IS PERMITTED FOR UP TO 24 FLIGHT HOURS, IF NECESSARY, TO RETURN TO A LOCATION WHERE TROUBLESHOOTING OR ENGINE REMOVAL CAN BE ACCOMPLISHED.
(ENSURE STEPS 1 - 15 HAVE BEEN COMPLETED AND FOUND ACCEPTABLE.)
NOTE: IF ANY OPERATING TIME WAS ACCUMULATED IN STEP 19, IT MUST BE COUNTED TOWARDS THE 24 FLIGHT HOUR LIMIT.
IF A FLYBACK IS NOT NECESSARY, CONTINUE TO STEP 24.

24 IS THE FREQUENCY OF THE N1 TYPE OR N2 TYPE?

25 IF THE FREQUENCY IS OF THE N2 TYPE AND IS ABOVE THE LIMITS GIVEN IN THE MAINTENANCE MANUAL, ENSURE THAT ALL CHECKS IN STEPS 1 THOUGH 15 WERE COMPLETED AND FOUND ACCEPTABLE. IF THEY HAVE ALREADY BEEN COMPLETED, REPLACE THE ENGINE.

GO TO STEP 26

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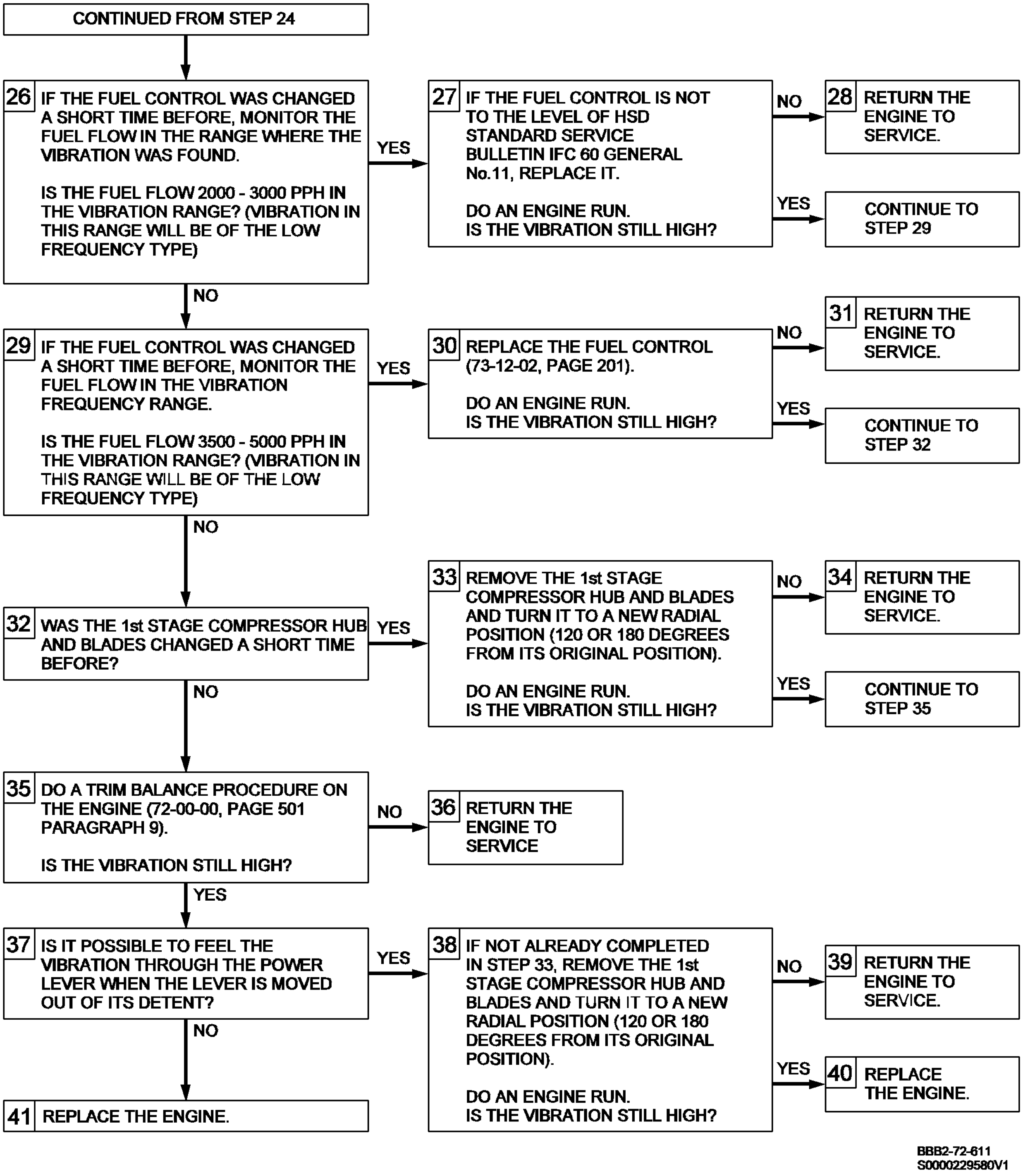
Vibration Troubleshooting
Figure 101/72-00-05-990-809 (Sheet 2 of 3)

N1 TYPE VIBRATION



26 IF THE FUEL CONTROL WAS CHANGED A SHORT TIME BEFORE, MONITOR THE FUEL FLOW IN THE RANGE WHERE THE VIBRATION WAS FOUND.

IS THE FUEL FLOW 2000 - 3000 PPH IN THE VIBRATION RANGE? (VIBRATION IN THIS RANGE WILL BE OF THE LOW FREQUENCY TYPE)

27 IF THE FUEL CONTROL IS NOT TO THE LEVEL OF HSD STANDARD SERVICE BULLETIN IFC 60 GENERAL No.11, REPLACE IT.

DO AN ENGINE RUN.
IS THE VIBRATION STILL HIGH?

28 RETURN THE ENGINE TO SERVICE.

CONTINUE TO STEP 29

29 IF THE FUEL CONTROL WAS CHANGED A SHORT TIME BEFORE, MONITOR THE FUEL FLOW IN THE VIBRATION FREQUENCY RANGE.

IS THE FUEL FLOW 3500 - 5000 PPH IN THE VIBRATION RANGE? (VIBRATION IN THIS RANGE WILL BE OF THE LOW FREQUENCY TYPE)

30 REPLACE THE FUEL CONTROL (73-12-02, PAGE 201).

DO AN ENGINE RUN.
IS THE VIBRATION STILL HIGH?

31 RETURN THE ENGINE TO SERVICE.

CONTINUE TO STEP 32

32 WAS THE 1st STAGE COMPRESSOR HUB AND BLADES CHANGED A SHORT TIME BEFORE?

33 REMOVE THE 1st STAGE COMPRESSOR HUB AND BLADES AND TURN IT TO A NEW RADIAL POSITION (120 OR 180 DEGREES FROM ITS ORIGINAL POSITION).

DO AN ENGINE RUN.
IS THE VIBRATION STILL HIGH?

34 RETURN THE ENGINE TO SERVICE.

CONTINUE TO STEP 35

35 DO A TRIM BALANCE PROCEDURE ON THE ENGINE (72-00-00, PAGE 501 PARAGRAPH 9).

IS THE VIBRATION STILL HIGH?

36 RETURN THE ENGINE TO SERVICE

37 IS IT POSSIBLE TO FEEL THE VIBRATION THROUGH THE POWER LEVER WHEN THE LEVER IS MOVED OUT OF ITS DETENT?

38 IF NOT ALREADY COMPLETED IN STEP 33, REMOVE THE 1st STAGE COMPRESSOR HUB AND BLADES AND TURN IT TO A NEW RADIAL POSITION (120 OR 180 DEGREES FROM ITS ORIGINAL POSITION).

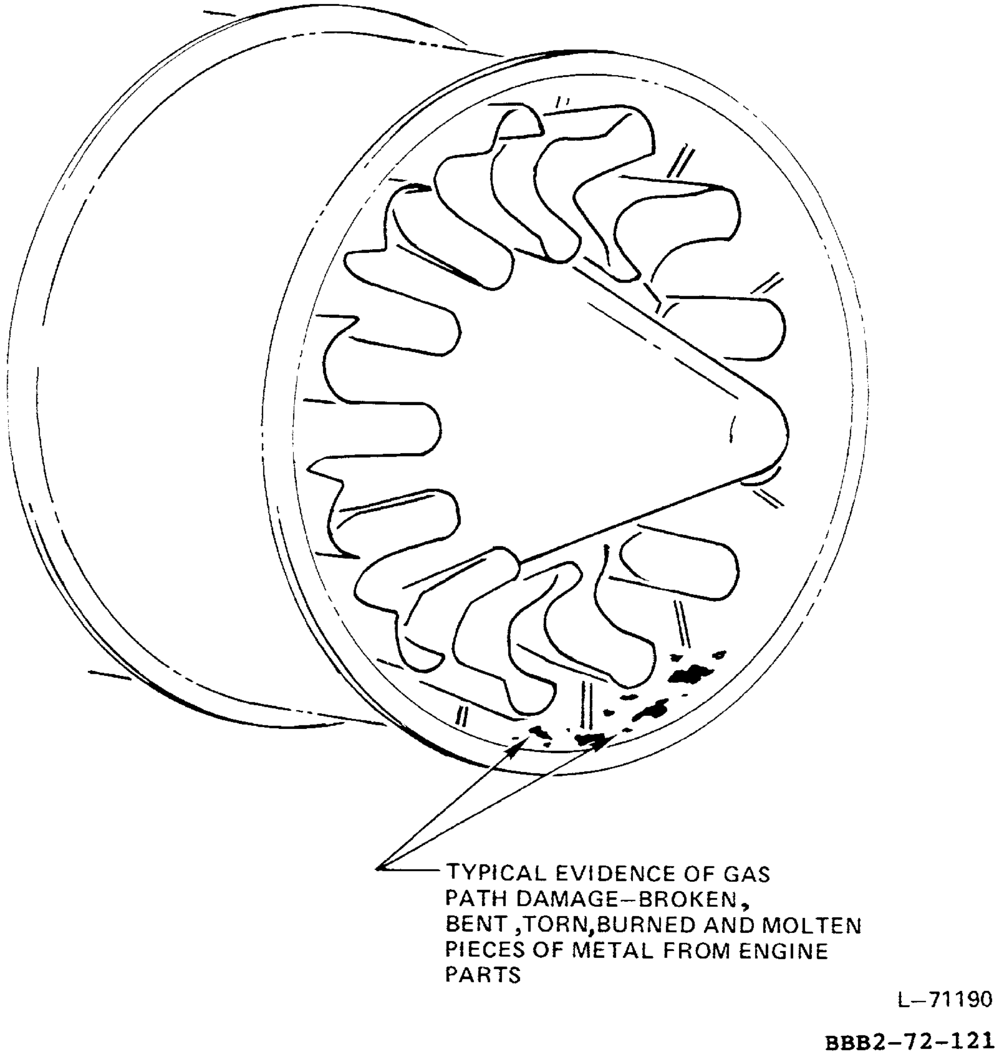
DO AN ENGINE RUN.
IS THE VIBRATION STILL HIGH?

39 RETURN THE ENGINE TO SERVICE.

40 REPLACE THE ENGINE.

41 REPLACE THE ENGINE.

Vibration Troubleshooting
Figure 101/72-00-05-990-809 (Sheet 3 of 3)



Exhaust Area Check
Figure 102/72-00-05-990-810

EXTERNAL PARTS - REMOVAL/INSTALLATION-01

1. Remove Fuel Control Condensation Trap

A. Prerequisites

(1) Access for removal of condensation trap is through the lower forward cowl door.

(2) For procedures to open cowl doors on all engines, refer to PAGEBLOCK 71-10-03/201 Config 1.

B. Equipment And Materials Required Support Equipment None Consumables None

C. Procedure

(1) Disconnect fuel control rear Pb tube at fuel control condensation trap elbow.

(2) Disconnect fuel control front Ps4 tube at connector on left side of condensation trap.

(3) Unbolt and remove condensation trap.

NOTE: If trap is to be replaced, remove bottom hex plug for transfer to new trap.

2. Install Fuel Control Condensation Trap

A. Equipment And Materials Required

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

(1) Support Equipment

None

(2) Consumables

Petrolatum (PMC 9609)(DPM 675)

B. Procedure

WARNING: WHITE PETROLATUM IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN WHITE PETROLATUM IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT BREATHE THE MIST.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(WARNING PRECEDES)

CAUTION: BE SURE THAT THE DRAIN HOLE IN THE BOTTOM OF THE CONDENSATION TRAP PLUG IS NOT BLOCKED BY THE LOCKWIRE USED TO SAFETY THE PLUG TO THE TRAP (AN OPEN DRAIN HOLE IS NECESSARY TO LET WATER OUT OF THE TRAP). INSTALL LOCKWIRE THROUGH ONLY ONE SIDE OF THE PLUG, NOT FULLY ACROSS THE BOTTOM OF THE PLUG.

(1) If the condensation trap is new, install a bottom hex plug with new packing lubricated with a thin layer of petrolatum. Torque the plug. Safety the plug to the trap with lockwire.

CAUTION: BE SURE THAT THE TRAP IS THE CORRECT PART NUMBER FOR THIS POSITION ON THE ENGINE (THE TRAP AT THE PT7 POSITION IS A DIFFERENT PART NUMBER AND IS NOT INTERCHANGEABLE). IF THE CORRECT PART NUMBER TRAP IS NOT USED, THE RESULT CAN BE INCORRECT ENGINE PRESSURES AT THE FUEL CONTROL.

(2) Bolt condensation trap to fuel control. Torque bolts and lockwire.

(3) Connect fuel control front Ps4 tube and rear Pb tube to condensation trap. Torque connections and lockwire.

C. Postrequisites

(1) To close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

EXTERNAL PARTS - REMOVAL/INSTALLATION-02

1. Fuel Control Rear PB Tube Removal

A. Prerequisites

(1) Access for removal of fuel control rear Pb tube is through the lower forward cowl door.

(2) For procedures to open cowl doors on all engines, refer to SUBJECT 71-10-03, Page 201.

B. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

C. Procedure. (Figure 401 or Figure 402)

(1) Establish clip and/or bracket locations for installation.

(2) Disconnect clips.

(3) Loosen nut at upper right on combustion chamber and turbine fan duct.

(4) Loosen nut at front end from moisture trap.

(5) Remove tube.

2. Fuel Control Rear Pb Tube Installation

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure. (Figure 401 or Figure 402)

(1) Position tube on engine and secure nut at front to moisture trap.

(2) Secure rear nut at upper right on combustion chamber and turbine fan duct.

(3) Torque and lockwire nuts.

(4) Secure clips and/or brackets to tube.

NOTE: Minimum clearance between any two adjacent tubes or between one single tube and any other adjacent engine part shall be 0.125 inch (3.175 mm) unless otherwise specified. Exceptions to this clearance requirement are permitted at specific locations where adjacent tubes are clipped together or where other local constraints will prevent tube contact at clearances below 0.125 inch (3.175 mm) minimum.

Minimum clearance refers only to clearance relative to tube and not to fittings or other attached hardware.

C. Postrequisites

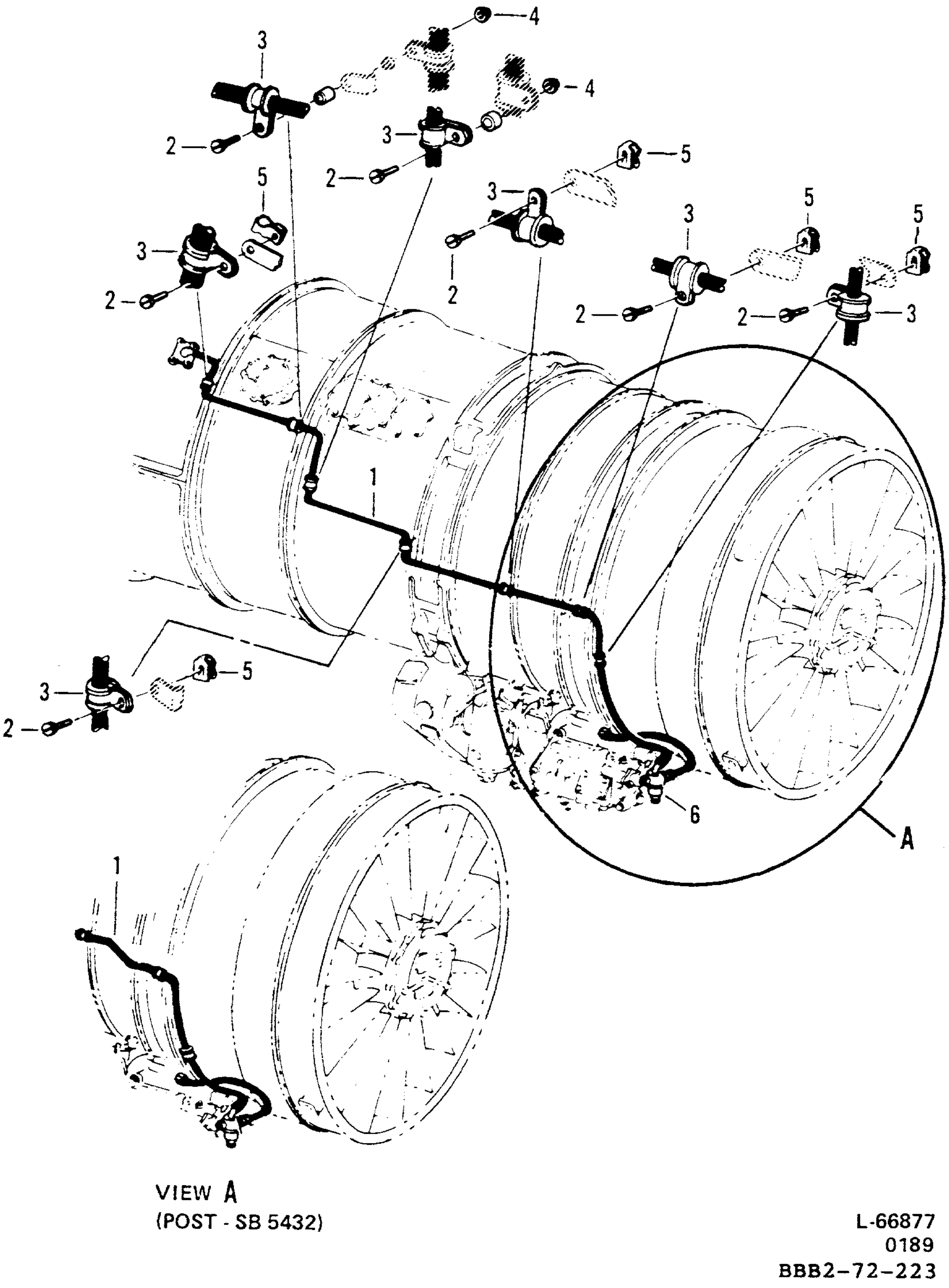
(1) To close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

Key to Figure 401 or Figure 402

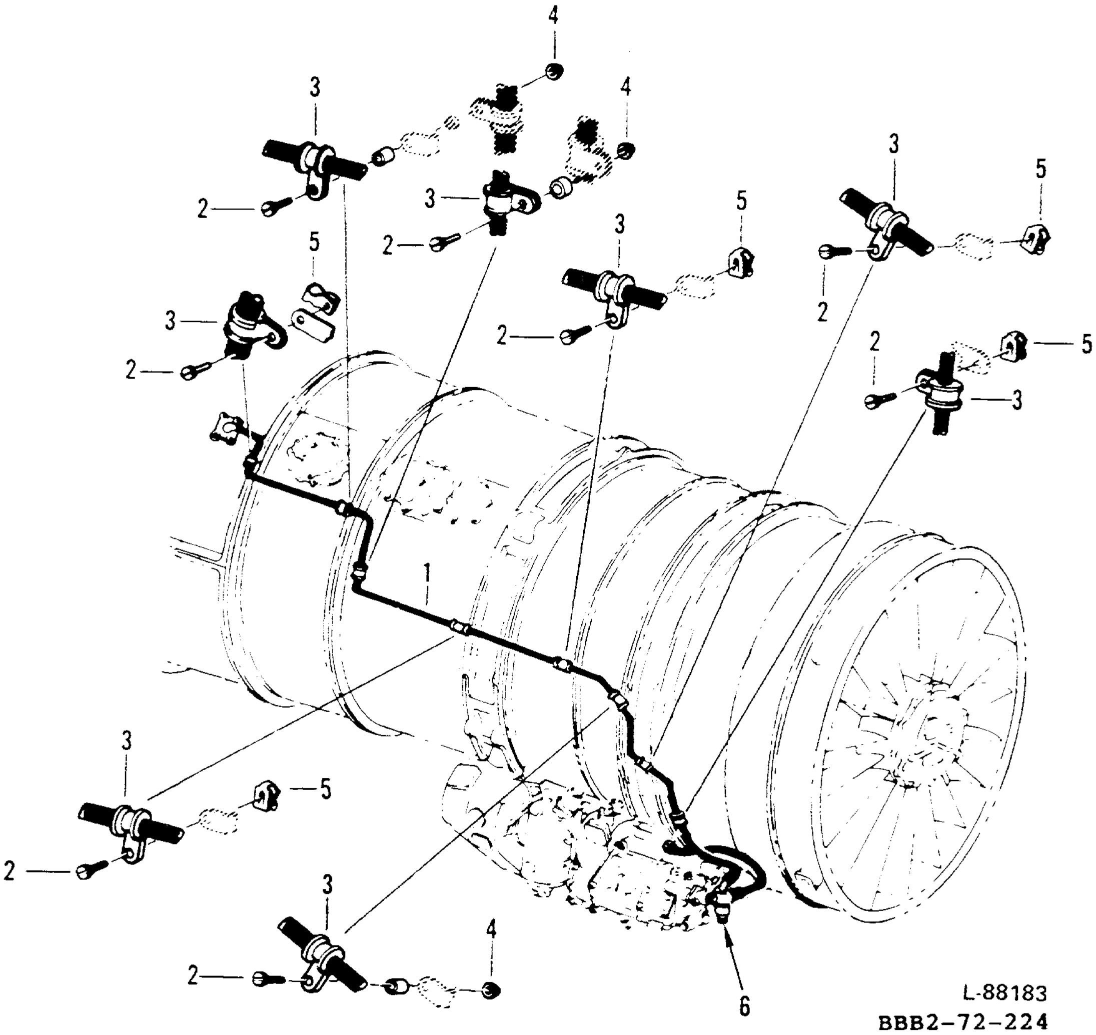
Index No.	Nomenclature
1	Fuel Control Rear Pb Tube
2	Screw
3	Clip
4	Nut
5	Clip Nut

(Continued)

Key to Figure 401 or Figure 402	
Index No.	**Nomenclature**
6	Moisture Trap



Fuel Control Rear Pb Tube Replacement (Pre - SB 5808)
Figure 401/72-09-72-990-801



Fuel Control Rear Pb Tube Replacement (Post - SB 5808)
Figure 402/72-09-72-990-802

EXTERNAL PARTS - REMOVAL/INSTALLATION-03

1. Fuel Control Front Pb Tube Removal

A. Prerequisites

(1) Access for removal of front Pb tube is through the lower forward cowl door.

(2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

B. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Disconnect fuel control front Pb tube at moisture trap cover and fuel control, and remove tube.

2. Fuel Control Front Pb Tube Installation

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

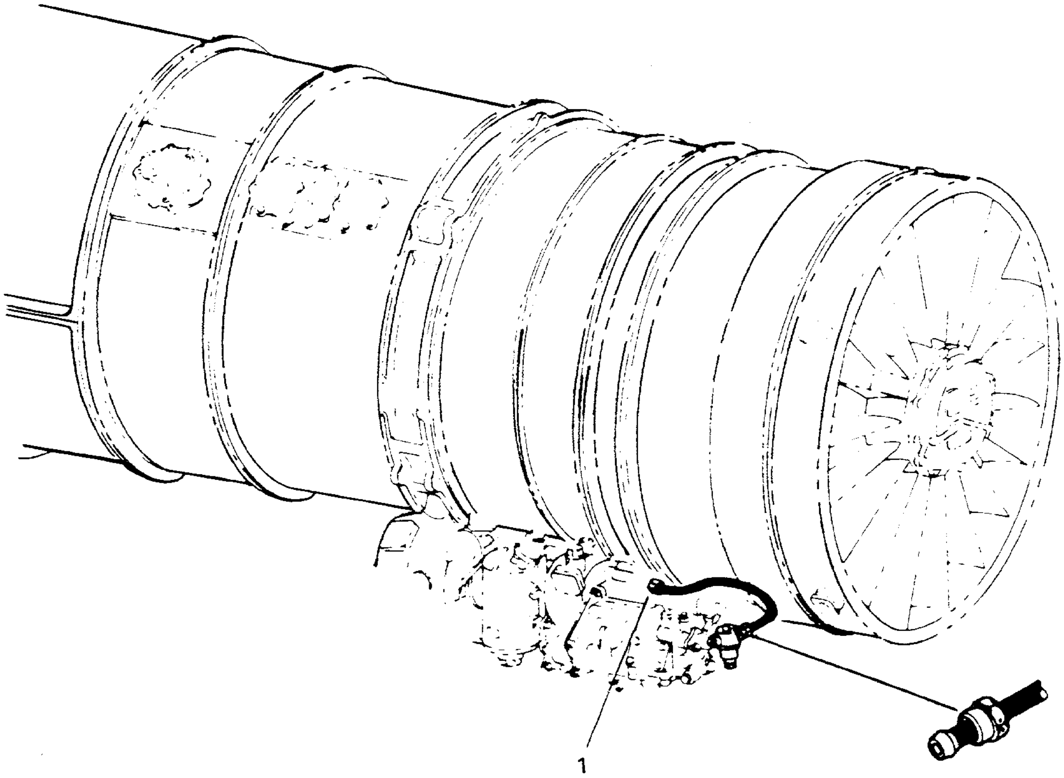
B. Procedure. (Figure 401)

(1) Connect fuel control front Pb tube to moisture trap and to connector on fuel control.

(2) Torque tube nuts and lockwire.

C. Postrequisites

(1) For procedures to close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.



1. Fuel Control Front Pb Tube

BBB2–72–225

Fuel Control Front Pb Tube Replacement
Figure 401/72-09-73-990-801

EXTERNAL PARTS - REMOVAL/INSTALLATION-04

1. PT7 Condensation Trap Removal (Post SB 5452)

A. Prerequisites

(1) Access for removal of PT7 condensation trap is through the aft lower cowl doors.

NOTE: Forward lower cowl door overlaps the aft lower cowl door and must be opened first.

(2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

B. Equipment and Materials - None

C. Procedure. (Figure 401)

(1) Loosen and disconnect tube coupling nut on PT7 condensation trap tube.

(2) Loosen and disconnect tube coupling nut on PT7 lower left manifold.

(3) Loosen and remove two machine bolts and nuts which hold condensation trap on condensation trap bracket. Remove condensation trap.

NOTE: If the trap is to be replaced, remove the bottom metering plug and keep it for the new trap.

2. PT7 Condensation Trap Installation (Post SB 5452)

A. Equipment and Materials

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

(1) Consumables

Petrolatum (PMC 9609)(DPM 675)

B. Procedure

WARNING: WHITE PETROLATUM IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN WHITE PETROLATUM IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT BREATHE THE MIST.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIER'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THIS HAZARDOUS AGENT.

(WARNING PRECEDES)

CAUTION: BE SURE THAT THE DRAIN HOLE IN THE BOTTOM OF THE CONDENSATION TRAP PLUG IS NOT BLOCKED BY THE LOCKWIRE USED TO SAFETY THE PLUG TO THE TRAP (AN OPEN DRAIN HOLE IS NECESSARY TO LET WATER OUT OF THE TRAP). INSTALL LOCKWIRE THROUGH ONLY ONE SIDE OF THE PLUG, NOT FULLY ACROSS THE BOTTOM OF THE PLUG.

(1) If the condensation trap is new, install a bottom metering plug. Use new packing with metering plug and lubricate packing with a thin layer of petrolatum. Torque the metering plug and lockwire.

CAUTION: BE SURE THAT THE TRAP IS THE CORRECT PART NUMBER FOR THIS POSITION ON THE ENGINE (THE PS4 TRAP AT THE FUEL CONTROL IS A DIFFERENT PART NUMBER AND IS NOT INTERCHANGEABLE). IF THE CORRECT PART NUMBER TRAP IS NOT USED, PT7 PRESSURES USED FOR EPR CALCULATION CAN BE INCORRECT.

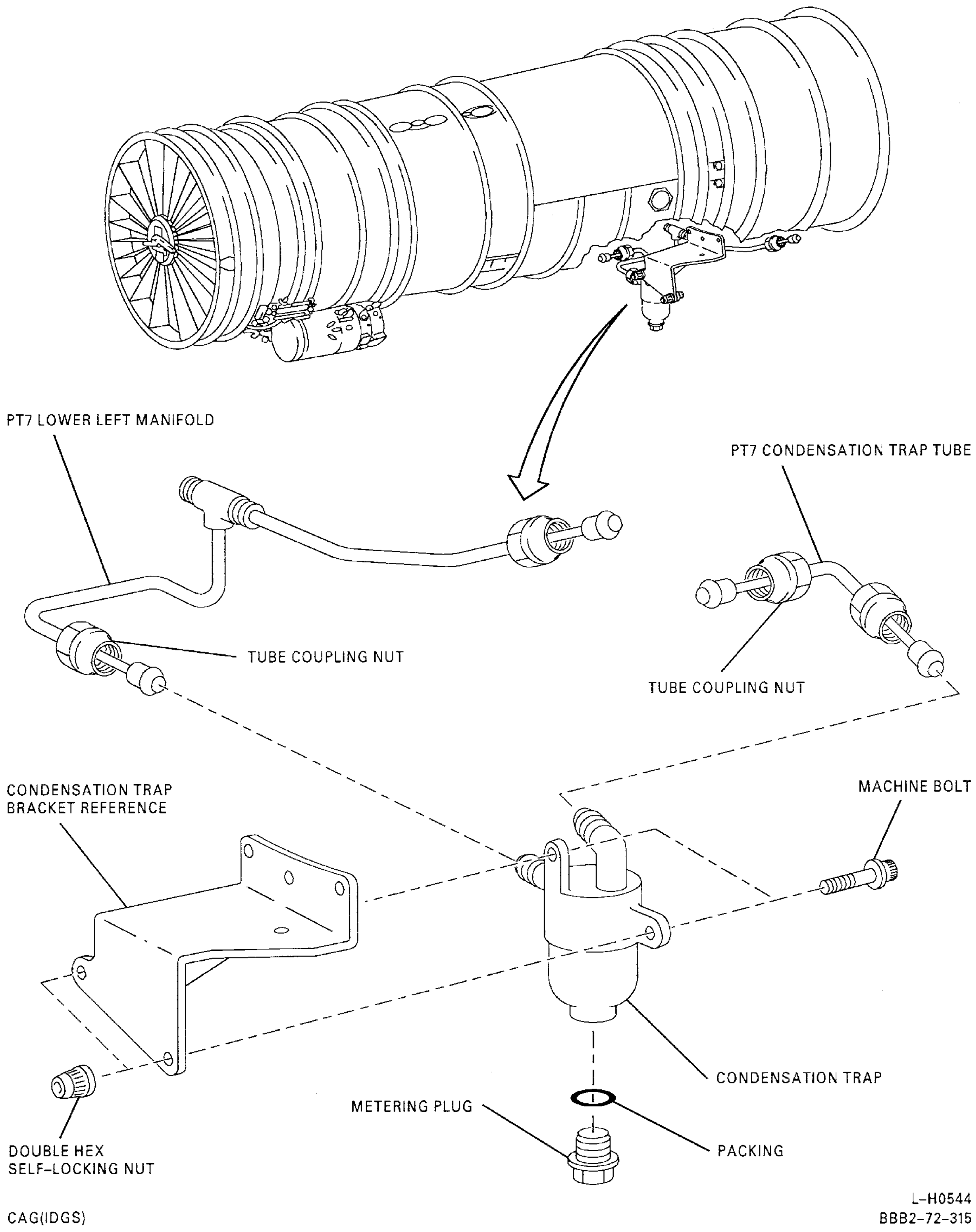
(2) Attach condensation trap to condensation trap bracket with two machine bolts and two self-locking nuts. Tighten self-locking nuts.

(3) Attach PT7 lower left manifold to side port of trap with tube coupling nut. Torque nut and safety it with lockwire.

(4) Attach PT7 condensation trap tube to the top elbow port on trap with tube coupling nut. Torque nut and safety it with lockwire.

C. Postrequisite

(1) For procedures to close aft lower cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.



PT7 Condensation Trap Replacement
Figure 401/72-09-74-990-801

AIR INLET FRONT ACCESSORY SECTION - DESCRIPTION

1. Front Accessory Support Assembly

The front accessory support assembly is bolted to the front of the fan inlet case. This assembly, of cast magnesium, is used to duct oil and breather to and from the No. 1 bearing compartment and to support the N1 tachometer drive and No. 1 bearing oil scavenge pump. Internal passages and transfer tube ports in the front accessory support carry pressure oil from inlet case plumbing to the No. 1 bearing compartment where replaceable nozzles in the support direct oil to the bearing. A boss at the top of the support carries the N1 tachometer drive outward so that airframe tachometer connections can be made. An internal mounting pad at the bottom of the support carries the No. 1 bearing oil scavenge pump; this pump drives scavenged oil from the No. 1 bearing out of the bearing compartment through front accessory support passages and inlet case plumbing.

AIR INLET FRONT ACCESSORY SECTION - REMOVAL/INSTALLATION-01

1. Remove Front Accessory Drive Group

A. Prerequisites

(1) Remove inlet bullet (INLET BULLET - MAINTENANCE PRACTICES, PAGEBLOCK 71-10-02/201).

(2) Remove N1 tachometer generator (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201).

B. Equipment And Materials Required

(1) Support Equipment

PWA 103521 Puller-Knocker, Front Accessory Group

(2) Consumables - None

C. Procedure. See Figure 401

(1) Remove bolts securing front accessory drive group to fan inlet case. Leave several opposite pairs of bolts threaded several turns into case to keep front accessory drive group from falling.

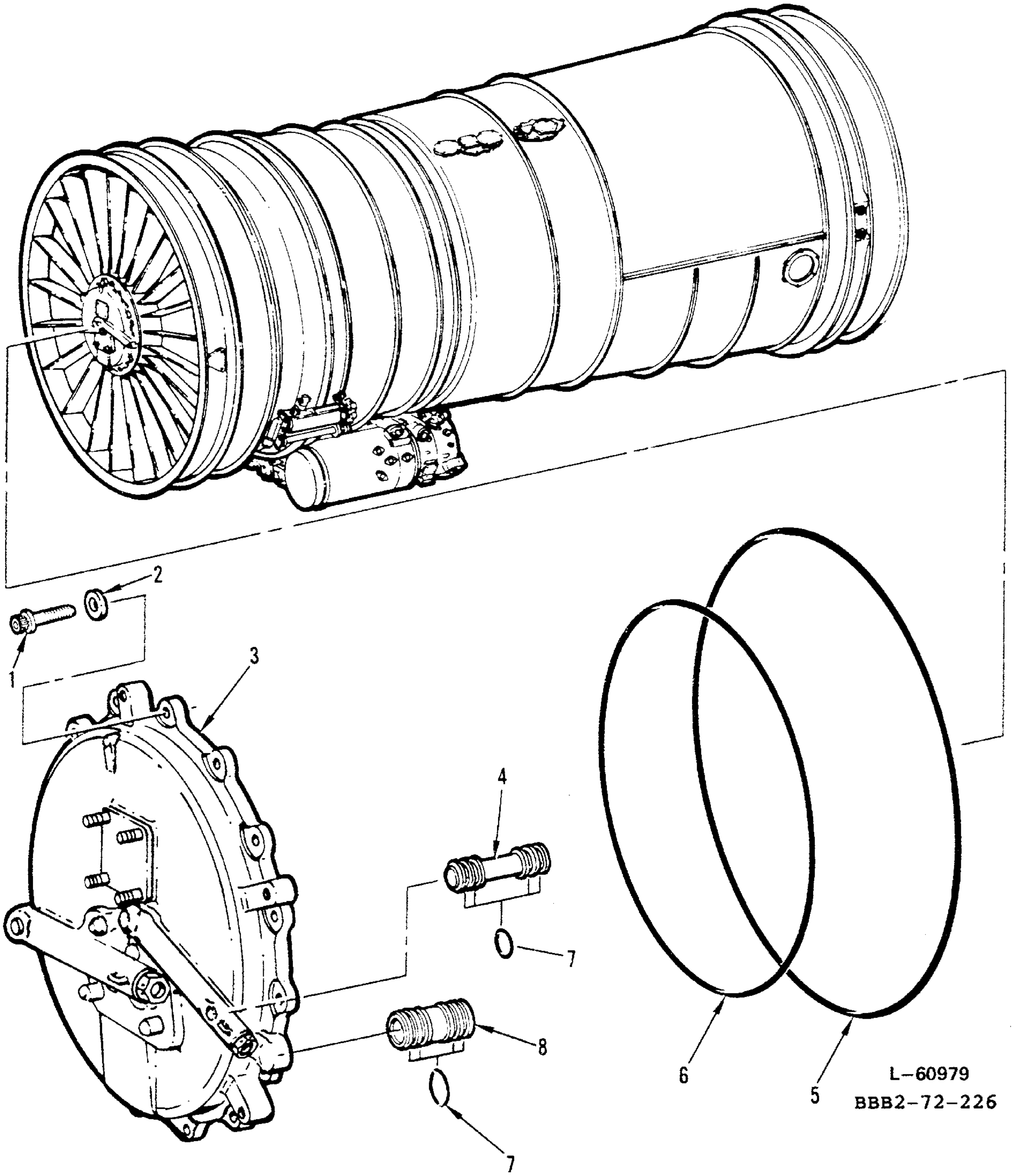
(2) Install PWA 103521 Puller Knocker on the larger (0.3125-18) studs on the front face of the front accessory support. Use the slide hammer action of the puller to disengage the front accessory drive group from the inlet case. Remove the puller from the front accessory group and remove the group from the inlet case (remove the remaining bolts from around the group). Remove and discard the preformed packings from the grooves in the No. 1 bearing housing and inlet case (inlet cone mounting flange).

NOTE: Front accessory drive group transfer tubes may remain either in inlet case or in front accessory support.

(3) Place front accessory drive group rear side up on bench.

(4) Remove transfer tubes from front accessory support. Remove and discard preformed packings.

NOTE: If transfer tubes remained in No. 1 bearing housing ports, remove tubes from housing.



Front Accessory Drive Group Removal/Installation
Figure 401/72-21-00-990-801

2. Install Front Accessory Drive Group

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables

Assembly Fluid (PWA 36500) Petrolatum (PMC 9609)

B. Procedure. See Figure 401

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Install four new preformed packings, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, on each transfer tube.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid #1 from Ultrachem Inc., Wilmington, DE 19899.

(2) Install transfer tubes in oil ports on No. 1 bearing housing assembly.

(3) Install new preformed packings, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, on No. 1 bearing housing flange and on inlet case mounting flange.

(4) Install front accessory drive group on No. 1 bearing housing flange by tapping front accessory support into place with dead-blow mallet (do not tap on bolting lugs or on N1 tachometer pad). Be careful to engage No. 1 bearing scavenge pump and N1 tachometer drive gears with front accessory spur gear, and to align transfer tubes with their respective oil ports in front accessory support.

CAUTION: DO NOT DRAW FRONT ACCESSORY DRIVE GROUP INTO PLACE WITH BOLTS OR DAMAGE TO PARTS MAY RESULT. TORQUE BOLTS IN CROSS PATTERN TO AVOID MISALIGNING FRONT ACCESSORY SUPPORT.

(5) Secure front accessory drive group with bolts and washers. Torque bolts to standard torque in pairs approximately 180 degrees apart, first one pair, then another pair 90 degrees from the first, then another pair 45 degrees from the previous pair, etc. until all bolts except one are torqued. Torque final bolt to complete pattern.

C. Postrequisites

(1) Install N1 tachometer generator (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201).

(2) Install inlet bullet (INLET BULLET - MAINTENANCE PRACTICES, PAGEBLOCK 71-10-02/201).

Key to Figure 401

Index No.	Nomenclature
1	Bolt
2	Washer
3	Front Accessory Drive Group
4	Transfer Tube (To No 1 Bearing Housing)

(Continued)

Key to Figure 401	
Index No.	**Nomenclature**
5	Preformed Packing (Inlet Case Groove)
6	Preformed Packing (No. 1 Bearing Housing Groove)
7	Preformed Packing (Four Per Transfer Tube)
8	Transfer Tube (To Inlet Case) (Three Required)

AIR INLET FRONT ACCESSORY SECTION - INSPECTION/CHECK-01

1. Front Accessory Support Inspection

A. Equipment And Materials - None

B. Procedure

(1) Visually inspect the front accessory support for damage, material abnormalities, or cracks.

(2) Fluorescent penetrant inspect by SPOP 62. See Standard Practices Manual. No cracks allowed. Front accessory supports with cracks must be removed from service.

AIR INLET FRONT ACCESSORY SECTION - INSPECTION/CHECK

1. General

A. This procedure contains MSG-3 task card data.

TASK 72-21-00-211-801

2. Detailed Inspection of the Engine Front Accessory Support Assembly

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
71-10-02 P/B 201	INLET BULLET - MAINTENANCE PRACTICES

B. Prepare for the Detailed Inspection of the Engine Front Accessory Support Assembly

SUBTASK 72-21-00-010-001

(1) Remove inlet bullet. (INLET BULLET - MAINTENANCE PRACTICES, PAGEBLOCK 71-10-02/201)

C. Detailed Inspection of the Engine Front Accessory Support Assembly

SUBTASK 72-21-00-211-001

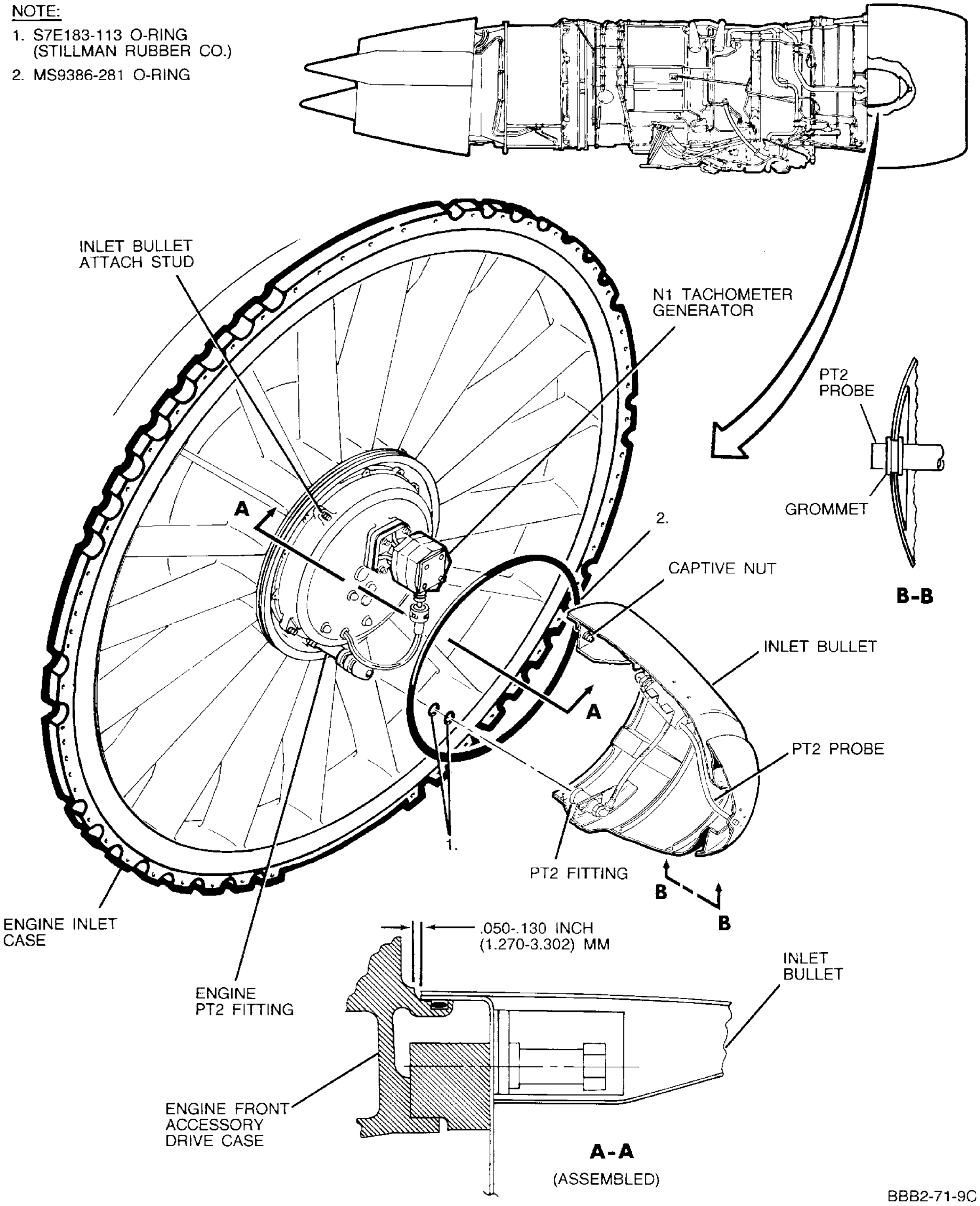
(1) Do a detailed inspection of the engine front accessory support assembly.
  (a) Inspect front accessory drive support assembly for condition of support.
  (b) Visually inspect inlet bullet attach studs.
  (c) Inspect N1 tachometer and front accessory assembly for excessive wear and damage.

D. Job Close-up

SUBTASK 72-21-00-410-001

(1) Install inlet bullet. (INLET BULLET - MAINTENANCE PRACTICES, PAGEBLOCK 71-10-02/201)

——— END OF TASK ———



Inlet Bullet
Figure 601/72-21-00-990-802

NO. 1 BEARING OIL SCAVENGE PUMP - REMOVAL/INSTALLATION-01

1. Remove No. 1 Bearing Oil Scavenge Pump

A. Prerequisites

(1) Remove nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)

(2) Remove N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Remove front accessory drive group. (AIR INLET FRONT ACCESSORY SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-21-00/401)

B. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Remove nuts and washers securing No. 1 bearing oil scavenge pump to front accessory drive group.

(2) Remove No. 1 bearing oil scavenge pump from front accessory drive group.

2. Install No. 1 Bearing Oil Scavenge Pump

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

B. Procedure. (Figure 401)

(1) Install No. 1 bearing oil scavenge pump on studs in front accessory drive group.

CAUTION: ENSURE THAT LOCKWIRE IN FOLLOWING STEP DOES NOT BLOCK OR INTERFERE WITH PUMP DRIVE GEAR.

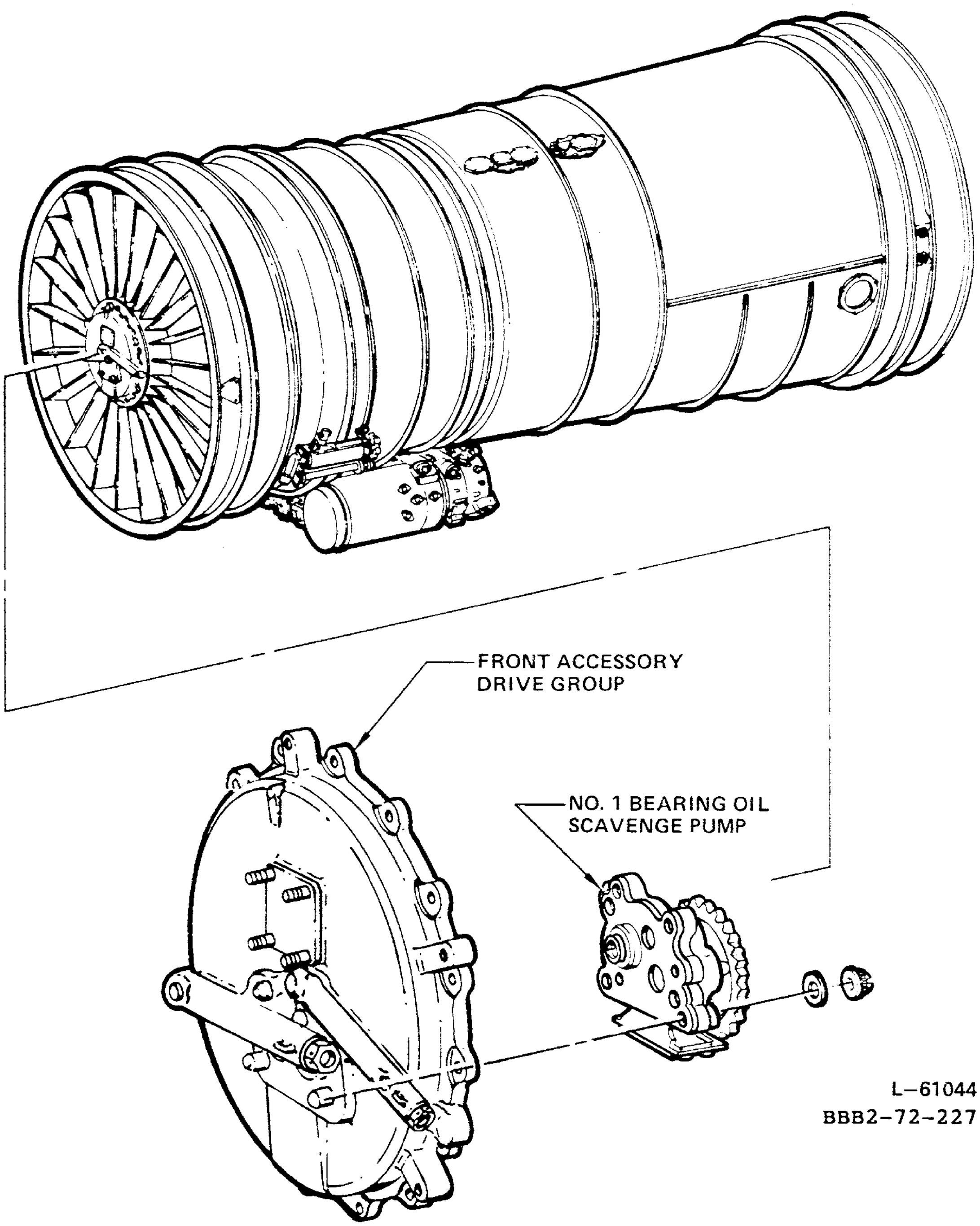
(2) Secure pump with washers and nuts. Torque nuts and lockwire.

C. Postrequisites

(1) Install front accessory drive group. (AIR INLET FRONT ACCESSORY SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-21-00/401)

(2) Install N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Install nose cow. (NOSE COWL, SUBJECT 71-10-01, Page 201)



No. 1 Bearing Oil Scavenge Pump Removal/Installation
Figure 401/72-21-02-990-801

N1 TACHOMETER DRIVE OIL SEAL HOUSING AND SEAL - REMOVAL/INSTALLATION-01

1. N1 Tachometer Drive Oil Seal Removal

A. Prerequisites

(1) Remove N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

B. Equipment And Materials Required

(1) Support Equipment

PWA 7146 Puller

(2) Consumables

None

C. Procedure. See Figure 401

(1) Remove four nuts and washers and then remove square tachometer drive pad cover or tachometer.

(2) Remove two screws which secure tachometer drive seal housing to front accessory drive support.

(3) Remove tachometer drive seal retainer from front accessory drives support, using PWA 7146 Puller.

(4) Remove packing from OD of retainer.

2. N1 Tachometer Drive Oil Seal Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 14047 Guide

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

B. Procedure. See Figure 401

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Put a new packing, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, in the OD groove of the seal retainer.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But is it better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(2) Using PWA 14047 Guide, install seal retainer into tachometer drive opening in front accessory drives support.

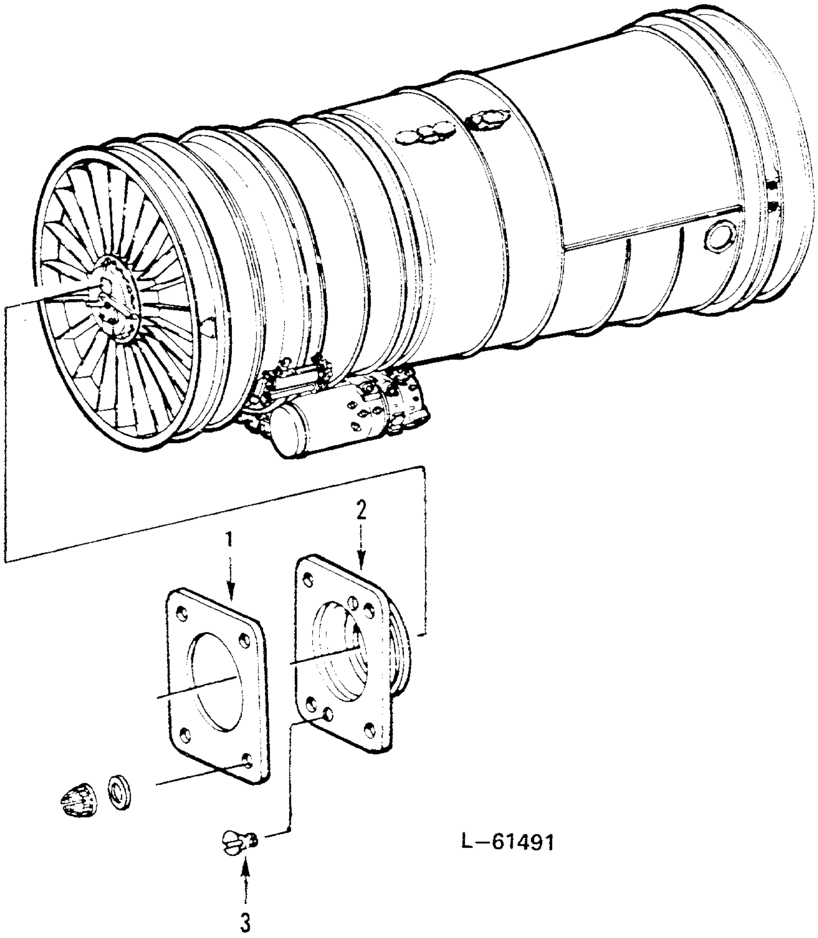
NOTE: Lubricate seal ID with engine oil prior to installing retainer and seal assembly over tachometer shaft.

(3) Secure tachometer drive seal retainer to front accessory drives support using two countersunk screws.

(4) Using new gasket, install tachometer drive pad cover or tachometer and secure using four washers and nuts.

C. Postrequisites

(1) Install N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)



1. Gasket
2. Seal And Housing Assembly
3. Screw (Two Required)

BBB2-72-228

N1 Tachometer Drive Oil Seal Replacement
Figure 401/72-21-05-990-801

COMPRESSOR INLET SECTION - DESCRIPTION

1. Fan Inlet Case Assembly

The fan inlet case is the frontmost case in the engine and extends from Flange A to B. This case contains 23 inlet guide vanes which direct air at the 1st stage fan blades. The bottom center vane (6 o'clock position) carries air, oil, and electrical tubing to and from the No. 1 bearing compartment.

The fan inlet case contains the No. 1 bearing support structures and also supports the front accessory drive group on the front of the case.

Bosses on either side of the case accept anti-icing air piped from the 8th stage of the compressor; this air flows through spaces in the case outer section and through the hollow inlet guide vanes to the case center section to prevent icing on case surfaces.

The outer section of the inlet case is ported for a total pressure (Pt2) probe to supply the inlet signal for the pressure ratio bleed control and for the inlet temperature (Tt2) probe connected to the fuel control.

COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-01

1. Remove No. 1 Bearing

A. Prerequisites

(1) Remove nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)

(2) Remove N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Remove front accessory group. (AIR INLET FRONT ACCESSORY SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-21-00/401)

B. Equipment And Materials

(1) Support Equipment

PWA 3755 Hydraulic Pump (Replaced by PWA 29398)

PWA 18872 Wrench (Hydraulic)(Replaced by PWA 33732)

PWA 29389 Hydraulic Pump (Replaces PWA 3755)

PWA 32766 Rivet Remover

PWA 33732 Wrench (Hydraulic)(Replaces PWA 18872)

PWA 45009 Puller

PWA 45023 Wrench

PWA 45024 Adapter

PWA 45025 Puller (Pre SB 6050)

PWA 45232 Adapter (Used With PWA 45418)

PWA 45233 Adapter (Used With PWA 45418)

PWA 45418 Wrench (Mechanical)(Replaced by PWA 80187)

PWA 45419 Multiplier (Used With PWA 45418)

PWA 77036 Puller (Post SB 6050)

PWA 77039 Puller (Post SB 6050)

PWA 80187 Wrench (Mechanical)(Replaces PWA 45418)

(2) Consumables

None

C. Procedure. (Figure 401) (Figure 402)

(1) Remove retaining ring holding front accessory drive gear-shaft in front hub. Engage PWA 45009 Puller behind gear-shaft gearteeth and remove gearshaft carefully with knocker action.

(2) Remove rivet from No. 1 bearing inner race, using PWA 32766 Rivet Remover as follows:

(a) Mount tool on ID spline of 1st stage compressor hub.

(b) Actuate jackscrew to break flare and move rivet outward.

(c) Remove tool and cautiously remove freed rivet using standard needlenose pliers.

(3) Remove No. 1 bearing inner race retaining nut, using hydraulic or mechanical method, as follows.

(a) Install PWA 45023 Wrench on nut and install PWA 45024 Adapter through wrench and into hub ID spline.

(b) Hydraulic method.

1) Position PWA 33732 (formerly 18872) Wrench against slot in retaining nut wrench, mating with spline of adapter.

2) Actuate wrench hydraulically to remove retaining nut.

NOTE: Hydraulic wrench hold retaining nut stationary and turns hub; set wrench to turn hub clockwise as seen from front.

(c) Mechanical method.

1) Position PWA 45232 Adapter against holding pins of PWA 80187 (formerly PWA 45418) Wrench.

2) Install PWA 45233 Adapter in splines of PWA 45418 Wrench from opposite side.

CAUTION: POSITION WRENCH AT ANGLE OUT OF VERTICAL LINE SO AS NOT TO DAMAGE PT2 TUBE AT CENTER OF INLET CASE. DO NOT ALLOW WRENCH TO MOVE OUT OF POSITION WHILE APPLYING TORQUE.

3) Position wrench and adapters against retaining nut wrench, mating with slot in retaining nut wrench and spline of adapter in hub. Break torque, then unscrew nut using PWA 45419 Multiplier.

(4) Shim tips of 1st stage compressor blades to maintain rotor position.

(5) Pre SB 6050 Bearing

(a) Position center puck detail of PWA 45025 Puller in hub, engage puller jaws in puller groove of No. 1 bearing inner race and lock in place with ring.

CAUTION: BEFORE ACTUATING PULLER, CHECK PUCK OF PULLER TO ENSURE THAT IT IS FIRMLY POSITIONED IN HUB. PARTS MAY BE DAMAGED IF PUCK IS NOT SEATED IN HUB WHEN PUMP PRESSURE IS APPLIED.

(b) Using PWA 29389 (formerly PWA 3755) Pump, actuate puller and remove bearing inner race and rollers.

(c) Transfer PWA 45025 Puller to No. 1 bearing seal plate and remove seal plate.

(d) Unbolt and remove No. 1 bearing retaining plate and stop from No. 1 bearing housing. (Figure 403)

(e) Remove No. 1 bearing outer race from No. 1 bearing housing.

(f) Remove seal rings from outer race OD.

(6) Post-SB 6050 Bearing

NOTE: In a No. 1 bearing post-SB 6050, the rollers are held in the outer race. Remove this bearing with the procedures that follow:

(a) Remove the bolts that hold the No. 1 bearing retaining plate stop.

(b) Remove the plate and stop from the No. 1 bearing housing.

(c) Put the center adapter detail of PWA 77039 Puller in the end of the compressor hub.

(d) Engage the puller jaws in the puller groove of the outer race and rollers and adjust the hand knobs to lock them in position.

(e) Turn the jackscrew to actuate the puller and remove the bearing outer race and rollers from No. 1 bearing housing.

(f) Remove the seal rings from the outer grooves in the No. 1 bearing outer race.

CAUTION: MAKE SURE THE CENTER PUCK OF THE PULLER IS IN ITS CORRECT POSITION IN THE END OF THE HUB. DAMAGE TO THE HUB IS POSSIBLE IF THE PUCK IS NOT IN POSITION WHEN THE PULLER IS ACTUATED.

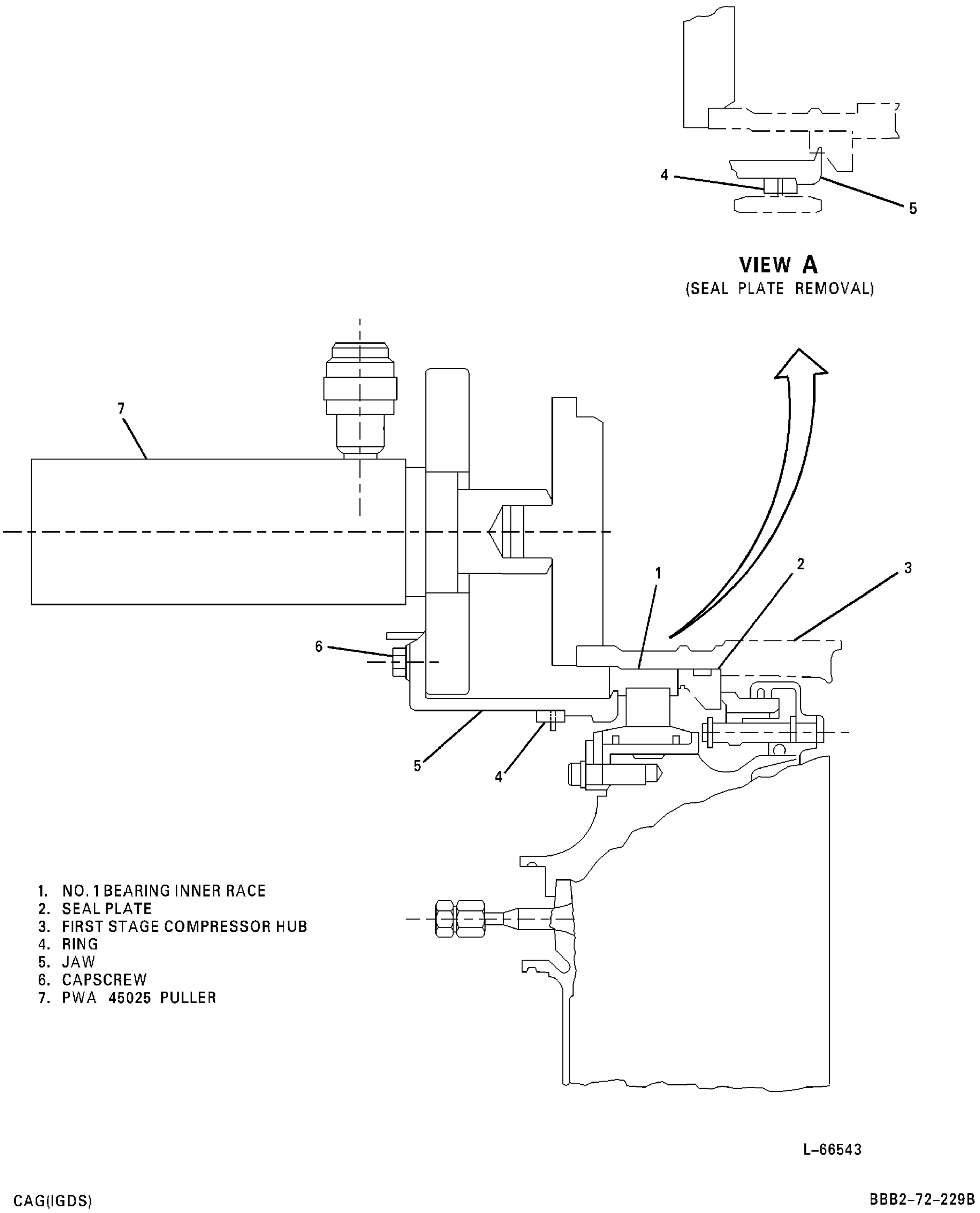
(g) Put the center puck detail of PWA 77036 Puller in the end of the compressor hub.

NOTE: It is necessary to use PWA 77036 Puller to remove a post SB 6050 bearing race and seal plate. Do not use PWA 45025 Puller to do this.

CAUTION: BE VERY CAREFUL WHEN YOU INSTALL THE PULLER JAWS OVER THE BEARING INNER RACE AND INTO THE SEAL SEAT PULLER GROOVE. THE JAWS CAN DAMAGE THE INNER RACE SURFACE.

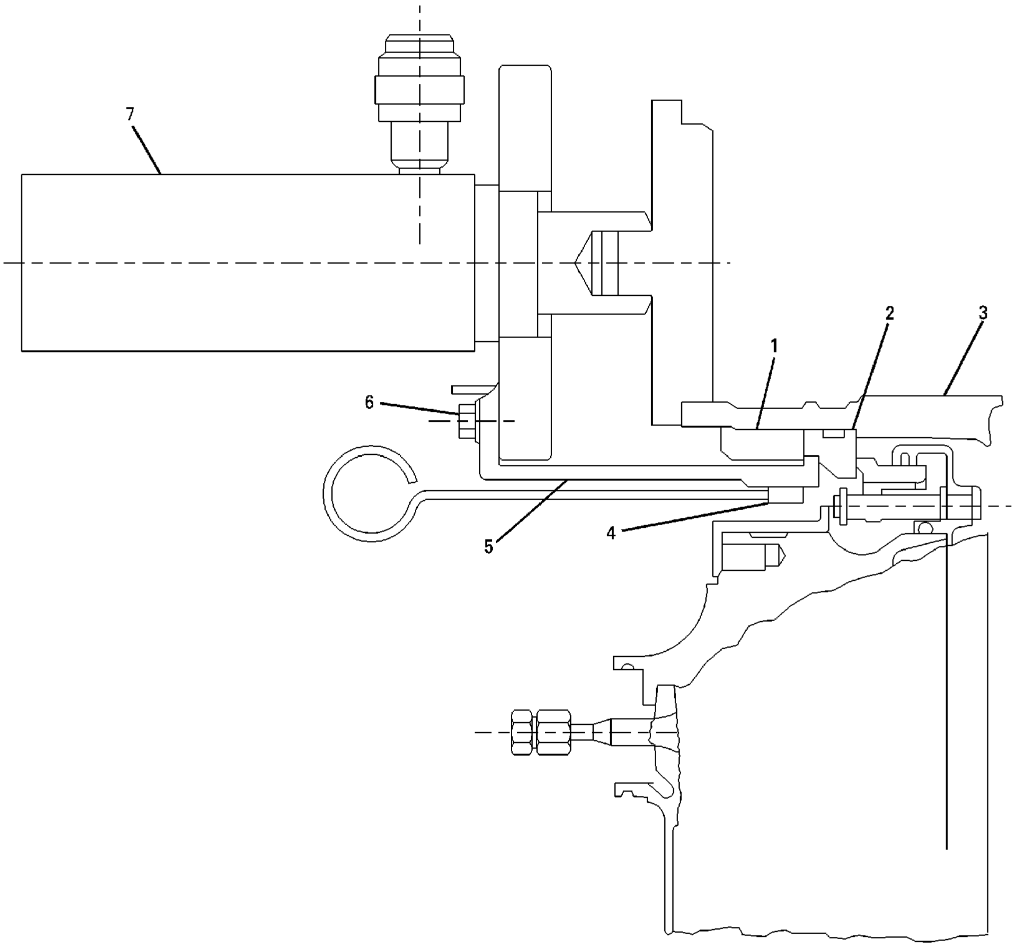
(h) Extend the puller jaws into the bearing compartment until they engage the puller groove on the No. 1 bearing seal seat. Lock the jaws in position with the ring detail.

(i) Pressurize the puller with PWA 29389 (formerly PWA 3755) Pump to actuate the puller. Carefully remove the inner race and seal from the hub journal.



1. NO. 1 BEARING INNER RACE
2. SEAL PLATE
3. FIRST STAGE COMPRESSOR HUB
4. RING
5. JAW
6. CAPSCREW
7. PWA 45025 PULLER

No. 1 Bearing Inner Race And Seal Plate Removal (Pre-SB 6050 Bearing)
Figure 401/72-23-01-990-801



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1. NO. 1 BEARING INNER RACE
2. SEAL SEAT
3. FIRST STAGE COMPRESSOR HUB
4. RING
5. JAW
6. CAPSCREW
7. PWA 77036 PULLER

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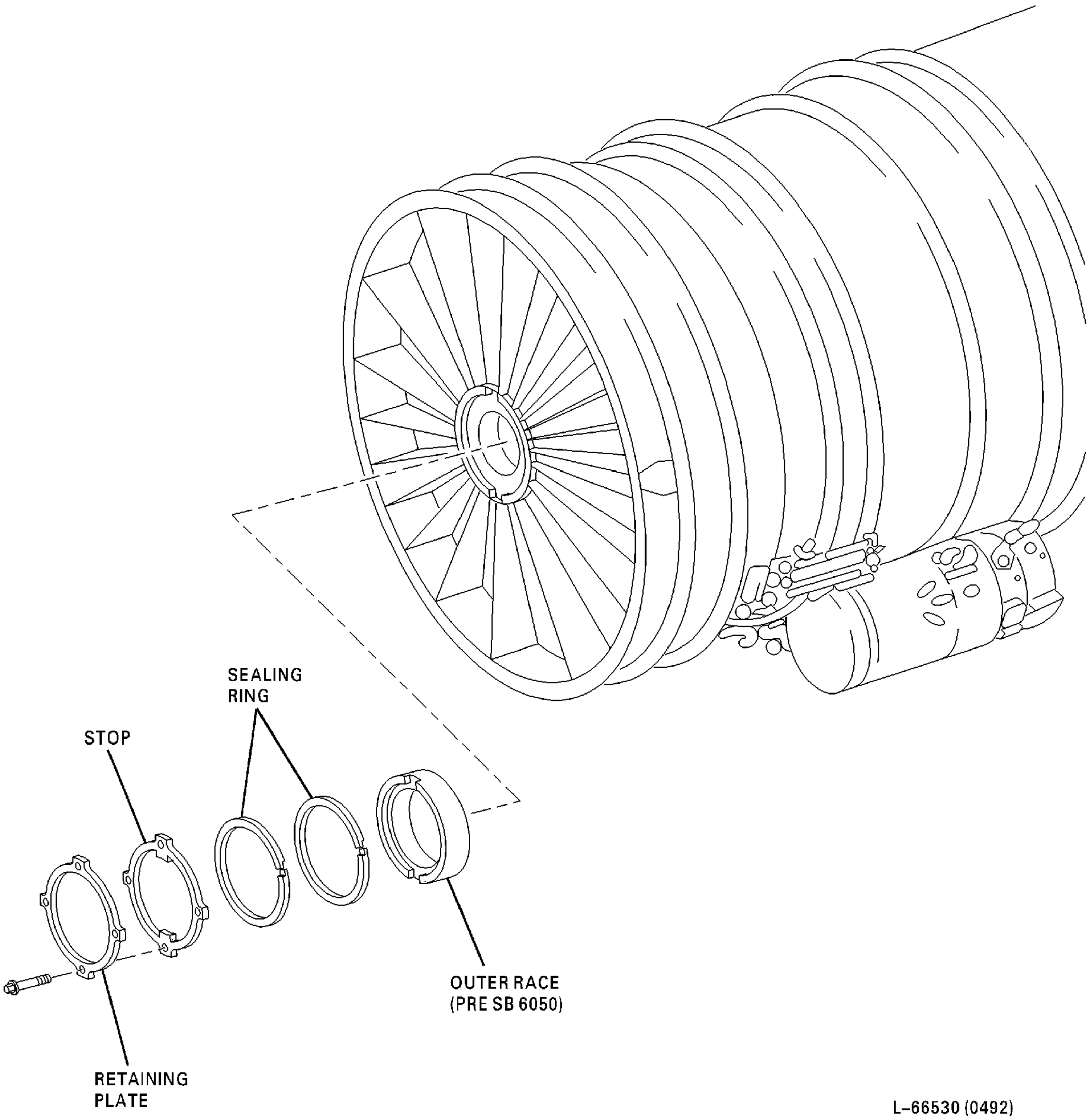
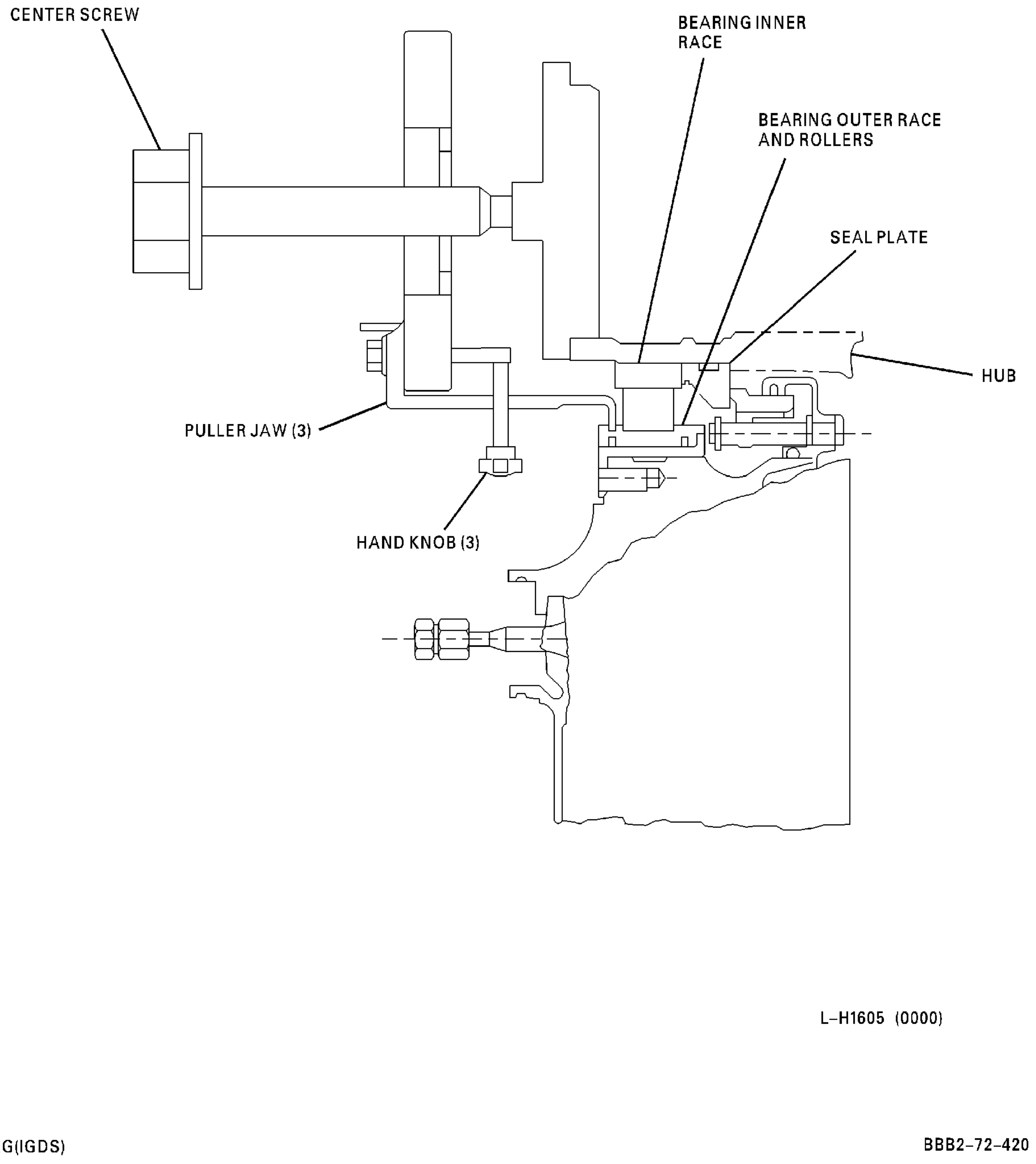
No. 1 Bearing Inner Race and Seal Plate Removal (Post-SB 6050 Bearing)
Figure 402/72-23-01-990-802



No. 1 Bearing Outer Race Removal
Figure 403/72-23-01-990-803 (Sheet 1 of 2)



No. 1 Bearing Outer Race Removal
Figure 403/72-23-01-990-803 (Sheet 2 of 2)

2. Install No. 1 Bearing

A. Equipment And Materials

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 3755 Pump (Replaced by PWA 29389)

PWA 18872 Wrench (Hydraulic) (Replaced by PWA 33732)

PWA 21598 Riveter

PWA 29389 Hydraulic Pump (Replaced PWA 3755)

PWA 33732 Wrench (Hydraulic) (Replaces PWA 18872)

PWA 45023 Wrench

PWA 45024 Adapter

PWA 45232 Adapter (Mechanical)

PWA 45233 Adapter (Mechanical)

PWA 45234 Compressor

PWA 45418 Wrench (Mechanical) (Replaced by PWA 80187)

PWA 45419 Multiplier (Mechanical)

PWA 46296 Pusher

PWA 75028 Gage

PWA 77038 Guide (Post SB 6050)

PWA 80187 Wrench (Mechanical) (Replaces PWA 45418)

(2) Consumables

Assembly Fluid (PWA 36500)

B. Procedure. (Figure 404) (Figure 405)

(1) Compress No. 1 bearing carbon seal element using PWA 45234 Compressor as follows (see figure):

(a) Position pusher detail in ID of bearing housing, with flange out.

(b) Align four holes in pusher detail with four tapped holes in housing.

(c) Insert four thumbscrews and tighten evenly until pusher is bottomed out on housing.

(2) Install seal plate, with puller groove forward, against shoulder of hub journal.

(3) Install No. 1 bearing inner race as follows:

(a) Insert draw bar of PWA 46296 Pusher in ID of front compressor front hub with clamps retracted.

(b) Pull draw bar outward to expand clamps against hub.

(c) Position No. 1 bearing inner race and rollers (pre-SB 6050) or inner race (post-SB 6050) on hub journal and assemble ram and locator on draw bar of pusher.

NOTE: Make sure the front side of the bearing inner race is pointed to the operator. On a pre-SB 6050 bearing the front side has a puller groove. On a post-SB 6050 bearing the front side has a bevel on the ID. (Figure 404)

(d) Connect PWA 75028 Gage, or equivalent pressure gage capable of indicating 10000 psi (68947.6 kPa) pump pressure, between PWA 29389 (formerly PWA 3755) Pump and PWA 46296 Pusher.

(e) Using 5870 psi (40472.2 kPa) maximum pump pressure, push bearing inner race into position.

(4) Remove seal compressor from No. 1 bearing housing.

(5) Check to ensure that seal rings for No. 1 bearing outer race have 0.032 - 0.045 inch (0.081 - 1.140 mm) end gap.

NOTE: Seal ring end gap at 7.484 inch (190.084 mm) diameter is 0.032 - 0.042 inch (0.810 - 1.070 mm).

(6) Install seal rings in grooves at each end of No. 1 bearing outer race OD with identification marked sides of rings facing each other.

(7) Check to ensure that seal ring side clearance is 0.001 - 0.007 inch (0.030 - 0.170 mm).

(8) Pre-SB 6050 bearing: Install outer race in bearing housing with antirotation slots facing outward. Drift to seat as necessary.

(9) Post-SB 6050 Bearing

(a) Install PWA 77038 Guide on the front of the No. 1 bearing housing with four cap screws.

(b) Put the No. 1 bearing outer race and rollers in position on the guide (be sure the antirotation slots on the bearing race are pointed out of the bearing compartment).

(c) Install the outer race and rollers into the bearing housing. Remove the guide from the housing.

(10) Install the stop and retaining plate to hold the outer race in position as follows:

(a) Find the bolt hole in the stop and retaining plate that is offset radially 0.050 inch (1.270 mm) as shown in Figure 405.

(b) Align the offset hole in the stop with the offset hole (at the four o'clock position) on the No. 1 bearing housing and install the stop against the bearing housing (the lugs in the stop engage the slots in the bearing outer race).

(c) Align the offset hole in the retaining plate with the same hole in the stop and housing and install the retaining plate against the stop. Install bolts in the four holes to attach the place and stop.

(d) Torque the four bolts and safety them with lockwire.

(11) Check to ensure that end clearance of outer race and retaining place is within 0.002 - 0.006 inch (0.051 - 0.152 mm). (Figure 405)

(12) Remove shims from 1st stage compressor blade tips.

(13) Lubricate inner race retaining nut threads with engine oil and thread nut onto hub handtight.

(14) Install tools to torque No. 1 bearing inner race as follows:

(a) Install PWA 45023 Wrench on inner race retaining nut and install PWA 45024 Adapter through wrench and into hub ID spline.

(b) Hydraulic tooling method.

1) Install PWA 33732 (formerly 18872) Wrench against slot in retaining nut wrench, mating with spline of adapter.

2) Actuate wrench hydraulically to tighten retaining nut.

NOTE: Hydraulic wrench holds retaining nut stationary and turns hub; set wrench to turn hub counter-clockwise as seen from front.

(c) Mechanical tooling method.

1) Position PWA 45232 Adapter against holding pins of PWA 80187 (formerly PWA 45418) Wrench.

2) Install PWA 45233 Adapter in splines of PWA 45418 Wrench from opposite side.

CAUTION: POSITION WRENCH AT ANGLE OUT OF VERTICAL LINE SO AS NOT TO DAMAGE PT2 TUBE AT CENTER OF INLET CASE. DO NOT ALLOW WRENCH TO MOVE OUT OF POSITION WHILE APPLYING TORQUE.

3) Position wrench and adapters against retaining nut wrench, mating with slot in retaining nut wrench and spline of adapter in hub. Take up slack in retaining nut using PWA 45419 Multiplier.

(15) Torque No. 1 bearing inner race retaining nut as follows:

(a) Tighten nut to 20000 - 24000 lb-in. (2259.696 - 2711.635 N·m).

(b) Mark nut and hub for reference.

(c) Loosen nut and repeat Paragraph 2.B.(15)(a).

(d) If reference marks are in line, or nut mark is beyond hub mark within 0° 30' maximum, loosen nut and torque to 4000 lb-in. (451.939 N·m). Apply final angle of turn per Paragraph 2.B.(15)(f).

(e) If reference marks are not within limits per Paragraph 2.B.(15)(d), repeat Paragraph 2.B.(15)(b) through Paragraph 2.B.(15)(c) until marks are within limits, then loosen nut and torque to 4000 lb-in. (451.939 N·m). Apply final angle of turn per Paragraph 2.B.(15)(f).

(f) Turn nut through angle of 5 - 8 degrees.

(16) Install retaining nut rivet, head inward, through nut and hub and flare using PWA 21598 Riveter.

(17) Install new packing, lubricated with PWA 36500 Assembly Fluid, on front accessory drive gearshaft and install gearshaft on front hub. Secure with retaining ring.

NOTE: PWA 36500 Assembly Fluid is available as:

Ultrachem Assembly Fluid #1 from Ultrachem Inc., Wilmington, DE 19899

or

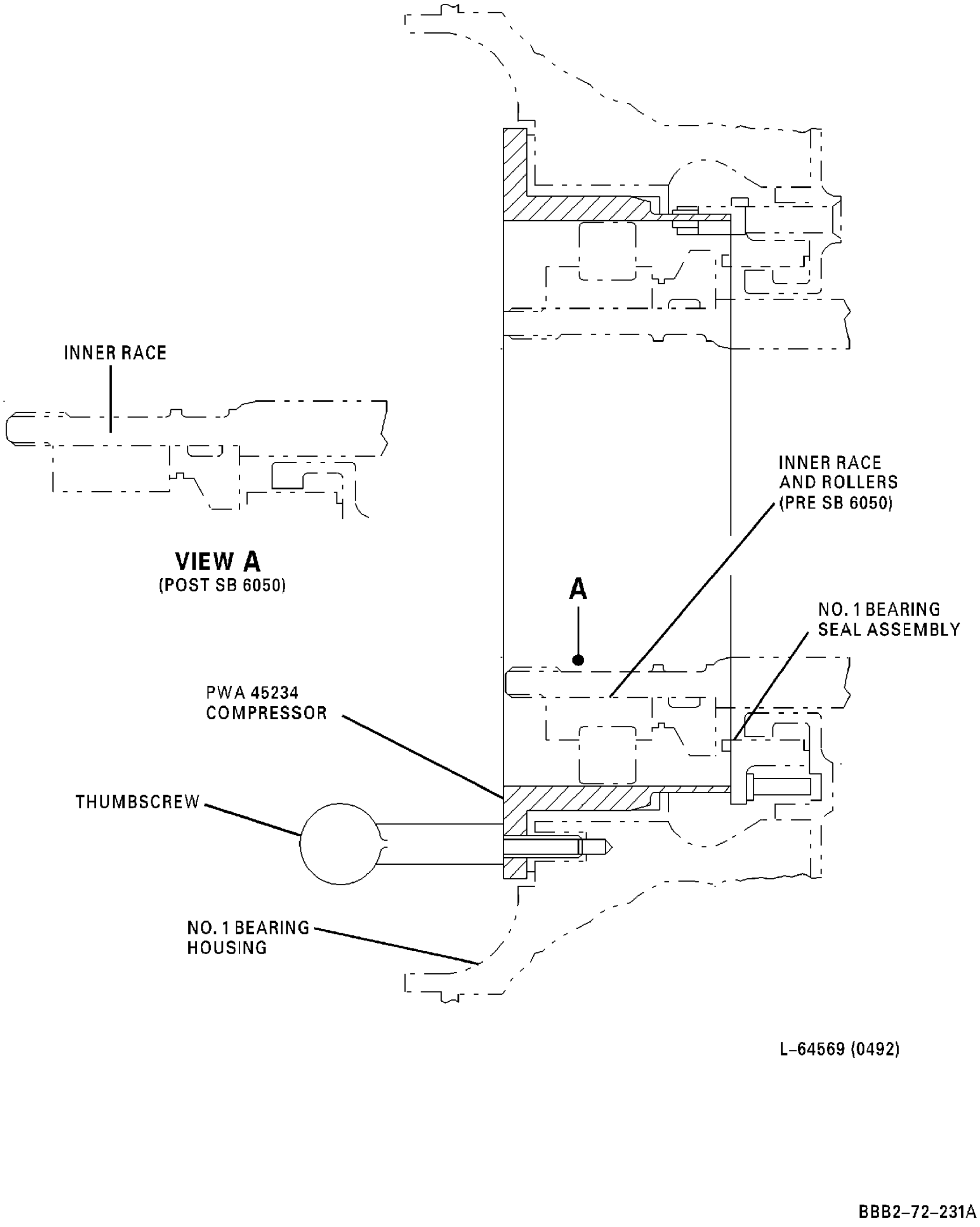
Reyco HC825 from Royal Lubricants Co. Inc., East Hanover, NJ 07936

C. Postrequisites

(1) Install front accessory drive group. (AIR INLET FRONT ACCESSORY SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-21-00/401)

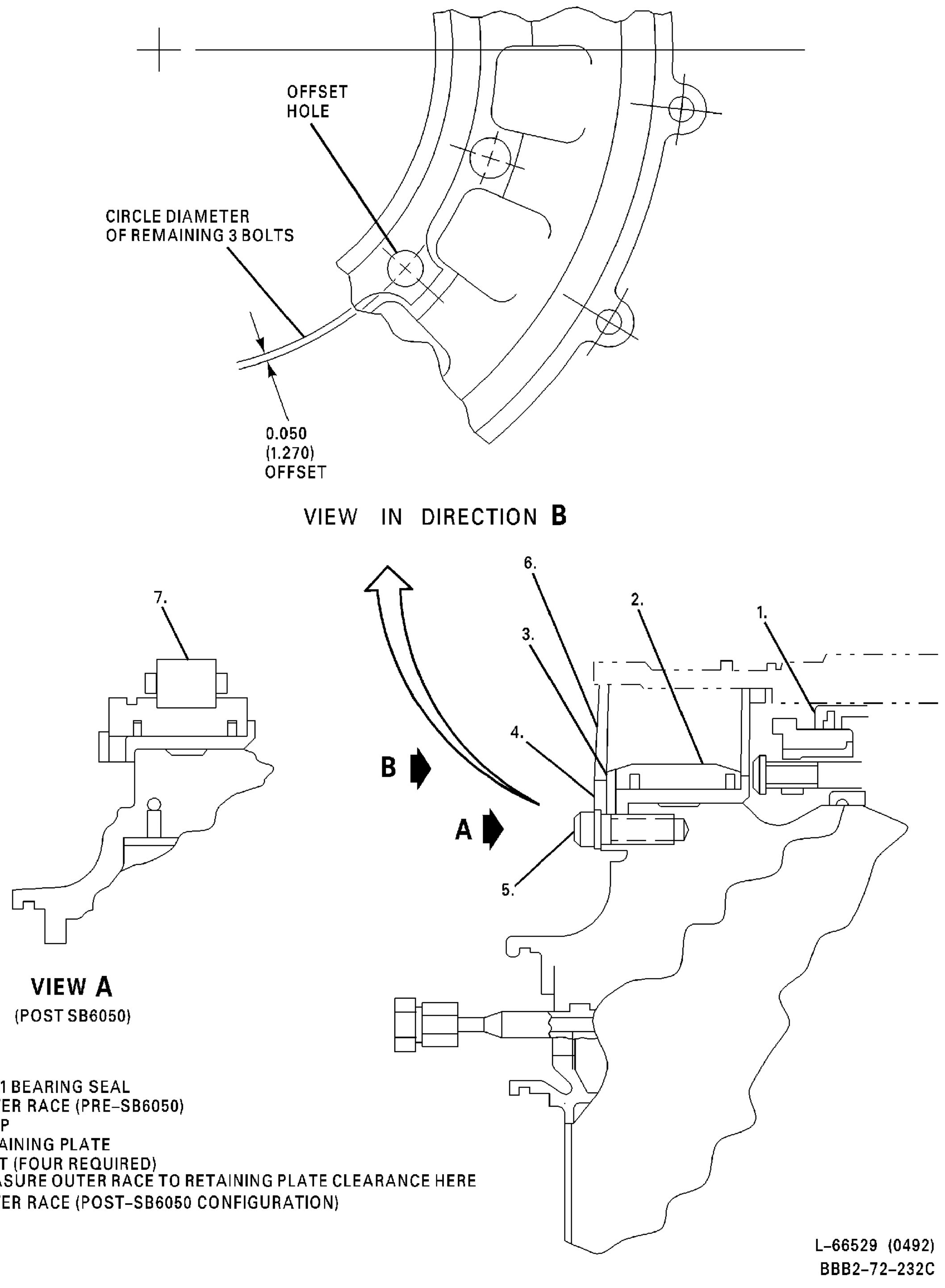
(2) Install N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Install nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)



No. 1 Bearing Inner Race Installation
Figure 404/72-23-01-990-804

COMPRESSOR INLET SECTION – REMOVAL/INSTALLATION-01



1. NO. 1 BEARING SEAL
2. OUTER RACE (PRE-SB6050)
3. STOP
4. RETAINING PLATE
5. BOLT (FOUR REQUIRED)
6. MEASURE OUTER RACE TO RETAINING PLATE CLEARANCE HERE
7. OUTER RACE (POST-SB6050 CONFIGURATION)

CAG(IGDS)

No. 1 Bearing Outer Race Position Check
Figure 405/72-23-01-990-805

COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-02

1. Remove Compressor Inlet Group

A. Prerequisites

(1) Remove nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)

(2) Remove N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Remove No. 1 bearing. (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-23-01/401)

B. Equipment And Materials

(1) Support Equipment

PWA 45050 Eye

PWA 45128 Protector

PWA 45130 Protector

PWA 45771 Rail Support

PWA 45772 Rail Support (Replaced by PWA 46125)

PWA 46125 Rail Support (Replaces 45772)

(2) Consumables

None

C. Procedure. (Figure 401) (Figure 402)

(1) Remove external parts as follows:

(a) Disconnect Tt2 sensor bulb at inlet case and coil sensor cable at fuel control

(b) Unbolt and remove font anti-icing tubes from actuator and valve and inlet case boss at left and right sides.

(c) Disconnect Pt2 sense tube from inlet case to pressure ratio bleed control at inlet case (5 o'clock position).

(d) Disconnect No. 1 bearing oil drain tube at lower left side of inlet case.

(2) Install PWA 46125 Rail Support (formerly PWA 45722) on engine as follows:

(a) Mount brace assembly on intermediate case mount rail, with angle brace positioned at outboard side of engine. Secure with lockpins.

WARNING: ENSURE THAT HOIST AND TROLLEY ASSEMBLY ARE IMMOBILIZED ON BEAM BY MEANS OF LOCKPIN PROVIDED BEFORE HANDLING BEAM AND SUPPORT ASSEMBLY.

(b) With beam attached to rear support, lift beam and support, with hoist and trolley secured by lockpin, and lower onto engine. Bolt beam to brace assembly and secure rear plate of support to exhaust duct mount rail with lockpin.

(c) Remove lockpin securing hoist and trolley and move trolley into position over inlet case.

(3) Secure PWA 45050 Lifting Eye to inlet case at 12 o'clock position. Attach hoist, and take up slack.

(4) Remove inlet case attaching bolts from Flange B.

(5) Carefully remove compressor inlet group and place on blocks or suitable device, on bench or pallet front end down. Remove eye and hoist.

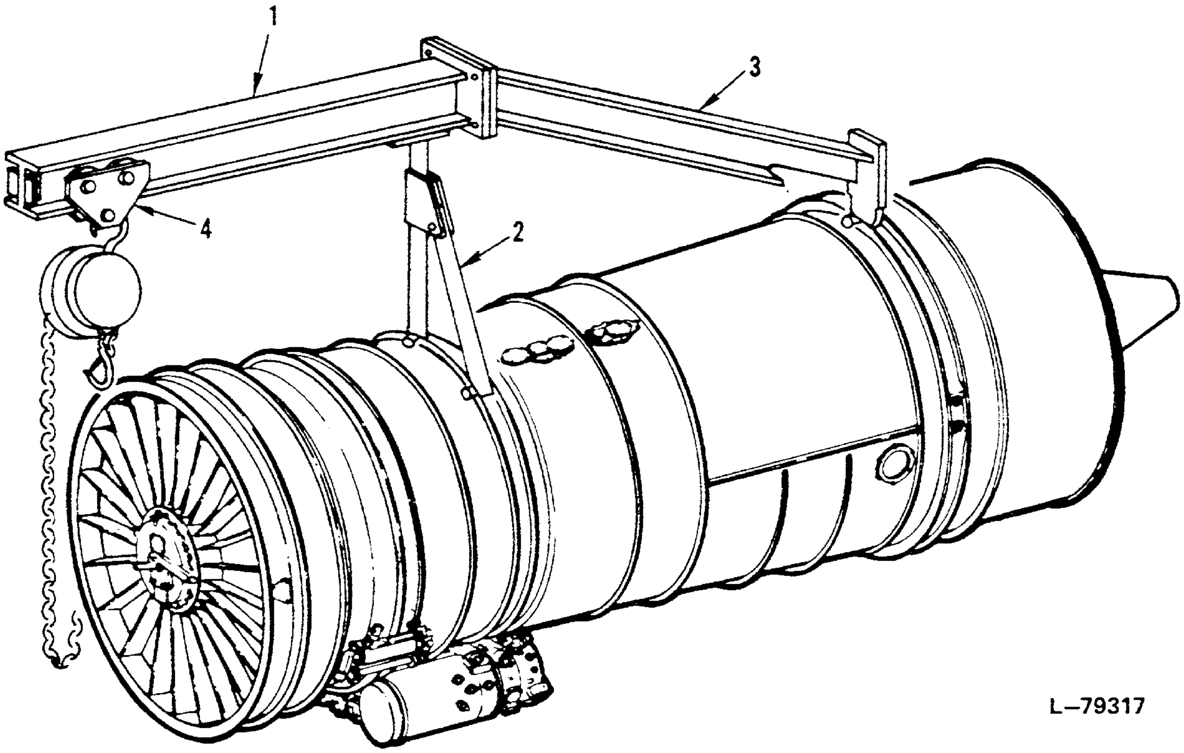
NOTE: Blocks, or suitable device, are necessary to raise group from bench or pallet to protect Pt2 tube at six o'clock position on inlet case inner ring.

If necessary, remove compressor No. 1 bearing airsealing ring and seal assembly from inlet case. (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-03, PAGEBLOCK 72-23-03/401)

(6) Protect knife-edge seals on 1st stage compressor hub as follows:

(a) Install PWA 45128 Protector on 1st stage airseal.

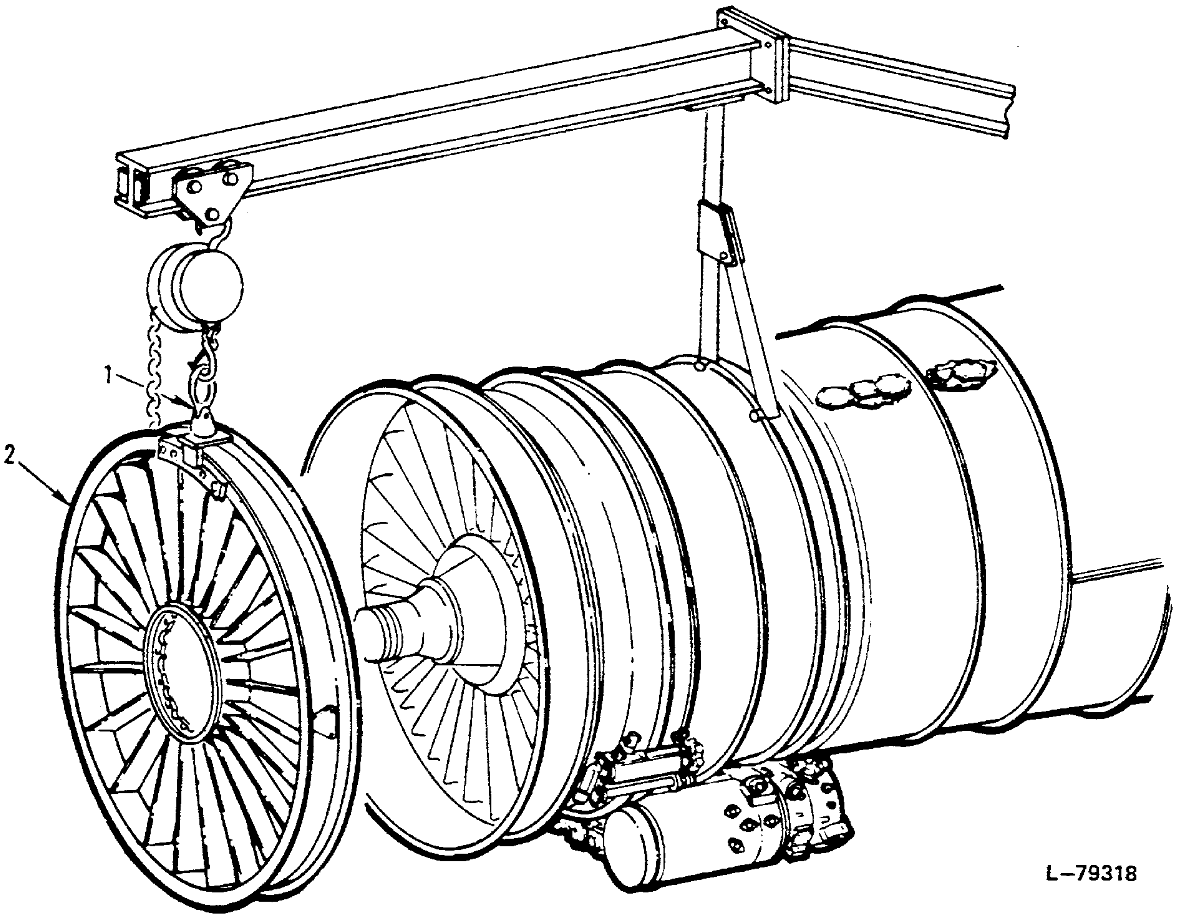
(b) Install PWA 45130 Protector on No. 1 bearing airseal.



1. Beam
2. Brace Assembly
3. Rear Support
4. Hoist And Trolley

BBB2-72-233

Rail Support Installation
Figure 401/72-23-02-990-801



1. PWA 45050 Eye

2. Fan Inlet Case

BBB2-72-234

Compressor Inlet Group Removal/Installation
Figure 402/72-23-02-990-802

2. Install Compressor inlet Group

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 45050 Eye

(2) Consumables

Lubricant (PWA 36500)

Solvent (PMC 9076)(Optional To PMC 90080

Solvent (PMC 9008)(Optional To PMC 9076)

B. Procedure. (Figure 401) (Figure 402)

NOTE: If compressor No. 1 bearing airsealing ring and seal assembly were removed, install them (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-03, PAGEBLOCK 72-23-03/401).

1 bearing installation tools require that bearing outer race be removed from inlet group. To satisfy this requirement and to ensure that outer race is not damaged during installation of inlet group, ensure that outer race has been removed.

(1) Secure PWA 45050 Lifting Eye to inlet case at 12 o'clock position. Attach to hoist.

(2) Remove knife-edge seal protectors from 1st stage compressor hub.

(3) Position compressor inlet group assembly, leading edges of vanes forward, on front of engine.

(4) Align the offset holes at the bottom of the Flange B bolthole circle and install the inlet case on front fan case.

(5) Install and secure bolts, washers, and brackets on Flange B.

(6) Remove hoist and lifting eye.

(7) Install external parts as follows:

(a) Install a new packing (coated with PWA 36500 lubricant) and retainer, connect the Pt2 sense tube to the connector on inlet case at the five o'clock position. Torque the tube nut and safety it with lockwire..

(b) Install left and right front anti-icing tubes between anti-icing air shutoff valves and inlet case, using new gasket at each side of inlet case. Secure with washers and bolts.

(c) Connect Tt2 sensor probe at inlet case as follows:

1) Clean surfaces of probe and probe port in inlet case by SPOP 208. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

2) Install probe in inlet case and secure with bolts.

3) Apply PWA 36003 Sealant to inner surface of inlet case around probe, sufficiently thick to fill gap all around probe. (Figure 402)

NOTE: PWA 36003 Sealant is available as RTV-159 from General Electric Co., Waterford, New York 12188, U.S.A.

(d) Connect No. 1 bearing oil drain tube at lower left side of inlet case.

(8) Remove PWA 45772 Rail Support as follows:

WARNING: ENSURE THAT HOIST AND TROLLEY ASSEMBLY ARE IMMOBILIZED ON BEAM BY MEANS OF LOCKPIN PROVIDED BEFORE HANDLING BEAM AND SUPPORT ASSEMBLY.

(a) Secure hoist and trolley with lockpin and attach lifting equipment to beam. Unbolt beam from brace assembly and remove rear support lockpin from exhaust duct mount rail.

CAUTION: BE SURE TO LIFT BEAM AND SUPPORT AWAY FROM ENGINE WITHOUT CAUSING ANY BENDING STRESS TO MOUNT RAILS.

(b) Remove beam and support from engine.

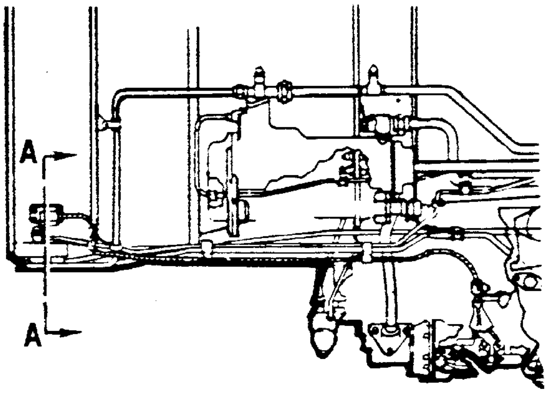
(c) Remove brace assembly from intermediate case mount rail.

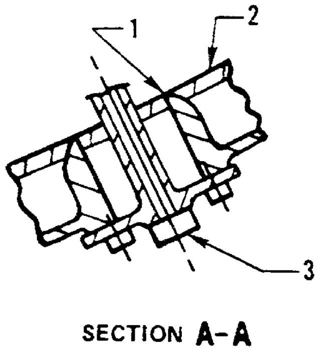
C. Postrequisites

(1) Install No. 1 bearing. (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-23-01/401)

(2) Install N1 tachometer generator per. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Install nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)





1. Apply Sealant Here (See Text)
2. Inlet Case
3. TT2 Probe

BBB2-72-235

TT2 Sensor Probe Sealant Application
Figure 403/72-23-02-990-803

COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-03

1. Remove No. 1 Bearing Airsealing Ring And Seal

A. Prerequisites

(1) Remove nose cowl (NOSE COWL, SUBJECT 71-10-01, Page 201).

(2) Remove N1 tachometer generato . (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201).

(3) Remove compressor inlet group (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-02, PAGEBLOCK 72-23-02/401).

B. Equipment And Materials Required

(1) Support Equipment

PWA 45106 Puller

PWA 45106 Puller

(2) Consumables - None

C. Procedure. See Figure 401, Table 401, Figure 402, and Table 402.

(1) Remove No. 1 bearing airsealing ring. See Figure 402, Table 402.

(a) Remove bolts securing No. 1 bearing sealing ring to No. 1 bearing seal assembly and No. 1 bearing housing assembly.

(b) Using PWA 45106 Puller remove No. 1 bearing sealing ring.

1) Position locator of puller so that it pilots on ID of seal assembly.

2) Position jaws of puller behind scallops of seal ring and secure jaws.

3) Using jackscrew action remove sealing ring.

4) Remove preformed packing from ring groove at OD of No. 1 bearing housing assembly.

(2) Remove No. 1 bearing seal assembly. See Figure 403. Table 403.

(a) Place plate of PWA 45109 Puller (Index 9) (assembled with Index 7 clamps, Index 8 knurled nuts, and Index 6 stud details) on ID of No. 1 bearing seal assembly (Index 2) inserting plate from rear.

NOTE: Clamp details must be positioned so their feet clear seal assembly ID as plate is inserted.

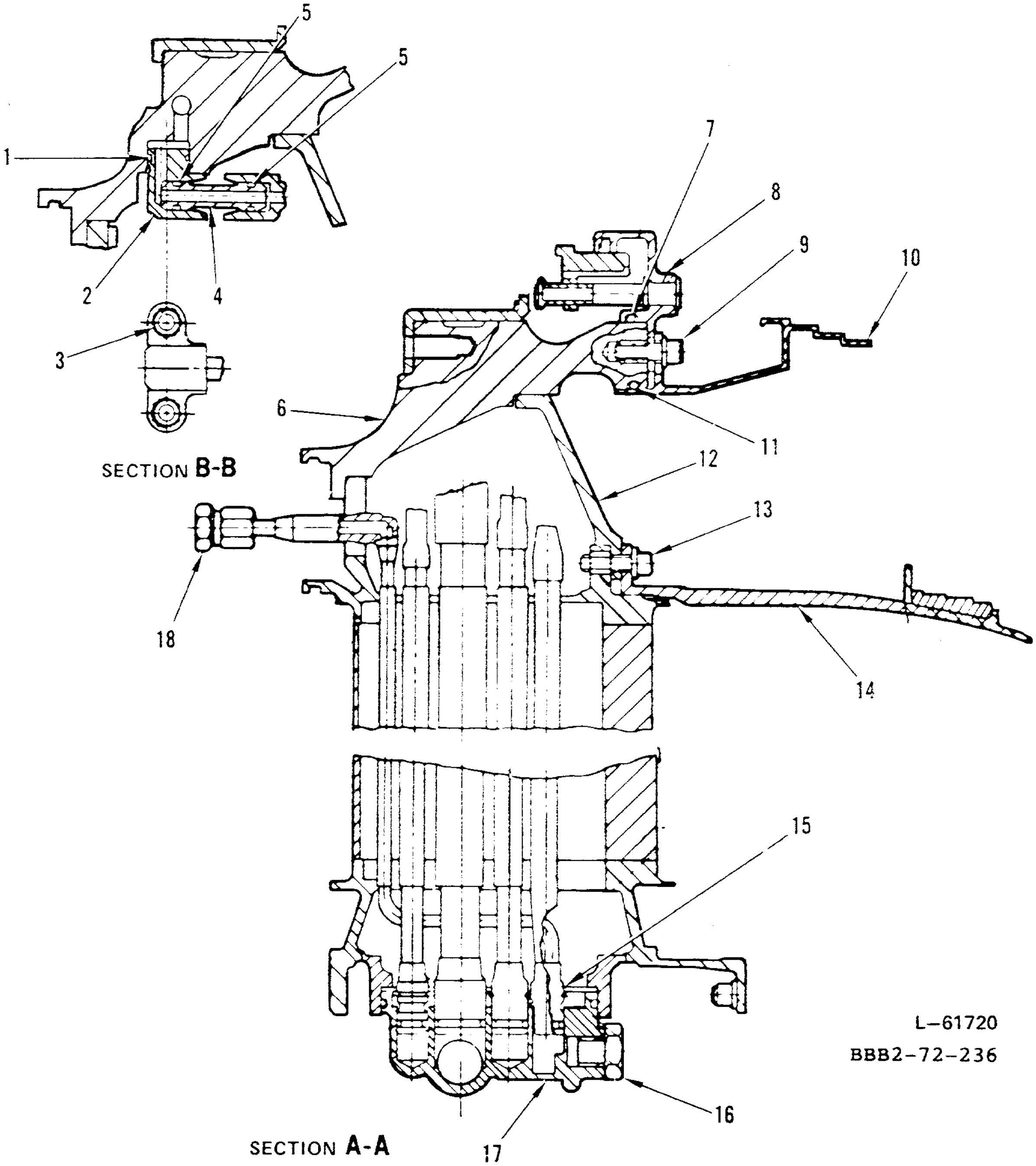
(b) With plate resting against seal ring holder, rotate clamp details and tighten knurled nuts (Index 8) until plate is secured to seal assembly.

(c) Position body (Index 4) over plate with stud protruding through center hole of plate.

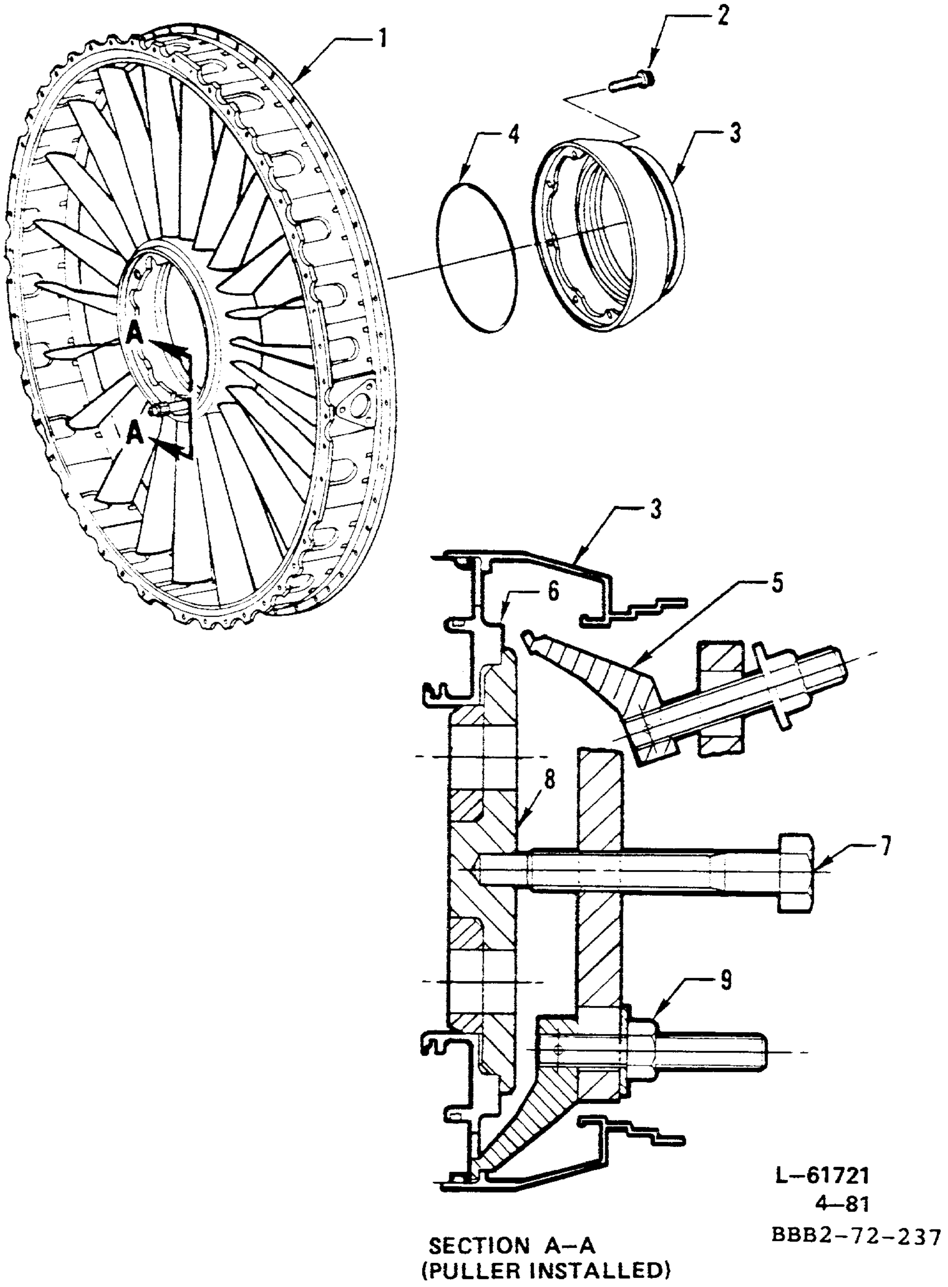
(d) Pilot body on No. 1 bearing housing assembly (Index 10). Move swing washer (Index 5) into place against stud (Index 6).

(e) Tighten stud not to secure body and continue tightening to jack seal assembly from No. 1 bearing housing.

(f) Remove preformed packing from ring groove at the OD of No. 1 bearing seal assembly.



Fan Inlet Case Assembly
Figure 401/72-23-03-990-801



No. 1 Bearing Airsealing Ring Removal
Figure 402/72-23-03-990-802

2. Install No. 1 Bearing Airsealing Ring And Seal

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 45551 Aligning Pin (Two Required)

(2) Consumables

Assembly Fluid (PWA 36500)

Petrolatum (PMC 9609)

B. Procedure. See Figure 401, Table 401.

(1) Install No. 1 bearing seal assembly.

(a) Install two PWA 45551 Aligning Pins 180 degrees apart at the ID rear flange of No. 1 bearing housing assembly.

CAUTION: IF PETROLATUM IS APPLIED TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM

(b) Install a new preformed packing (lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum) into the ring groove at the OD of the No. 1 bearing seal assembly.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(c) Chill No. bearing seal assembly and install seal assembly to seat on flange, carbon face down. Position assembly over aligning pins and align offset hole in seal assembly with offset hole in housing.

(d) Tap seal to seat, then install work bolts to secure seal assembly. Remove work bolts.

(2) Install No. 1 bearing air sealing ring.

NOTE: Ensure that PWA 45551 Aligning Pins are still in place.

(a) Place No. 1 bearing air sealing ring in oven and heat at 250°F (121°C) for ten minutes.

(b) Install a new preformed packing (lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum) into the ring groove at the OD of the No. 1 bearing housing assembly.

(c) Remove No. 1 bearing sealing ring from oven and install flange end down to seat on No. 1 bearing seal assembly. Align offset holes in sealing ring with offset holes in No. 1 bearing support. Tap to seat.

(d) Using 3/16 inch (5 mm) wrench on flats of PWA 45551 Aligning Pins, remove pins.

(e) Install bolts and torque.

C. Postrequisites

(1) Install compressor inlet group (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-02, PAGEBLOCK 72-23-02/401).

(2) Install N1 tachometer generator (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201).

(3) Install nose cowl (NOSE COWL, SUBJECT 71-10-01, Page 201).

Table 401

Key to Figure 401

Index No.	Nomenclature
1	Preformed Packing
2	No. 1 Bearing Elbow
3	Machine Bolt
4	Transfer Tube
5	Preform Packing
6	No. 1 Bearing Housing Assembly
7	Preform packing
8	No. 1 Bearing Seal Assemly
9	Machine Bolt
10	No. 1 Bearing Sealing Ring
11	Preform Packing
12	No. 1 Bearing Support
13	Machine Bolt
14	Compressor Inlet Duct Assembly
15	Inlet Case Positioning Plate
16	Plug
17	No.1 Bearing Tube Connector Assembly
18	Plug

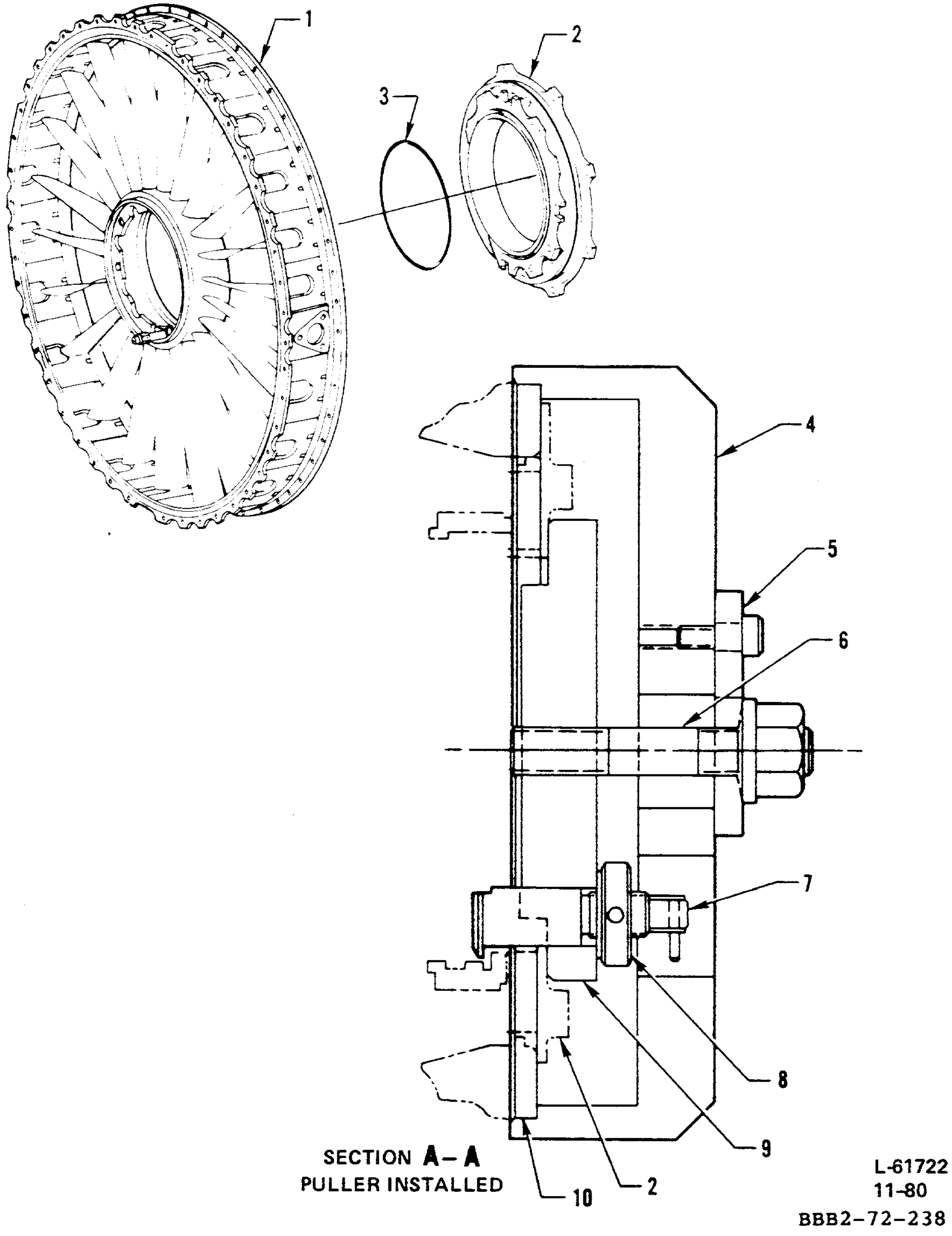
Table 402

Key to Figure 402

Index No.	Nomenclature
1	Inlet Case
2	Bolt
3	No.1 Bearing Airsealing Ring
4	Packing
5	Jaw (Tilt As Shown To Fit Behind Airsealing Ring)
6	No. 1 Bearing Seal
7	Jackscrew
8	Locator
9	Jaw Nut (Tighten When Jaws Are In Place)

Table 403

Key to Figure 403	
Index No.	**Nomenclature**
1	Inlet Case
2	No. 1 Bearing Seal
3	Packing
4	Body
5	Swing Washer
6	Stud
7	Clamp (Four)
8	Knurled Nut (Four)
9	Plate
10	No. 1 Bearing Housing Assembly



No. 1 Bearing Seal Removal
Figure 403/72-23-03-990-803

FAN INLET CASE - REPAIR-01

1. Fan Inlet Case Crack Repair

A. Equipment And Materials Required

  (1) Support Equipment - None

  (2) Consumables - None

B. Procedure

CAUTION: PRIOR TO STOP-DRILLING CRACKS, REVIEW GUIDELINES.

  (1) Do a review of the guidelines before stop-drilling cracks. ENGINE GENERAL, SUBJECT 72-00-00, Page 601.

  (2) Use dye check inspection to establish ends of crack.

  (3) Stop-drill just ahead of end of crack with 3/32 inch (2.38 mm) drill.

    (a) Use a new drill for each hole.

    (b) Avoid excessive force on drill to prevent burrs on inner surface as drill breaks through.

    (c) Keep drill speed below 1100 rpm.

  (4) Finished hole must be of good quality (no external burrs, ragged or sharp edges permissible).

  (5) After stop-drilling crack repeat dye check inspection to verify that crack does not extend beyond hole.

  (6) Following stop-drilling procedure, inlet case may be continued-in-service providing guidelines in ENGINE GENERAL, SUBJECT 72-00-00, Page 601, are observed.

FRONT COMPRESSOR SECTION - DESCRIPTION

1. Front Compressor Rotor And Stator Assembly

The front compressor rotor and stator assembly consists of a seven stage front compressor rotor and the stator stages through stage five. The 6th stage vanes are an integral part of the compressor intermediate case. (COMPRESSOR INTERMEDIATE SECTION - DESCRIPTION, PAGEBLOCK 72-34-00/001)

The numbering of the front compressor stages is one through 6, with a 1.5 stage following the 1st stage so that the total of the stages is seven. This is done so that the numbering of the stages in the rear compressor, which is derived from other JT8D engine models having a six stage front compressor, can remain the same. The 1st stage blades are considerably larger than the following stages and are used to accelerate air for fan bypass as well as for the primary gaspath; these 1st stage compressor blades are also referred to as "fan blades".

2. Front Compressor Rotor

The front compressor rotor consists of a front hub (which also serves as the 1st stage compressor disk), a rear hub (which also serves as the 4th stage disk), and the three additional rotor disks, spaced away from each other by integral spacing flanges on the 1.5, 3rd, and 5th stage disks. Tiebolts secure disk mating surfaces together, and each disk is fitted with blades in dovetail-shaped slots. Airsealing between each disk and blade stage and its adjacent stators is accomplished by knife-edge seals on the disks which rotate inside matching stator seal rings.

3. Front Compressor Stators

The stators consist of vanes held stationary in the gaspath by inner seal rings and outer shroud structures. The vanes turn the air accelerated by the previous blade stage and direct the air into the succeeding blade stage at the proper angle. The stator shrouds, when bolted together, form the outer support structure of the front compressor.

4. Front Compressor Coupling

The front compressor is driven by the front compressor drive turbine and is connected to the front compressor drive turbine shaft at the rear hub by a turbine shaft coupling. (COMPRESSOR INTERMEDIATE SECTION - DESCRIPTION, PAGEBLOCK 72-34-00/001)

FRONT COMPRESSOR SECTION - INSPECTION/CHECK

1. General

A. This procedure contains MSG-3 task card data.

TASK 72-33-00-211-801

2. Detailed Inspection of the Visible Parts of the Fan Blades

A. Detailed Inspection of the Visible Parts of the Fan Blades

SUBTASK 72-33-00-211-001

(1) Do a detailed inspection of the visible parts of the fan blades.

(a) Inspect the visible parts of the engine compressor section fan blades.

END OF TASK

FRONT COMPRESSOR GROUP - REMOVAL/INSTALLATION-01

1. Remove 1st Stage Compressor Disk And Blades Assembly

A. Prerequisites

(1) Remove nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)

(2) Remove N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Remove compressor inlet group. (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-02, PAGEBLOCK 72-23-02/401)

B. Equipment And Materials Required

(1) Support Equipment

PWA 45005 Eye

PWA 45007 Puller

PWA 45126 Pusher

PWA 45128 Protector

PWA 45129 Protector (Replaced by PWA 45547-1)

PWA 45333 Sling

PWA 45532 Adapter

PWA 45547-1 Protector (Replaces PWA 45129)

(2) Consumables

Shim Stock

C. Procedure. See Figure 401 through Figure 403.

(1) Remove shims from between tips of 1st stage blades and rear fan case wall.

CAUTION: TAKE CARE TO PREVENT DAMAGE TO FIRST STAGE AIRSEAL WHEN INSTALLING OR REMOVING TIEROD NUT WRENCH.

(2) Remove tierod nuts using standard wrench and remove washers. Use PWA 45532 Adapter in spline of hub, with bar through adapter holes, for counterforce.

(3) Remove 1st stage airseal using PWA 45007 Puller as follows:

CAUTION: MARK AIRSEAL RADIAL POSITION IN RELATION TO HUB AND TO ROTOR TO ENSURE REINSTALLATION OF AIRSEAL WITH BALANCE WEIGHTS IN PROPER POSITION. MARK HUB IN RELATION TO AIRSEAL AND ROTOR IF SAME HUB IS TO BE REINSTALLED.

(a) Remove protector from 1st stage airseal.

(b) Loosen detail clamp and install on seal with detail block behind seal and detail clamp third knife-edge. Tighten clamp with hand knob.

(c) Using knocker action remove seal, moving puller around seal to ensure seal is removed evenly.

NOTE: Reinstall PWA 45128 Protector on 1st stage airseal after airseal has been removed from hub.

(4) Remove 1st stage hub and blades assembly as follows:

(a) Position PWA 45126 Pusher over hub so three legs on large diameter ring are against front face of hub between tierods, and detail large dowel pin is at approximately 12 o'clock position.

(b) Install PWA 45333 Sling on hub and engage hole in upright with dowel pin in pusher.

(c) Attach hoist from overhead beam to sling at middle hole of sling.

(d) Thread PWA 45005 Eye on hub to secure sling and pusher.

(e) Thread in six (6) detail rods in pusher spacing rods equally 60 degrees apart, at locations where there are no counterweights in disk holes.

CAUTION: BE CAREFUL TO HOLD HUB AND BLADES ASSEMBLY LEVEL WHILE REMOVING ASSEMBLY FROM ENGINE. AIR SEALING SURFACE ON 1ST STAGE COMPRESSOR STATOR MAY BE DAMAGED BY HUB SEAL IF ASSEMBLY IS TILTED DURING REMOVAL.

(f) Jack out hub and blades assembly using detail rods and withdraw assembly from engine.

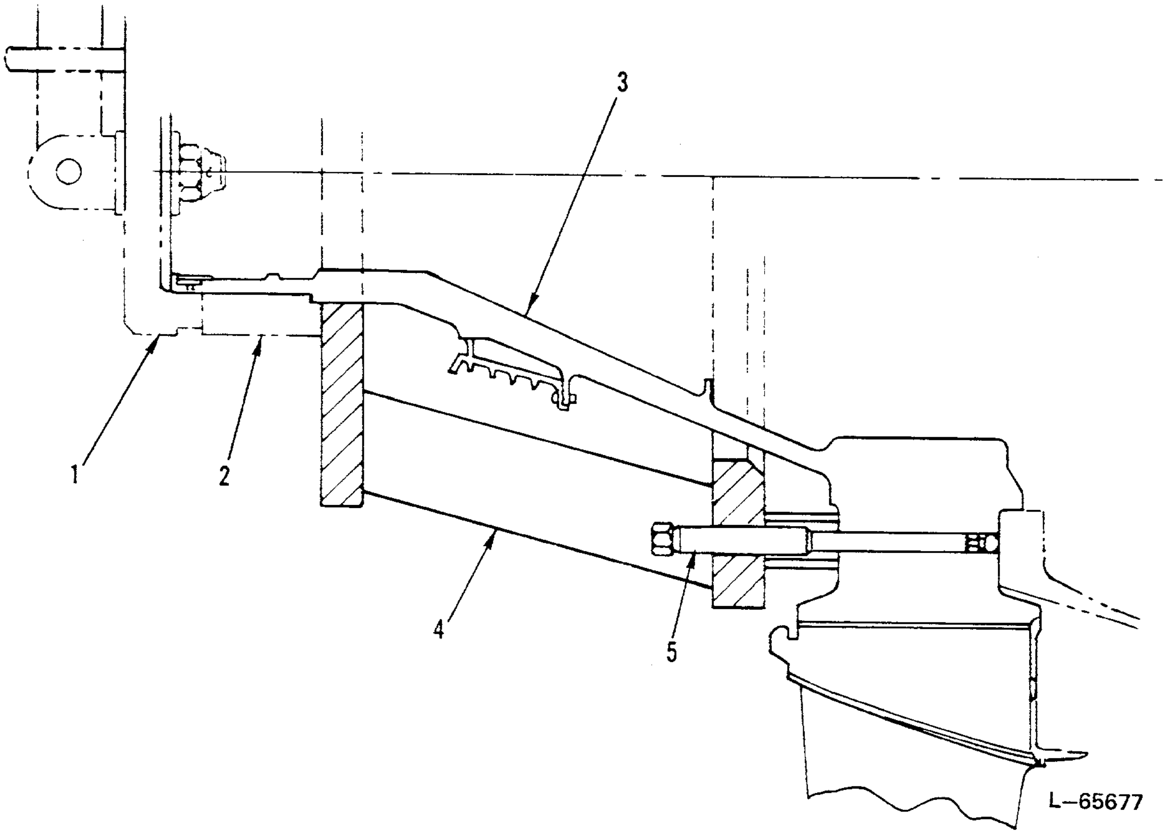
(g) Attach second hoist to link of PWA 45005 Eye and trunnion assembly to rear end down position.

(5) Place PWA 45547-1 (formerly PWA 45129) Protector on duct airseal.

NOTE: Ensure that protector is in place on hub 1st stage airseal.

CAUTION: POSITION BLOCKS OR SUPPORTS UNDER HUB REAR SURFACE SO THAT DUCT AIRSEAL IS NOT DAMAGED WHEN HUB IS LOWERED ONTO PALLET OR BENCH.

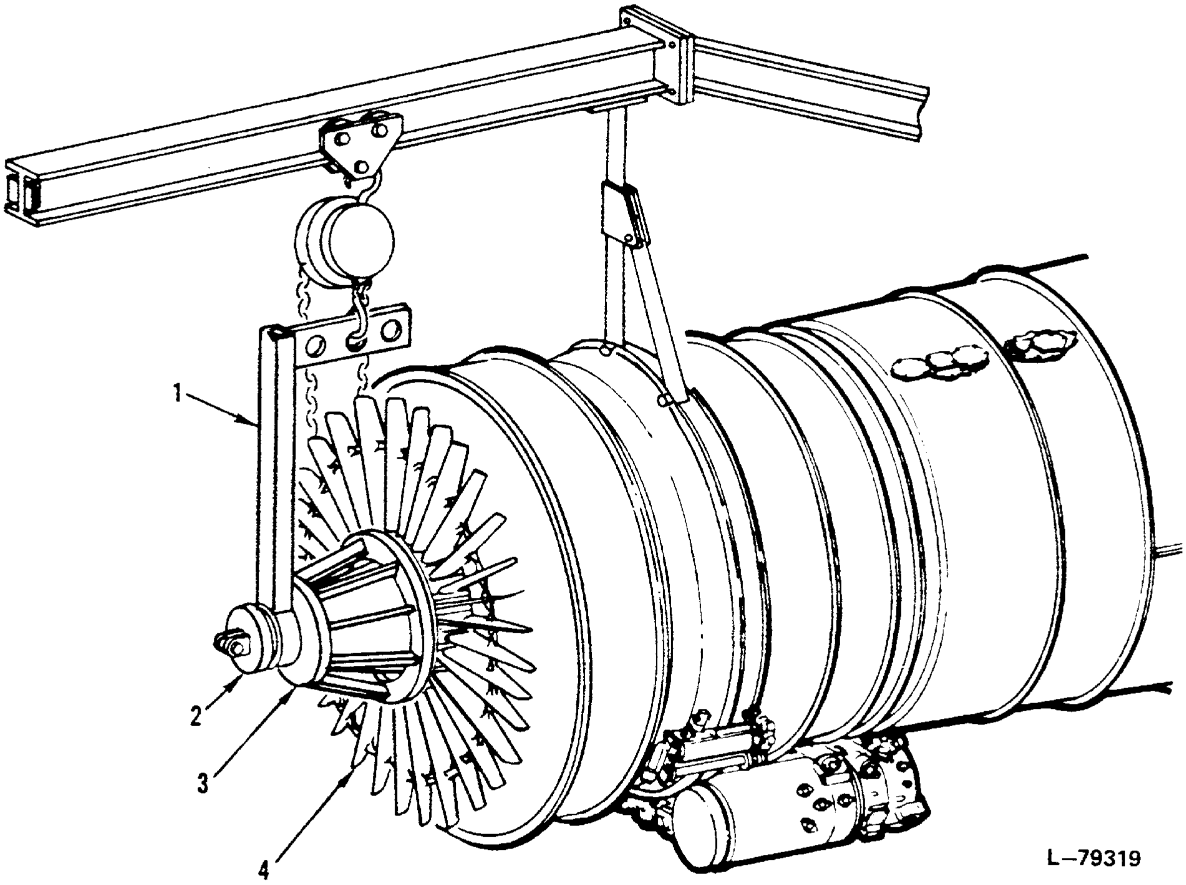
(6) Place hub and blades assembly onto pallet or bench.



1. PWA 45005 Eye
2. PWA 45333 Sling
3. Hub
4. PWA 45126 Pusher
5. Jackscrew (Use Empty Counterweight Holes Between Tierods)

BBB2-72-239

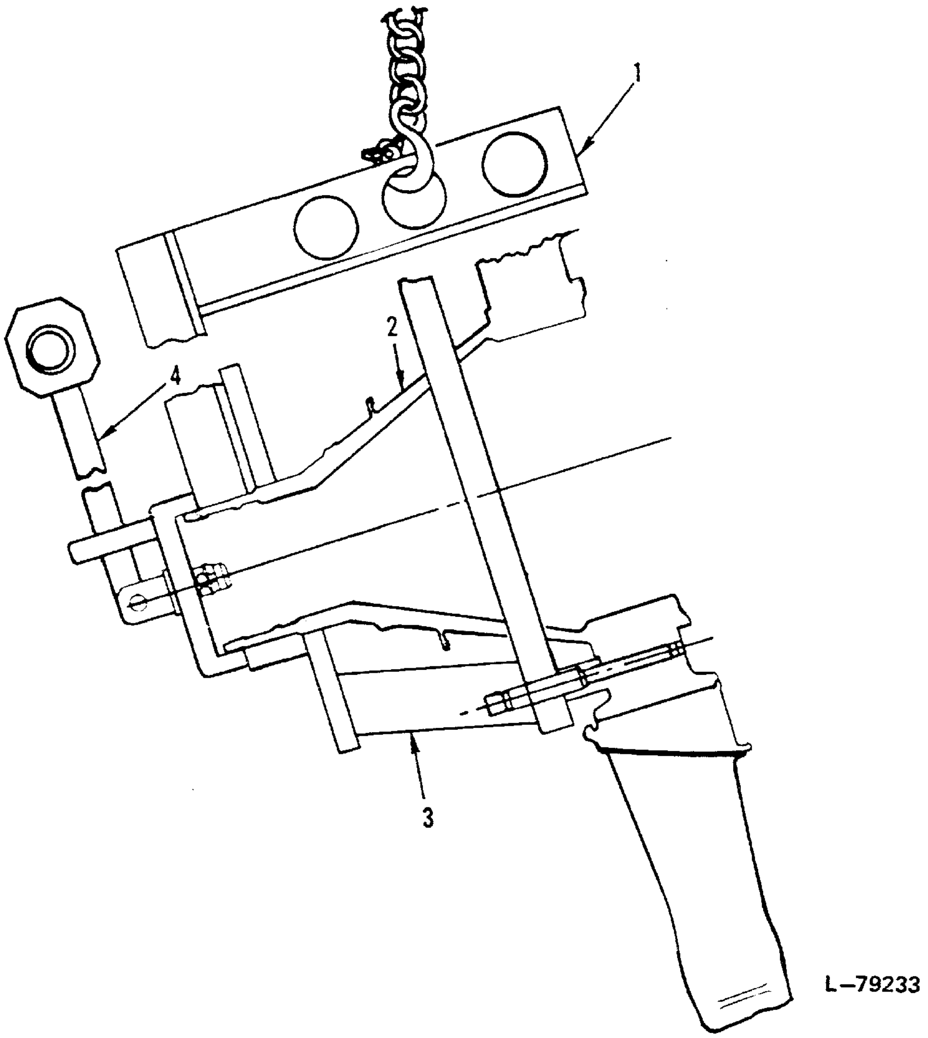
Pusher Installed On First Stage Compressor Disk And Blades
Figure 401/72-33-02-990-801



1. PWA 45333 Sling
2. PWA 45005 Eye
3. PWA 45126 Pusher
4. Hub And Blades Assembly

BBB2-72-240

First Stage Compressor Disk And Blades Removal
Figure 402/72-33-02-990-802



1. PWA 45333 Sling
2. Hub And Blades Assembly
3. PWA 45126 Pusher
4. PWA 45005 Eye

BBB2-72-241

Trunnioning Disk And Blades To Vertical Position
Figure 403/72-33-02-990-803

2. Install 1st Stage Compressor Disk And Blades Assembly

NOTE: After hub and blades assembly has been removed, inspect 1st stage compressor stator vanes and 1.5 stage compressor rotor blades. (ENGINE GENERAL, SUBJECT 72-00-00, Page 601)

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 25672 Control (Replaced by PWA 29754)

PWA 29754 Control (Replaces PWA 25672)

PWA 45005 Eye

PWA 45203 Wrench

PWA 45333 Sling

PWA 46049 Heater

PWA 45532 Adapter

(2) Consumables

Anti-Seize Paste (PWA 36246)

B. Procedure. See Figure 404 and Figure 405.

(1) Position PWA 46049 heater on front flange of 1.5 stage disk and secure temporarily using spacer and nut on top center tierod. Connect PWA 29754 Heater Control (formerly PWA 25672) and heat disk flange.

NOTE: Heater shall obtain 125°F (69.5°C) temperature differential between 1.5 stage disk and hub. Disk temperature must not exceed 300°F (148.9°C).

(2) Install PWA 45333 Sling on hub and thread PWA 45005 Eye on hub threads to secure sling.

(3) Attach hoist from overhead beam to sling. Attach second hoist to PWA 45005 Eye.

(4) Lift and trunnion hub and blades assembly to flight position. Remove hoist from PWA 45005 Eye. Remove lifting link from PWA 45005 Eye. See Figure 404.

NOTE: Ensure that multi-knife-edge seal rearward of bearing journal is protected by PWA 45130 Protector while handling hub and blades.

(5) Remove heater from 1.5 stage disk.

CAUTION: BE CAREFUL TO HOLD HUB AND BLADES ASSEMBLY LEVEL WHILE INSTALLING ASSEMBLY IN ENGINE. AIR SEALING SURFACE ON 1ST STAGE COMPRESSOR STATOR MAY BE DAMAGED BY HUB SEAL IF ASSEMBLY IS TILTED DURING INSTALLATION.

(6) Position hub and blades assembly in front of rotor, aligning tierods in 1.5 stage disk with tierod holes in hub. Remove PWA 45129 Protector from 1st stage compressor duct on rear of hub. Slide hub assembly over tierods and seat against 1.5 stage disk using four tierod nuts and spacers equally spaced. Tighten nuts evenly in pairs until hub is seated. Remove sling and lifting eye. See Figure 405.

(7) At each of four tierod locations used to draw hub into position, treat spacer and threads of tierod and nut with wet anti-seize paste (PWA 36246) and remove unwanted paste. Remove tierod nuts and spacers after hub is seated.

(8) Remove PWA 45128 Protector from 1st stage airseal, align reference marks (if applicable) and seat airseal on hub.

(9) Treat tierod threads, nuts and spacers with anti-seize paste (PWA 36246) (omit bake and surface preparation requirements) and remove unwanted paste.

(10) Install nuts and spacers onto tierods.

(11) Install tools and torque tierod nuts as follows:

CAUTION: WHEN INSTALLING PWA 45203 WRENCH, MOVE DETAIL SOCKETS INBOARD TO AVOID DAMAGE TO 1ST STAGE AIRSEALS.

(a) Install PWA 45203 Wrench over tierods and clamp wrench to front lip of 1st stage compressor airseal. Use standard 1/2 inch drive torque wrench to turn wrench sockets.

(b) Install PWA 45532 Adapter in spline of hub and use bar through holes in adapter for counterforce while torquing tierod nuts.

(c) Torque tierod nuts as follows:

1) Torque two pairs (four tierod nuts) approximately 90 degrees apart to seating torque of 520 - 530 lb-in. (58.752 - 59.882 N·m). If desired, torque tierod nuts in sequence shown in Figure 406.

NOTE: Throughout tierod nut torquing procedure, each pair of tierod nuts shall be torqued simultaneously. When two pairs (four nuts) are to be torqued, torque one pair of tierod nuts simultaneously, then torque remaining pair of tierod nuts simultaneously.

2) Torque two more pairs approximately 45 degrees from first set to seating torque of 520 - 530 lb-in. (58.752 - 59.882 N·m).

3) Torque remaining tierod nuts in sets of two pairs approximately 90 degrees apart to seating torque of 520 - 530 lb-in. (58.752 - 59.882 N·m).

4) Reapply seating torque of 520 - 530 lb-in. (58.752 - 59.882 N·m) in same sequence until no further rotation of tierod nuts occurs.

5) After applying seating torque to tierod nuts, loosen one pair of tierods and with a maximum temperature differential of 40°F (22.2°C) between mating parts seat nut to stack by torquing pair of tierod nuts to 100 - 150 lb-in. (11.298 - 16.948 N·m).

6) Loosen detail set screws in indicator assemblies of PWA 45203 Wrench. Align zero on degree plate with scribe line on base and secure in position with set screws.

CAUTION: WHILE APPLYING ANGLE OF TURN, STOP PROCEDURE AND CHECK PARTS FOR POSITION OR DAMAGE IF TIEROD NUTS CANNOT BE TURNED THROUGH REQUIRED ANGLE WITHOUT EXCEEDING TORQUE LIMITS.

7) Apply 157 - 161 degrees angle of turn to tierod nuts and check that during angle of turn torque is 850 - 1950 lb-in. (96.036 - 220.319 N·m).

8) Torque and apply angle of turn on remaining pairs of tierod nuts in same sequence as for seating torque.

9) Remove wrench and hub adapter.

(12) Insert shims between tips of 1st stage compressor blades and rear fan case wall to centralize front compressor rotor.

NOTE: Centralize rotor with shims as carefully as possible to facilitate subsequent bearing installation.

C. Postrequisites

(1) Install compressor inlet group. (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-02, PAGEBLOCK 72-23-02/401)

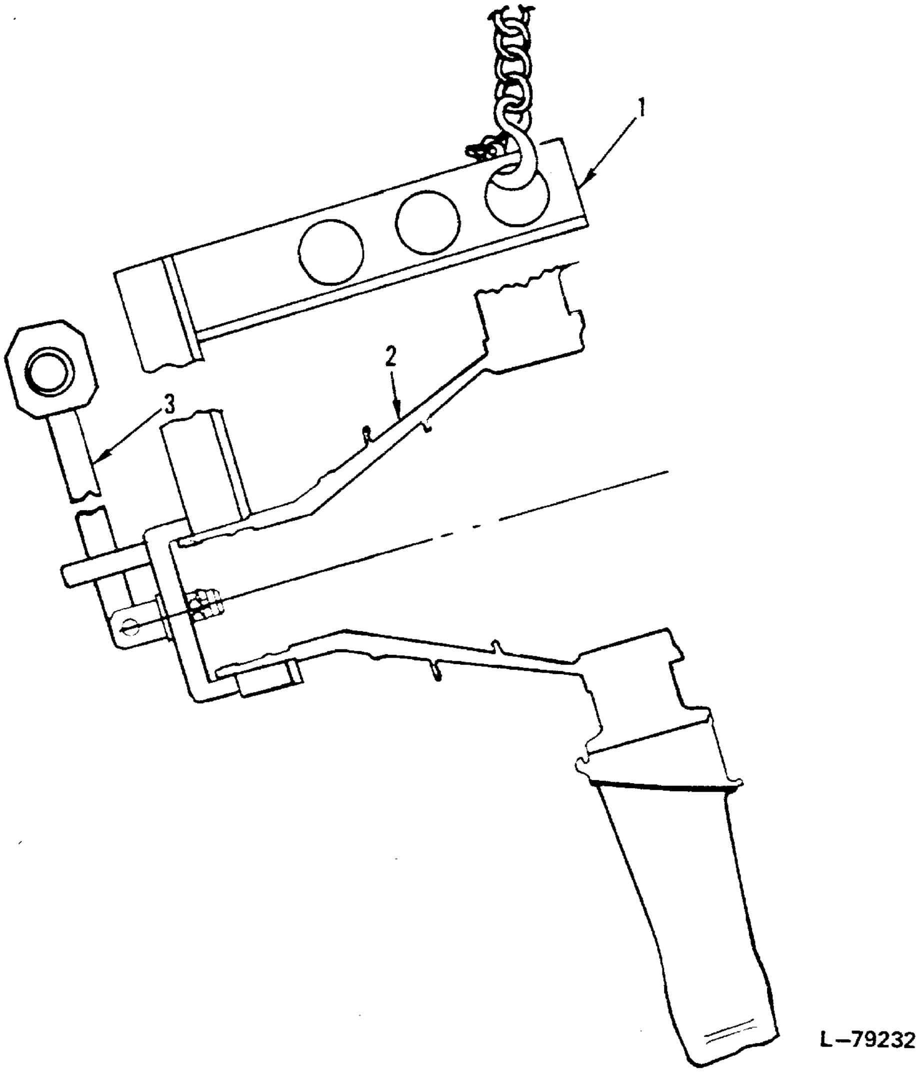
(2) Do test G, engine breather pressure check. (ENGINE GENERAL, SUBJECT 72-00-00, Page 501)

(a) If necessary, it is permitted to operate the engine for up to 24 flight hours before the breather pressure check is done. This will permit the aircraft to fly to a maintenance base that can do the breather pressure check.

(3) Do test I, engine vibration check. (ENGINE GENERAL, SUBJECT 72-00-00, Page 501)

(a) If necessary, it is permitted to operate the engine for up to 24 flight hours before the vibration check is done. This will permit the aircraft to fly to a maintenance base that can do the vibration check.

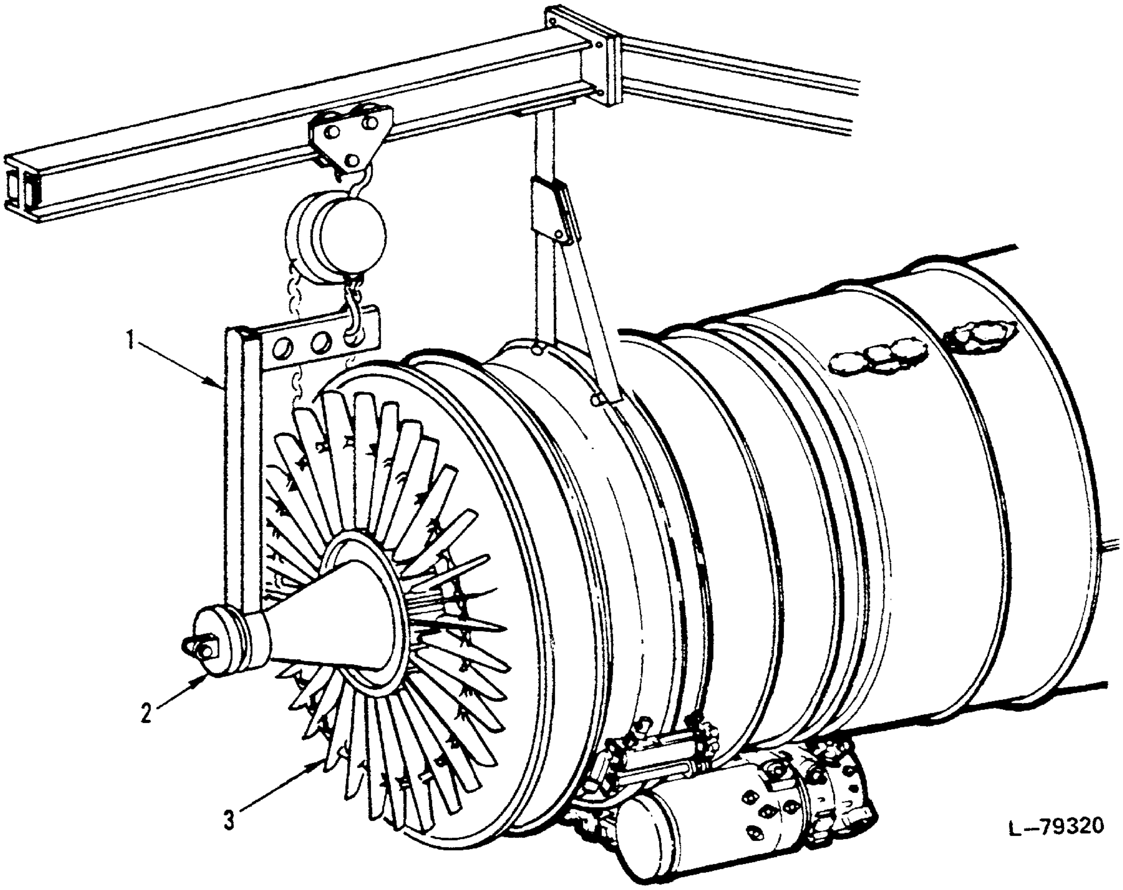
(b) The above 24 hour flyback limit is only for aircraft that do not have engine vibration monitor equipment available (either cockpit installed or available on the ground).



1. PWA 45333 Sling
2. Hub And Blades Assembly
3. PWA 45005 Eye

BBB2-72-242

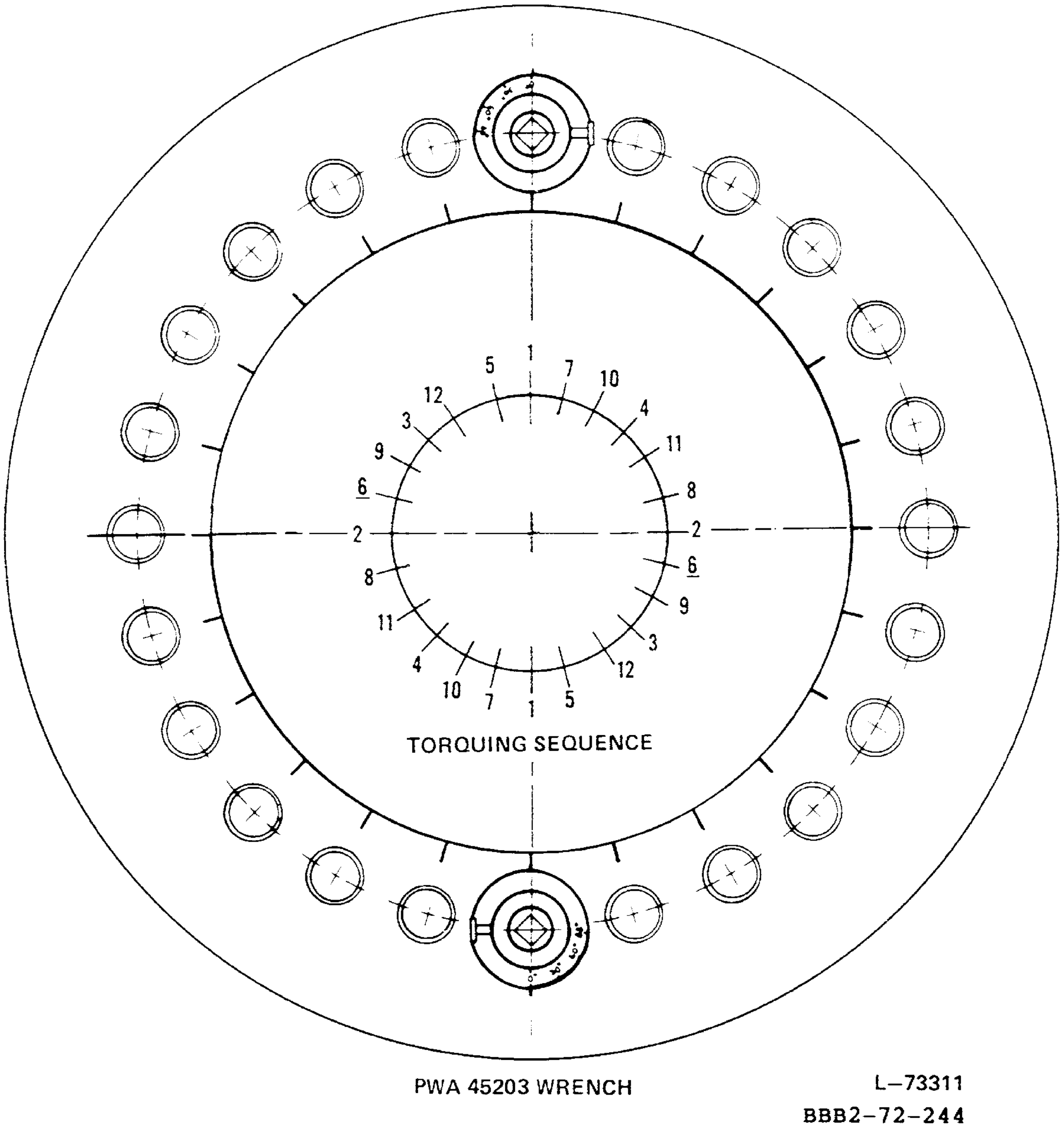
Trunnioning Disk And Blades To Horizontal Position
Figure 404/72-33-02-990-804



1. PWA 45333 Sling
2. PWA 45005 Eye
3. Hub And Blades Assembly

BBB2-72-243

First Stage Compressor Disk And Blades Installation
Figure 405/72-33-02-990-805



PWA 45203 Torque Wrench And Torquing Sequence
Figure 406/72-33-02-990-806

FRONT COMPRESSOR GROUP - REMOVAL/INSTALLATION

1. General

A. This procedure contains MSG-3 task card data.

TASK 72-33-02-901-801

2. Discard the Rotor

A. Discard the Rotor

SUBTASK 72-33-02-901-001

(1) Discard left and/or right engine compressor rotor per manufacturer's life limits.

——— END OF TASK ———

COMPRESSOR BLADES, FIRST STAGE - REMOVAL/INSTALLATION-01

1. Replace 1st Stage Compressor Blades

A. Prerequisites

(1) Remove nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)

(2) Remove N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Remove compressor inlet group. (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-02, PAGEBLOCK 72-23-02/401)

B. Equipment And Materials Required

(1) Support Equipment

PWA 45007 Puller

PWA 45203 Wrench

PWA 45532 Adapter

(2) Consumable

Shim Stock

C. Procedure. (Figure 401)

(1) Remove shims from between tips of 1st stage blades and rear fan case wall.

CAUTION: TAKE CARE TO PREVENT DAMAGE TO FIRST STAGE AIRSEAL WHEN INSTALLING OR REMOVING TIE-ROD NUT WRENCH.

(2) Remove tie-rod nuts using standard wrench and remove spacers. Use PWA 45532 Adapter in spline of hub, with bar through adapter holes, for counter-force.

CAUTION: MARK AIRSEAL RADIAL POSITION IN RELATION TO HUB AND TO ROTOR TO ENSURE REINSTALLATION OF AIRSEAL WITH BALANCE WEIGHTS IN PROPER POSITION.

(3) Remove 1st stage airseal using PWA 45007 Puller as follows:

(a) Remove protector from 1st stage airseal.

(b) Loosen detail clamp and install on seal with detail block behind seal and detail clamp behind third knife-edge. Tighten clamp with hand knob.

(c) Using knocker action remove seal, moving puller around seal to ensure seal is removed evenly.

NOTE: Reinstall protector on 1st stage airseal after airseal has been removed from hub.

(4) Install tie-rod nuts and spacers on four equally spaced tie-rods to hold hub in place. Use work washers under spacers to protect hub surface.

(5) Remove blade lock from groove on front of hub.

(6) Move all 1st stage compressor blades forward in small increments, one at a time, until blades have moved approximately 70 percent of their root engagement length.

(7) When blades are positioned sufficiently far forward to permit blade removal, remove blade to be replaced.

(8) Remove blade diametrically opposite (180 degrees) from blade being replaced.

(9) Install moment-weight matched set of blades into diametrically opposite blade slots.

NOTE: A pair of blades must be within 0.6 oz-in (432 g.mm) of each other. Moment-weight value of each new or overhauled blade is marked on concave side of airfoil between mid-span shroud and tip.

CAUTION: USE MINIMUM NECESSARY FORCE WHEN INSTALLING BLADES TO AVOID OVERSTRESSING BLADE SHROUDS.

(10) Using suitable soft drift and mallet, install blades by tapping evenly on blade roots in circular pattern around hub rim until blades contact 1st stage compressor duct at rear of hub and blade lock slots in blades and hub are aligned.

(11) Install blade lock . Measure inner diameter as shown. Indicated minimum dimension will ensure proper seating of lock.

(12) Remove tie-rod nuts and work washers.

(13) Remove PWA 45128 Protector from 1st stage airseal, align reference marks (if applicable) and seat airseal on hub.

(14) Treat tie-rod threads, nuts and spacers with antigalling compound (omit bake and surface preparation requirements).

(15) Install nuts and spacers onto tie-rods.

(16) Install tools and torque tie-rod nuts as follows:

CAUTION: WHEN INSTALLING PWA 45023 WRENCH, MOVE DETAIL SOCKETS INBOARD TO AVOID DAMAGE TO 1ST STAGE AIRSEALS.

(a) Install PWA 45203 Wrench over tie-rods and clamp wrench to front lip of 1st stage compressor airseal. Use standard 1/2 inch drive torque wrench to turn wrench sockets.

(b) Install PWA 45532 Adapter in spline of hub and use bar through holes in adapter for counter-force while torquing tie-rod nuts.

(c) Torque tie-rod nuts as follows:

1) Torque two pairs (four tie-rod nuts) approximately 90 degrees apart to seating torque of 520 - 530 lb-in. (58.752 - 59.882 N·m).

NOTE: Throughout tie-rod nut torquing procedure, each pair of tie-rod nuts shall be torqued simultaneously. When two pairs (four nuts) are to be torqued, torque one pair of tie-rod nuts simultaneously, then torque remaining pair of tie-rod nuts simultaneously. If desired, torque tie-rod nuts in sequence shown in Figure 402.

2) Torque two more pairs approximately 45 degrees from first set to seating torque of 520 - 530 lb-in (58.752 - 59.882 N·m).

3) Torque remaining tie-rod nuts in sets of two pairs approximately 90 degrees apart to seating torque of 520 - 530 lb-in (58.752 - 59.882 N·m).

4) Reapply seating torque of 520 - 530 lb-in. (58.752 - 59.882 N·m) in same sequence until no further rotation of tie-rod nuts occurs.

5) After applying seating torque to tie-rod nuts, loosen one pair of tie-rods and with a maximum temperature differential of 40°F (22.2°C) between mating parts seat nut to stack by torquing pair of tie-rod nuts to 100 - 150 lb-in. (11.298 - 16.948 N·m).

6) Loosen detail set screws in indicator assemblies of PWA 45203 Wrench. Align zero on degree plate with scribe line on base and secure in position with set screws.

CAUTION: WHILE APPLYING ANGLE OF TURN, STOP PROCEDURE AND CHECK PARTS FOR POSITION OR DAMAGE IF TIE-ROD NUTS CANNOT BE TURNED THROUGH REQUIRED ANGLE WITHOUT EXCEEDING TORQUE LIMITS.

7) Apply 157 - 161 degrees angle of turn of tie-rod nuts and check that during angle of turn torque is 850 - 1950 lb-in. (96.036 - 220.319 N·m).

8) Torque and apply angle of turn on remaining pairs of tie-rod nuts in same sequence as for seating torque.

9) Remove wrench and hub adapter.

(17) Insert shims between tips of 1st stage compressor blades and rear fan case wall to centralize front compressor rotor.

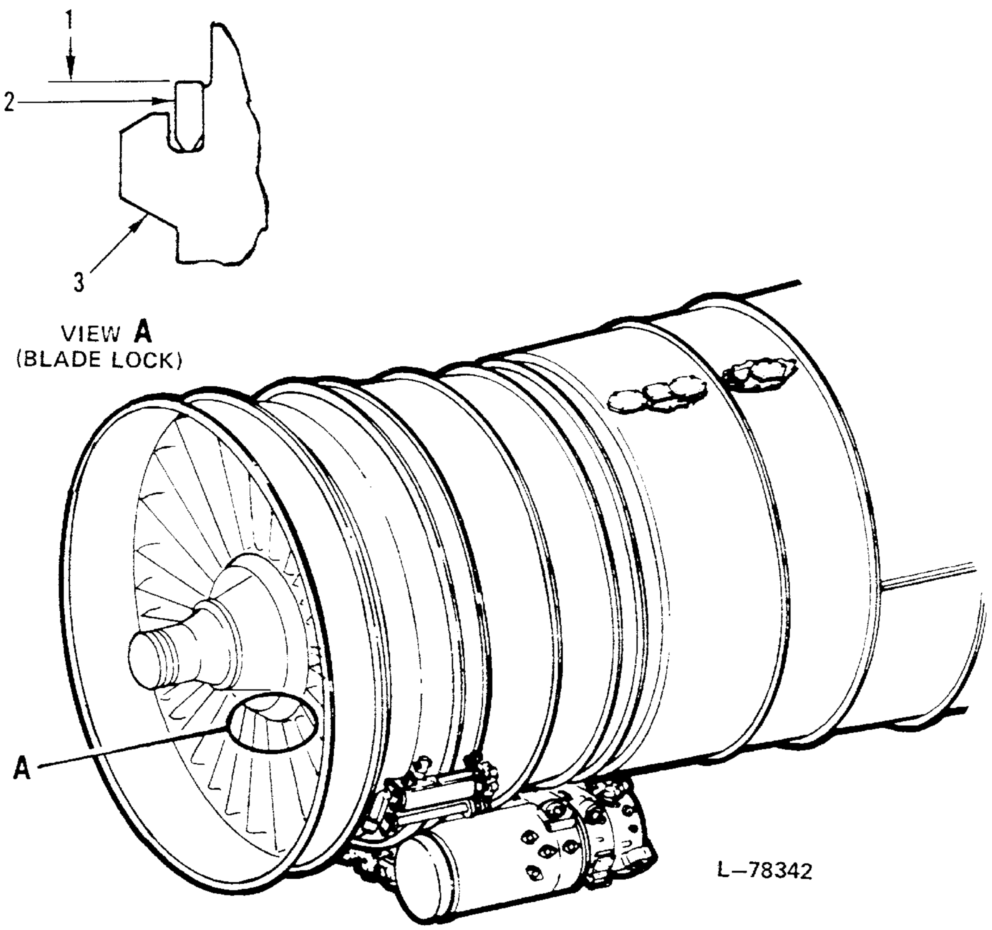
NOTE: Centralize rotor with shims as carefully as possible to facilitate subsequent bearing installation.

D. Postrequisites

(1) Install compressor inlet group. (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-23-01/401)

(2) Install N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

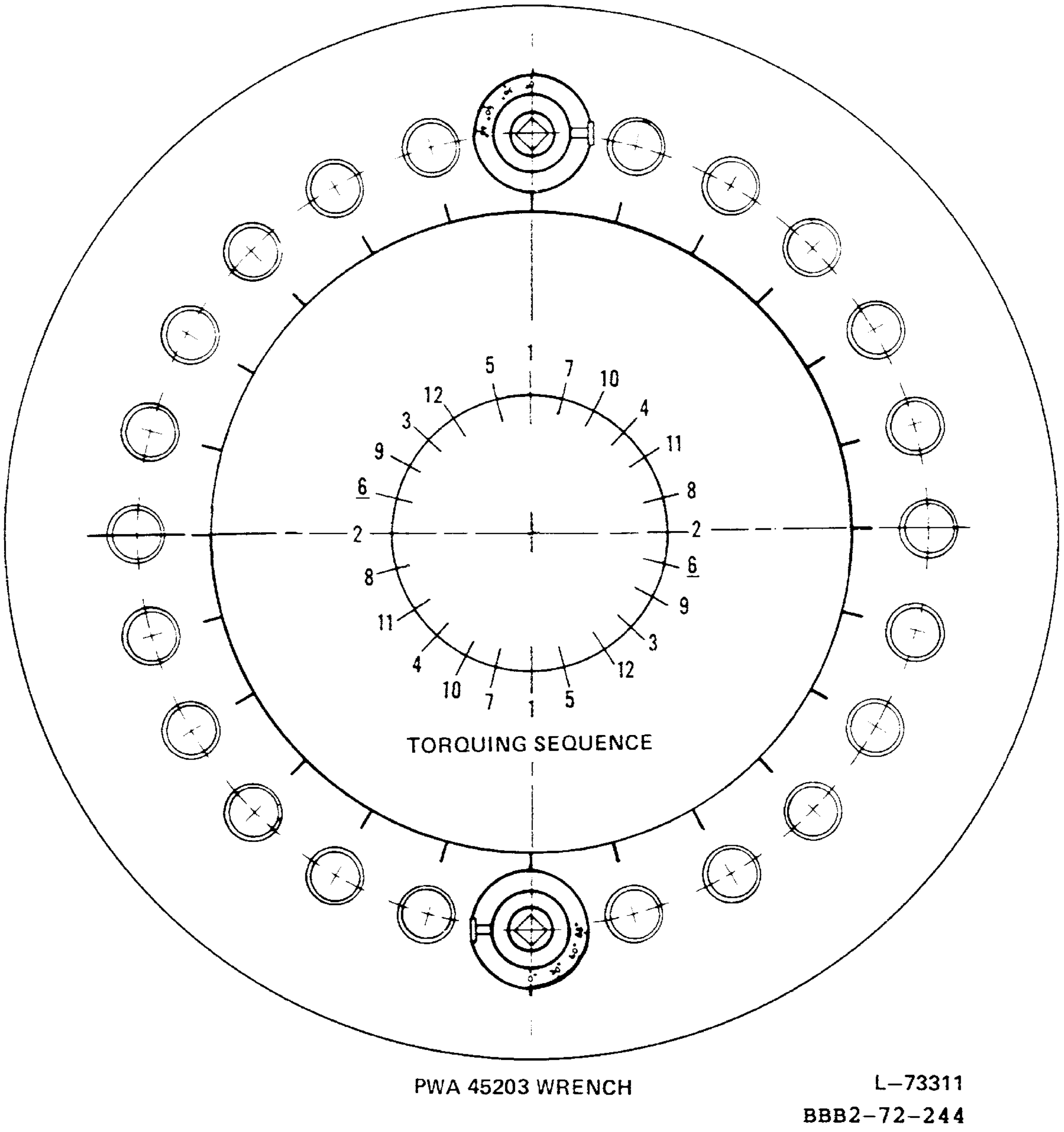
(3) Install nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)



1. 16.900 Inches (429.260 mm) Diameter Minimum After Lock Is Installed (See Text).
2. Blade Lock
3. First Stage Compressor Hub

BBB2-72-245

First Stage Compressor Blade Lock Positioning Check
Figure 401/72-33-21-990-801



PWA 45203 Torque Wrench And Torquing Sequence
Figure 402/72-33-21-990-803

COMPRESSOR BLADES, FIRST STAGE - REPAIR-01

1. Repair 1st Stage Compressor Blade Minor Damage By Blending

A. Equipment and Materials Required

(1) Support Equipment - None.

(2) Consumables - None.

B. Procedure. (Figure 801)

NOTE: Make note in engine records that blend repaired blades shall be bead peened per engine manual instructions, the next time blades are accessible in shop.

Blends must remove only enough material necessary to eliminate damage, while complying with contour and dimensional requirements. Area to be blended with power tool must be completely masked to ensure no metal splatter or sparks can strike repair blade, other blades, or hub surfaces. When power tools are used, a minimum of 0.060 inch (1.524 mm) of material must remain for hand filing and polishing to ensure removal of any heat-affected area.

Impact damage in excess of 0.020 inch (0.51 mm) depth located between blade platform and blade part span shroud requires borescope inspection of 6th and 7th stage compressor blades per ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1.

CAUTION: AREA TO BE BLENDED WITH POWER TOOL MUST BE COMPLETELY MASKED TO ENSURE NO METAL SPLATTER OR SPARKS CAN STRIKE REPAIR BLADE, OTHER BLADES, OR HUB SURFACES.

(1) When power tools are used, a minimum of 0.060 inch (1.524 mm) of material must remain for hand filing and polishing to ensure removal of any heat-affected area.

(2) Total blended length on an edge shall not be in excess of 1/3 total edge length.

(3) Any pair of blends on leading and trailing edges must not be directly opposite and must be such that shortest straight line between them is not less than blade chord lengths at an undamaged span section midway between blends. (Figure 801 (Sheet 1))

(4) Blends must comply with length/depth blend ratio for that area of blade.

(5) Not more than two (2) edge blends, to maximum limit, per blade edge. Additional blends to one-half (1/2) maximum limit permitted provided two-thirds (2/3) of total edge is unblended.

(6) In Area A, no unblended damage is allowed.

(7) Midspan shroud leading edge radius.

(a) Scattered pits in midspan shroud radius up to maximum depth of 0.017 inch (0.431 mm) may be removed by blending, provided airfoil thickness is not reduced. Radius of 0.422 - 0.453 inch (10.719 - 11.506 mm) and rounded edges should be maintained after blending.

Table 801

Key to Figure 801 (Sheet 2)	
Index No.	**Nomenclature**
1	1.250 Inch (31.75 mm) Radius
2	0.500 Inch (12.7 mm)
3	0.010 Inch (0.254 mm) Minimum Leading Edge Radius

Table 801 (Continued)

Key to Figure 801 (Sheet 2)	
Index No.	**Nomenclature**
4	0.008 Inch (0.203 mm) Minimum Trailing Edge Radius
5	4.350 Inches (110.49 mm)
6	3.750 Inches (95.25 mm)
7	0.015 Inch (0.381 mm) Minimum Trailing Edge Radius
8	2.200 Inches (55.88 mm)
9	1.000 Inch (25.40 mm)
10	2.800 Inches (71.12 mm)

(8) Examine the blades by SPOP 70 portable fluorescent penetrant (ultra-high sensitivity) after the blend repair is completed. See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201 for details of the SPOP 70 procedure. No crack indications are permitted. Time limits for fluorescent penetrant inspection are as follows:

NOTE: Make note in engine records that blend repaired blades shall be bead peened per engine manual instructions, the next time blades are accessible in shop.

(a) If the maintenance base at which the blend repair is done cannot do the fluorescent penetrant inspection:

1) Do the fluorescent penetrant inspection no more than 50 hours after the repair.

2) If no crack or tear was found in the blade material before blade blend repair, visual inspection is sufficient.

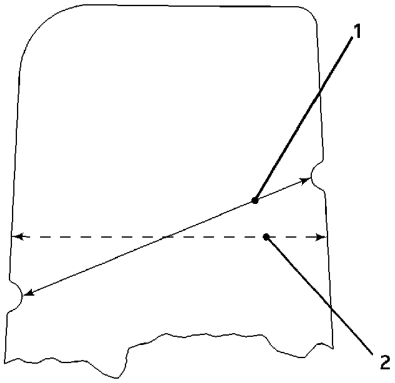
3) No repeated inspections are necessary.

(b) If the blend repair is done at a maintenance base which can do the fluorescent penetrant inspection:

1) If a crack or tear was found in the blade material before the blade blend repair, do a SPOP 70 fluorescent penetrant inspection of the blade immediately after the repair.

2) If no crack or tear was found in the blade material before blade blend repair, visual inspection is sufficient.

3) No repeated inspections are necessary.



1. EDGE BLEND SEPERATION TO BE EQUAL TO OR GREATER THAN MEAN CHORDAL LENGTH
2. MEAN CHORD LENGTH

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CAG(IGDS)

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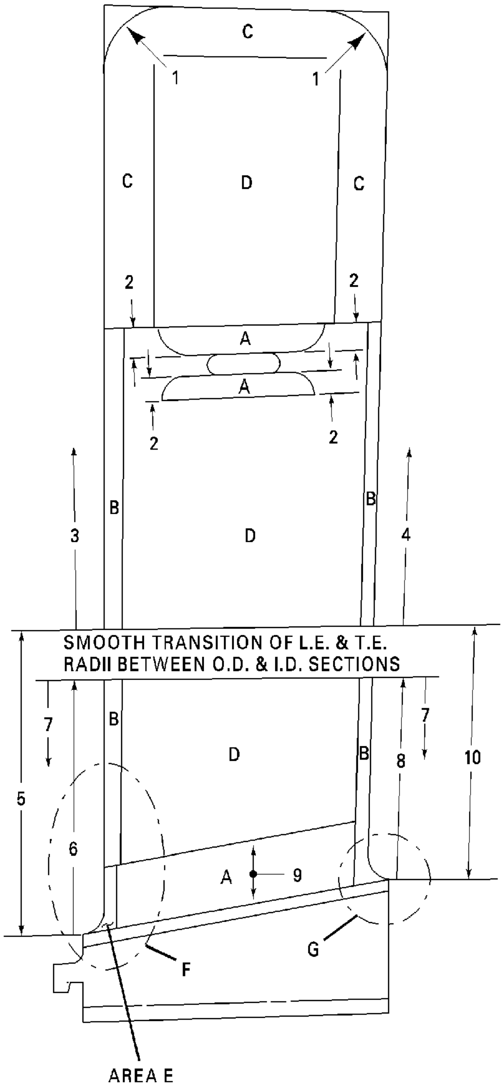
First Stage Compressor Blade Blending
Figure 801/72-33-21-990-804 (Sheet 1 of 3)

AREA	ACCEPTABLE DAMAGE LIMIT, EXCEPT NO TEARS OR CRACKS PERMISSIBLE INCHES (MILLIMETERS)	BLEND LIMITS INCHES (MILLIMETERS)	BLEND RATIO (LENGTH/DEPTH)
A	NONE		
B	0.005 (0.127)	1/8 D (3.175)	12/1
C	0.020 (0.508)	11/32 D (8.731)	6/1
D	0.010 (0.254)	0.040 RB (1.016)	6/1
E	0.003 (0.076)	0.040 D (1.016) SEE NOTES	12/1

RB– ROUND BOTTOM

D – DEPTH



NOTES:

BLADES BLENDED TO A DEPTH OF 0.020 INCH (0.508mm) OR LESS IN AREA E MAY BE CONTINUED IN SERVICE BUT MUST BE FLUORESCENT PENETRANT INSPECTED AT 500 HOUR INTERVALS.

BLADES BLENDED TO A DEPTH OF MORE THAN 0.020 INCH (0.508mm) BUT LESS THAN 0.040 INCH (1.016mm) IN AREA E MAY BE CONTINUED IN SERVICE FOR A MAXIMUM OF 24 HOURS. BLENDING MUST BE PERFORMED BEFORE NEXT FLIGHT.

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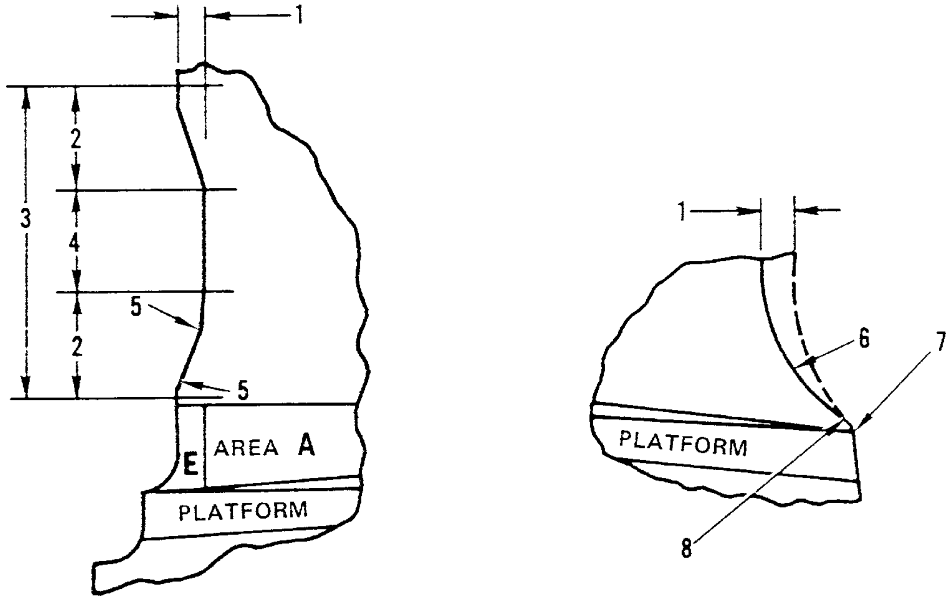
First Stage Compressor Blade Blending
Figure 801/72-33-21-990-804 (Sheet 2 of 3)



LEADING EDGE

VIEW F

TRAILING EDGE

VIEW G

1. 0.125 Inch (3.175 mm)
2. Length Four (4) Times Blend Depth
3. Length Twelve (12) Times Blend Depth
4. Flat Portion Of Blend. Length Four Times Blend Depth.
5. 0.750 Inch (19.05 mm) Minimum Radius
6. 0.297 - 0.328 Inch (7.544 - 8.331 mm) Radius
7. Terminate Blend Smoothly At Platform Without Undercutting Blade-To-Platform Fillet Radius.
8. 0.030 - 0.050 Inch (0.762 - 1.270 mm) Radius Between Blend And Existing Surface.

BBB2-72-184

First Stage Compressor Blade Blending
Figure 801/72-33-21-990-804 (Sheet 3 of 3)

COMPRESSOR BLADES, FIRST STAGE - REPAIR-02

1. Repair 1st Stage Compressor Blade Major Foreign Object Damage (FOD)

A. Equipment And Materials Required

(1) Support Equipment -None

(2) Consumables - None

B. Procedure. See Figure 801 and Figure 802

(1) Repairs should be performed within following limits:

(a) Remove only enough material necessary to completely eliminate damage, while complying with contour and dimensional requirements.

(b) Dimensions given in figure define maximum material removal envelopes. Except for minor blend repairs per Repair-01, no repair is permitted outside these envelopes.

NOTE: Any blades with bent tips, or repairs per this section, operated with fan case rubstrip wear more than 0.020 inch (0.508 mm) in depth over 60 degree arc length may cause engine stall margin to deteriorate during reverse thrust operation.

(2) Blade repairs to remove FOD, including bent tips, confined within areas and dimensions in Sheets 1 and 2 of Figure 801, may be continued in service provided following conditions are met.

(a) Repair shall be performed prior to next flight.

(b) Blade repair per Sheet 2 of Figure 801 may be accomplished with individual cuts per View A or any combination of cuts 1, 2, and 3, per View B, to maximum material removal envelope.

(c) Blades repaired per Sheets 1 and 2 of Figure 801 must not exceed limits specified in ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1.

(3) FOD may be repaired along leading edge up to dimensions shown in Figure 802, provided:

(a) Repair shall be performed prior to next flight.

(b) Blades repaired per figure may be continued in service for 24 flight hours maximum.

(c) Blades repaired per figure conform with limits specified in ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1.

(4) Proceed with repairs as follows:

(a) Insert piece of scrap sheet stock between blade tip and fan case.

CAUTION: AREA TO BE REPAIRED WITH CUTOFF WHEEL MUST BE COMPLETELY MASKED TO ENSURE NO METAL SPLATTER OR SPARKS CAN STRIKE REPAIR BLADE, OTHER BLADES, OR HUB SURFACES.

(b) Remove damage with a hacksaw, or other suitable hand tool, or per following:

1) Using a 2 in. (50.8 mm) diameter cutoff wheel, cut away major portion of material to be removed.

NOTE: Minimum of 0.060 in. (1.524 mm) of material must remain for hand filing and polishing to ensure removal of any heat affected areas.

2) Use Norton A601-0BNA2 or Carborundum Co. A-60-TB2067, or equivalent, cutoff wheel in an ARO air chuck model 7015S, or equivalent, which has operating speed of 18,000 rpm maximum. A 3/16 inch (4.762 mm) rotary file may be used as an alternate tool to cutoff wheel.

(5) Hand file and polish edges where cuts have been made, restoring to original leading edge profile as closely as possible.

(6) Examine the blades by SPOP 70 portable fluorescent penetrant (ultra-high sensitivity). See STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201 for details of the SPOP 70 procedure. No cracks are permitted.

(a) If the maintenance base at which the blend repair is done cannot do the fluorescent penetrant inspection:

1) Do the fluorescent penetrant inspection no more than 50 hours after the repair.

2) If no crack or tear was found in the blade material before blade blend repair, visual inspection is sufficient.

3) No repeated inspections are necessary.

(b) If the blend repair is done at a maintenance base which can do the fluorescent penetrant inspection:

1) If a crack or tear was found in the blade material before the blade blend repair, do a SPOP 70 fluorescent penetrant inspection of the blade immediately after the repair.

2) If no crack or tear was found in the blade material before blade blend repair, visual inspection is sufficient.

3) No repeated inspections are necessary.

C. Keys To Figures

Key to Figure 801 (Sheet 1)

Call-out Number	Reference
1	0.625 Inch (15.875 mm)
2	0.625 Inch (15.875 mm) Radius Minimum
3	1.400 Inch (35.56 mm) Minimum
4	Leading Edge (Reference)
5	Midspan Shroud (Reference)

Table 801

Key to Figure 801 (Sheet 2)

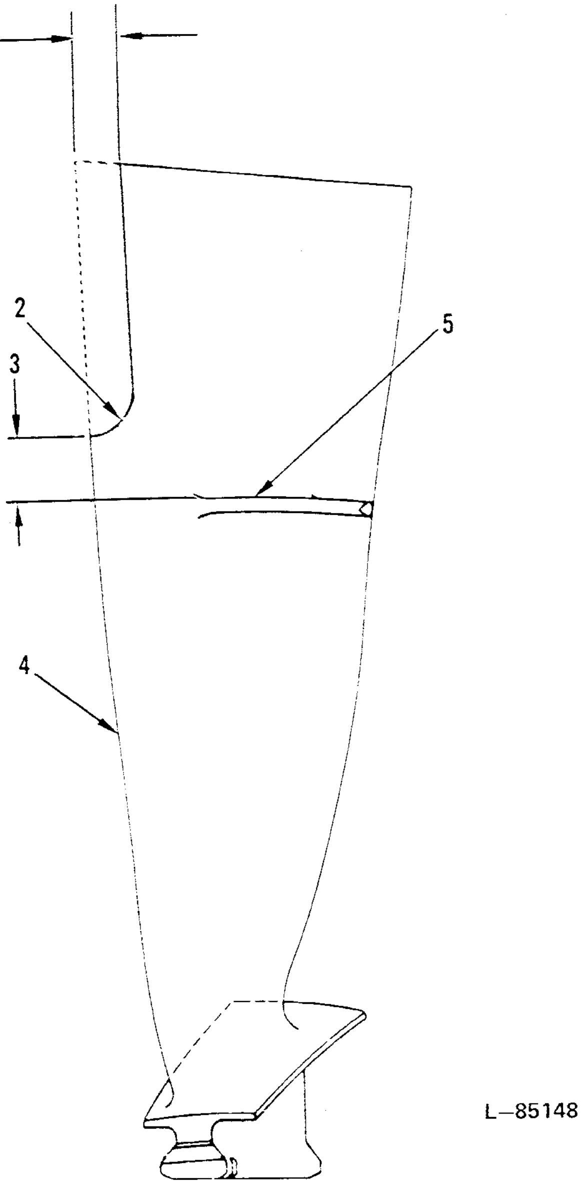
Call-out Number	Reference
1	Cut No. 1
2	Cut No. 2
3	Cut No. 3
4	2.000 Inches (50.8 mm) Maximum
5	1.250 Inches (31.75 mm) Maximum
6	0.750 Inch (19.05 mm) Maximum
7	3.850 Inches (97.79 mm) Maximum
8	2.150 Inches (54.61 mm) Maximum
9	1.150 Inches (29.210 mm) Maximum

Table 801 (Continued)

Key to Figure 801 (Sheet 2)	
Call-out Number	**Reference**
10	Leading Edge (Reference)
11	Midspan Shroud (Reference)
12	2.000 Inches (50.8 mm) Maximum
13	0.875 Inch (22.225 mm) Maximum
14	0.500 Inch (12.7 mm) Maximum
15	0.650 Inch (16.51 mm) Maximum
16	1.300 Inches (33.02 mm) Maximum
17	3.850 Inches (97.79 mm) Maximum

Table 802

Key to Figure 802	
Call-out Number	**Reference**
1	Leading Edge (Reference)
2	1.400 Inches (35.56 mm) Maximum
3	0.250 Inch (6.35 mm) Maximum
4	1.000 Inch (25.4 mm) Radius Minimum Two Places
5	4.000 Inches (101.6 mm) Maximum
6	Midspan Shroud (Reference)



1. 0.625 Inch (15.875 mm)
2. 0.625 Inch (15.875 mm) Radius Minimum
3. 1.400 Inch (35.56 mm) Minimum
4. Leading Edge (Reference)
5. Midspan Shroud (Reference)

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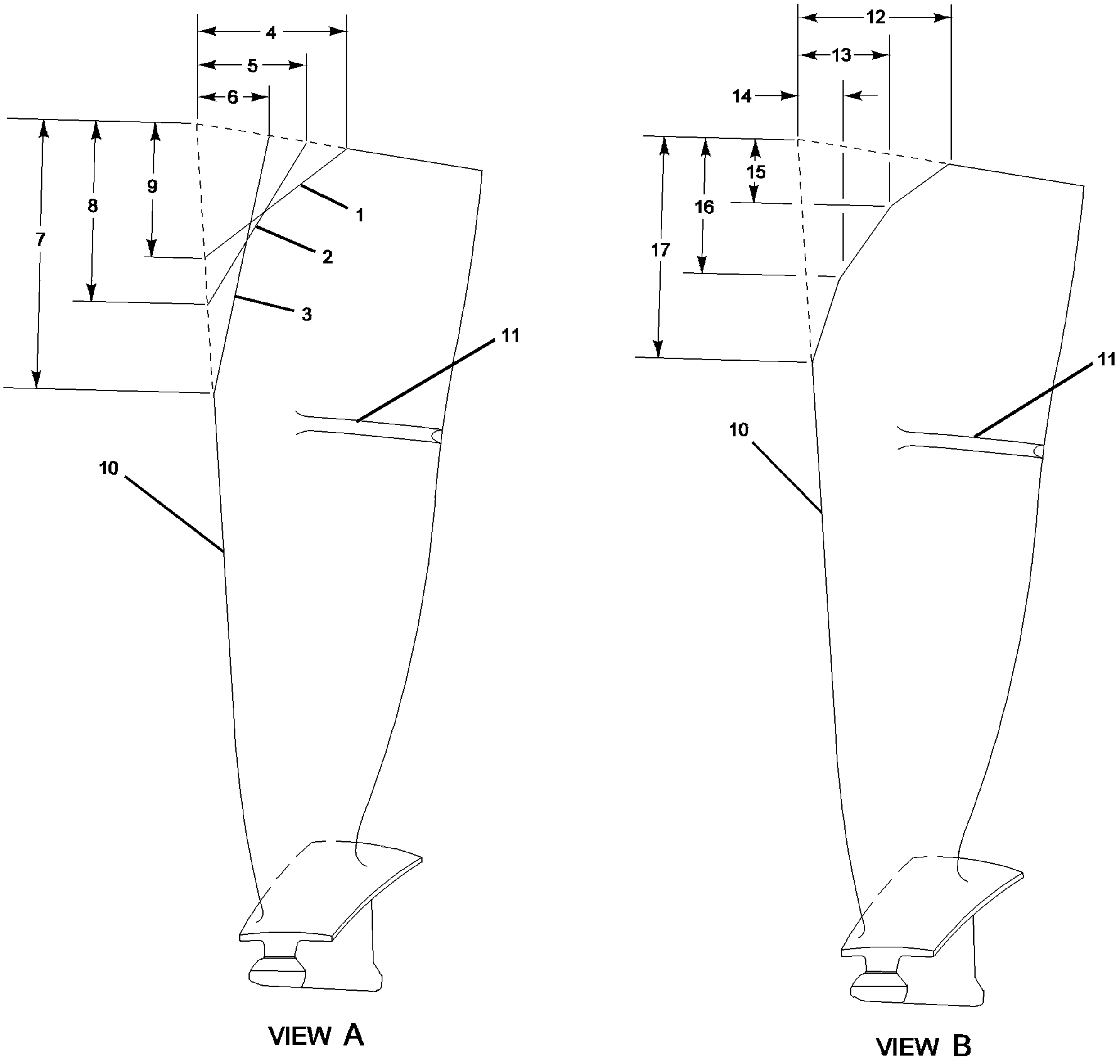
Blade Tip Continue-In-Service Repair Limits
Figure 801/72-33-21-990-805 (Sheet 1 of 2)



LEGEND:

1. CUT No. 1
2. CUT No. 2
3. CUT No. 3
4. 2.000 in. (50.8 mm) MAXIMUM
5. 1.250 in. (31.75 mm) MAXIMUM
6. 0.750 in. (19.05 mm) MAXIMUM
7. 3.850 in. (97.79 mm) MAXIMUM
8. 2.150 in. (54.61 mm) MAXIMUM
9. 1.150 in. (29.210 mm) MAXIMUM
10. LEADING EDGE (REFERENCE)
11. MIDSPAN SHROUD (REFERENCE)
12. 2.000 in. (50.8 mm) MAXIMUM
13. 0.875 in. (22.225 mm) MAXIMUM
14. 0.500 in. (12.7 mm) MAXIMUM
15. 0.650 in. (16.51 mm) MAXIMUM
16. 1.300 in. (33.02 mm) MAXIMUM
17. 3.850 in. (97.79 mm) MAXIMUM

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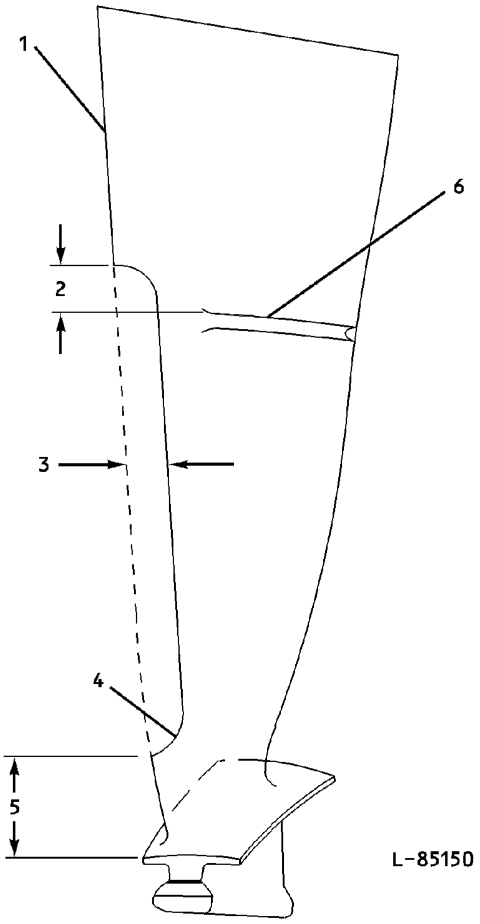
Blade Tip Continue-In-Service Repair Limits
Figure 801/72-33-21-990-805 (Sheet 2 of 2)



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Blade Leading Edge 24 Hour Continue-In-Service Repair Envelope
Figure 802/72-33-21-990-806

COMPRESSOR BLADES, STAGE 1.5 - REPAIR-01

1. Blade Surface Damage Blending

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure. See Figure 801 and Figure 803.

NOTE: Compressor blade blend limits, as specified in this manual, are evaluated from the standpoint of structural integrity only. Use of a substantial number of blades reworked at or near maximum limits, or blades having many reworked areas, may adversely affect compressor efficiency and engine performance. Unless otherwise specified, length of blends must be four times depth of blends.

(1) Blend blades within following limits.

(a) Repair of minor injuries to compressor blades can be made, provided injury can be removed without exceeding allowable limits. Blend wear to limits shown in figures.

NOTE: Nicks in leading and trailing edges become more critical, closer to blade root.

(b) Any injury in inner half of airfoil should be considered for repair only after most careful inspection.

(c) Blade portions, which have sustained indentations (having blade material compressed and edges raised) and injuries with small radii or ragged edges, must be repaired. See Figure 801.

(d) Segregate those blades having deep nicks along leading, or trailing edge from those having minor scratches and pits.

(e) Well rounded injuries to blade leading and trailing edges (Areas A and B) to central portion (Area C only), which can be seen on opposite side, are acceptable without rework, provided injury is on outer half and indentation does not exceed 0.010 inch (0.254 mm). See Figure 802 and Table 801.

(f) Total blended length on any blade edge shall not be in excess of 1/4 of total edge length.

(g) Blends on both edges must not be directly opposite and must be separated diagonally by minimum distance equal to mean chordal length of blade (Figure 803).

(h) Length of blade must be minimum of four times depth.

(i) Not more than three (3) blends on one edge, and two (2) on opposite side, are permitted.

NOTE: Blends in Area E (Figure 802 and Table 801) can be considered separately and are not accountable in computing above limits.

Make note in engine records that blades are to be glass bead peened at next shop visit where the compressor section is to be disassembled and the blades are available to be removed for further work.

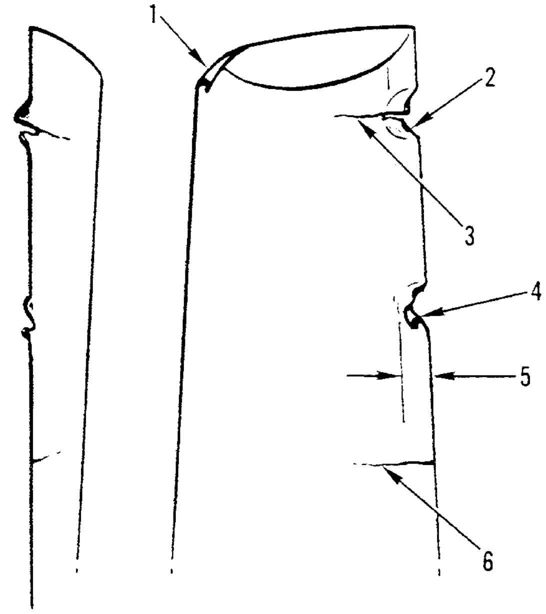
Table 801

Key to Figure 802	
Index No.	**Nomenclature**
1	0.250 Inch (6.35 mm) If Only One Edge, 0.188 Inch (4.775 mm) If Both Edges.
2	0.250 Inch (6.35 mm)
3	Area Y; Both Sides.

Table 801 (Continued)

Key to Figure 802	
Index No.	**Nomenclature**
4	Area X; Front And Rear.
5	Chord
6	These Dimensions Controlled By Depth Limit.
7	Areas A and B
8	Airfoil Mean Line
9	0.275 Inch (9.525 mm) If Only One Edge, 0.188 Inch (4.775 mm) If Both Edges.

CAUTION: LIMITS IN AREAS A AND B PERTAIN TO LOCK, ISOLATED DAMAGE AREAS, ONLY AND MUST NOT BE INTERPRETED AS AUTHORITY FOR MATERIAL REMOVAL ACROSS ENTIRE TIP OF LEADING AND TRAILING EDGES, AS MIGHT BE DONE IN SINGLE MACHINING CUT.



1. Corner Tip Curl. May Be Blended If All Evidence Of Curl Is Removed Within Limits Of Area E. See Figure 802.
2. Injury Resulting From Impact Acceptable If Within Maximum Limits After Blend.
3. Fracture Not Confined To Immediate Locale Of Injury; Crack Progression Not Acceptable.
4. Tear Injury, Acceptable If Injury Blend-Out Is Within Depth Limits.
5. Maximum Depth Of Injury Blend-Out Depth To Be Measured And Compared To Maximum Limits.
6. Crack With No Evidence Of Damage Unacceptable Regardless Of Length.

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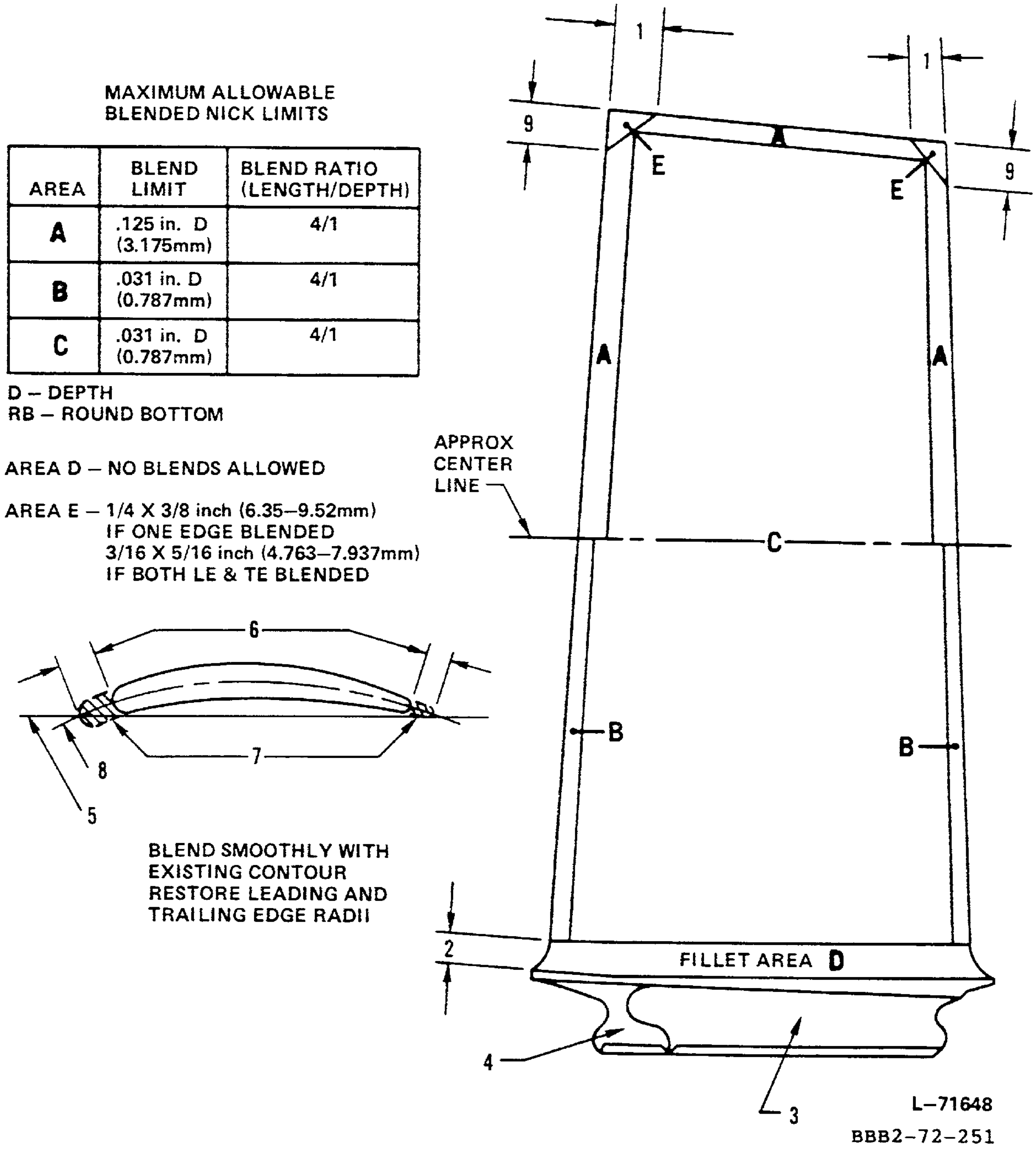
Blade Edge Damage
Figure 801/72-33-23-990-801



MAXIMUM ALLOWABLE
BLENDED NICK LIMITS

AREA	BLEND LIMIT	BLEND RATIO (LENGTH/DEPTH)
A	.125 in. D (3.175mm)	4/1
B	.031 in. D (0.787mm)	4/1
C	.031 in. D (0.787mm)	4/1

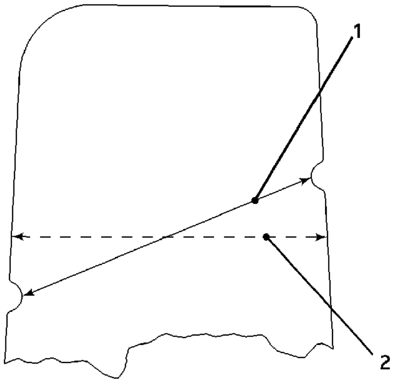
D – DEPTH
RB – ROUND BOTTOM

AREA D – NO BLENDS ALLOWED

AREA E – 1/4 X 3/8 inch (6.35–9.52mm)
IF ONE EDGE BLENDED
3/16 X 5/16 inch (4.763–7.937mm)
IF BOTH LE & TE BLENDED

BLEND SMOOTHLY WITH
EXISTING CONTOUR
RESTORE LEADING AND
TRAILING EDGE RADII

Blade Blend Limits
Figure 802/72-33-23-990-802



1. EDGE BLEND SEPERATION TO BE EQUAL TO OR GREATER THAN MEAN CHORDAL LENGTH
2. MEAN CHORD LENGTH

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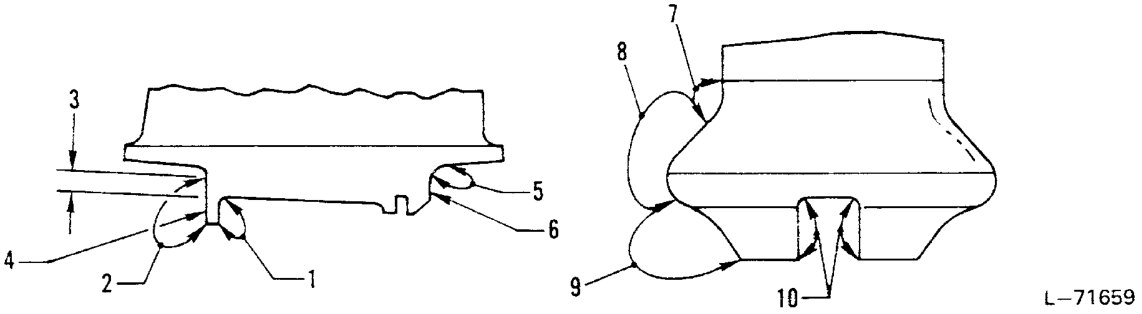
Edge Blend Separation
Figure 803/72-33-23-990-803



1. 0.005 Inch (0.127 mm) Maximum Wear
2. 0.020 Inch (0.508 mm) Maximum Wear Blended
3. 0.100 Inch (2.54 mm) Maximum
4. Front Face
5. No Service Time Marking Permitted On Radius.
6. Rear Face
7. Surface Damage May Be Blend Repaired Up To 0.005 Inch (0.127 mm) Maximum.
8. Surface Damage Unacceptable After Repair.
9. Blend Surface Damage Up To 0.005 Inch (0.127 mm) Maximum.
10. 0.020 Inch (0.508 mm) Maximum Wear (Inner Edges Of Ingestion Tang And Inner Sides Of Blade Lock Retainer Slot).

BBB2-72-252

Blend Root Wear Blending
Figure 804/72-33-23-990-804

COMPRESSOR STATOR, FIRST STAGE - REPAIR-01

1. Airfoil Blending

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

B. Procedure. See Figure 801.

(1) Repair of minor injuries may be made, provided injury can be removed without exceeding repair limits.

(2) Injuries to concave and convex airfoil surfaces may be blended to maximum depth of 0.020 inch (0.508 mm). Round bottom dents are acceptable without blending.

(3) Total length of combined leading edge and trailing edge or leading edge and trailing edge blends singly, must not exceed 0.500 inch (12.700 mm).

(4) Not more than two repairs to the maximum depth limit are allowed per vane.

(5) Radial length of blend must be a minimum of four times the depth of the nick (see figure).

(6) Blends to maximum depth on both leading and trailing edge must not be at the same radial station and must be radially separated by not less than the vane mean chordal length.

(7) Blends not to maximum depth limit on leading and trailing edge and within vane chordal length radial spacing, are acceptable only if combined blended depth does not exceed single blend nick limit given above.

(8) A maximum of fifteen inches (381.000 mm) total leading edge and/or trailing edge blend length rework is allowed in vane and shroud assembly.

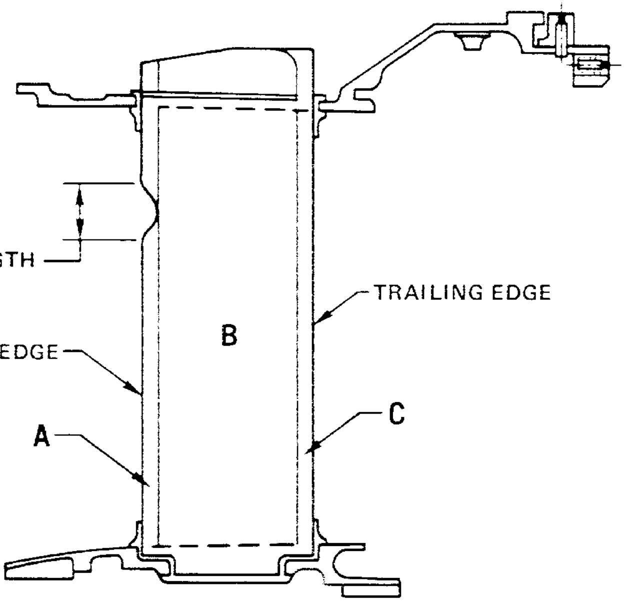
(9) Damage or pitting to concave and convex surfaces of vanes (Area B) must not exceed a maximum of 0.020 inch (0.508 mm) deep, for total repaired area not exceeding ten percent of vane surface.

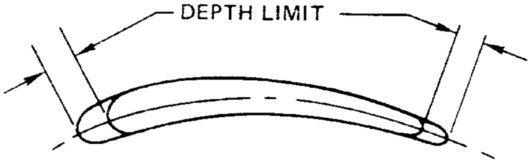
(10) All local blending on concave and convex surfaces must extend over an area at least fifteen times depth of injury.

(11) Pitting and corrosion are not considered serious provided pitting does not exceed 0.005 inch (0.127 mm) in depth.

(12) Damage which can be seen on opposite side of vane is not acceptable.

(13) Surface finish on repaired vanes must be comparable to that of a new vane.





BLEND SMOOTHLY WITH EXISTING CONTOUR. RESTORE LEADING EDGE AND TRAILING EDGE RADII

DAMAGE DEPTH LIMITS AFTER BLENDING

	VANE STAGE 1
A	5/64 in. D (1.981mm)
B	.020 in. D (0.508mm) SEE TEXT
C	5/64 in. D (1.981mm)

D = DEPTH

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Airfoil Blending Limits
Figure 801/72-33-51-990-801

COMPRESSOR STATOR, STAGE 1.5 - REPAIR-01

1. Airfoil Blending

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables - None

B. Procedure. See Figure 801.

(1) Repair of minor injuries may be made, provided injury can be removed without exceeding repair limits.

(2) Injuries to concave and convex airfoil surfaces may be blended to maximum depth of 0.020 inch (0.508 mm). Round bottom dents are acceptable without blending.

(3) Total length of combined leading edge and trailing edge or leading edge and trailing edge blends singly, must not exceed 0.500 inch (12.700 mm) per vane.

(4) Not more than two repairs to the maximum depth limit are allowed per vane.

(5) Radial length of blend must be a minimum of four times the depth of the nick.

(6) Blends to maximum depth on both leading and trailing edge must not be at the same radial station and must be radially separated by not less than the vane mean chordal length.

(7) Blends not to maximum depth limit on leading and trailing edge and within vane chordal length radial spacing, are acceptable only if combined blended leading edge depth and blended trailing edge depth does not exceed above single blend nick limit.

(8) A maximum of fifteen inches (381.000 mm) total leading edge and/or trailing edge blend length repair is allowed in vane and shroud assembly.

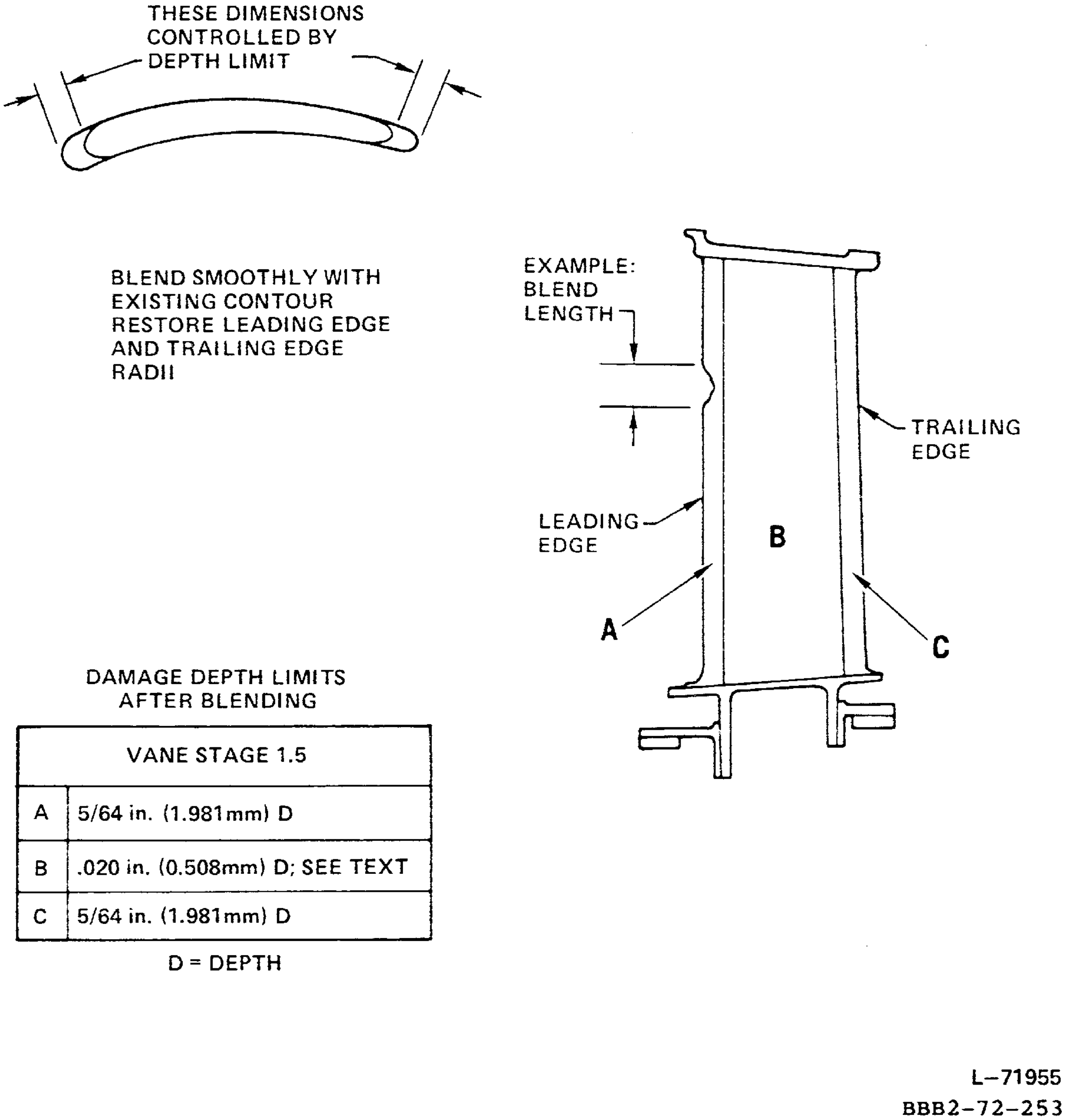
(9) Damage or pitting to concave and convex surfaces of vanes (Area B) must not exceed a maximum of 0.020 inch (0.508 mm) deep, for a total blended repaired area not exceeding ten percent of vane surface.

(10) All local blending on concave and convex sides must exceed over an area at least 15 times depth of injury.

(11) Pitting and corrosion are repairable provided pitting does not exceed 0.005 inch (0.127 mm) in depth.

(12) Surface finish on repaired vane must be comparable to that of a new vane.

(13) Damage which can be seen on opposite side of vane is unacceptable.



DAMAGE DEPTH LIMITS AFTER BLENDING

VANE STAGE 1.5	
A	5/64 in. (1.981mm) D
B	.020 in. (0.508mm) D; SEE TEXT
C	5/64 in. (1.981mm) D

D = DEPTH

Stage 1.5 Compressor Stator Vane Repair Limits
Figure 801/72-33-52-990-801

FAN CASES GENERAL - REPAIR-01

1. Sound Absorbing Liner Repair (Minor)

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

NAME AND NUMBER	MANUFACTURER
Solvent, Reagent Grade Methyl Ethyl Ketone (PMC 1820)	
or Solvent, Trichlorotrifluoroethane	
Potting Compound (PWA 603)	

B. Procedure (Figure 801) (Table 801)

Table 801 Maximum Total Area And Distribution Of Repairs

Extent Of Damage In Degrees Of Arc	Permissible Repair Area In Square Inches (mm ^{2})
10°	14 (9032)
30°	25 (16,129)
180°	100 (64,516)
360°	150 (96,774)

(1) PWA 603 potting compound may be used to repair damage described as follows, provided that total repair area does not exceed limits shown in Table 801.

(a) Disbonds, each up to 5.0 square inches (3226 mm^2), discovered by sonic or tap testing.

(b) Dents, nicks or scratches beyond acceptable limits in face sheets or duct walls.

NOTE: All liners which exhibit visual damage beyond limits specified must be sonic or tap tested to determine extent of disbond area.

WARNING: WHEN USING SOLVENTS, WEAR SUITABLE DISPOSABLE PLASTIC GLOVES OVER COTTON GLOVES.

(2) Thoroughly flush repair area with reagent grade MEK or trichlorotrifluoroethane. Rotate part, as necessary, to drain out all liquid solvent. Area must be free front dirt, oil, grease and other foreign materials.

(3) Wipe external portion of repair area with clean, unsized cheesecloth.

NOTE: Sized cheesecloth contains resin binders which may dissolve in solvents and contaminate bond surface. Solvent dispensers must be squirt or pour type to avoid repeated dipping and contamination by work cloths.

WARNING: DO NOT USE HEAT GUN UNTIL AFTER AIR DRYING AT ROOM TEMPERATURE.

CAUTION: DO NOT EXCEED MAXIMUM TEMPERATURE OF 220°F (104.4°C) ON PERFORATED LINER SKIN.

(4) Dry for at least 15 minutes at room temperature in a well-ventilated area. Then thoroughly dry repair area with a heat gun at 220°F (104.4°C) maximum. It is recommended that Tempilabel Tabs (available from Omega Engineering, Inc., P.O. Box 4047, Stamford, CT 06907), or equivalent, be used to ensure that surface temperature limit is not exceeded.

(5) Apply PWA 603 potting compound as follows:

NOTE: PWA 603 (Eccobond SF-40) is available from Emerson & Cuming Incorporation, 869 Washington St, Canton, MA 02021.

(a) Prepare PWA 603 compound per manufacturer's instructions.

(b) For exposed honeycomb cells, apply compound with spatula.

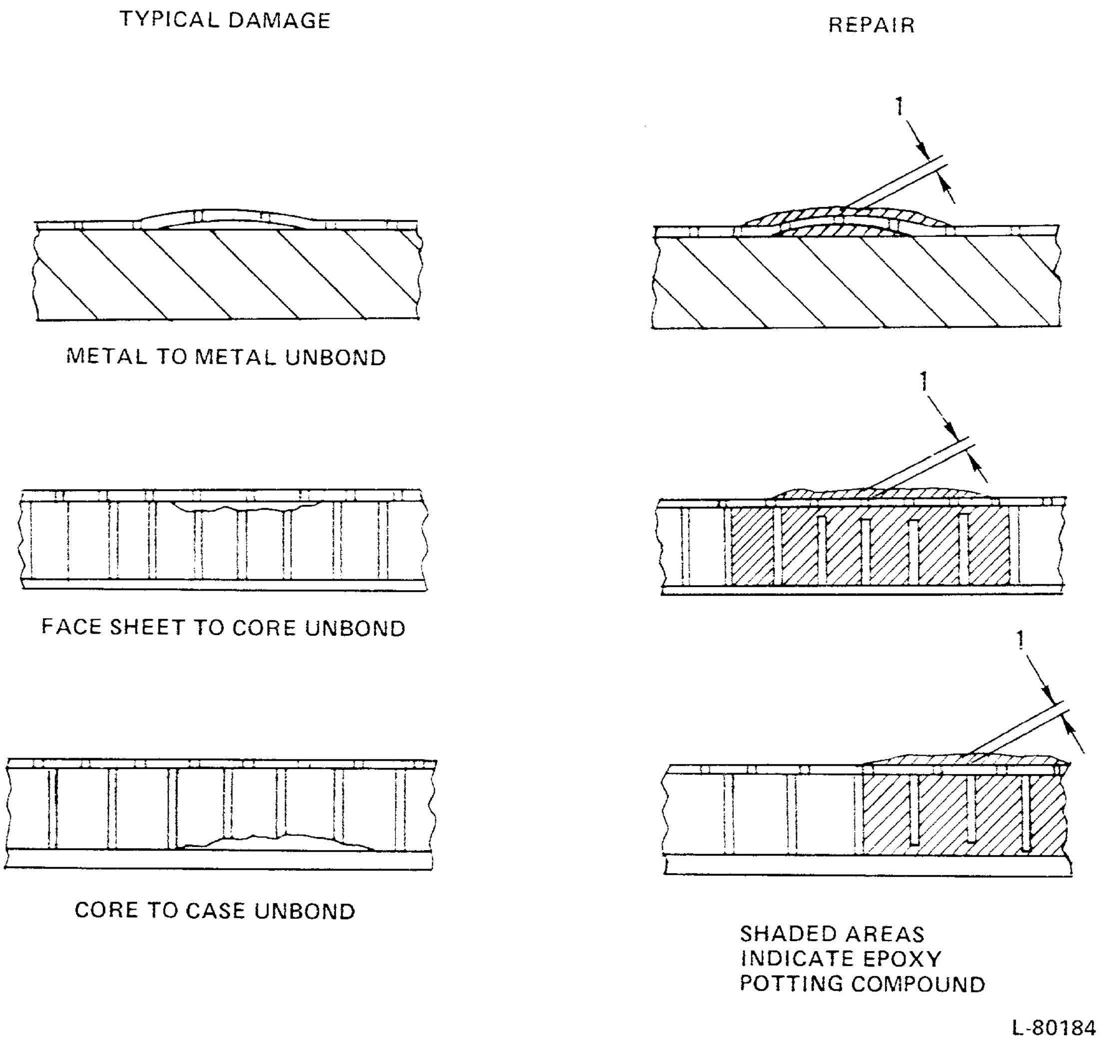
(c) For less accessible disbonded areas, use pressure injection to apply compound. Injected compound should extrude from adjacent perforated holes and should be molded to form a 0.025 inch (0.635 mm) crown over entire disbonded or damaged area, as shown in figure.

NOTE: One perforation per honeycomb cell may be enlarged to 0.100 inch (2.540 mm) diameter, if necessary, for injection.

(d) Cure compound for one hour at 60° - 100°F (16° - 38°C), followed by two hours minimum at 180° - 220°F (82° - 104°C).

(e) After compound has cured, smooth repaired area with fine sandpaper to form a gentle, sloped transition with adjacent surface. Remove dust with vacuum.

NOTE: Adjacent undamaged perforated sheet should be masked off to prevent grit and dust from filling cells not being repaired.



1. 0.020 - 0.030 Inch (0.51 - 0.76 mm)

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Sound Absorbing Liner Epoxy Repair
Figure 801/72-33-65-990-801

FAN CASES GENERAL - REPAIR-02

1. Sound Absorbing Liner Repair (Damaged Perforated Sheet But Honeycomb Intact)

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

NAME AND NUMBER	MANUFACTURER
Solvent, Reagent Grade Methyl Ethyl Ketone (PMC 1820)	
or Solvent, Trichlorotrifluoroethane	
Adhesive Compound, Epoxy P08-016 (PWA 457-1), P08-025 (PWA 457-2) or P08-044 (PWA 457-5)	

B. Procedure. (Table 801)

Table 801 Maximum Total Area And Distribution Of Repairs

Extent Of Damage In Degrees Of Arc	Permissible Repair Area In Square Inches (mm ^{2})
10°	14 (9032)
30°	25 (16,129)
180°	100 (64,516)
360°	150 (96,774)

(1) Liners with perforated sheet damage up to four inches (101.600 mm) in diameter at each location, but with honeycomb intact, may be repaired provided total damage does not exceed limits of Table 801.

NOTE: If honeycomb is also damaged, repair per Repair-03. (FAN CASES GENERAL - REPAIR-03, PAGEBLOCK 72-33-67/801)

(2) Using fine-tooth hole-type cutter, cut out damaged perforated sheet only. Keep depth of cut to minimum.

(3) Straighten walls of damaged cells. Cut out material that sticks into flowpath, but leave sound cell material to reinforce epoxy repair.

WARNING: WHEN USING SOLVENTS, WEAR SUITABLE DISPOSABLE PLASTIC GLOVES OVER COTTON GLOVES.

(4) Remove surface grease from the repair area by SPOP 208 (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201). Remove all liquid solvents from the repair area after dirt, oil, grease and other unwanted materials are removed.

(5) Wipe external portion of repair area with clean, unsized cheesecloth.

NOTE: Sized cheesecloth contains resin binders which may dissolve in solvents and contaminate bond surface. Solvent dispensers must be squirt or pour type to avoid repeated dipping and contamination by work cloths.

WARNING: DO NOT USE HEAT GUN UNTIL AFTER AIR DRYING AT ROOM TEMPERATURE.

CAUTION: DO NOT EXCEED MAXIMUM TEMPERATURE OF 220°F (104.4°C) ON PERFORATED LINER SKIN.

(6) Dry for at least 15 minutes at room temperature in a well-ventilated area. Then thoroughly dry repair area with a heat gun at 220°F (104.4°C) maximum. It is recommended that Tempilabel Tabs (available from Omega Engineering, Inc., P.O. Box 4047, Stamford, CT 06907) or equivalent, be used to ensure that surface temperature limit is not exceeded.

(7) Fill all exposed honeycomb cells with P08-016 PWA 457-1, P08-025 PWA 457-2 or P08-044 PWA 457-5 epoxy adhesive compound. Trowel to be flush with adjacent surface. If adhesive flows out of repair, hold in position by damming with material which conforms to liner curvature.

NOTE: PWA 457 is available as EA 934 NA epoxy adhesive from Dexter Hysol Aerospace Inc., The Dexter Corp., 2850 Willow Pass Road, P.O. Box 312, Pittsburg, CA 94565-3237 USA.

NOTE: Damming material should be faced with a thin film which can be removed easily after adhesive has cured.

(8) Cure compound for one hour at 60° - 100°F (16° - 38°C), followed by two hours minimum at 180° - 220°F (82° - 104°C).

(9) After adhesive has cured, smooth repaired surface with fine sandpaper to form a gentle contour conforming to adjacent surfaces.

NOTE: Surrounding undamaged perforated sheet should be masked off to prevent grit and dust from entering cells not being repaired.

FAN CASES GENERAL - REPAIR-03

1. Sound Absorbing Liner Repair (For Damage To Preformatted Sheet And Honeycomb)

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Adhesive Paste, Epoxy (P08-016) (PWA 457-1)

B. Procedure (Figure 801) (Table 801)

Table 801 Maximum Total Area And Distribution Of Repairs

Extent Of Damage In Degrees Of Arc	Permissible Repair Area In Square Inches (mm ^{2})
10°	14 (9032)
30°	25 (16,129)
180°	100 (64,516)
360°	150 (96,774)

(1) Liners with perforated sheet damage up to 4.0 inches (101.600 mm) in diameter at each location, and with damage to honeycomb, may be repaired as follows, provided total repair area does not exceed limits shown in Table 801. If any repair hole size exceeds 4.0 inches (101.600 mm) diameter, or accumulation of repairs exceeds limits in table, liner must be replaced. This may be accomplished by replacing case assembly.

(2) Using fine-tooth hole-type cutter, cut out damaged perforated sheet only. Keep depth of cut to minimum.

(3) Using router or electric drill with router bit, cut out damaged honeycomb. Be careful not to cut or nick other surfaces. (Figure 801).

WARNING: WHEN USING SOLVENTS, WEAR SUITABLE DISPOSABLE PLASTIC GLOVES OVER COTTON GLOVES.

(4) Remove surface grease from the repair area by SPOP 208 STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201. Remove all liquid solvents from the repair area after dirt, oil, grease and other unwanted materials are removed.

(5) Wipe external portion of repair area with clean, unsized cheesecloth (P05-038) (GA 100-2). (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

NOTE: Sized cheesecloth contains resin binders which may dissolve in solvents and contaminate bond surface. Solvent dispensers must be squirt or pour type to avoid repeated dipping and contamination by work clothes.

WARNING: DO NOT USE HEAT GUN UNTIL AFTER AIR DRYING AT ROOM TEMPERATURE.

CAUTION: DO NOT EXCEED MAXIMUM TEMPERATURE OF 220°F (104.4°C) ON PERFORATED LINER SKIN.

(6) Dry for at least 15 minutes at room temperature in a well-ventilated area. Then thoroughly dry repair area with a heat gun at 220°F (104.4°C) maximum. It is recommended that Tempilabel Tabs (available from Omega Engineering, Inc., P.O. Box 4047, Stamford, CT 06907), or equivalent, be used to ensure that surface temperature limit is not exceeded.

(7) From a newly purchased liner segment assembly, get a replacement honeycomb core to fill hole. Insert replacement core in hole.

NOTE: It is permitted to use a part of a used liner segment which is not damaged.

- (a) JT8D-209, 217, 217A: For reference, front fan case sound absorbing liners are available as PN 5000655-01 (six segments, pre SB 6478) or PN 822495-01 (one piece, post SB 6478).
- (b) JT9D-217C, -219: For reference, front fan case sound absorbing liners are available as PN 799482 (six segments, pre SB 6478) or PN 822496-01 (one piece post SB 6478).
- (c) Rear fan case sound absorbing liners are available as PN 5000697-01.

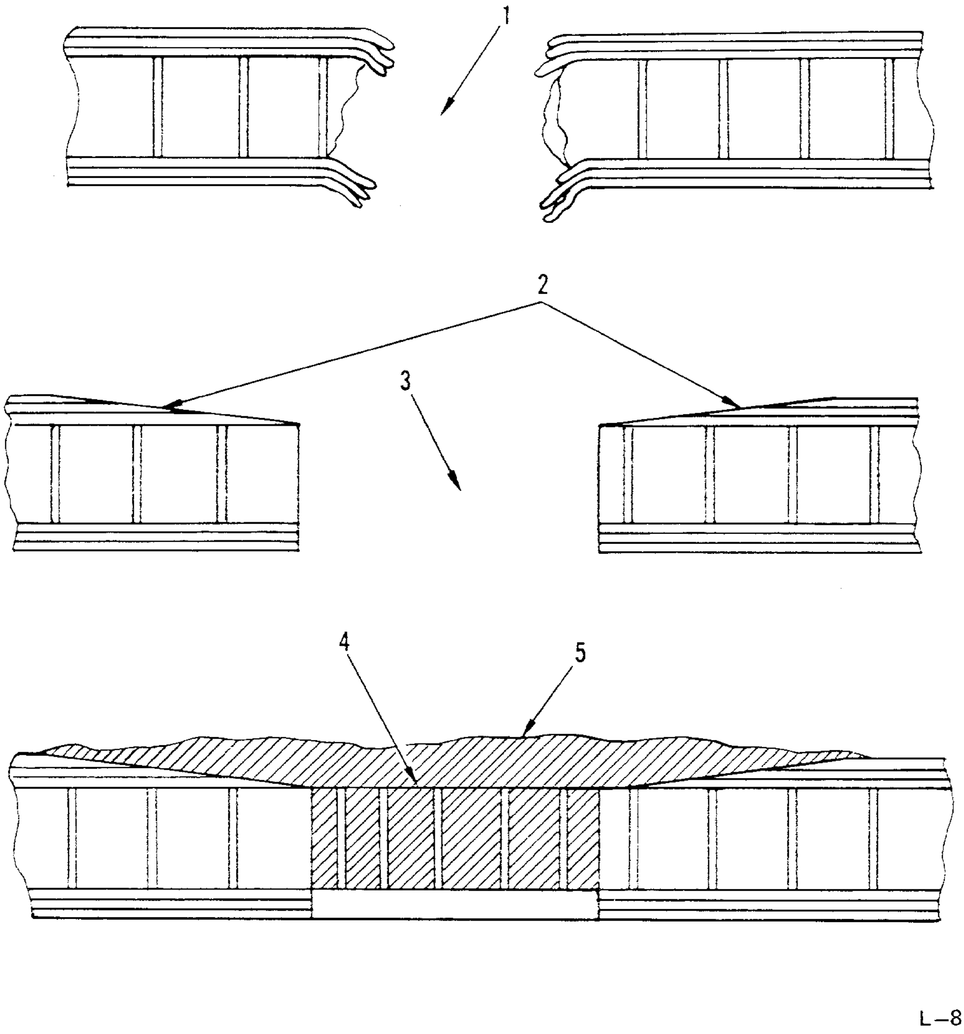
(8) Bevel surface around replaced core, as shown.

(9) Fill all exposed honeycomb cells with epoxy adhesive paste (P08-016) (PWA 457-1). Trowel adhesive to be flush to slightly higher than adjacent surface. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

(10) Cure compound for one hour at 60° - 100°F (16° - 38° C), followed by two hours minimum at 180° - 220°F (82° - 104°C).

(11) After adhesive has cured, smooth repaired surface with fine sandpaper to form a gentle contour conforming to adjacent surfaces.

NOTE: Mask off surrounding undamaged perforated sheet to prevent grit and dust from entering cells not being repaired.



1. Damaged Honeycomb
2. Bevel Surface
3. Trim Hole
4. Replace Core
5. Apply PWA 609 Epoxy Compound

BBB2-72-255

Liner Honeycomb Repair
Figure 801/72-33-67-990-801

FRONT FAN CASE - REMOVAL/INSTALLATION-01

1. Remove Front Fan Case

A. Prerequisites

(1) Remove compressor inlet group, (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-02, PAGEBLOCK 72-23-02/401)

B. Equipment and Materials

(1) Support Equipment:

PWA 45053 Bracket

PWA 45211 Jackscrew (12 Required)

PWA 75135 Safety Hook

(2) Consumables:

PWA 36500 Fluid, Assembly

C. Procedure (Figure 401)

(1) Remove bolts and spacers that attach fuel/oil cooler front bracket to Flange C.

NOTE: Provide a suitable method to support front end of fuel/oil cooler during removal and installation of front fan case.

(2) Mark position of tube clamp brackets and remove bolts and spacers that attach tube clamp brackets to Flange C.

(3) Attach PWA 45053 Bracket to front fan case at twelve o'clock position and connect to hoist with PWA 75135 Safety Hook (Figure 401).

(4) Remove remaining bolts and spacers that attach front fan case.

(5) Separate front fan case from rear fan case with 12 equally spaced PWA 45211 Jackscrews and then remove case from engine.

CAUTION: HANDLE CASE WITH EXTREME CARE DURING AND AFTER REMOVAL TO AVOID SEPARATING ACOUSTIC LINING FROM CASE.

(6) Lower case to pallet or bench and remove tools.

2. Install Front Fan Case

A. Equipment and Materials

(1) Support Equipment:

PWA 45053 Bracket

PWA 75135 Safety Hook

B. Procedure (Figure 401 and Figure 402)

(1) Install PWA 45053 Bracket at twelve o'clock position on front fan case and connect to hoist with PWA 75135 Safety Hook (Figure 401).

CAUTION: HANDLE CASE WITH EXTREME CARE BEFORE AND DURING INSTALLATION TO AVOID SEPARATING ACOUSTIC LINING FROM CASE.

(2) Place front fan case in position on engine and align offset hole at six o'clock position.

(3) Install bolts and spacers to attach front fan case to rear fan case. Position tube clamp brackets on Flange C and install bolts and spacers. Install bolts and spacers to attach fuel/oil cooler front bracket to Flange C (Figure 402).

(4) Seat front fan case against rear fan case and torque retaining bolts.

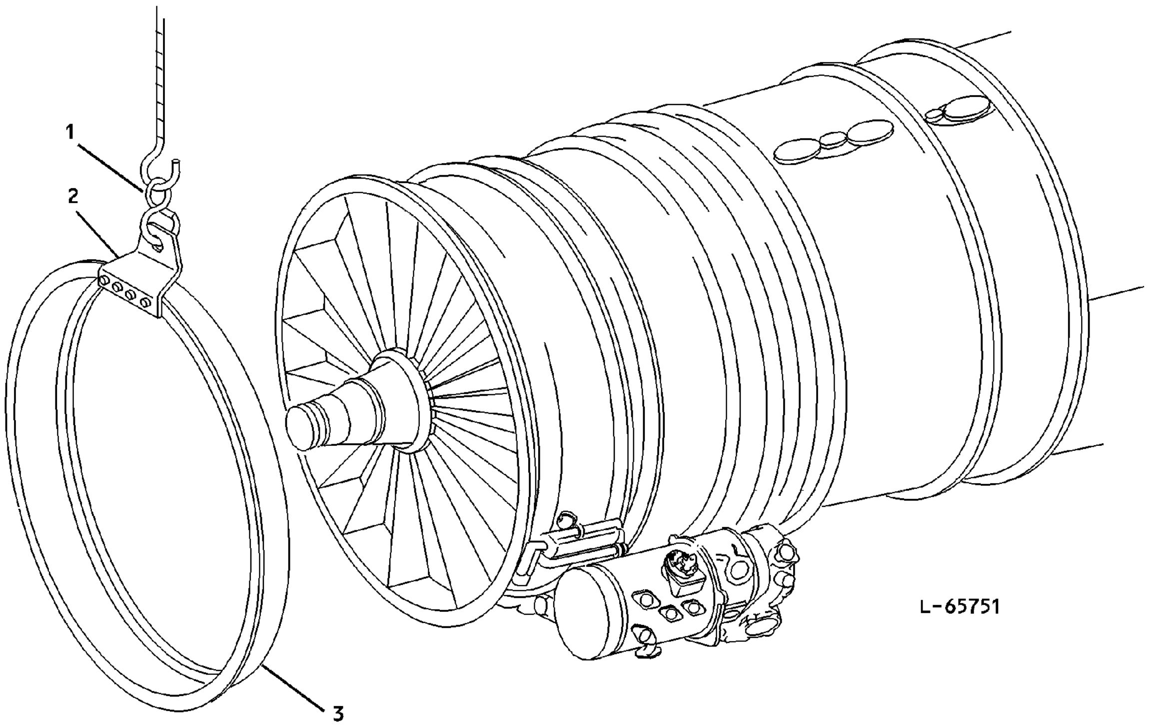
(5) Remove handling tools.

C. Postrequisites

(1) Install compressor inlet group (COMPRESSOR INLET SECTION - REMOVAL/INSTALLATION-02, PAGEBLOCK 72-23-02/401).

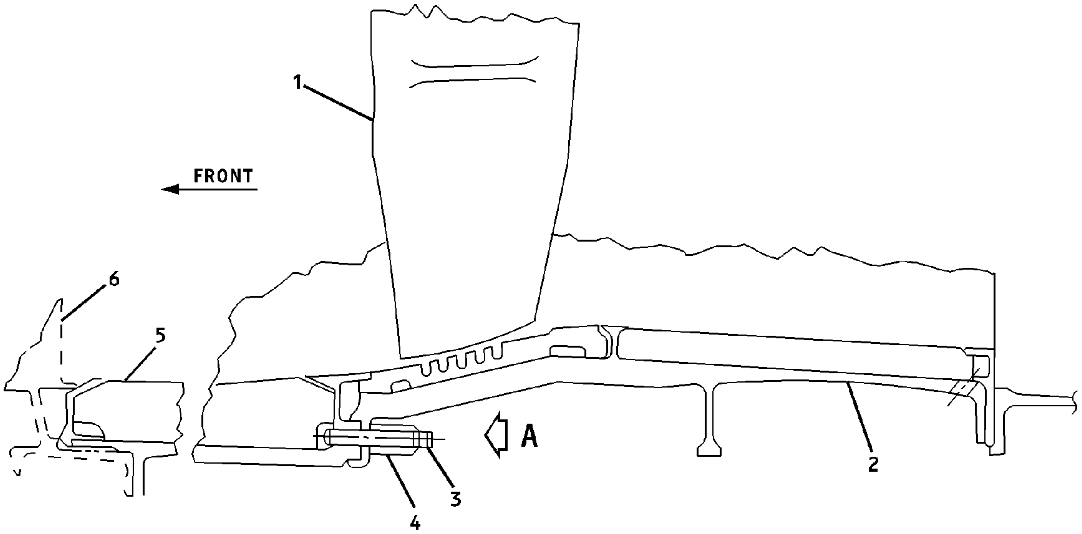
Table 401

Key to Figure 402	
Index No.	**Nomenclature**
1	First Stage Compressor Blade
2	Rear Fan Case
3	Bolt
4	Spacer
5	Front Fan Case
6	Compressor Inlet Group (Reference)
7	Oil Cooler Support Bracket
8	Tubing Bracket

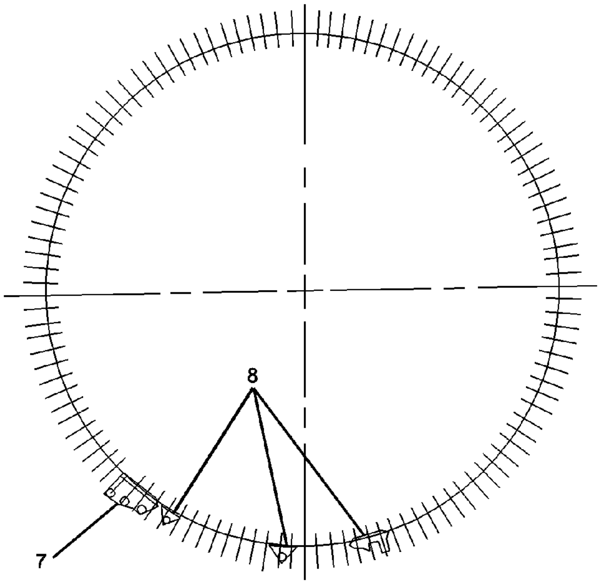


LEGEND:
1. PWA 75135 HOOK
2. PWA 45053 BRACKET
3. FRONT FAN CASE

Front Fan Case Handling
Figure 401/72-33-68-990-801



CROSS SECTION THROUGH FAN CASES



SCHEMATIC VIEW A
(FLANGE C)

CAG(IGDS)

L-65754

BBB2-72-567

Front Fan Case Installation
Figure 402/72-33-68-990-802

REAR FAN CASE - REMOVAL/INSTALLATION-01

1. Remove Rear Fan Case

A. Prerequisites

(1) Remove oil tank (OIL TANK - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-65/401).

(2) Remove 1st stage compressor hub and blades (FRONT COMPRESSOR GROUP - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-02/401).

(3) Remove front fan case (FRONT FAN CASE - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-68/401).

B. Equipment and Materials

(1) Support Equipment:

PWA 45004 Bracket

PWA 45543 Jackscrew (12 Required)

PWA 75135 Safety Hook

(2) Consumables:

PWA 36500 Fluid, Assembly

C. Procedure. (Figure 401 and Figure 402)

(1) Disconnect No. 1 bearing drain tube at main bearing drain manifold and remove drain tube.

(2) Disconnect No. 1 bearing scavenge tube at gearbox and remove tube.

(3) Disconnect No. 1 bearing breather tube at gearbox and remove tube.

(4) Disconnect and remove No. 1 bearing pressure tube.

(5) Disconnect oil cooler-to-oil pressure relief valve tube at connector on front of oil cooler.

(6) Disconnect main bearing pressure manifold at connector to rear of oil cooler outlet connector.

(7) Disconnect oil cooler inlet tube (gearbox-to-oil cooler tube) at elbow on top rear of oil cooler.

(8) Unfasten nuts holding fuel outlet tube retaining plate at rear of oil cooler and slide plate rearward.

(9) Remove bolts that attach oil cooler assembly to engine bracket (Flange E).

(10) Disconnect fuel flowmeter inlet tube connector from fuel flowmeter inlet tube (fuel control-to-flowmeter tube).

(11) Carefully remove oil cooler (and flowmeter, if attached) by easing it forward and off the fuel outlet tube (oil-cooler-to-pressurizing and dump valve tube).

(12) Mark positions of tube brackets at Flange D.

(13) Attach PWA 45004 Bracket to rear fan case front flange and connect to hoist with PWA 75135 Safety Hook (Figure 401).

(14) PN 810493: Remove bolts that hold fan exit guide vane case stops to Flange E and remove stops (Figure 402).

(15) Remove nuts and bolts that attach rear fan case to fan exit case. Remove tube support brackets.

(16) Use 12 equally spaced PWA 45543 Jackscrews to separate rear fan case from fan exit case. Remove from engine.

CAUTION: HANDLE CASE WITH EXTREME CARE DURING AND AFTER REMOVAL TO AVOID SEPARATING ACOUSTIC LINING FROM CASE.

(17) Place rear fan case on bench or pallet and remove tools.

2. Install Rear Fan Case

A. Prerequisite

(1) Install front fan case (FRONT FAN CASE - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-68/401).

B. Equipment and Materials

(1) Support Equipment:

PWA 45004 Bracket

PWA 75135 Safety Hook

C. Procedure. (Figure 401 and Figure 402)

(1) Attach PWA 45004 Bracket and connect to hoist with PWA 75135 Safety Hook (Figure 401).

CAUTION: HANDLE CASE WITH EXTREME CARE BEFORE AND DURING INSTALLATION TO AVOID SEPARATING ACOUSTIC LINING FROM CASE.

(2) Raise rear fan case from pallet or bench and position on front of engine, aligning offset holes at twelve and six o'clock positions.

(3) Install nuts, bolts, and brackets where indicated, to seat rear fan case against fan exit case. With PN 810493: Install seven stops at location shown in Figure 402 (one bracket on Flange D is in a new location as shown). Torque bolts to standard value.

(4) Remove lifting bracket and hoist.

(5) Install new packing, lubricated with PWA 36500 Assembly Fluid, on oil cooler fuel outlet tube. Position oil cooler (and flowmeter, if attached) on engine and carefully move oil cooler rearward to join with fuel outlet tube.

(6) Secure fuel inlet tube connector to engine bracket with nuts and washers.

(7) Bolt oil cooler to engine bracket located at rear of oil cooler. Torque bolts and lockwire.

(8) Slide fuel outlet tube retaining plate forward and fasten outlet tube (oil cooler-to-pressurizing and dump valve tube) at rear of oil cooler, with three nuts.

(9) Use a new packing and retainer and install oil cooler outlet sensing tube (cooler-to-oil pressure relief valve tube) at connector at front of oil cooler.

(10) Use a new packing and retainer and connect main bearing pressure manifold at rear of oil cooler outlet connector. Torque manifold nut to 130-140 lb-in. (14.688 - 15.818 N·m).

(11) Connect oil cooler inlet tube (gearbox-to-oil cooler tube) at rear of oil cooler, with new packing, retainer, and ferrule. Torque tube nut to 130-140 lb-in. (14.688 - 15.818 N·m).

NOTE: With PN 810493, install tube clamp screw on oil pressure manifold from inner surface of clamp (this screw is too near a Flange D stop if installed from outer surface).

(12) Lockwire all tube nuts after they are properly torqued.

(13) Connect upper end of fuel flowmeter inlet tube to adapter connector and lock with key washer (Ref. Standard Practices Manual).

(14) Install bleed control Pt2 tube (with new packing and retainer lightly lubricated with PWA 36500 Assembly Fluid) at pressure ratio bleed control and clip in place. Torque connection and lockwire.

(15) Install No. 1 bearing breather tube (with new packing and retainer lubricated with PWA 36500 Assembly Fluid) at gearbox. Torque connection and lockwire.

(16) Install No. 1 bearing scavenge tube (with new packing and retainer lubricated with PWA 36500 Assembly Fluid) at gearbox. Torque connection and lockwire.

(17) Install No. 1 bearing drain tube at tee on main bearing drain manifold. Torque connection and lockwire.

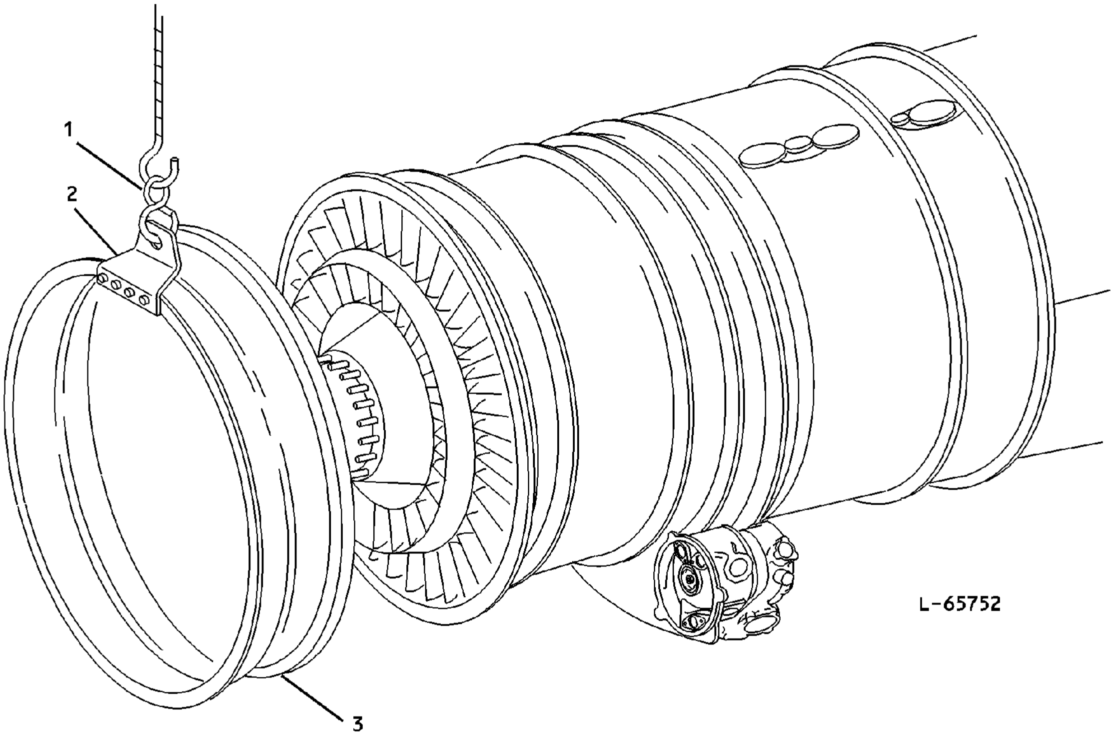
(18) Install No. 1 bearing pressure tube at oil cooler outlet connector, with new packing and retainer (lubricated with PWA 36500 Assembly Fluid).

D. Postrequisites

(1) Install front fan case (FRONT FAN CASE - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-68/401).

(2) Install 1st stage compressor hub and blades (FRONT COMPRESSOR GROUP - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-02/401).

(3) Install oil tank (OIL TANK - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-65/401).



LEGEND:
1. PWA 75135 HOOK
2. PWA 45004 BRACKET
3. REAR FAN CASE

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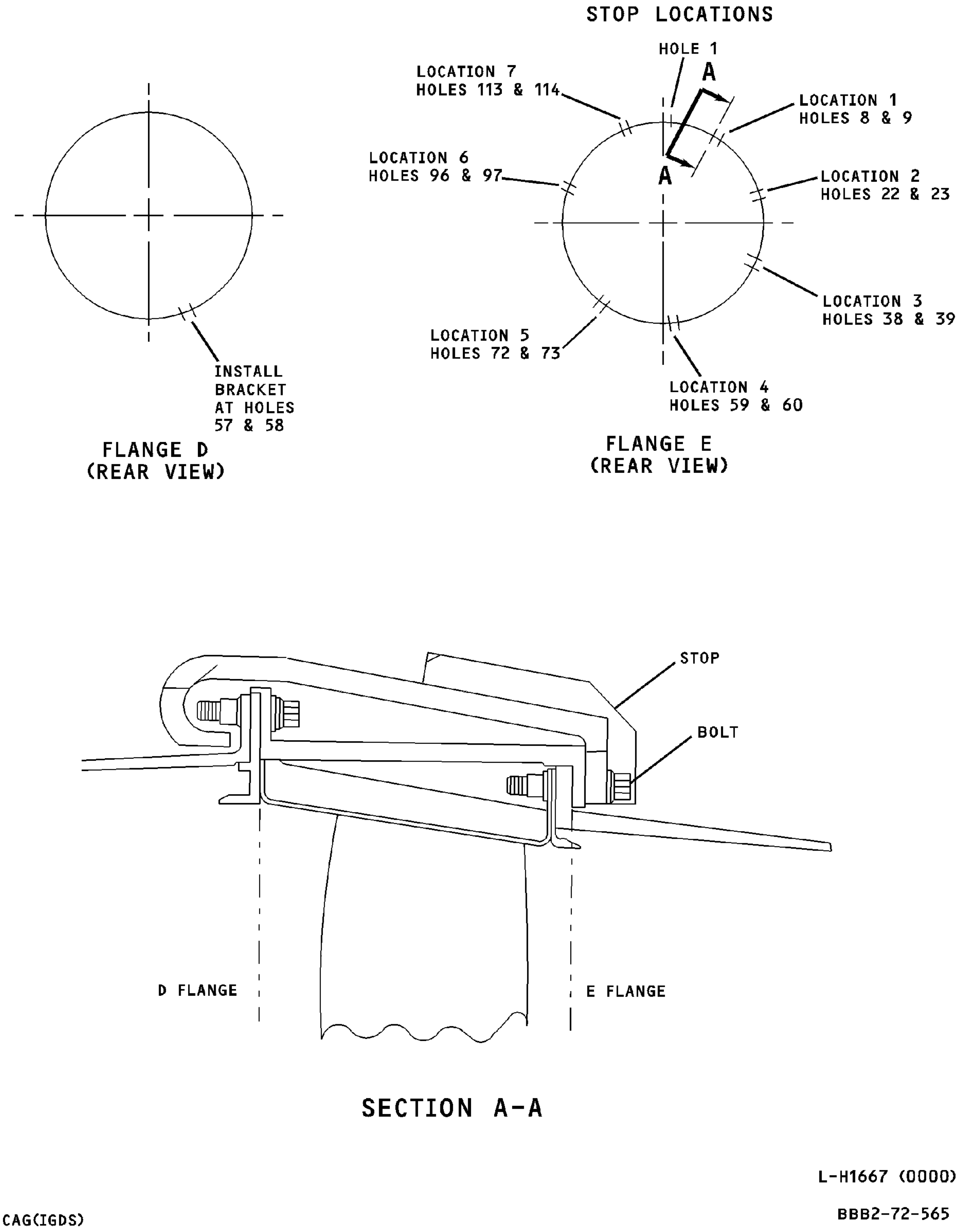
Rear Fan Case Installation
Figure 401/72-33-69-990-801



Fan Exit Guide-Vane Case Stop Installation (PN 810493)
Figure 402/72-33-69-990-802

REAR FAN CASE - REPAIR-01

1. Rubstrip Segment - Epoxy Restoration Repair (Small Cracks)

A. Prerequisites

(1) Do an inspection (ENGINE GENERAL, SUBJECT 72-00-00, Page 601).

B. Equipment and Materials

(1) Consumables

PWA 421-2 Epoxy Resin, Liquid

PWA 422-1 Curing Agent - Curing Agent, Amine-Type

Cab-O-Sil M5 (Thickening Agent)

PWA 457-4 Epoxy Compound, Liquid

C. Procedure. (Figure 801) (Table 801)

NOTE: Small crack repair is for gaps 0.003 inch (0.076 mm) or less.

(1) Clean area of crack by SPOP 208 solvent wipe method. (Ref. Standard Practices Manual, Section 70-00-00).

(2) Apply heated dry air to crack area. Raise temperature to 150° - 180°F (65.6° - 82.2°C). Hold until crack area is completely dry and rubstrip material around crack has stabilized at evaluated temperature.

(3) Seal crack immediately with epoxy mixture (describe below) while rubstrip material is still hot.

(4) Mix epoxy as follows:

(a) Mix 100 parts/weight of PWA 421-2 Curing Agent, 25 parts/weight of PWA 422-1 Epoxy Resin, and 5 parts/weight of Cab-O-Sil M5 Thickening Agent.

NOTE: Additional thickening agent may be added until consistency of mixture is reached that applies to application. Use caution when mixing because too much of thickening agent may effect epoxy adhesion properties.

(b) Allow epoxy mixture to cure at room temperature 65° - 85°F (18.3° - 29.4°C) and relative humidity at 45-55 percent for a minimum of two hours.

(5) Restore rubstrip grooves by Figure 801 and Table 801.

(6) Do an inspection of case assembly (ENGINE GENERAL, SUBJECT 72-00-00, Page 601).

NOTE: It is permitted to substitute epoxy used in Paragraph 1.C.(4) above with mixture that follows:

(a) Use PWA 457-4 Liquid Epoxy Compound to mix resin and curing agent as follows:

1) Mix 100 parts/weight of part A with 30 parts/weight of part B.

2) Cure epoxy for 24 hours at room temperature or 150° ± 10°F (65.6° ± 5.6°C) for 90 minutes minimum.

2. Rubstrip Segment - Epoxy Restoration Repair (Large Cracks)

A. Prerequisite

(1) Do an inspection (ENGINE GENERAL, SUBJECT 72-00-00, Page 601).

B. Equipment and Materials

(1) Consumables

PWA 421-2 Epoxy Resin, Liquid

PWA 422-1 Curing Agent - Curing Agent, Amine-Type

PWA 450-1 Microballons, Glass

Cab-O-Sil M5 (Thickening Agent)

PWA 457-4 Epoxy Compound, Liquid

C. Procedure. (Figure 801), (Table 801)

NOTE: Large crack repair is for gaps greater than 0.003 inch (0.076 mm).

(1) Rout out crack area completely to make a groove in rubstrip segment surface which will result in 45° sides.

(2) Clean routed area by SPOP 208 solvent wipe method (Ref. Standard Practices Manual, Section 70-00-00).

(3) Mix patch epoxy material by method that follows: (for rubstrip segment material PWA 635 Molded Epoxy Composite).

(a) Mix 100 parts/weight of PWA 421-2 Liquid Epoxy Resin, 25 parts/weight of PWA 422-1 Curing Agent, 25 parts/weight of PWA 450-1 Glass Microballons, and 5 parts/weight of Cab-O-Sil M5 Thickening Agent.

NOTE: Additional thickening agent may be added until mixture reaches consistency applicable to application. Use caution when you are mixing because too much use of thickening agent may effect epoxy adhesion properties.

(4) Patch crack area with a clean, dry tool. Hold epoxy in position with tape.

NOTE: Flashing tape is available as TM6044-02 from Taconic Plastics Ltd., 3070 Skyway Drive, Building 502, Santa Maria, CA 93455.

(5) Allow epoxy mixture to cure at room temperature at 65° - 85°F (18.3° - 29.4°C) and relative humidity at 45-55 percent for a minimum of two hours.

(6) Remove tape and blend repair surface area flush with machine inside diameter of rubstrip segment.

(7) Cut rubstrip groove to dimensions shown in Figure 801, Table 801.

(8) Do an inspection (ENGINE GENERAL, SUBJECT 72-00-00, Page 601).

(9) It is permitted to substitute epoxy mixture used above with mixture that follows:

(a) Use PWA 457-4 Liquid Epoxy Compound and mix resin and curing agent with 100 parts/weight of part A and 30 parts/weight of part B.

(b) Cure epoxy for 24 hours at room temperature or 150° ± 10°F (65.6° ± 5.6°C) for 90 minutes minimum.

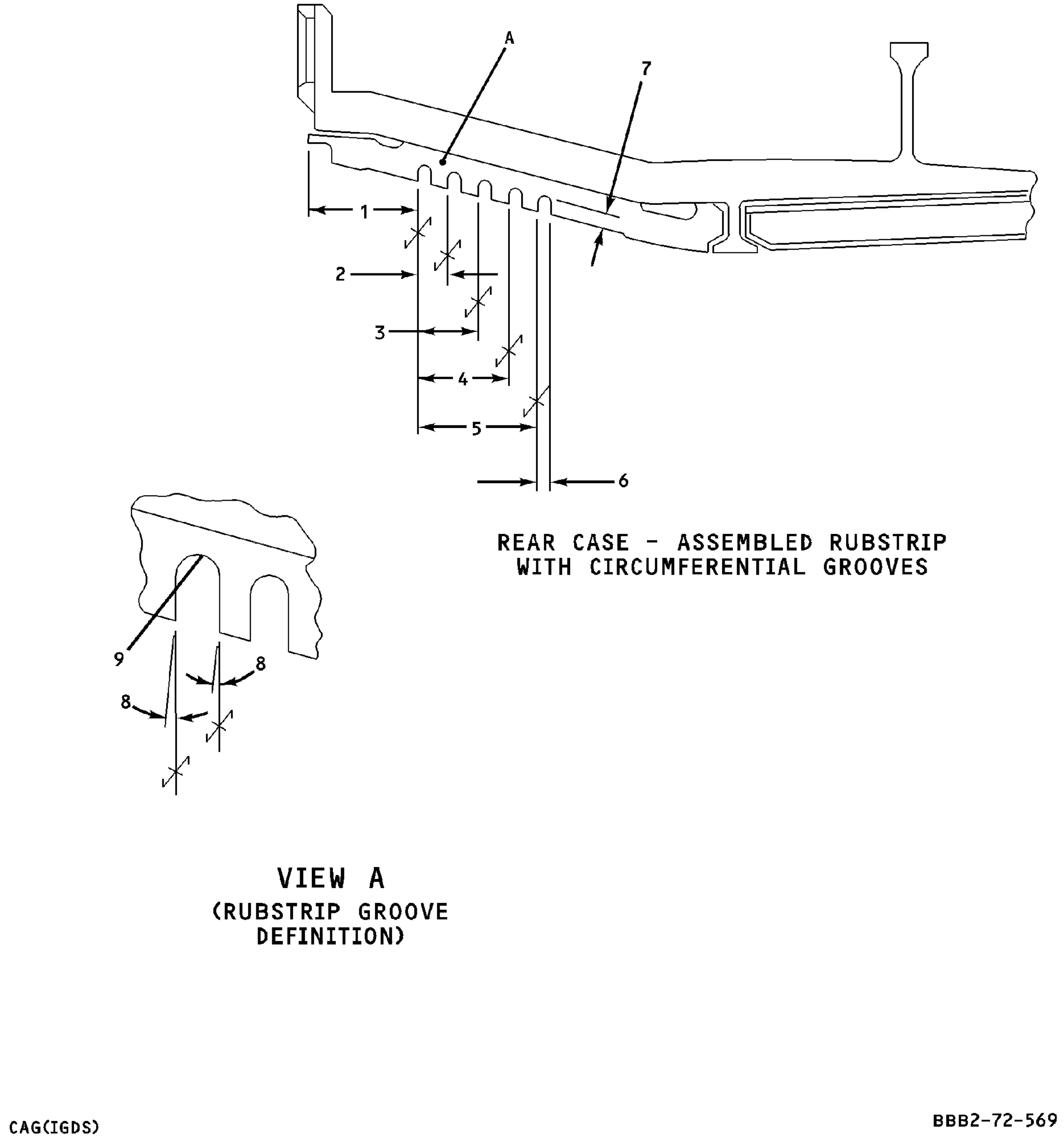
Table 801

Key to Figure 801

Index No.	Nomenclature
1	1.065 - 1.095 Inches (27.05 - 27.81 mm)
2	0.290 - 0.310 Inch (7.37 - 7.87 mm)
3	0.590 - 0.610 Inch (14.99 - 15.49 mm)
4	0.890 - 0.910 Inch (22.61 - 23.11 mm)
5	1.190 - 1.210 Inches (30.23 - 30.73 mm)
6	0.170 - 0.180 Inch (4.32 - 4.57 mm), 5 Places
7	0.207 - 0.237 Inch (5.26 - 6.02 mm)

Table 801 (Continued)

Key to Figure 801	
Index No.	**Nomenclature**
8	1°15' ± 1°15', 5 Places
9	Radius, 5 Places



Restoration of Rubstrip Segment Grooves
Figure 801/72-33-69-990-803

FAN EXIT FAIRING - REMOVAL/INSTALLATION-01

1. Remove Fan Exit Fairing

A. Prerequisites

(1) Remove nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)

(2) Remove N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(3) Remove 1st stage compressor disk and blades assembly. (FRONT COMPRESSOR GROUP - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-02/401)

Or

(4) Remove 1st stage compressor blades. (COMPRESSOR BLADES, FIRST STAGE - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-21/401)

B. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Remove screws securing fan exit fairing to 1st stage compressor stator.

(2) Remove fan exit fairing.

2. Install Fan Exit Fairing

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

B. Procedure. (Figure 401)

(1) Install fan exit fairing on 1st stage compressor stator, lining up screw holes.

(2) Install screws and torque.

C. Postrequisites

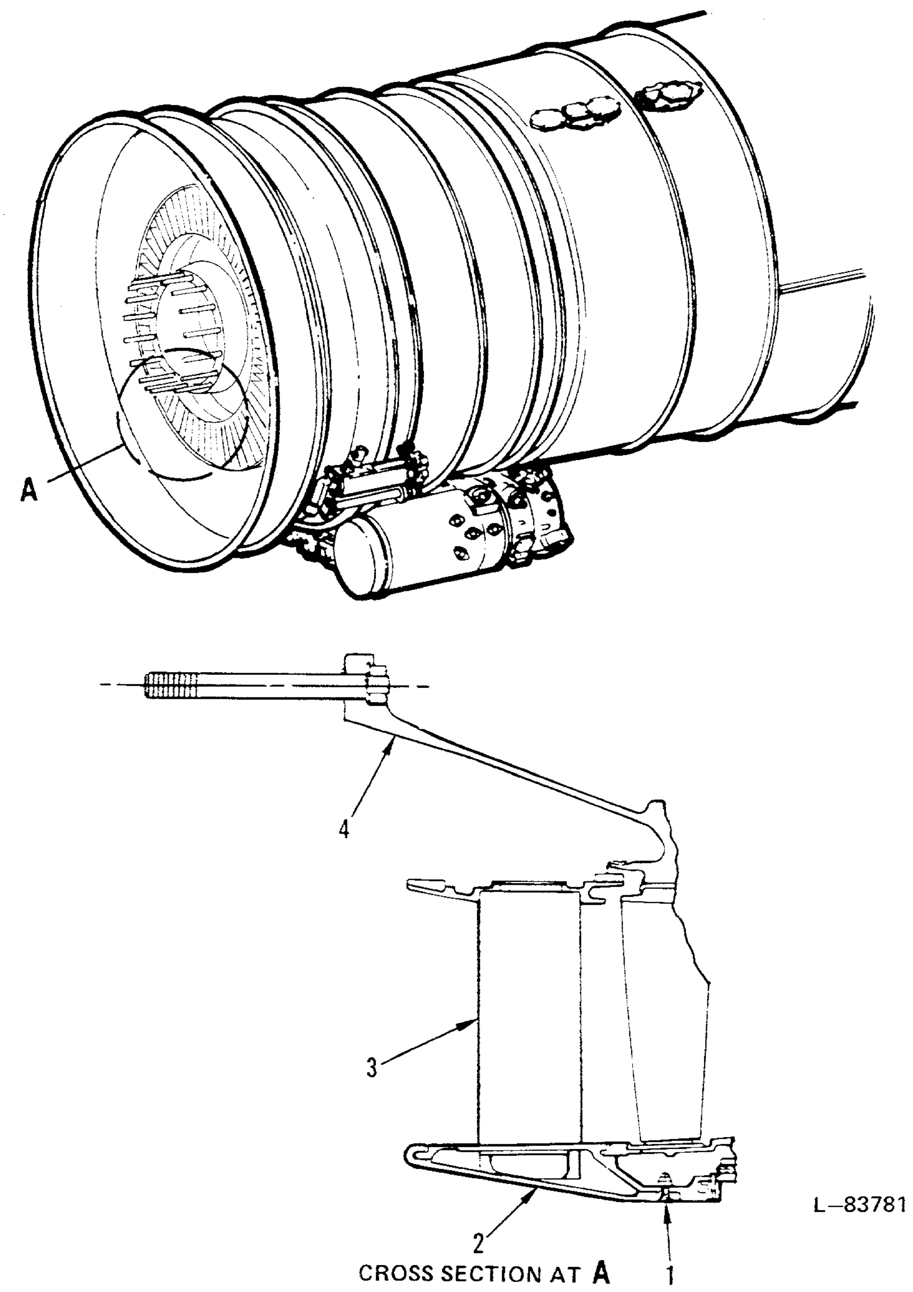
(1) Install 1st stage compressor disk and blades assembly. (FRONT COMPRESSOR GROUP - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-02/401)

Or

(2) Install 1st stage compressor blades. (COMPRESSOR BLADES, FIRST STAGE - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-33-21/401)

(3) Install N1 tachometer generator. (N1 TACHOMETER GENERATOR - MAINTENANCE PRACTICES, PAGEBLOCK 77-12-02/201)

(4) Install nose cowl. (NOSE COWL, SUBJECT 71-10-01, Page 201)



1. Screw (28 Required)
2. Fan Exit Fairing
3. 1st Stage Compressor Stator
4. 1.5 Stage Compressor Disk

BBB2-72-256

Fan Exit Fairing Removal/Installation
Figure 401/72-33-70-990-801

FAN EXIT STATOR SEGMENTS - REPAIR-01

1. Fan Exit Vane Blending

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

B. Procedure. See Figure 801.

(1) Local isolated damage to leading and trailing edges of aluminum vanes can be repaired by blending.

(2) Blends to maximum depth on both leading and trailing edge must not be at some radial station and must be separated by minimum diagonal distance of 2.500 inches (63.500 mm). A minimum diagonal distance of 2.375 inches (60.325 mm) is permitted, if not more than three vanes (that are not adjacent) per segment and no more than six segments in an engine are blended to this limit.

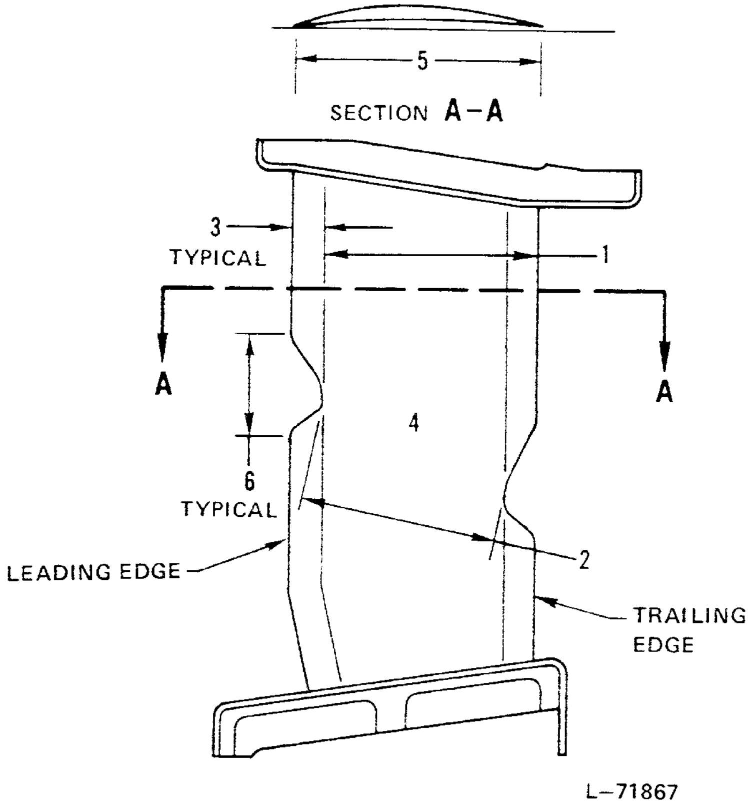
(3) Blends not to maximum depth limit on leading and trailing edges and at some radial station are acceptable provided chordal distance between blends is not less than 2.500 inches (63.500 mm). A minimum chordal distance between blends of 2.375 inches (60.325 mm) is permitted, if not more than three vanes (that are not adjacent) per segment and no more than six segments in an engine are blended to this limit.

(4) Local isolated injuries to convex and concave surfaces can be blended out provided depth of removal does not exceed 0.020 inch (0.508 mm). round bottom dents up to 0.020 inch (0.508 mm) deep on convex and concave surfaces are accept-able without blending. No cracks in vanes are allowed. Local blending must extend over an area at least 15 times depth of injury.

(5) Surface finish on repaired vanes must be comparable to that of a new vane.

(6) Total length of combined leading and trailing edge blends or leading and trailing edge blends singularly must not exceed 1.500 inches (38.100 mm) per vane when blending to maximum allowed. If blend depth is less than three quarters maximum allowed, total blend length may be 2.250 inches (57.150 mm). If blend depth is less than one-half maximum allowed, total blend length may be 3.000 inches (76.200 mm).

(7) Radial length of blend must be minimum of three times depth of blend.



1. 2.500 Inches (63.500 mm) Minimum Allowable Chordal Length, 2.375 Inches (60.325 mm) In No More Than Three Vanes (That Are Not Adjacent) Per Segment And No More Than Six Segments Per Engine.
2. 2.500 Inches (63.500 mm) Minimum Diagonal Separation 2.375 Inches (60.325 mm) In No More Than Three Vanes (That Are Not Adjacent) Per Segment And No More Than Six Segments Per Engine.
3. 0.375 Inch (9.525 mm) Maximum Blend Depth Limit For LE and TE 0.500 Inch (12.700 mm) In No More Than Three Vanes (That Are Not Adjacent) Per Segment And No More Than Six Segments Per Engine.
4. 0.060 Inch (1.524 mm) Maximum Round Bottom Dents
5. 2.875 Inches (73.025 mm) Chordal Length Reference
6. Blend Length. Leading And Trailing Edge Radii Are To Be Restored In This Area.

BBB2-72-190

Fan Exit Vane Blend Limits
Figure 801/72-33-80-990-801

COMPRESSOR INTERMEDIATE SECTION - DESCRIPTION

1. Compressor Intermediate Case Assembly

At the rear of the front compressor rotor is the compressor inter-mediate case. This case provides support for the rear of the front compressor rotor and the front of the rear compressor rotor through bearing housing structures, and extends outward to form the outer wall of the engine between Flanges F and G. Reinforced case rails at these two flange positions provide the front mounting point for the engine and the attachment point (at the bottom) for the main accessory gearbox. In the engine gaspath, 6th stage vanes integral with the case turn front compressor discharge air for entry into the rear compressor. In the fan bypass, streamlined integral case struts allow the passage of bypass air.

The bearing support features of the compressor intermediate case consist of a bore in the front side to accept the No. 2 bearing and its seal assembly and an extended support structure on the rear side in which the No. 3 bearing housing assembly fits. Accessory drive features transmitting power from the rear compressor rotor to the gearbox are also supported by a gearbox drive bearing housing at the 6 o'clock position in the compressor intermediate case. The gearbox drive bevel gearshaft and gearbox drive shaft (towershaft) run vertically downward through the gearbox drive bearing housing to the main accessory gearbox, which is attached to the bottom of the compressor intermediate case.

Internal tubing in the case accepts pressure oil from the main accessory gearbox and directs it to a nozzle which lubricates the No. 2 and 3 bearings and the gearbox drive bevel gearshaft bearings. See ENGINE GENERAL - DESCRIPTION, PAGEBLOCK 72-00-00/001 for details of this oil delivery system.

2. Front Compressor Inner/Outer Ducts And Liners

Extending forward from the compressor intermediate case, on the inner and outer side of the fan bypass stream, are the front compressor inner and outer ducts and sound absorbing liners. The inner and outer duct structures are bolted to the front of the compressor intermediate case; the inner sound absorbing liner is bolted at its front end to the 3rd stage compressor case, and the front compressor outer fan duct is bolted to the fan exit case at Flange E. The inner liner and the outer fan duct both contain sound absorbing material to reduce noise emitted by the fan stream. The outer duct also features borescope bosses which allow inspection of the 6th compressor stage.

WJE 875-879

3. Rear Compressor Case

The rear compressor case is riveted to the rear of the compressor intermediate case and extends rearward around the outside of the rear compressor rotor. This case is bolted at the rear to the diffuser case front flange. Mounted on the wall of the rear compressor case are 8th stage bleed valves (two for JT7D-209, -217 and -217A, three for JT8D-217C and JT8D-219) which bleed 8th stage compressor air into the fan stream. (COMPRESSOR CONTROL - DESCRIPTION AND OPERATION, PAGEBLOCK 75-30-00/001 Config 1)

WJE 401-412, 414-427, 429, 861-866, 868, 869, 871-874, 880, 881, 883, 884, 886, 887, 891-893

4. Rear Compressor Case

The rear compressor case is riveted to the rear of the compressor intermediate case and extends rearward around the outside of the rear compressor rotor. This case is bolted at the rear to the diffuser case front flange. Mounted on the wall of the rear compressor case are 8th stage bleed valves (two for JT7D-209, -217 and -217A, three for JT8D-217C and JT8D-219) which bleed 8th stage compressor air into the fan stream. (COMPRESSOR CONTROL - DESCRIPTION AND OPERATION, PAGEBLOCK 75-30-00/001 Config 2)

WJE ALL

5. No. 3 Bearing Housing Assembly

The No. 3 bearing and its related labyrinth airseals and carbon oil seals, together with the gearbox drive bevel gear, are contained in a removable No. 3 bearing housing assembly. This housing assembly is bolted into a support on the rear of the compressor intermediate case. Internal passages in the case support carry breather and scavenge oil inward toward the center of the No. 2 and 3 bearing compartment, away from the No. 3 bearing housing. Heatshields around the rear of the bearing housing protect the No. 3 bearing and seals from excessive heat.

6. Gearbox Drive Bevel Gear And Gearshaft

The gearbox drive bevel gear (on the front of the rear compressor rotor, supported by the No. 3 bearing) mates with the gearbox drive bevel gearshaft and transmit rotor power to the gearshaft. The gearbox drive bevel gearshaft rides in upper roller and lower ball bearings at the bottom of the No. 2 and 3 bearing compartment. A coupling at the lower end of the gearbox drive bevel gearshaft connects the gearshaft with the gearbox drive shaft (towershaft) which extends downward to the main accessory gearbox through an enlarged vane and strut at the 6 o'clock position in the compressor intermediate case.

REAR COMPRESSOR SECTION - DESCRIPTION

1. Rear Compressor Rotor and Stator Assembly

The rear compressor rotor and stator assembly receives air compressed and accelerated by the front compressor and compresses and accelerates the air further before delivering it into the diffuser section. The rear compressor consists of seven rotor stages, with a stage of stator vanes following every rotor stage. The last rotor stage, the 13th stage, is followed by the compressor exit stator, which is part of the diffuser case assembly and is described in DIFFUSER SECTION, SUBJECT 72-37-00Section.

The rear compressor rotor is driven by the rear compressor drive (1st stage) turbine through the rear compressor drive turbine shaft. This shaft splines into the rear compressor rear hub and is secured by a turbine shaft coupling. The rear hub extends rearward from the 13th stage compressor disk into the No. 4 bearing; the rear compressor front hub is integral with the 8th stage compressor disk and extends forward through the 7th stage compressor disk into the gearbox drive bevel gear (supported by the No. 3 bearing). For oil sealing purposes, a rear compressor rotor tube extends from the front hub to the rear hub, isolating the inner rotor space from the front compressor drive turbine shaft which passes through it.

Each rear compressor rotor stage consists of a disk and blade assembly. The blades of the 7th stage are secured around the circumference of the disk with axial root pins; the blades of the 8th through the 13th stages are held in dovetail-shaped slots in the same manner as in the front compressor. The disk and blade assemblies are separated by disk spacers which carry knife-edge seals mating with stator sealing rings. The disks, hubs and spacers are held together by tiebolts extending the full length of the rotor.

REAR COMPRESSOR SECTION - INSPECTION/CHECK

1. General

A. This procedure contains MSG-3 task card data.

TASK 72-36-00-290-801

2. Special Detailed Inspection of the 13th Stage Compressor Blades Aft Face (Borescope)

NOTE: This procedure is a scheduled maintenance task.

A. Tools/Equipment

NOTE: When more than one tool part number is listed under the same "Reference" number, the tools shown are alternates to each other within the same airplane series. Tool part numbers that are replaced or non-procurable are preceded by "Opt:", which stands for Optional.

Reference	Description
SPL-9531	Puller - Inner Liner Bolts **MD80-81, -82, -83, -88** Part #: PWA45248 Supplier: 77445
SPL-9532	Adapter - Rotor Tuning Tool **MD80-81, -82, -83, -88** Part #: PWA10408 Supplier: 77445

B. Special Detailed Inspection of the 13th Stage Compressor Blades Aft Face (Borescope)

SUBTASK 72-36-00-010-001

(1) Unbolt and remove cover from two or ten o'clock position on diffuser outer fan duct. Remove and discard cover packing.

SUBTASK 72-36-00-010-002

(2) Remove cover in diffuser sound absorbing liner segment as follows:

   (a) Thread puller, SPL-9531 into threaded hole in center of cover.

   (b) Using 7/32 (5 mm) hex wrench, loosen inner liner bolts until they are free of mating boss (they will be retained by cover flange).

SUBTASK 72-36-00-010-003

(3) Remove instrumentation boss cover from diffuser case as follows:

   (a) Thread PWA 45248 puller into threaded hole in cover.

   (b) Loosen two 5/16-inch (8 mm) bolts securing cover until they are free of diffuser case boss (they will be retained by plug flange).

   (c) Using knocker detail of puller, remove cover.

CAUTION: ENGINE INTERNAL TEMPERATURES IN EXCESS OF 149°F (65°C) MAY DAMAGE FIBER OPTIC BORESCOPE COMPONENTS. ENGINE INTERIOR MUST BE ALLOWED TO COOL BELOW 149°F (65°C) FOLLOWING ENGINE OPERATION PRIOR TO INSERTING BORESCOPE. ALLOW COOLDOWN PERIOD ON NEWLY SHUTDOWN ENGINE PRIOR TO INSPECTION TO ENSURE THAT PERSONNEL ARE NOT INJURED AND EQUIPMENT IS NOT DAMAGED. DO NOT ATTEMPT TO REMOVE FOUR NUTS WHICH RETAIN SPARK IGNITER PACKING HOLDER ON RIGHT SIDE OF ENGINE AS BOLTS ARE NOT RETAINED ON INNER SIDE OF FAN DUCT.

(4) Allow approximately two hours after engine shutdown before beginning borescope inspection when outside temperature is approximately 75°F (24°C); allow approximately two and a half hours if outside temperature is above 80°F (27°C), and allow approximately one hour if temperature is 30°F (-1°C) or lower. Rate of cool down can be increased by motoring engine after shutdown with starter for 30 second periods.

SUBTASK 72-36-00-290-001

(5) Using borescope, inspect condition of 13th stage blades and compressor exit stator.

NOTE: Turn rotor using adapter, SPL-9532 in gearbox starter drive to bring all blades into view.

NOTE: There are 74 blades in the 13th stage compressor rotor and 99 vanes in the compressor exit stator.

(a) Thirteenth stage blade leading and trailing edge damage must not exceed limits given. (Figure 601)

(b) If blade damage exceeds limits given, engine must be removed and disassembled for compressor repair.

SUBTASK 72-36-00-290-002

(6) Using borescope inspect all 13th stage compressor blades for airfoil tip fractures. For this inspection an airfoil tip fracture is defined as a fracture originating at blade airfoil tip and extending to blade trailing edge. (Figure 602)

(a) Engines may continue in service provided only one compressor blade is fractured, as described above. These engines must be re-borescope inspected at intervals not to exceed 450 hours.

(b) Engines with more than one blade tip fracture, as described above, must be removed from service within 100 hours and disassembled for compressor repair.

(c) Engines with a single 13th stage blade with multiple fractures must be removed from service within 100 hours and disassembled for compressor repair. (Figure 602)

(d) Damage limits must be maintained for 13th stage compressor blade leading and trailing edges as described in step B (5).

(e) All other required operational parameters and limits must be maintained.

SUBTASK 72-36-00-290-003

(7) Using borescope, inspect diffuser case and edges of borescope hole for cracks.

SUBTASK 72-36-00-410-001

(8) Prepare instrumentation boss cover for installation as follows:

(a) Thread PWA 45248 puller into cover to facilitate handling cover.

(b) On Part Number (P/N) 775980 cover ensure that sealing ring is centralized so as not to jam when cover is installed.

NOTE: P/N 792712 centering ring may be used inside sealing ring to take up internal space in ring groove of P/N 775980 cover, facilitating centering of outer ring. Subsequent P/N 792704 cover does require optional use of centering ring.

(c) The large chamber on the P/N 807417 seal ring must face towards the tip of the cover shank.

SUBTASK 72-36-00-410-002

(9) Insert cover into instrumentation boss on engine case, lining up bolts with bolt holes. Secure cover with bolts and torque bolts to 62 – 72 in-lb. (7.005 – 8.135 N.m).

NOTE: Torque only applies if anti-seize paste is applied.

NOTE: The self-locking nuts on the instrumentation boss covers are silver plated to prevent seizure of the bolts. However, the plating may no longer be effective after several of the bolts have been removed several times. To prevent bolt lock up, it is optional to apply wet anti-seize paste PWA 36246 to the bolt threads.

SUBTASK 72-36-00-410-003

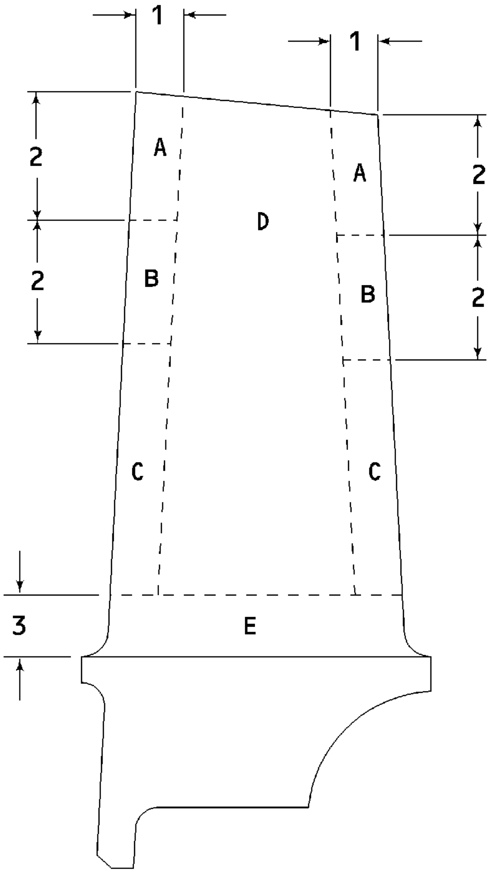
(10) Position inner liner cover in place, using PWA 45248 puller to hold cover. Turn fasteners to secure cover and torque fasteners to 40 - 60 in-lb. (4.519 - 6.779 N.m).

SUBTASK 72-36-00-410-004

(11) Install packing, lightly coated with PWA 36500 assembly fluid, on fan duct cover and bolt cover in place. Torque bolts.

——— END OF TASK ———

AREA	ACCEPTABLE DAMAGE LIMITS
A	ANY DAMAGE UP TO 1/16 INCH (1.588mm) ANY ROUND BOTTOMED DAMAGE UP TO .135 INCH (3.429mm) NO TEARS OR CRACKS ALLOWED BEYOND 1/16 INCH (1.588mm)
B	ANY DAMAGE UP TO 1/16 INCH (1.588mm) ANY ROUND BOTTOMED DAMAGE UP TO .135 INCH (3.429mm) NO TEARS OR CRACKS ALLOWED BEYOND 1/16 INCH (1.588mm)
C	INDENTATIONS UP TO 1/32 INCH (0.793mm) NO TEARS OR CRACKS
D	ANY INDENTATION NO TEARS OR CRACKS
E	INDENTATION UP TO 0.010 INCH (0.254mm) NO TEARS OR CRACKS



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NOTE:

DAMAGE THAT TRANSCENDS DEFINED BOUNDARIES CAN BE ADDRESSED BY ALLOWING THE GREATER DAMAGE LIMIT TO PREVAIL (NO TEARS OR CRACKS ALLOWED IN AREAS "C" OR "D". THIS NOTE DOES NOT APPLY BETWEEN BOUNDARY "C" TO "E" OR "D" TO "E".

1. 3/16 Inch (4.762 mm)
2. 1/4 Inch (6.350 mm)
3. 1/8 Inch (3.175 mm)

CAG(IGDS)

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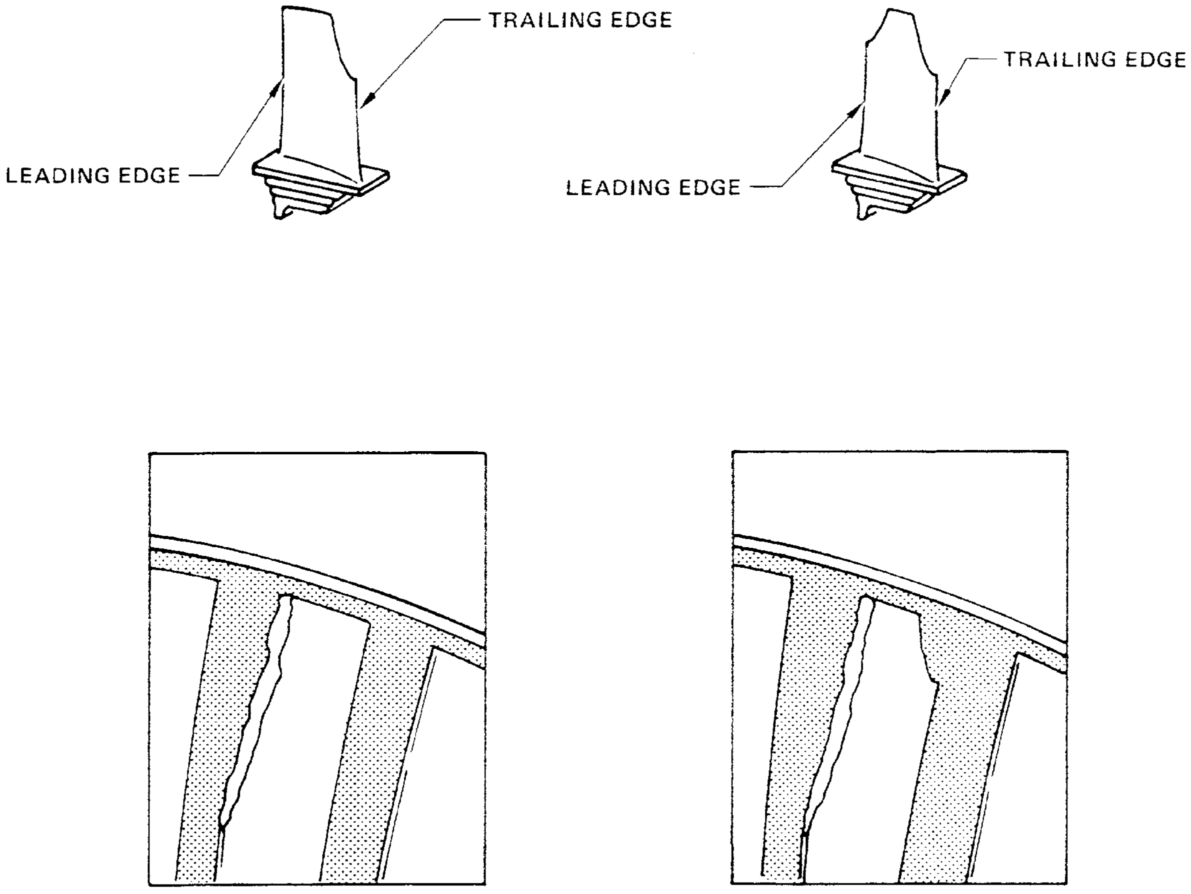
Thirteenth Stage Blade Inspection Limits
Figure 601/72-36-00-990-801



TYPICAL SINGLE FRACTURE WITH TRAILING EDGE TIP LOSS

TYPICAL MULTIPLE FRACTURE WITH TRAILING EDGE AND LEADING EDGE TIP LOSS

Thirteenth Stage Blade Tip Fractures
Figure 602/72-36-00-990-802

COMPRESSOR BLADES, SEVENTH STAGE - REPAIR-01

1. Seventh Stage Compressor Blade Airfoil Blend Repair (For An Assembled Engine)

A. Prerequisite

(1) Remove the borescope cover and plug. Do a borescope inspection of the 7th stage compressor blades. See ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1, Paragraph titled “Borescope Inspect Sixth And Seventh Stage Compressor Blades”.

NOTE: You can use the borescope equipment from this repair to do the borescope inspection.

B. Equipment and Materials Required

(1) Standard Tools:

Machida Borescope and Power Blending Set Model No. MA-KPDA2 or Equivalent

The vendor for the above required standard tool is as follows:

Machida, Inc.

40 Ramland Road South

Orangeburg, NY 10962-2698

USA

(2) Special Tools

PWA 10408 Adapter or Equivalent

C. General

(1) The purpose of this repair is to blend the leading edge of damaged 7th stage compressor blades, found by routine damage inspection, in an assembled engine. Seventh stage blades that are damaged more than the borescope limits (see Prerequisite above) can be blend repaired to the limits of this repair. This blend repair limit includes an additional 0.012 inch (0.305 mm) of undamaged material that must be removed beyond the damage depth.

(2) This procedure uses a flexible borescope with an attached power rotary file or rotary stone. The rotary file is used first to blend the damaged blade. The rotary stone is used second to remove burrs. A video monitor is attached to see the blades and rotary tools. Some video monitors have a video micrometer to measure the damage and blend depth and location. Access to the 7th stage blades is through either the 4 or 8 o'clock borescope ports.

(3) Persons selected to do this repair should first practice on a training unit or non flight worthy engine. You must do satisfactory blend repairs on practice blades before you repair flight worthy engines. For training procedures, contact the Pratt & Whitney department that follows:

Pratt & Whitney

Customer Training Center

Weathersfield, CT 06109 USA

D. Procedure

WARNING: DO THE BORESCOPE INSPECTION IN AN AREA WHICH HAS PROTECTION FROM THE WEATHER. IF A BORESCOPE INSPECTION IS DONE IN WET CONDITIONS, USE SUFFICIENT PROTECTION TO PREVENT POSSIBLE ELECTRICAL SHOCK TO THE OPERATOR OR DAMAGE TO THE EQUIPMENT.

(1) Prepare the equipment as follows: (Figure 801)

(a) Attach the carbide rotary file to the end of the power blending scope. Tighten the jamnut.

NOTE: Make sure the jamnut is tight but do not tighten too much.

(b) Attach the camera to the power blending scope and lock with the thumbscrews. Attach the camera cable to the video system (video in).

(c) Turn the video power unit on.

(d) Connect the light guide to the light source and turn the power on.

(e) Calibrate the video micrometer.

NOTE: This step is only necessary if the video equipment has the video micrometer feature.

1) Install the calibration blade in the calibration fixture.

2) Install the blending scope in the calibration fixture.

3) Put the round brass guide from the rotary file over the leading edge of the calibration blade so the file rests on the leading edge.

4) Focus the camera on the blade and rotary file. Adjust the light source as necessary.

5) Choose a grid square on the calibration blade. First adjust the bottom X and left Y axis and then the top X and right Y axis on the screen to the size of the grid square on the blade.

6) Set the digital display on the screen to X = 0.100 and Y = 0.100.

7) Calibration is now complete. Remove the blending scope from the fixture.

NOTE: If the power is turned off to the video system, the calibration values will be lost.

All future measurements must be done with the rotary file installed, not the rotary stones.

(f) Slide the guide tube over the power blending scope.

(g) Put the blending scope into the borescope access port. While watching the video monitor, gently put the blending scope through the outer and inner compressor case ports.

(h) Slide the guide tube down the blending scope and into the borescope ports. Attach the guide to the access port with two bolts.

(i) Push the blending scope gently in until the tip touches the inner case. While watching the video monitor, rotate the outer articulating knob to turn the blending scope to the rear. Gently push the blending scope approximately 2 - 3 inches (51. - 76. mm) in. Rotate the inner articulating knob to turn the tip to the rear. Push the blending scope farther to the rear, the 7th stage blades should now be in view on the video monitor. The blending scope tip should not touch the 7th stage blade at this time. Lock the articulating knobs by pulling out on both knobs. Lock the blending scope by tightening the guide tube thumbscrew.

(j) Adjust the video picture with the focus adjustment. Adjust the light output as necessary. Rotate the camera to put the blade in a horizontal position on the video monitor.

(k) Attach the miniter drive motor as follows:

1) Rotate the lockring to the open position.

2) Gently install the miniter drive motor to the driveshaft.

3) Rotate the lockring to the closed position.

NOTE: The miniter drive motor must not be attached to the driveshaft whenever the blending scope is installed or removed from the engine.

4) Connect the miniter drive motor cord to the miniter power unit.

(l) Connect the foot pedal control to the miniter power unit.

CAUTION: THE MINITER DRIVE MOTOR MUST NOT TURN MORE THAN 4000 RPM FOR THIS REPAIR. DO NOT USE THE MANUAL MODE ON THE SELECTION SWITCH THAT IS ON THE BACK OF THE MINITER POWER UNIT. THE MANUAL MODE CAN PERMIT THE MOTOR TO TURN UP TO 15000 RPM.

(m) Set the control switch on the rear of the miniter power unit to the foot switch control position.

This position will automatically set the miniter drive motor speed to the 4000 rpm limit.

(n) Set the rotation direction to the forward mode on the miniter power unit and turn the power switch on.

(o) The equipment is now prepared for the blend procedure.

(2) Examine the 7th stage blades as follows: (Figure 802)

(a) Remove the air starter from the gearbox and install a PWA 10408 Adapter in the spline drive or install other equivalent tools that will turn the rear compressor rotor.

CAUTION: THE BLENDSCOPE TIP MUST NOT TOUCH THE 7TH STAGE BLADES WHENEVER YOU TURN THE COMPRESSOR ROTOR. YOU MUST RETRACT THE BLENDSCOPE FAR ENOUGH TO PERMIT THE 7TH STAGE BLADES TO TURN AND NOT TOUCH THE BLENDSCOPE. YOU CAN DAMAGE THE ENGINE OR BLENDSCOPE IF YOU DO NOT RETRACT THE BLENDSCOPE BEFORE YOU TURN THE COMPRESSOR.

(b) Have a helper slowly turn the rear compressor rotor while you examine all of the 7th stage blades (count 60 blades) on the video monitor. The maximum permitted damage depth is 0.012 inch (0.305 mm) less than the Figure 802 limits. This is necessary because an additional 0.012 inch (0.305 mm) of undamaged material must be removed during the blend procedure and still be less or equal to the Figure 802 limits. Use the video micrometer to determine the damage depth and radial location.

NOTE: You can not repair cracked blades, fractured blades or blades that cannot be blend repaired to the limits of Figure 802.

(3) Blend the 7th stage blades as follows:

(a) Select a damaged 7th stage blade on the video monitor. Put the rotary file over the damage on the leading edge of the blade.

(b) Adjust the thumbscrew on the guide tube to permit the blending scope to turn but will stay in position when you let go.

(c) Start the miniter drive motor by stepping on the foot pedal control.

(d) Slowly lower the rotary file onto the blade by manually twisting the blending scope. Gently apply a slight downward pressure on the blade. The tool will want to move in the direction of tool rotation along the leading edge. Apply pressure to the articulating knob to keep the rotating file located at the damage.

(e) Continue to machine the damage to the limits that follow:

1) The maximum depth after all blend repairs is shown in Figure 802.

2) An additional 0.012 inch (0.305 mm) of undamaged material must be removed beyond the damage depth and still be less than or equal to the Figure 802 depth limits.

3) The length of the blend (radial direction along the leading edge) must be four times the depth.

4) The total length of all blends along the leading edge must not be more than 25 percent of the total leading edge length.

5) Sharp edges or corners are not permitted.

6) Burrs and rolled over material are not permitted and must be removed.

NOTE: Burrs are removed with the rotary stones, not the rotary file.

(f) When you think the damage has been completely removed (except the burrs), stop the motor and push the blending scope until the tip is about 0.250 inch (6.350 mm) away from the damage. You may have to turn the compressor rotor to get a good view. Examine the blade to see if all the damage has been removed. If the damage has not been completely removed, continue the blending procedure until all the damage is removed. Blend to the Figure 802 limits which includes the removal of an additional 0.012 inch (0.305 mm) of undamaged material.

(g) Blend repair any other leading edge damage to this blade by the above procedure.

(h) Retract the blending scope away from the repaired blade.

(i) Turn the compressor to the next damaged blade and repeat the above procedure.

(j) Repeat this procedure until all the damaged blades have been blend repaired with the rotary file.

(k) After all blades have been blend repaired to the above procedure, turn the power off and remove the miniter drive motor.

NOTE: You must make all necessary measurements with the video micrometer before you remove the rotary file.

(l) Unlock the articulating knobs and loosen the guide tube thumbscrew.

(m) Remove the power blending scope.

CAUTION: DO NOT OVERHEAT THE BLADES WITH A CLOGGED ROTARY STONE. TITANIUM MATERIAL FROM THE BLADES WILL ATTACH TO THE STONE. YOU MUST DRESS THE STONE OR REPLACE THE STONE REGULARLY AS NECESSARY.

(n) Remove the rotary file and install the rotary stone. Tighten the jamnut.

NOTE: The rotary stone must be 0.380 inch (9.652 mm) diameter and be aluminum oxide material.

(o) Reinstall the power blending scope with the rotary stone by the above procedures.

(p) Put the rotary stone on a blended blade. The leading edge of the blade must be in the V-groove of the stone.

(q) Start the motor by stepping on the foot pedal and polish the blended area.

(r) To remove all the burrs, turn the compressor slightly forwards and backwards with the blade in the V-groove of the stone. This will remove the burrs on both sides of the blade.

(s) Stop the motor, and put the miniter motor control in reverse. Start the motor and polish the blended area again. This step will make both ends of the blend area smooth.

(t) When you think the burrs have been removed, stop the miniter motor. Push the blending scope until the tip is about 0.250 inch (6.350 mm) away from the damage. Turn the compressor rotor as necessary to get a good view. Examine the blade to see if all burrs have been removed.

(u) Polish any other blend areas on this blade by the above procedures.

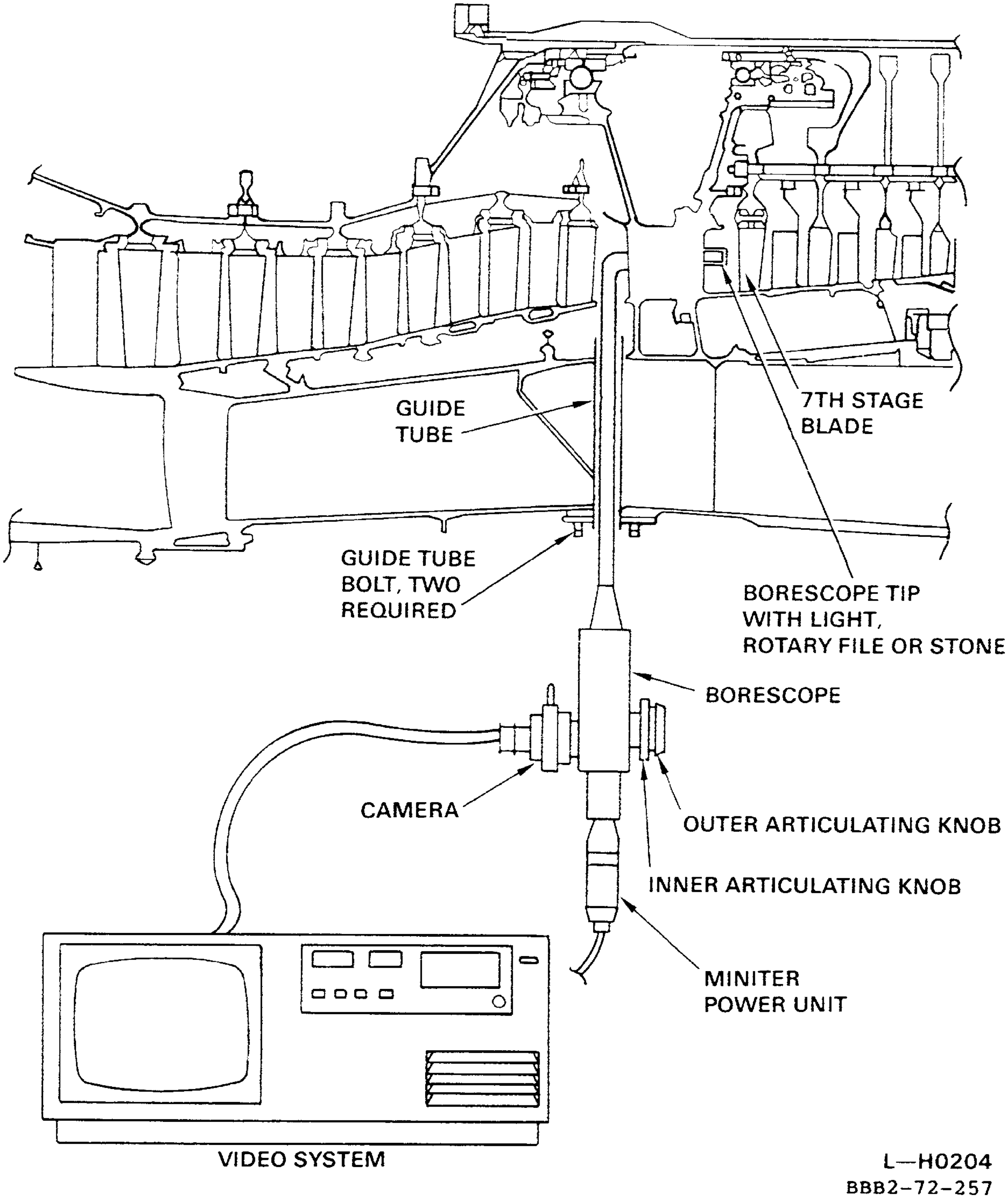
(v) Retract the blending scope away from the repaired blade.

(w) Turn the compressor rotor to the next blended blade and repeat the above polish procedure. Repeat until all blended blades have been polished.

(x) After all blades have been polished by the above procedure, turn the power off and remove the miniter motor. Unlock the articulating knobs and loosen the guide tube thumbscrew. Remove the blend scope. Remove the guide tube.

E. Postrequisite

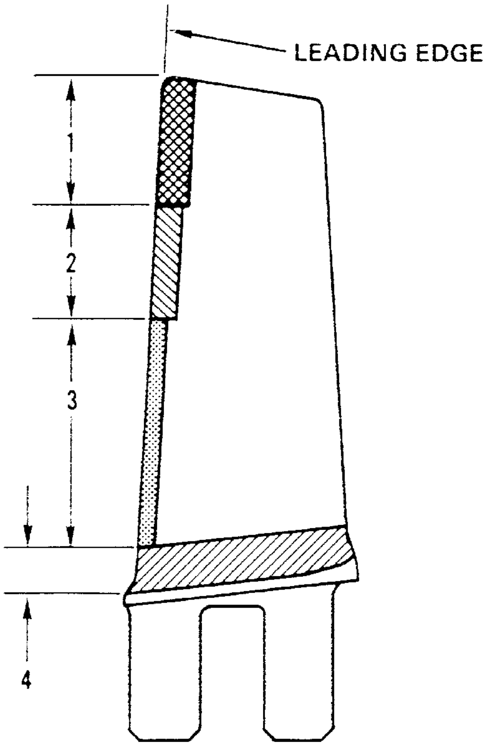
(1) Install the borescope cover and plug. See ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1 Paragraph titled "Borescope Inspect Sixth And Seventh Stage Compressor Blades".



Damaged 7th Stage Blade Blend Equipment For An Assembled Engine
Figure 801/72-36-31-990-801

BLADE AREA	MAXIMUM BLENDED DEPTH
▩	0.156 INCH (3.967 MM)
▧	0.125 INCH (3.175 MM)
░	0.062 INCH (1.588 MM)
▨	NO REPAIR PERMITTED

NOTE: THE ABOVE MAXIMUM BLENDED DEPTH LIMITS ARE AFTER ALL MACHINING. THESE LIMITS INCLUDE THE DAMAGE DEPTH BEFORE REPAIR PLUS AN ADDITION 0.012 INCH (0.305 mm) REMOVAL OF UNDAMAGED MATERIAL BEYOND THE DAMAGE DEPTH.



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1. 0.750 Inch (19.050 mm)
2. 0.625 Inch (15.875 mm)
3. Remaining Distance Between Indexes 2 And 4
4. 0.250 Inch (6.350 mm)

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Seventh Stage Blade Blend Limits For An Assembled Engine
Figure 802/72-36-31-990-802

DIFFUSER SECTION - DESCRIPTION

1. Diffuser Section - General

The function of the diffuser section is to straighten the air flow from the rear compressor and to diffuse the flow to the proper velocity for entry into the combustion chamber. The air passes through the last row of rear compressor blades at a fast rate of speed. This motion is both rearward and circular in pattern around the engine. A row of radial straightening exit guide vanes, located at the entrance of the diffuser case, slow the circular pattern and convert the velocity energy to pressure energy. After passing through these straightening vanes the air still has a strong rearward velocity. This velocity is so high that it would be nearly impossible to maintain a flame in the air stream. A gradually increasing cross section of the air passage decreases the velocity of the airflow and at the same time converts the velocity energy to pressure so that a flame can be sustained in the combustion section.

2. Diffuser Case

The main structural member of this section is the diffuser case. The forward part of this case is attached to the rearmost portion of the rear compressor case.

The exit stator assembly is bolted to flanges in the front opening of the diffuser case. This unit contains an inner shroud, outer shroud and small vanes brazed in place.

Located in the divergent section of the case are nine hollow struts having small circular openings on either side which supply compressor discharge air to an annulus around the diffuser case. The annulus provides the discharge air for fuel deicing and airframe use through two ports (upper left and upper right) on its outer perimeter.

Between the nine hollow struts, located radially hear the rear of the case are nine fuel nozzle support mounting pads. Behind the mounting pads are nine mounting lugs for the front of the individual combustion chambers.

3. No. 4 Bearing Housing

The No. 4 bearing housing is bolted to the rear side of the diffuser case and contains the duplex No. 4 ball bearing and its adjacent oil seal. A single seal drain tube leads accumulated oil downward from the No. 4 bearing seal assembly. The No. 4 and 5 bearing oil scavenge pump is bolted to the rear face of the No. 4 bearing housing and is driven by a gear on the rear compressor rear hub. This two-stage pump removed scavenged oil from the No. 4 and 5 bearing compartments and pumps it outward through diffuser case strut tubing to a scavenge oil tube on the outside of the engine.

DIFFUSER OUTER FAN DUCT SECTION - DESCRIPTION

1. The Diffuser Outer Fan Duct

2. The diffuser outer fan duct is a heavy, slightly conical duct which holds various connections carrying fuel, oil, and air in and out of the diffuser section of the engine. In addition to duct bosses on side of the case which carry oil pressure and scavenge fittings and fuel inlet tubes, an opening at the bottom of the duct carries the No. 4 bearing seal oil drain tube. The diffuser outer fan duct is also reinforced to support the fuel pressurizing and dump valve on the left side and the pressure ratio bleed control on the right. Bleed bosses on the upper left and right sides support rear compressor bleed manifolds and are for airframe bleed use. The diffuser outer fan duct is lined with sound-absorbent material for noise reduction in the fan bypass area.

NO. 4 BEARING AIR CHECK VALVE - REMOVAL/INSTALLATION-01

1. No. 4 Bearing Air Check Valve Removal

A. Prerequisites

(1) Access for No. 4 bearing air check valve is through the lower forward and aft cowl doors.

NOTE: Forward lower cowl door overlaps the aft lower cowl door and must be opened first.

(2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

B. Equipment And Materials Required

(1) Support Equipment

PWA 45336 Puller

(2) Consumables - None

C. Procedure. (Figure 401) (Table 401)

(1) Establish clip location for installation.

(2) Remove clip holding tube to engine.

(3) Remove four bolts securing No. 4 bearing air check valve to diffuser outer fan duct.

(4) Remove No. 4 bearing air check valve.

NOTE: With generator/CSD installed, interference may be encountered if check valve assembly and outer drain tube are removed as one unit.

(5) Remove No. 4 bearing outer drain tube using PWA 45336 Puller.

NOTE: Insert PWA 45336 Puller in outer drain tube (smaller tube) and turn hand knob to tighten tool in tube. Use handle of puller to overcome packing friction of tube and pull tube downward.

2. No. 4 Bearing Air Check Valve Installation

A. Equipment And Materials Required

(1) Support Equipment - None

(2) Consumables

Assembly Fluid (PWA 36500)

Petrolatum (PMC 9609)

B. Procedure. (Figure 401) (Table 401)

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Install dual Teflon piston ring seal and preformed packing, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum on the No. 4 bearing outer drain tube.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid, but it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(2) Install No. 4 bearing outer drain tube.

(3) Install check valve.

(4) Install and torque four bolts securing check valve.

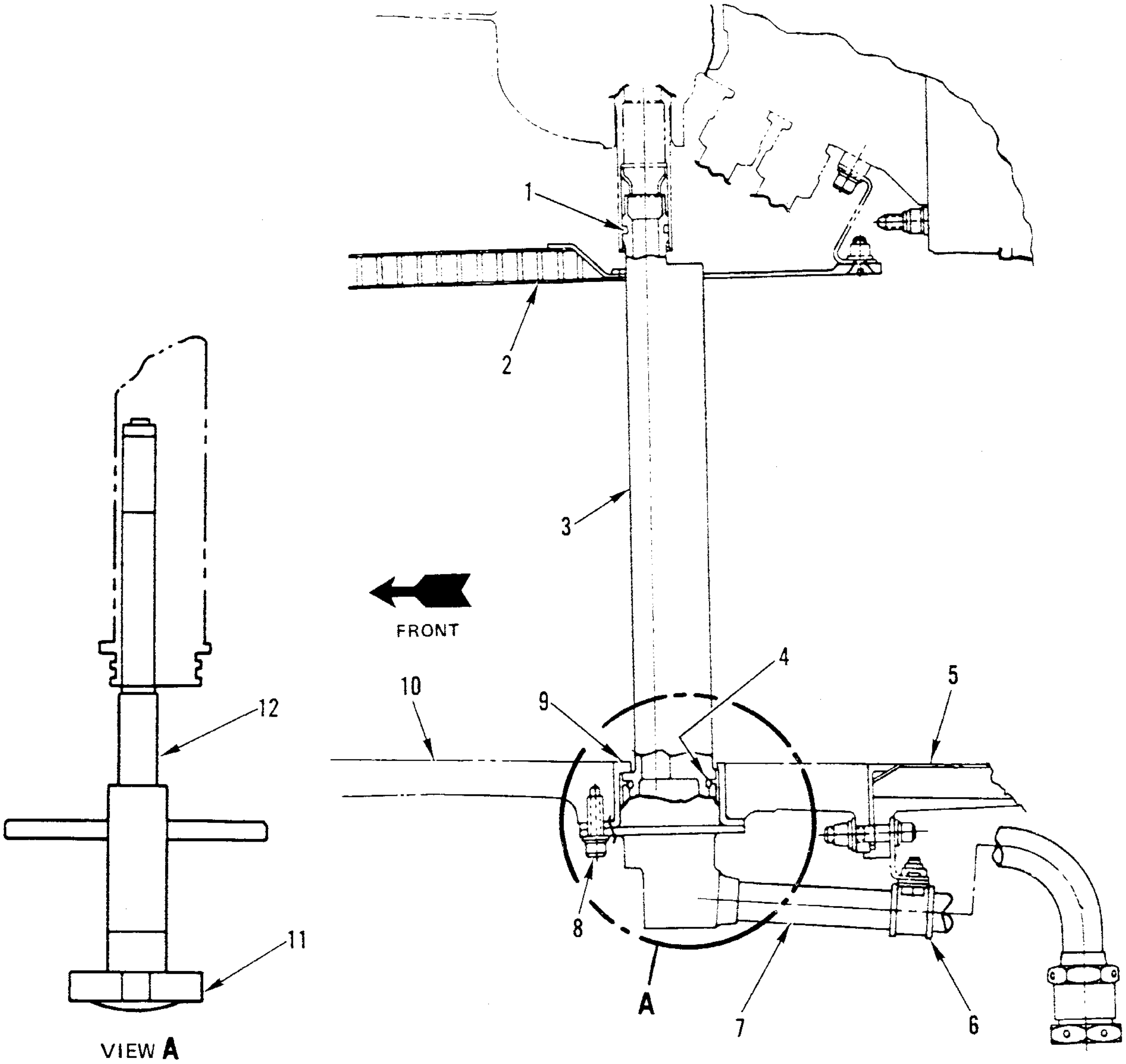
(5) Secure clip holding tube to engine.

C. Postrequisites

(1) For procedures to close lower forward and aft cowl doors, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

Table 401

Key to Figure 401	
Index No.	**Nomenclature**
1	Dual Teflon Piston Ring Seal Assembly
2	Diffuser Sound Absorbing Liner
3	No. 4 Bearing Outer Drain Tube
4	Preformed Packing
5	Combustion Chamber And Turbine Fan Duct
6	Clamp
7	No. 4 Bearing Air Check Valve
8	Bolt (Four)
9	Drain Tube Stop
10	Diffuser Outer Fan Duct
11	Hand Knob (Tighten To Grip Tube)
12	PWA 45336 Puller



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No. 4 Bearing Air Check Valve And Drain Tube Replacement
Figure 401/72-38-81-990-802

NO. 4 BEARING AIR CHECK VALVED - CLEANING-01

1. Clean No. 4 Bearing Air Check Valve

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment - None

(2) Consumables

PMC 3010 Cleaner

B. Procedure

(1) Clean carbon deposits from valve parts by SPOP 208 (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201) or by soft grit blasting with PMC 3010 cleaner if necessary. Clean ball by SPOP 208 and soft bristle brush.

(2) Inspect parts for wear after cleaning.

NO. 4 BEARING AIR CHECK VALVE - REPAIR-01

1. Repair No. 4 Bearing Air Check Valve

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

B. Procedure. See Figure 801.

(1) Remove retaining ring while holding stop and ball in place.

(2) Remove stop, ball, and spring.

(3) Clean valve parts per Cleaning-01.

(4) Inspect parts for physical damage and replace as necessary.

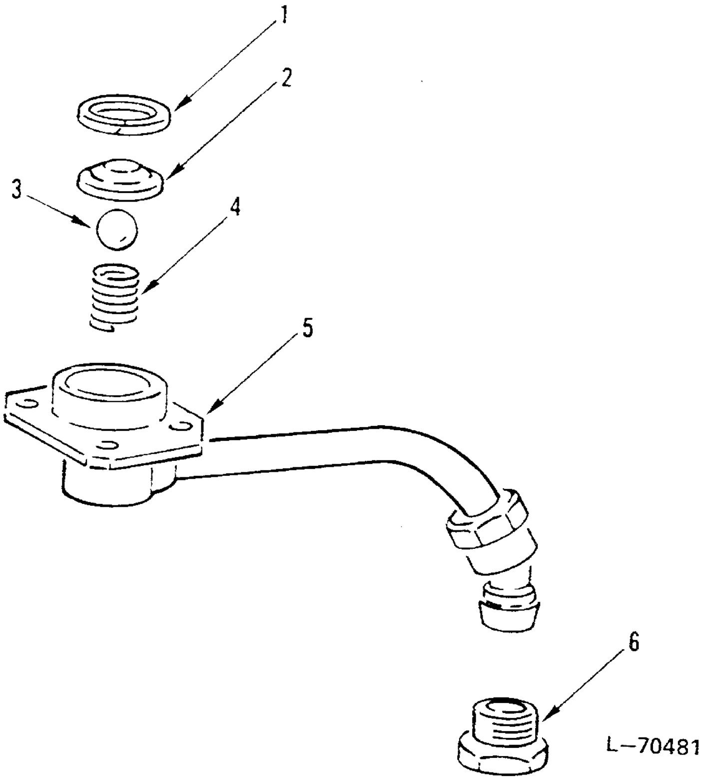
(5) Assemble spring and ball in valve and hold in place with stop.

(6) Secure stop with retaining ring.

(7) Check valve operation by applying metered air pressure to upper end. Valve should open at 7 psid (48.3 kPa) minimum and should close at 13 psid (89.6 kPa) maximum.

NOTE: Chattering of ball between full open and full closed position is normal and does not indicate malfunction. If necessary, replace ball and spring to obtain required operational pressure limits.

Use of 0.375 inch diameter or larger air supply line will assure sufficient cross sectioned area necessary for pressure drop across valve.



1. Retaining Ring
2. Stop
3. Ball
4. Spring
5. Housing Assembly
6. Plug

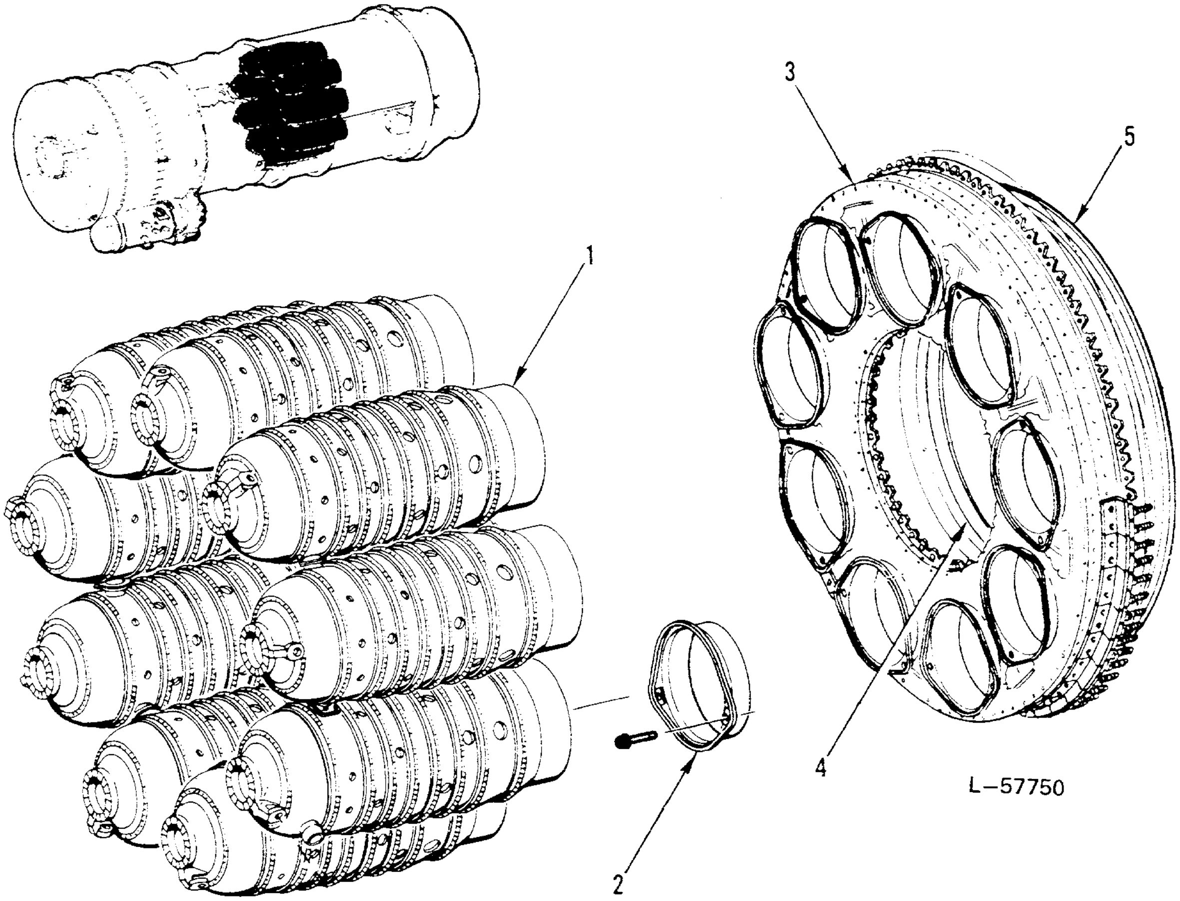
BBB2-72-260

No. 4 Bearing Air Check Valve Assembly
Figure 801/72-38-81-990-801

COMBUSTION SECTION - DESCRIPTION

1. Combustion Section - General

In the combustion section, fuel is mixed with air at the proper ratio, and the resultant fuel/air mixture is burned, adding energy to the air passing through the engine. The fuel is routed through left and right semi-circular manifolds secured around the outside of the diffuser case at the rear. Nine individually supported nozzles inside the diffuser case deliver fuel into the combustion chambers.



1. Combustion Chambers
2. Combustion Chamber Guide (Nine Required)
3. Combustion Chamber Duct Assembly
4. Combustion Chamber Outlet Inner Duct
5. Combustion Chamber Outlet Outer Duct

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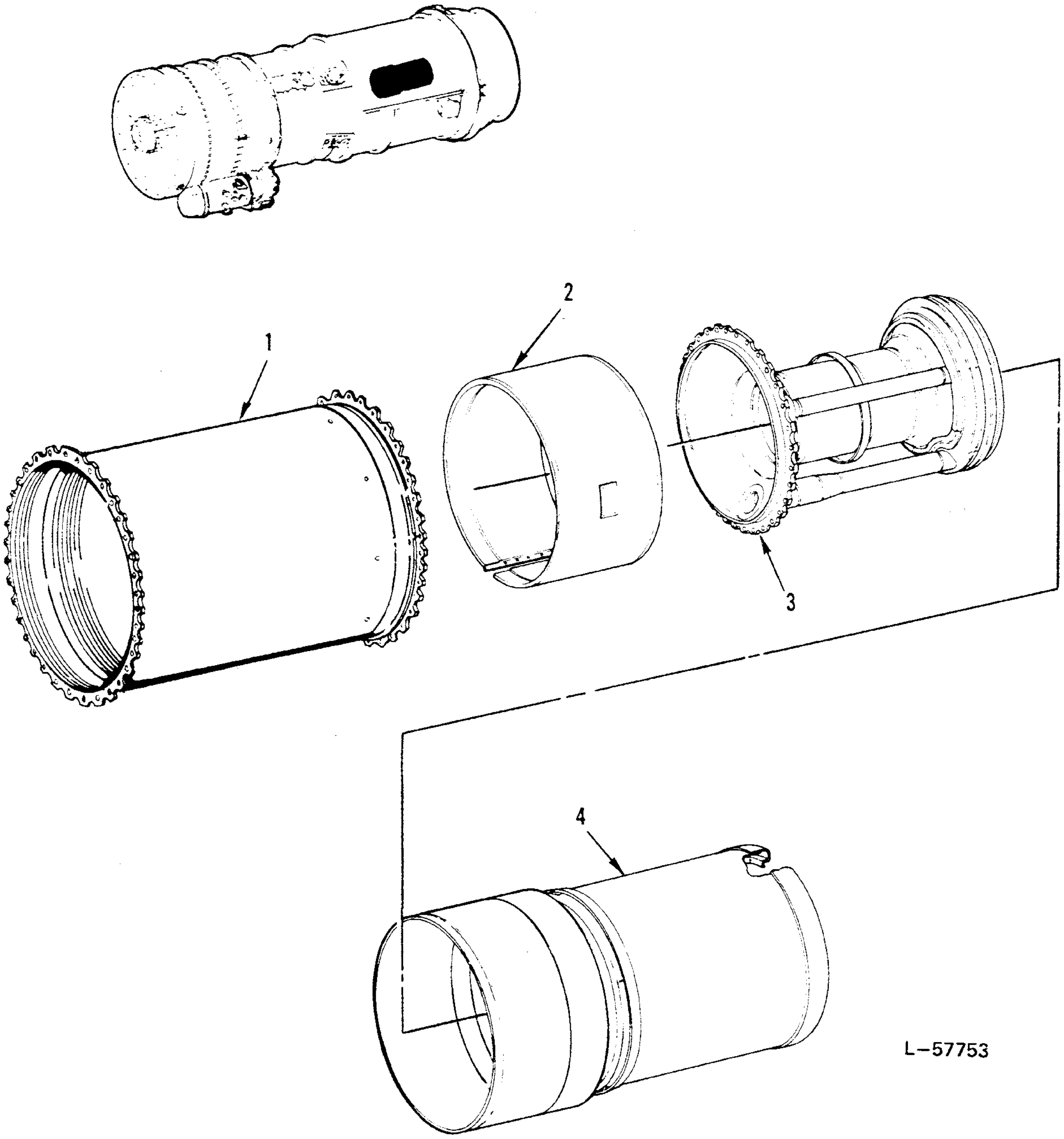
Combustion Chambers And Combustion Chamber Duct Assembly
Figure 1/72-41-00-990-801



1. Combustion Chamber Inner Case
2. No. 4 And 5 Bearing Heatshield
3. No. 4 And 5 Bearing Inner Shield Assembly
4. No. 4 And 5 Bearing Outer Heatshield Assembly

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Turbine Shafts And No. 4 1/2 Bearing Heatshields
Figure 2/72-41-00-990-802

2. Combustion Chamber Inner Case

The combustion chamber inner case is secured to the diffuser case inner rear flange and to the outer flange of the No. 5 bearing housing. It forms the inner wall of the combustion chanber and serves to position the No. 5 bearing through the bearing housing.

3. Combustion Chamber Outer Front Case

The combustion chamber outer front case is secured to the rear flange of the diffuser case and the front flange of the turbine nozzle case and encloses the combustion chamber. It forms the inner wall of the annular duct at this location.

The fuel drain valves are located on the bottom centerline of the case, one at the front and one at the rear. A fuel drain manifold carries any drain fuel to outside of outer duct. Both flanges of this case turn inward and the front flange is scalloped. Two igniter plug bosses are present, at the 4 and 8 o'clock positions on the case.

4. Combustion Chambers

NOTE: See Figure 1.

Nine one-piece combustion chambers (or burner cans) are located between the combustion chamber outer case and the combustion chamber inner case in a can-annular arrangement. Chamber Number 1 is at the 12 o'clock position and the chambers are numbered clockwise around the engine as viewed from the rear.

Each complete bullet-shaped combustion chanber is of welded construction, having a series of round liners. The chambers are equipped with positioning brackets.

The rear of the chambers fits into the nine openings in the front of the combustion chamber duct assembly (see TURBINE NOZZLE SECTION - DESCRIPTION, PAGEBLOCK 72-51-00/001). The chambers fit onto the nozzle of the fuel manifold at the front, where they are held by lockwired bolts and pins through positioning brackets. Interconnecting flame tubes between the chambers serve to spread the flame uniformly to all the chambers.

All the chambers have one male and one female flame tube. In addition, chambers four and seven have an igniter plug opening. Nine two-bolt interconnector tubes connect the male and female flame tubes of the chambers. The chambers are equipped with cooling deflectors (or air scoops) at the flame tubes.

5. Turbine Shafts And No. 4 1/2 Bearing Heatshields

NOTE: See Figure 2.

Located within the combustion chamber inner case and bolted to the rear of the No. 4 bearing support are the turbine shafts heatshields. The oil scavenge pump shield is cylindrical in shape and is held in place by the same bolts holding the No. 4 1/2 bearing heatshield assembly inside it.

The No. 4 1/2 bearing heatshield assembly is equipped with support tubes around its OD and has a reinforced wasp-waist shape. It is designed to accommodate axial movement of the bearing supporting structure.

6. No. 5 Bearing Housing

Bolted to the rear of the combustion chamber inner case is the No. 5 bearing housing. This assembly holds the No. 5 bearing and contains the oil-damping features which reduce rear compressor drive turbine rotor vibration by means of a layer of pressurized oil between the No. 5 bearing outer race damper and the bore of the housing (see ENGINE GENERAL - DESCRIPTION, PAGEBLOCK 72-00-00/001).

TURBINE NOZZLE SECTION - DESCRIPTION

1. Combustion Chamber Duct Assembly

Positioned at the rear of the combustion section is the combustion chamber duct assembly. This unit consists of a combustion chamber rear support with nine openings to support the rear of each combustion chamber, and an inner and an outer outlet duct. The outlet ducts form a convergent nozzle area which accelerates the combustion chamber gases for entry into the turbine.

2. First Stage Turbine Nozzle

After engine gaspath air has been compressed and accelerated, then expanded by heating in the combustion section, this air is directed through the combustion chamber outlet ducts to the 1st stage turbine vanes. These turbine nozzle guide vanes precede the 1st stage turbine blades and direct the flow of gases into the blades at the proper angle and velocity.

At the rear of the combustion chamber outlet ducts is the 1st stage turbine nozzle, composed of 46 vanes bolted to the turbine front (outer) case at the outside and to the 1st stage turbine stator support at the inside. These vanes are air-cooled by combustion chamber section air which travels rearward outside the combustion chambers and outer outlet duct and enters the vanes at their outer ends. This cooling air is released into the inner core of each vane, from which it exits into the gaspath through trailing edge holes, cooling the surfaces of the vanes.

3. Combustion Chamber/Turbine Cases

A short combustion chamber outer rear case extends from the rear flange of the combustion chamber outer front case to the front flange of the turbine front (outer) case. The turbine front case encloses the combustion chamber outlet ducts, the 1st stage turbine vanes, and the 1st stage turbine blades. A 1st stage turbine outer airseal is fitted into the turbine front case around the 1st stage turbine blade tips to control gas losses around the circumference of the turbine. A 1st stage turbine stator inner support forms the attachment point for the 1st stage turbine vane inner feet and positions a knife-edge seal against a sealing land on the front of the 1st stage turbine disk.

REAR COMPRESSOR DRIVE TURBINE ROTOR - DESCRIPTION

1. Rear Compressor Drive Turbine Rotor

NOTE: See Figure 1, Table 1, Figure 2.

The rear compressor drive turbine rotor consists of a 1st stage turbine disk and blades assembly bolted to a rear compressor drive turbine shaft. The turbine disk holds 80 (64 for JT8D-217C and -219) 1st stage turbine blades in serrated "fir-tree" slots. The turbine blades convert some of the force of the combustion section discharge gases into rotational energy and transmit this energy forward to the rear compressor rotor through the rear compressor drive turbine shaft. The remaining combustion section discharge gases are turned by the blade airfoils for entry into the 2nd stage turbine nozzle at the optimum angle and velocity. The JT8D-217, -217A, -217C and -219 turbine is equipped with air-cooled turbine blades. Cooler combustion section air discharged from the 1st stage turbine cooling air duct is carried through air holes in the 1st stage turbine disk to the roots of the 1st stage turbine blades. A U-shaped passage in the blades carries air out to the end of the airfoil and back to the root to be discharged rearward. (Figure 2) "Trip strips" and turning vanes along the blade airfoil inner cooling air path control the flow of cooling air for maximum heat dispersal.

A counterweight flange on the rear of the 1st stage turbine disk provides a means of balancing the rotor. Correct axial positioning of the rotor in the engine is accomplished by a classified ring spacer in the front of the rear compressor drive turbine shaft.

2. No. 5 Bearing Parts

NOTE: See Figure 1, Table 1.

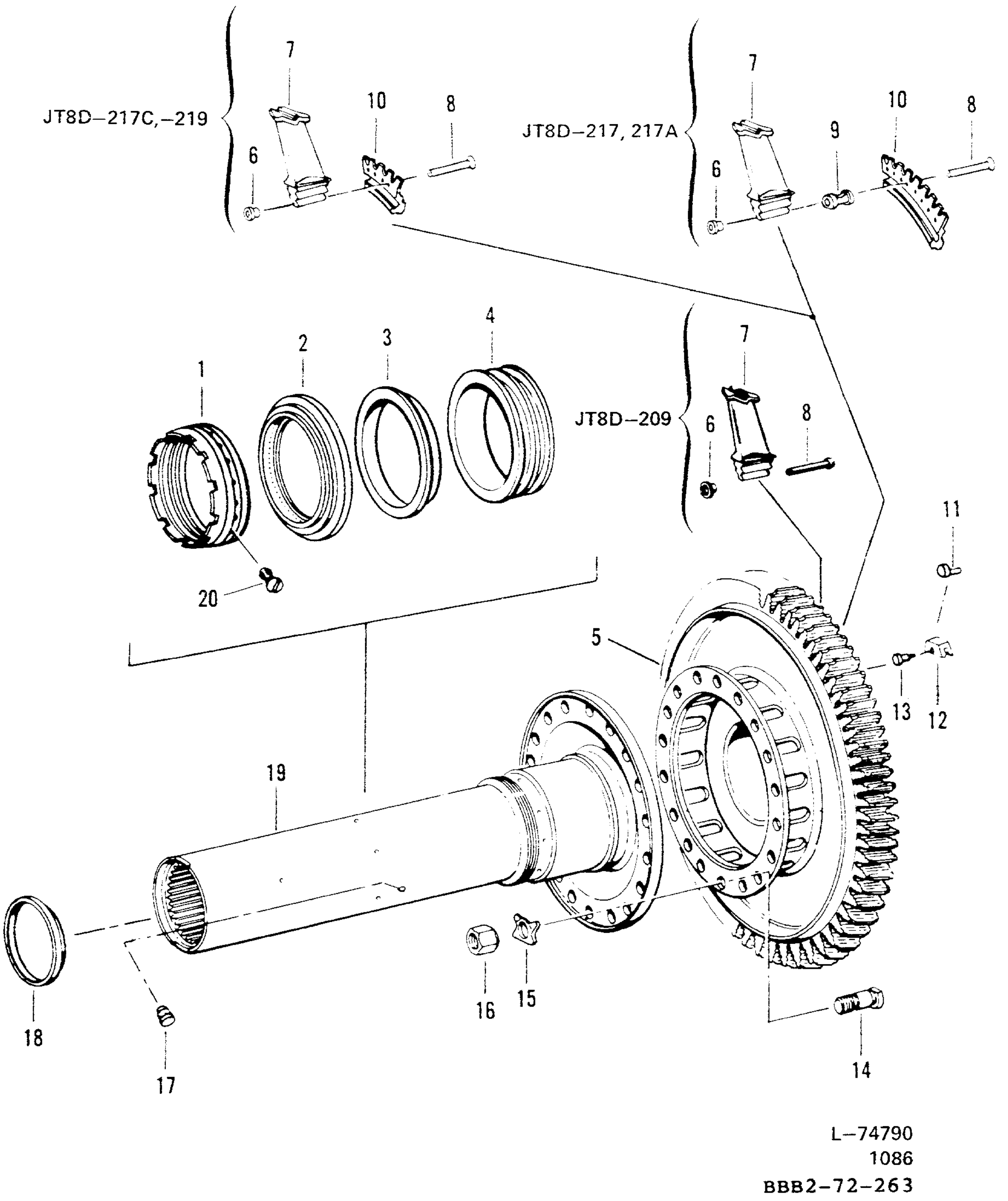
The rear compressor drive turbine is supported by the No. 5 bearing, and certain parts related to this bearing are assembled with the rotor and considered part of the rotor assembly. These parts include the No. 5 bearing and its inner race retaining nut, a labyrinth seal which rotates inside an airsealing ring on the No. 5 bearing seal assembly, a seal seat, and the No. 5 bearing seal assembly. The No. 5 bearing seal assembly is a double carbon face type unit which forms an oil seal against the rotating surfaces of the seal seat and the labyrinth seal (ENGINE GENERAL - DESCRIPTION, PAGEBLOCK 72-00-00/001).

Table 1

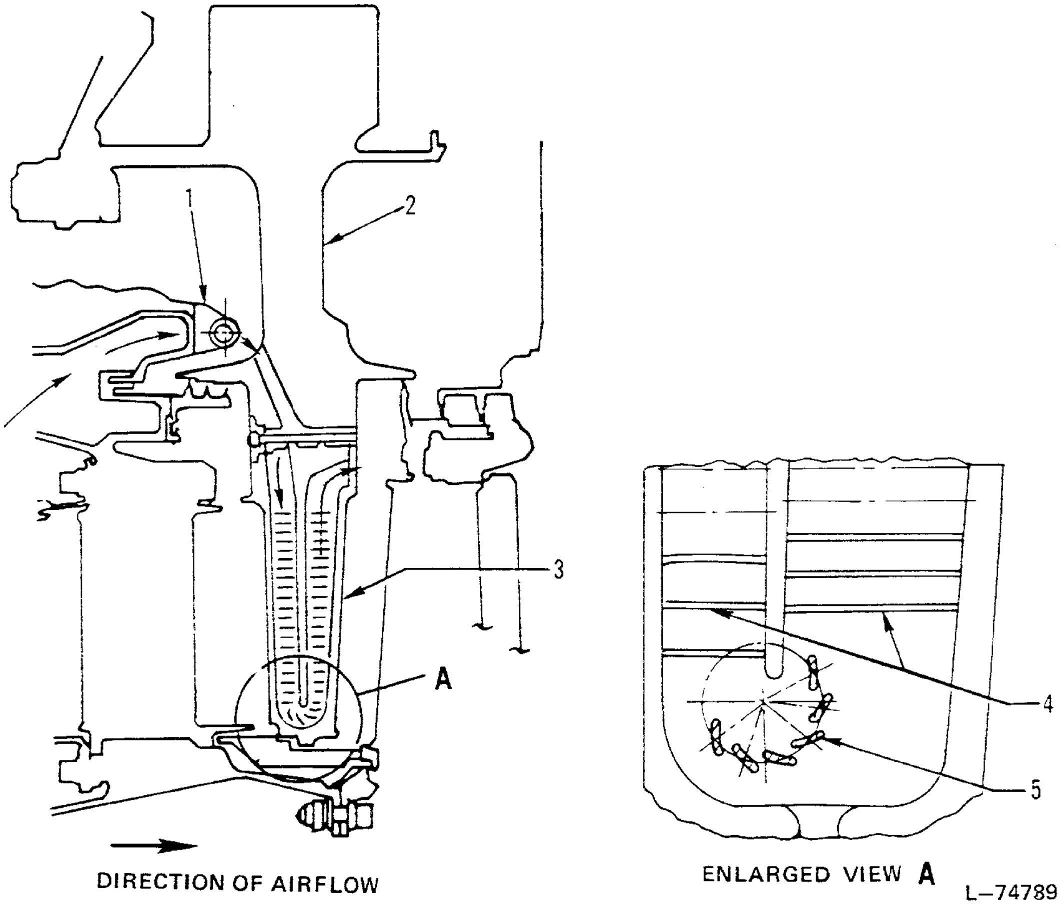
Key to Figure 1	
Index No.	**Nomenclature**
1	No. 5 Bearing Inner Race Retaining Nut
2	Seal Seat
3	Bearing Spacer
4	Labyrinth Seal
5	First Stage Turbine Disk
6	Washer
7	First Stage Turbine Blade
8	Rivet
9	Bushing
10	Retaining Plate
11	Counterweight (Rivet Type)
12	Counterweight
13	Rivet

Table 1 (Continued)

Key to Figure 1	
Index No.	**Nomenclature**
14	Tiebolt
15	Key Washer
16	Tierod Nut
17	Positioning Plug
18	Turbine Shaft Spacer
19	Rear Compressor Drive Turbine Shaft
20	Retaining Screw



Rear Compressor Drive Turbine Rotor Assembly
Figure 1/72-52-00-990-801



1. Turbine Cooling Air Duct
2. First Stage Turbine Disk
3. First Stage Turbine Blade
4. Trip Strips
5. Turning Vanes

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First Stage Turbine Blade Air-Cooling Features (JT8D-217,-217A,-217C,-219)
Figure 2/72-52-00-990-802

REAR COMPRESSOR DRIVE TURBINE ROTOR - REMOVAL/INSTALLATION

1. General

A. This procedure contains MSG-3 task card data.

TASK 72-52-00-901-801

2. Discard the Disks

A. Discard the Disk

SUBTASK 72-52-00-901-001

(1) Discard left and/or right engine turbine disk per manufacturer's life limits.

——— END OF TASK ———

REAR COMPRESSOR DRIVE TURBINE ROTOR - INSPECTION/CHECK

1. General

A. This procedure contains MSG-3 task card data.

TASK 72-52-00-290-801

2. Special Detailed Inspection of the Forward Face of the 1st Stage Turbine Vanes and Turbine Blades (Borescope)

NOTE: This procedure is a scheduled maintenance task.

A. References

Reference	Title
72-00-00 P/B 601 Config 1	ENGINE GENERAL - INSPECTION/CHECK-01

B. Special Detailed Inspection of the Forward Face of the 1st Stage Turbine Vanes and Turbine Blades (Borescope)

SUBTASK 72-52-00-290-003

(1) Do a borescope inspection of the 1st stage turbine vanes and 1st stage turbine blades for damage. (ENGINE GENERAL - INSPECTION/CHECK-01, PAGEBLOCK 72-00-00/601 Config 1)

——— END OF TASK ———

FRONT COMPRESSOR DRIVE TURBINE SECTION - DESCRIPTION

1. Front Compressor Drive Turbine Rotor

The front compressor drive turbine rotor includes the front compressor drive turbine shaft, the 2nd, 3rd, and 4th stage turbine disks and blades, the turbine hub, and the airseals between the disks. Sixteen tierods secure the disks to each other and to the rear flange of the rotor shaft, and a No. 4 1/2 and 6 bearing tube assembly is positioned inside the shaft.

The blades are secured in the disks by retaining lips on adjacent rotor airseals; 78 blades in the 2nd stage, 88 blades in the 3rd stage, and 58 blades in the 4th stage. Provisions are made for rotor counterweights on the front of the 2nd stage disk airseal and the rear face of the 4th stage disk.

Each of the 2nd, 3rd, and 4th turbine disks retains its blades in serrated, "fir-tree" slots. A front lip on the blade root and the rearward pressure of the adjacent rotor airseal keep each blade from moving axially in the disk slot.

To the rear of the 4th stage turbine disk and blades assembly is the turbine hub. An extended journal surface on the hub accepts the No. 6 bearing and seals, and the No. 6 bearing scavenge pump spur gearshaft is bolted to the rear of the bearing journal.

The front compressor is connected to the front compressor rotor rear hub by means of a spline and a threaded coupling.

2. Turbine Nozzle

In each turbine stage, nozzle guide vanes precede the turbine blades and direct the flow of gases into the blades at the proper angle and velocity. Nozzle area must change with each successive stage, and this is accomplished by nozzle guide vanes of increasing size from stage to stage and by a turbine rear case which increases in diameter from front to rear. To keep gas losses to a minimum, stator sealing rings with abradable linings are positioned opposite knife-edge seals on the turbine blade tips and on the turbine rotor airseals. In a JT8D-217C or -219 turbine, the inner and outer platforms of the 2nd and 3rd stage turbine vanes feature "feather seals," thin sealing strips which fill the gaps between the platforms and further reduce gas losses.

The 2nd stage turbine vanes precede the 2nd turbine rotor stage. There are 75 equally spaced vanes installed in 25 clusters of three each. The vanes are held at the outer feet by grooves in the turbine rear case wall and by lock rings holding the vanes in position axially. At the inner feet the vanes hold an inner air-sealing ring which provides a sealing clearance with the rear of the 1st stageturbine disk and the rotating knife-edge seal bolted to the front of the 2nd stage turbine disk.

There are 66 3rd stage turbine vanes preceding the 3rd stage turbine rotor, equally spaced and in 22 clusters of three each. The 3rd stage turbine vanes are retained in the same manner as the 2nd stage turbine vanes, between nozzle case slots and a riveted turbine airseal.

There are 75 4th stage turbine vanes preceding the 4th stage turbine rotor, equally spaced and in 25 clusters of three each. The 4th stage vanes are retained in the same manner as the 2nd and 3rd stage turbine vanes, between nozzle case slots and a turbine airseal. Both the 3rd and the 4th stage airseals at the inner feet of the vanes seal against rotating turbine airseal knife-edges.

3. No. 4 1/2 And 6 Bearing Tube Assembly

The No. 4 1/2 and 6 bearing tube assembly fits inside the front compressor drive turbine and extends forward through the front compressor drive turbine shaft to the No. 4 1/2 bearing area. This tube assembly accepts oil from the No. 4 1/2 bearing oil nozzle in the exhaust case assembly through an opening in the No. 6 bearing scavenge pump spur gearshaft. This oil is then drawn forward through the tube assembly to the No. 4 1/2 bearing area where it is allowed to flow outward through holes in the turbine shaft to the No. 4 1/2 bearing and seals. See ENGINE GENERAL - DESCRIPTION, PAGEBLOCK 72-00-00/001.

4. Turbine Rear Case

The front compressor drive turbine is a "unit turbine", meaning that it can be uncoupled and separated from the engine without major disassembly. The turbine rear case is bolted to the turbine front case at the parting point between the rear and front compressor drive turbines so that the front compressor drive turbine can be withdrawn as a unit.

FRONT COMPRESSOR DRIVE TURBINE ROTOR - INSPECTION/CHECK

1. General

A. This procedure contains MSG-3 task card data.

TASK 72-53-00-211-801

2. Detailed Inspection of the 4th Stage Blades, Vanes, and Outer Air Seal (Viewed from Exhaust)

A. Detailed Inspection of the 4th Stage Blades, Vanes, and Outer Air Seal (Viewed from Exhaust)

SUBTASK 72-53-00-211-001

(1) Do a detailed inspection of the 4th stage blades, vanes, and outer air seal.

  (a) Using a bright light, look up the tailpipe and check the visible portions of the 4th stage low pressure turbine blades and vanes for obvious dents, nicks, or other evidence of foreign object damage. Rotate rotor to bring all blades into view, there are 58 blades and 75 vanes in the 4th stage.

  (b) Inspect the seal segments for evidence of leaks and damage.

END OF TASK

NO. 6 BEARING SEALS AND SPACERS ASSEMBLY - REMOVAL/INSTALLATION-01

1. No. 6 Bearing and Seal Removal

A. Prerequisites

(1) Remove the No. 6 bearing oil pump. (NO. 6 BEARING OIL SCAVENGE PUMP ASSEMBLY - REMOVAL/INSTALLATION, PAGEBLOCK 72-54-25/401)

B. Equipment and Materials

(1) Support Equipment:

PWA 12292 Puller

PWA 45059 Holder

PWA 45060 Wrench

PWA 45121 Puller

PWA 45237 Puller

C. Bearing/Seal Removal. (Ref. Figure 401 through Figure 404)

(1) Put shims at the 4th stage turbine blade tips at the 5 and 7 o'clock positions to hold the turbine rotor in a center position while the bearing is removed.

(2) Bend away the key washers and remove the bolts that attach the No. 6 bearing scavenge pump gearshaft.

(3) Install the jaw of PWA 12292 puller around the gear end of the gearshaft. Remove the gearshaft with the puller.

(4) Remove the retaining ring that holds the seal in the end of the No. 4 1/2 and 6 bearing shield and tube assembly. Remove the seal from the tube.

NOTE: Removal and replacement of the tube seal is necessary when the No. 6 bearing oil pump is removed from the engine, to make sure that the engine is assembled with a seal in good condition at this location. NO. 6 BEARING OIL SCAVENGE PUMP ASSEMBLY - REMOVAL/INSTALLATION, PAGEBLOCK 72-54-25/401

(5) Install the puck detail of PWA 45121 puller on the front compressor drive turbine shaft. Engage the puller jaws in the puller groove of the No. 6 bearing inner race (loosen the capscrews at the outer end of the puller as necessary).

CAUTION: REMOVE THE BEARING CAREFULLY. THE BEARING RACES AND ROLLERS ARE EASY TO DAMAGE.

(6) Lock the puller jaws in position with the ring detail. Turn the jackscrew counterclockwise to pull the inner race and rollers from the hub (Figure 402).

(7) Remove the screws that attach the retaining plate to the bearing housing. Remove the retaining plate.

(8) Remove the No. 6 bearing. outer race (Figure 403).

(9) Install the puck detail of PWA 45237 puller in the end of the front compressor drive turbine shaft. Engage the puller jaws in the lip of the lip of the bearing seal and spacer assembly (Figure 404). Lock the jaws in position with the ring detail and tighten the capscrews at the outer end of the puller.

CAUTION: BE CAREFUL TO REMOVE THE SEAL AND SPACER SLOWLY AND CAREFULLY IN A STRAIGHT LINE. IT IS POSSIBLE TO CAUSE DAMAGE TO THE SEAL PARTS IF THEY COME OUT AT AN ANGLE OR CATCH ON OTHER PARTS.

(10) Turn the puller jackscrew clockwise to remove the No. 6 bearing seals and spacer assembly. Put the seal and spacer assembly in PWA 45059 holder (installed in a vise) with the rear spacer up.

(11) Install PWA 45060 wrench on the rear spacer and turn off the rear spacer with a square-drive wrench handle. Remove the rear spacer.

(12) Remove the carbon seal elements and spring washer.

(13) Remove the front spacer from the holder.

2. No. 6 Bearing and Seal Installation

A. Equipment and Materials

(1) Support Equipment:

PWA 12278 Drift

PWA 12280 Drift

PWA 12292 Puller

PWA 12702 Drift

PWA 45059 Holder

PWA 45060 Wrench

PWA 45244 Fixture

(2) Consumables:

PWA 521 Engine Oil

B. Seal and Spacer Assembly/Installation

(1) Install PWA 45059 holder in a vise.

(2) Put the No. 6 bearing front seal spacer on the holder with the thread end up.

(3) Install the carbon seal, spring washer, and second carbon seal (Figure 405).

(4) Engage the threads of the rear spacer on the front spacer in the front spacer and tighten the front and rear spacers hand tight. Use PWA 45060 wrench and a square-drive torque wrench to torque the spacer to 25 - 100 lb-in. (2.825 - 11.298 N·m).

CAUTION: BE CAREFUL WITH THE SEAL AND SPACER ASSEMBLY. THE SEALS ARE EASY TO DAMAGE.

(5) Remove the wrench and remove the seal and spacer assembly from the holder. Put the seal and spacer assembly in hot oil (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201).

CAUTION: INSTALL THE SEAL AND SPACER ASSEMBLY CAREFULLY AND DO NOT HIT ADJACENT SURFACES WITH THE SEAL PARTS. THE CARBON SEALS ARE EASY TO BREAK AND CAN GET SCRATCHES EASILY.

(6) When the seal and spacer assembly is at the correct temperature, install the assembly carefully into the bearing housing and fixture and on the front compressor drive turbine hub (Figure 406).

(7) Use PWA 12280 drift to push the seal and spacer assembly into position on the hub. Install the assembly tightly against the hub shoulder.

(8) Make sure that the No. 6 bearing outer race seal rings have the correct gap and side clearance with the outer race grooves. The limits are as follows:

  (a) Side clearance of the rings in the housing must be 0.001 - 0.007 inch (0.026 - 0.127 mm).

  (b) The ring gap must be 0.038 - 0.051 inch (0.97 - 1.30 mm).

  NOTE: The ring gap at 5.046 inch (128.168 mm) outside diameter is 0.032 - 0.042 inch (0.87 - 1.07 mm).

  (c) Replace all rings which do not have the correct gap or side clearance with the outer race.

(9) Install the outer race and seal ring assembly in the No. 6 bearing housing with the antirotation lugs out.

(10) Install the outer race retaining plate and attach it with three screws. Torque and stake the screws as shown in Figure 403.

(11) Measure the axial fit of the outer race with the retaining plate. The fit must be 0.007 - 0.012 inch (0.178 - 0.304 mm).

(12) Heat the bearing inner race and rollers in hot oil (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201).

(13) Start the inner race and rollers on the front compressor drive turbine rotor hub journal, puller groove out.

CAUTION: BE CAREFUL NOT TO CAUSE DAMAGE TO THE SEAL ASSEMBLY WHILE THE BEARING INNER RACE IS INSTALLED. DO NOT USE TOO MUCH FORCE TO PUT THE BEARING TIGHTLY AGAINST THE SEAL.

(14) Use PWA 12278 drift to push the bearing inner race into position on the hub against the seal assembly.

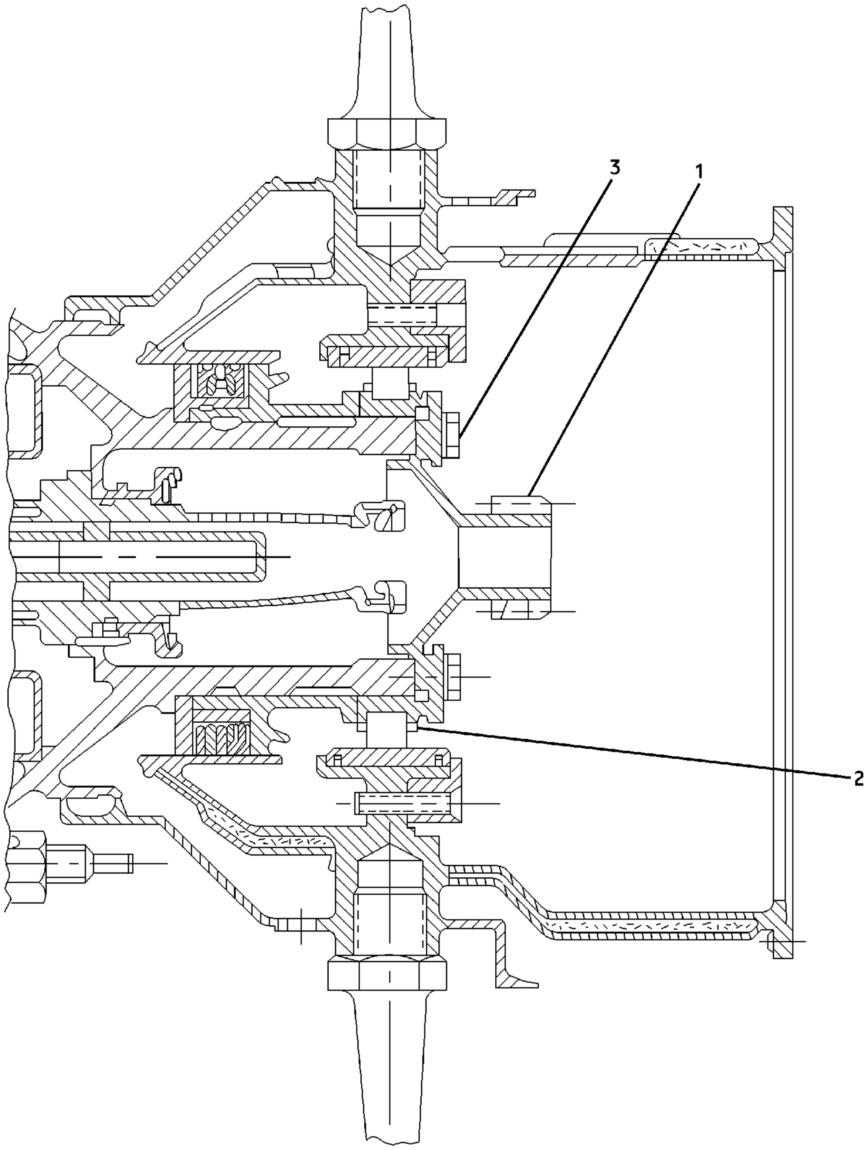
(15) Lubricate the seal for the No. 4 1/2 and 6 bearing shield and tube assembly with oil. Install the seal, with the inner seal lip and spring forward, into the rear of the tube assembly with PWA 12702 drift. Install the retaining ring in the end of the tube assembly to hold the seal in position.

(16) Install the No. 6 bearing scavenge pump gearshaft with eight bolts (lubricated with engine oil) and new key washers. Torque the bolts to 95 - 105 lb-in. (10.734 - 11.863 N·m). Bend the tabs of the key washers to safety the bolts.

(17) Remove the shims from the 4th stage turbine blade tips.

C. Postrequisites

(1) Install the No. 6 bearing oil pump. (NO. 6 BEARING OIL SCAVENGE PUMP ASSEMBLY - REMOVAL/INSTALLATION, PAGEBLOCK 72-54-25/401)



LEGEND:
1. SCAVENGE PUMP GEARSHAFT
2. NO. 6 BEARING INNER RACE AND ROLLERS
3. GEARSHAFT MOUNTING BOLTS (EIGHT)

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CAG(IGDS)

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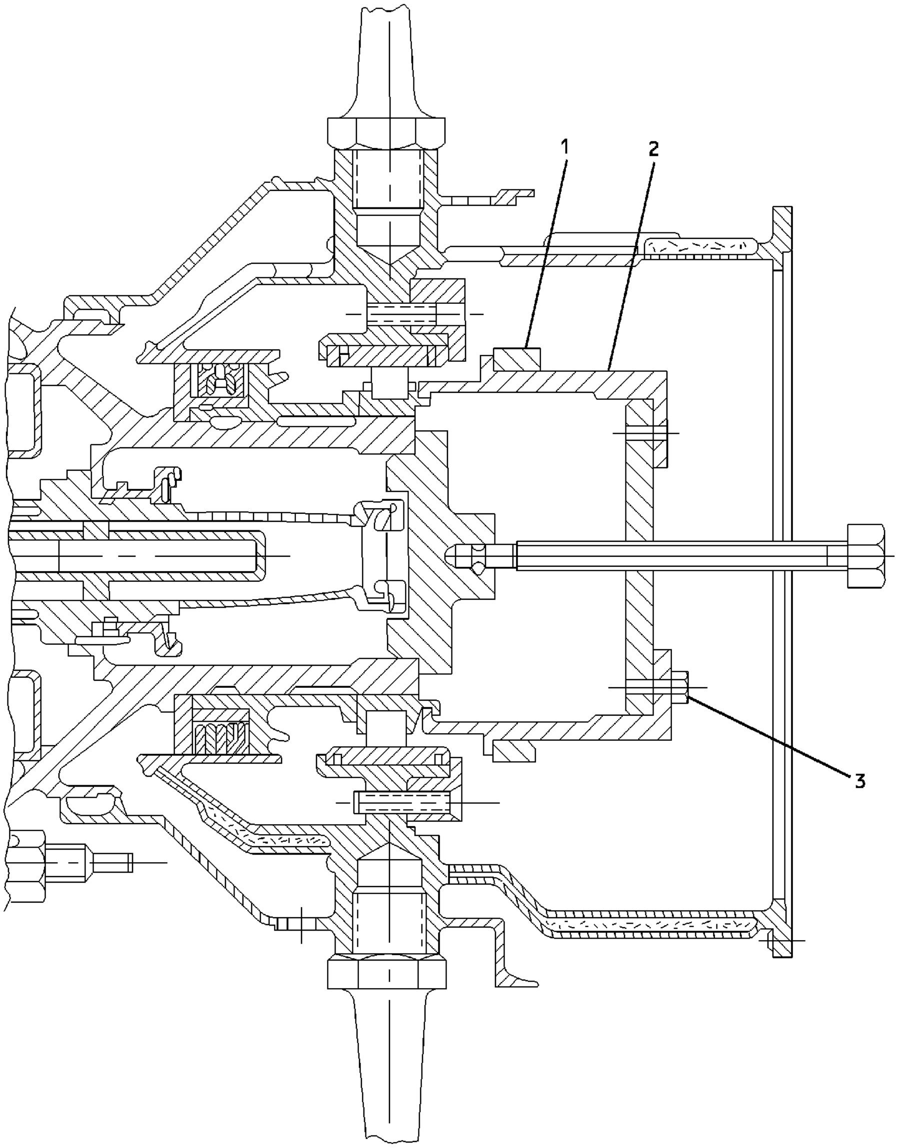
No. 6 Bearing Area
Figure 401/72-53-40-990-801



LEGEND:
1. JAW RETAINING RING
2. PULLER JAW
3. CAPSCREW

L-66547

CAG(IGDS)

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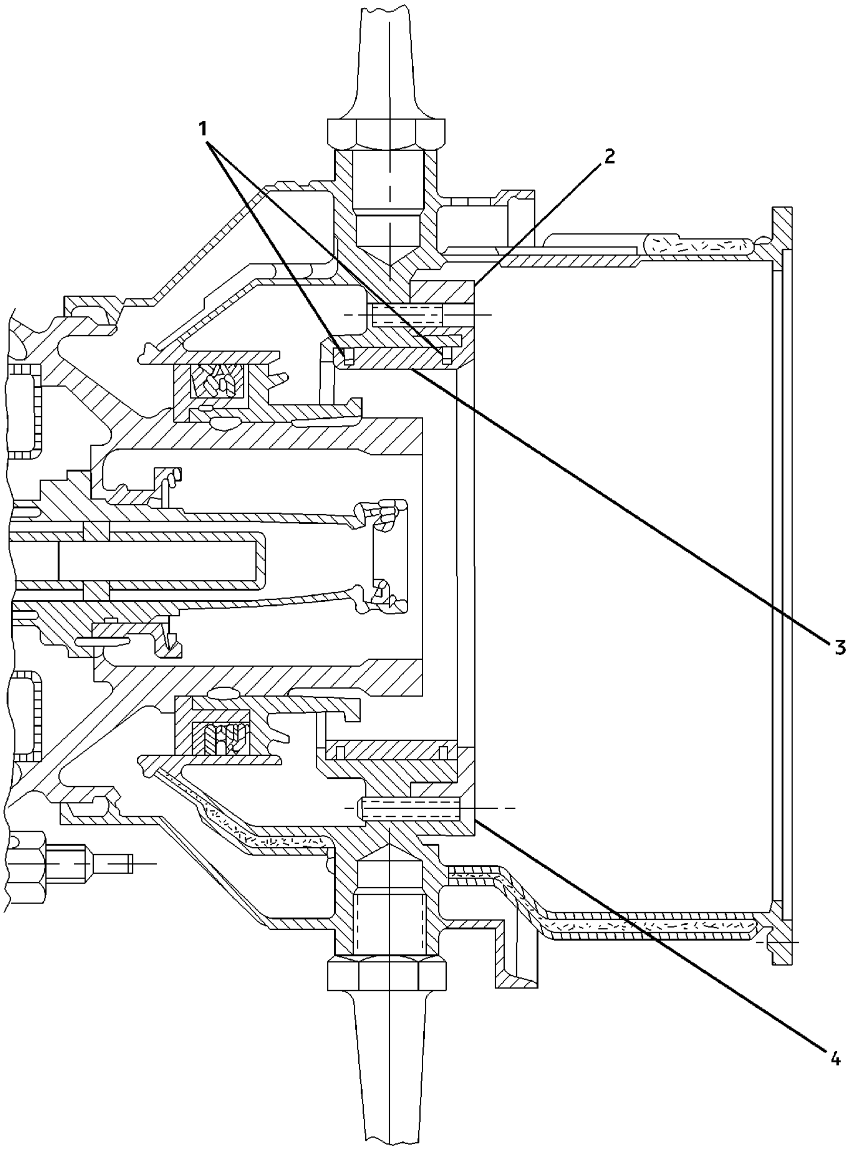
No. 6 Bearing Race and Roller Removal
Figure 402/72-53-40-990-802



LEGEND:
1. OUTER RACE SEAL RINGS
2. OUTER RACE RETAINING PLATE
3. NO. 6 BEARING OUTER RACE
4. RETAINING PLATE SCREWS (THREE). STAKE THESE SCREWS TIGHTLY INTO THE GROOVE ON EACH SIDE OF EACH SCREW.

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CAG(IGDS)

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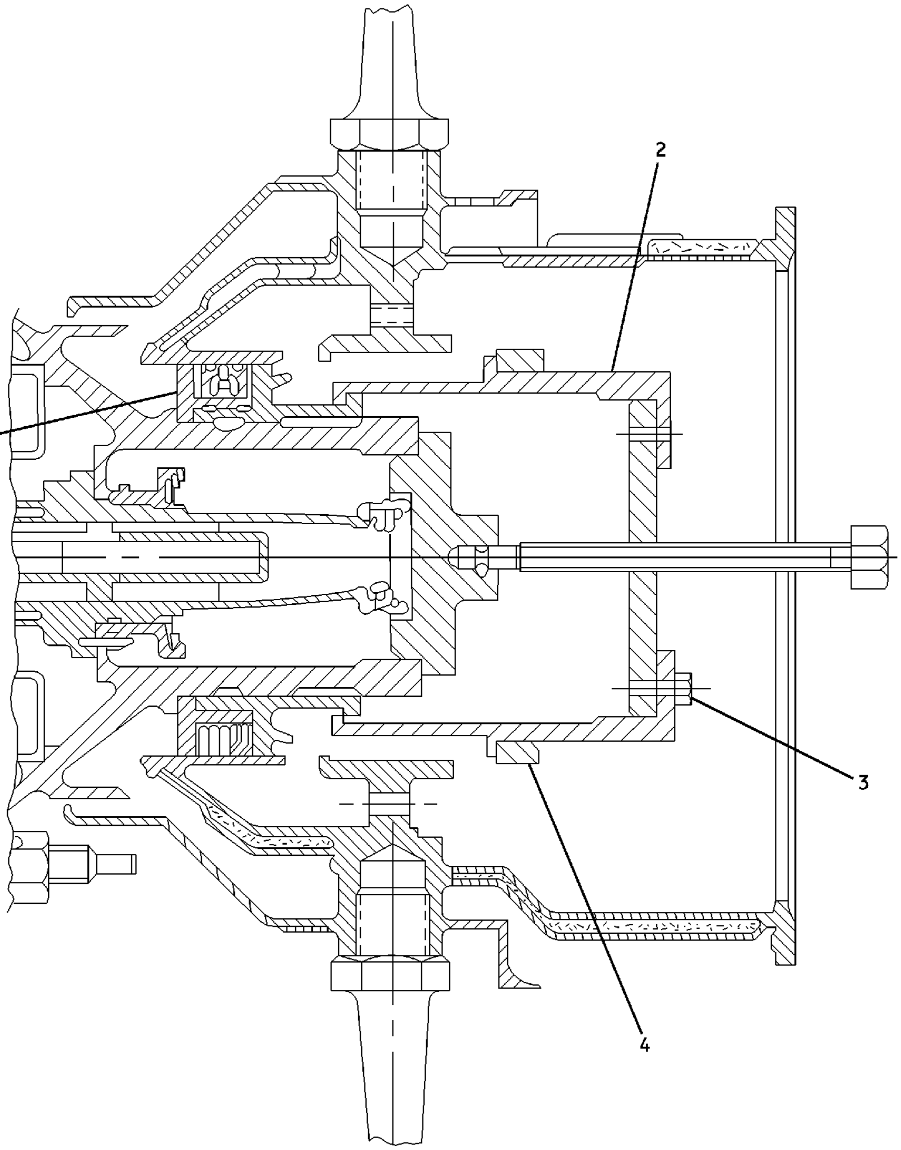
No. 6 Bearing Outer Race
Figure 403/72-53-40-990-803



LEGEND:

1. NO. 6 BEARING SEAL AND SPACER ASSEMBLY
2. PULLER JAW
3. CAPSCREW
4. RING

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CAG(IGDS)

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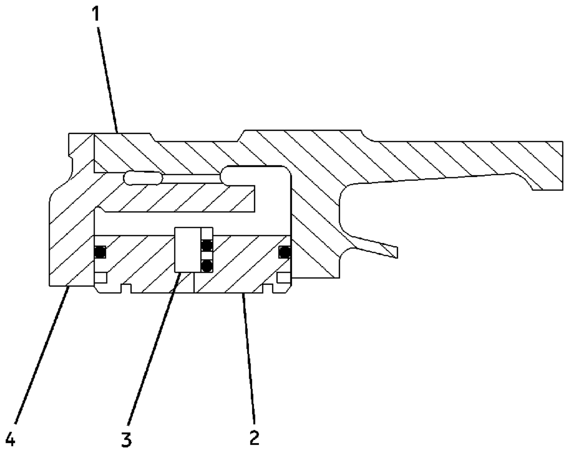
No. 6 Bearing Seal and Spacer Removal
Figure 404/72-53-40-990-804



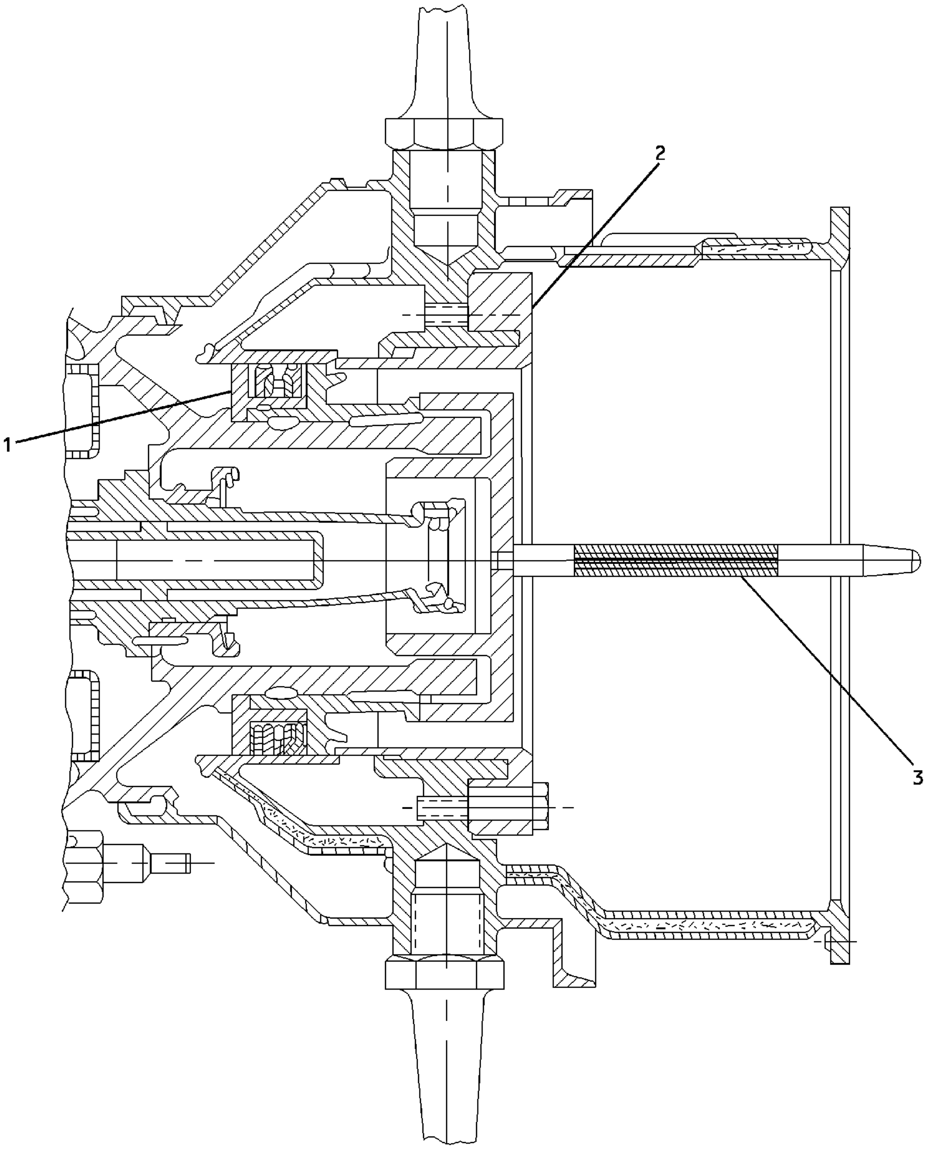
LEGEND:
1. NO. 6 BEARING REAR SEAL SPACER
2. CARBON SEAL (TWO)
3. SPRING TENSION WASHER
4. NO. 6 BEARING FRONT SEAL SPACER

L-66720

CAG(IGDS)

BBB2-72-544

No. 6 Bearing Seal and Spacer Assembly/Disassembly
Figure 405/72-53-40-990-805



LEGEND:
1. NO. 6 BEARING SEAL AND SPACER ASSEMBLY
2. FIXTURE
3. DRIFT

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CAG(IGDS)

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No. 6 Bearing Seal and Spacer Installation
Figure 406/72-53-40-990-806

TURBINE REAR CASE - REPAIR-01

1. Instrumentation Boss Clinch Nut Installation

A. Prerequisite

(1) Remove the combustion chamber and turbine fan duct borescope port cover and the turbine inner duct borescope port cover. See ENGINE GENERAL, SUBJECT 72-00-00, Page 601, Borescope Inspect 1st and 2nd Stage Turbine Blades and 2nd Stage Turbine Vanes.

B. Equipment And Materials - None

C. General

(1) It is possible for clinch nuts to become loose and disengage from the instrumentation boss assembly. This repair is for installation of instrumentation boss assembly clinch nuts which are disengaged and are not attached.

(2) This repair uses a locally made tool and a PWA 18750 Flaring Tool with a modification.

D. Procedure. See Figure 801, Figure 802, and Table 801.

(1) Make a clinch nut installation tool as follows:

NOTE: Use steel to make the clinch nut installation tool. Remove all sharp edges.

(a) Machine the clinch nut holder to the dimensions shown in Figure 801, Table 801.

(b) Machine the handle to the correct length and diameter as necessary.

(c) Drill a dowel pin hole through the handle.

(d) Push the dowel pin into the handle.

(e) Attach the handle to the holder and weld them together.

(2) Install the clinch nut into the instrumentation boss as follows:

(a) Apply beeswax to the 0.316 inch (8.026 mm) diameter hole in the holder. Put the wax into the hole from the handle side of the clinch nut installation tool.

(b) Put the clinch nut into the 0.316 inch (8.026 mm) diameter hole from the handle side of the clinch nut installation tool. See Figure 802 for the correct position of the clinch nut in the installation tool.

(c) Align the clinch nut with the correct hole in the instrumentation boss assembly. Push Surface A of the clinch nut holder against the radius of the instrumentation boss. Pull the clinch nut into the hole.

(d) Hold the clinch nut tightly with the clinch nut installation tool. Flare the clinch nut with a PWA 18750 Flaring Tool (Figure 802).

NOTE: It is necessary to make a modification to the PWA 18750 Flaring Tool. Increase the length of the PWA 18750 Flaring Tool handle sufficiently to have access to the clinch nut.

(e) Remove the clinch nut installation tool and the flaring tool after the clinch nut is installed.

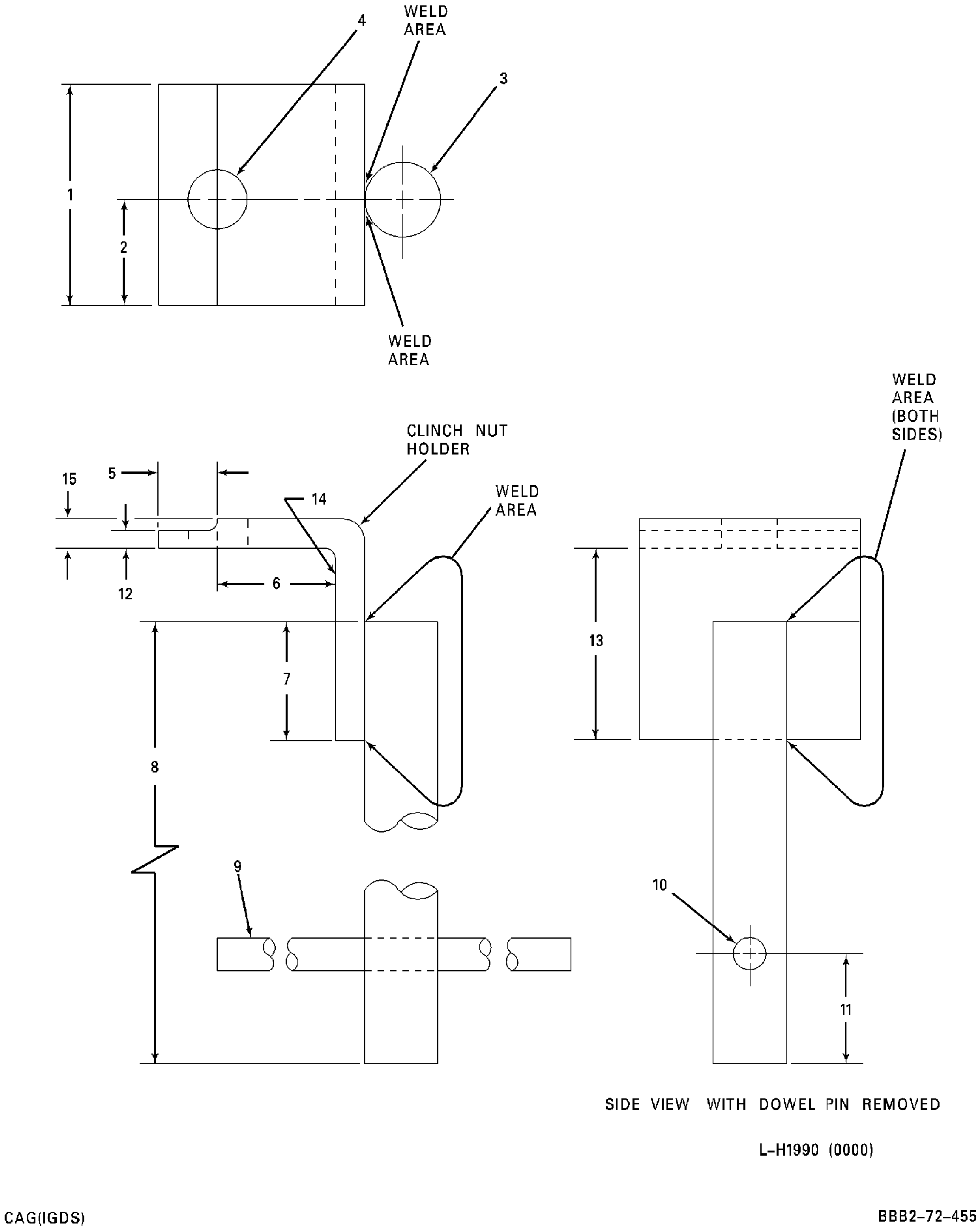
E. Postrequisite

(1) Install the turbine inner duct borescope port cover and the combustion chamber and turbine fan duct borescope port cover. See ENGINE GENERAL, SUBJECT 72-00-00, Page 601, Borescope Inspect 1st and 2nd Stage Turbine Blades and 2nd Stage Turbine Vanes.

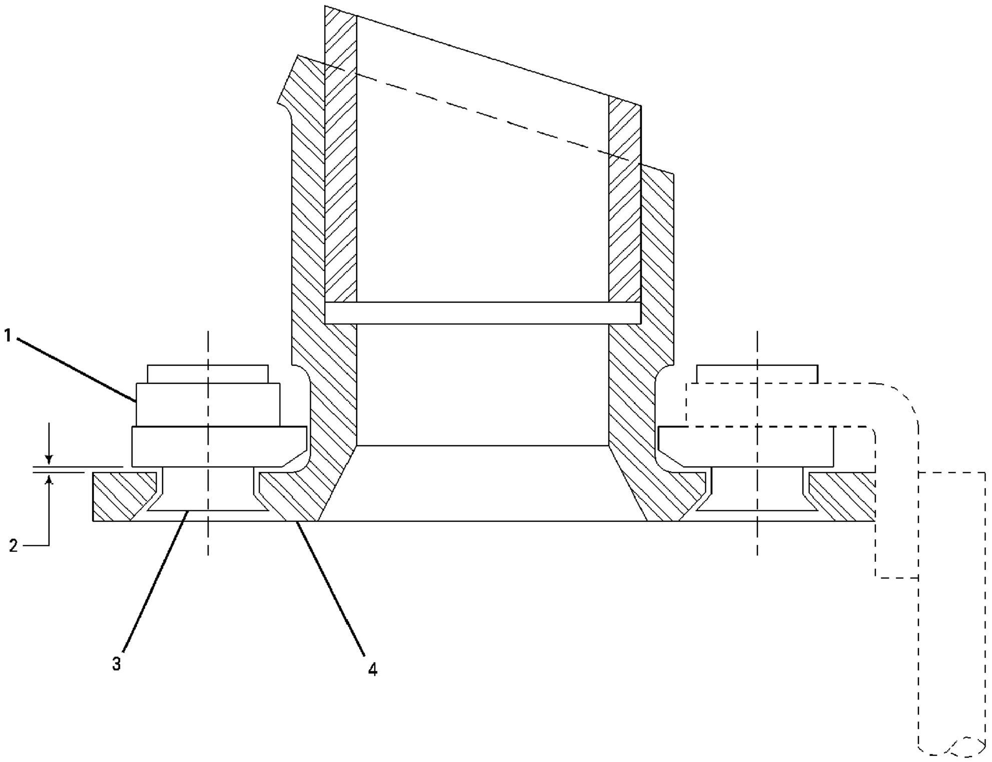
Table 801

Key to Figure 801	
Index No.	**Nomenclature**
1	3/4 Inch (19.05 mm)
2	3/8 Inch (9.525 mm)
3	1/4 Inch (6.35 mm)
4	0.316 Inch (8.026 mm) Diameter Through
5	13/64 Inch (5.1594 mm)
6	3/8 Inch (9.525 mm)
7	3/8 Inch (9.525 mm)
8	16 Inch (406.40 mm)
9	5/32 Inch (3.969 mm) x 2 Inch (50.8 mm) ± 1/64 Inch (0.3969 mm) Diameter Dowel Pin
10	0.1552 - 0.1557 Inch (3.9421 - 3.9547 mm) Diameter Through
11	1/2 Inch (12.7 mm)
12	5/64 Inch (1.9844 mm) Thickness
13	5/8 Inch (15.875 mm)
14	Surface A
15	1/8 Inch (3.175 mm) Thickness

NOTE: Index 1, 2, 3, 5, 6, 7, 8, 11, 12, 13, and 15 have a tolerance of ± 1/64 inch (0.3969 mm).



Locally Made Clinch Nut Installation Tool Dimensions
Figure 801/72-53-51-990-801



FLARE SHANK TO ATTACH CLINCH NUT. SHANK MUST BE FLUSH WITH OR BELOW SURFACE B AFTER FLARING.

1. PN 494674 CLINCH NUT BOTH SIDES
2. 0.000 – 0.010 INCH (0.00 – 0.25 MM) BOTH SIDES
3. SHANK
4. SURFACE B

L-H1991 (0000)

CAG(IGDS)

BBB2-72-456

Instrumentation Boss Assembly Clinch Nut Installation
Figure 802/72-53-51-990-802

EXHAUST SECTION - DESCRIPTION

1. Turbine Exhaust Case

The turbine exhaust case is bolted to the rear flange of the turbine rear case. The exhaust case is of nearly cylindrical inside diameter and serves to straighten the turbine exhaust gases. Eight integral exhaust struts in the gaspath shield the No. 6 bearing support strut rods which support the No. 6 bearing housing. The exhaust case also incorporates probe bosses to allow the passage of the combined Pt7/Tt7 probes into the gaspath.

2. No. 6 Bearing and Housing

In the center of the exhaust section, supporting the rear of the front compressor drive turbine rotor is the No. 6 bearing. This roller bearing is held by the No. 6 bearing housing, which incorporates bearing oil damping provisions; part of the pressure oil pumped into the No. 6 bearing compartment is ported between the bearing outer race and the bore to damp rotor vibrations. The No. 6 bearing oil scavenge pump is bolted to the rear face of the bearing housing and pumps scavenge oil from the No. 6 bearing housing sump into the rear of the No. 4 1/2 and 6 bearing tube assembly through the No. 4 1/2 and 6 bearing oil nozzle. A forward seal ring on the bearing housing mates with the No. 6 bearing carbon ring seals. Heatshields around the No. 6 bearing seals and housing sump protect these ares from excessive heat.

3. Fan Exhaust Duct

The fan exhaust duct forms the outer structure of the engine in the exhaust area. This duct encloses the fan bypass exhaust and positions the turbine exhaust case at its center by means of four pairs of strut rods. This duct assembly incorporates heavy mount rails which are the rear mounting point for the engine. The rear of the duct is ported for the combined Pt7/Tt7 probes, and the Pt7 manifolds and tubing are routed around the circumference of the duct. The inner wall of the duct is covered with a sound-absorbent liner to reduce noise.

TURBINE EXHAUST CASE - REPAIRS

1. General

A. This section provides instructions for the Turbine Exhaust Case Vane Crack Repair.

2. Turbine Exhaust Case - Repairs

A. Turbine Exhaust Case Vane Crack Repair

(1) The following is the key to (Figure 801).

- 1. Crack that starts at end of keyhole slot and goes adjacent to or halfway across stiffener weld (Repair by Stop-drill).
- 2. Crack that starts at end of old stop-drill hole (Drilled In Previous Repair) and goes adjacent to or halfway across stiffener weld (Repair by Stop-drill).
- 3. 5/16 inch (7.939 mm) minimum distance to edge of weld.
- 4. One crack permitted for each strut through stiffener radius.
- 5. Use 0.0468 - inch (1.189 mm) diameter drill bit at this area only (At all other areas use 0.125 - inch (3.175 mm) diameter or No. 3 drill bit).

(2) Turbine exhaust case vanes with cracks can continue in service if repaired by the procedure and limits that follow. It is permitted to repair cracks in the area of the leading edge stiffeners by stop-drill as shown in (Figure 801)

(a) Repair all cracks in the sheet-metal part of a vane by stop-drill.

(b) Stop-drill repairs are a satisfactory procedure for temporary repair of vane leading edge stiffeners, but it will be necessary to weld repair these cracks when turbine exhaust case is removed at the subsequent shop visit. Refer to TURBINE EXHAUST CASE, SUBJECT 72-54-01, Repair-03 in the JT8D-200 Engine Manual, PN 773128.

(c) Cases that were repaired before by stop-drill can be repaired again by these limits:

1) Vanes with cracks a maximum of one inch (25.4 mm) in length are permitted to continue in service if the cracks are fully contained in the stiffener and it is not very possible that material will immediately come free. Examine these parts again at the subsequent A Check or at each 750-hour interval (when one of these occurs first).

2) If cracks are between one and three inches (25.4 - 76.2 mm), they must get stop-drill repair before the case can continue in service. Use the stop-drill procedure below. examine these parts again at the subsequent A Check or at each 1500-hour interval (when one of these occurs first).

3) If vane cracks are longer than three inches (76.2 mm), shop weld repair in 100 hours or less will be necessary. Refer to TURBINE EXHAUST CASE, SUBJECT 72-54-01, Repair-03 in the JT8D-200 Engine Manual, PN 773128.

NOTE: If pieces of the stiffener are broken or missing, or if the crack went more than halfway through the weld seam, it will be necessary to replace the stiffener. Refer to TURBINE EXHAUST CASE, SUBJECT 72-54-01, Repair-07 in the JT8D-200 Engine Manual, PN 773128.

(d) Stop-drill vane cracks as follows:

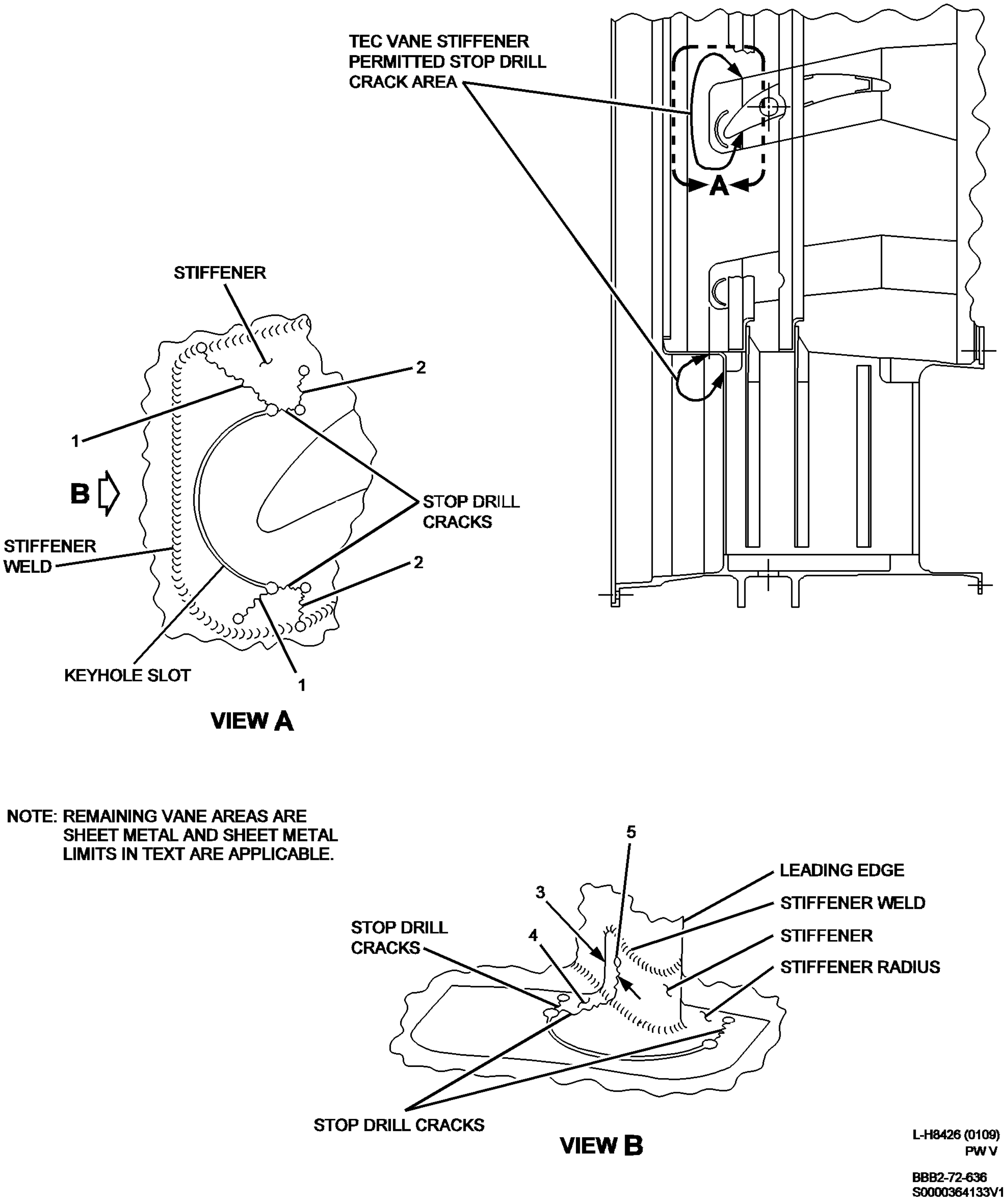
1) For cracks in the stiffener radius or cracks that extend into the radial part of the stiffener, use a 0.0468 inch (1.189 mm) diameter drill bit. For all other areas use a 0.125 inch 93.175 mm) diameter or No. 30 drill bit.

2) Drill through the outer skin only (but it is permitted for the conical tip of the drill to touch the inner skin).

3) Remove all burrs from the stop-drill hole.

4) Polish the new stop-drill hole and all other stop-drill holes that were not polished before.

(e) Do a SPOP 70 local fluorescent penetrant inspection (normal sensitivity) of the strut stiffener areas to be sure that all cracks got stop-drill repair. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)



NOTE: REMAINING VANE AREAS ARE SHEET METAL AND SHEET METAL LIMITS IN TEXT ARE APPLICABLE.

Turbine Exhaust Case - Repair
Figure 801/72-54-01-990-801

NO. 6 BEARING OIL SCAVENGE PUMP ASSEMBLY - REMOVAL/INSTALLATION

1. No. 6 Bearing Oil Scavenge Pump Removal

A. Prerequisites

(1) Remove the turbine exhaust cone.(TURBINE EXHAUST CONE ASSEMBLY - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-55-01/401)

B. Equipment and Materials Required

(1) Support Equipment

PWA 46342 Wrench

C. Procedure. See Figure 401, Table 401, Figure 402, and Table 402.

(1) Remove the bolts which attach the No. 6 bearing cover and heat shield. Remove the heat shield and cover. Discard the gasket.

(2) Disconnect the No. 4 1/2 and 6 bearing inner internal pressure tube at the outer duct. Disconnect and remove the No. 4 1/2 and 6 bearing rear pressure tube (Index 1 in Figure 401, Table 401) from the outer fan duct.

(3) Remove the bolts that attach the packing holder to the turbine exhaust duct. Remove the packing holder (Index 5 in Figure 401, Table 401).

(4) Use PWA 46342 Wrench to loosen the nut that attaches the inner internal pressure tube to the top of the No. 6 bearing compartment. Pull the tube away from the center of the engine until the inner end is out of the pump.

(5) Cut the lockwire from the No. 6 bearing pressure tube bolts and loosen the bolts so that the tube can move.

(6) Remove the three bolts which attach the No. 6 bearing scavenge pump. Remove the pump and tube from the engine.

(7) Remove the bolts which attach the No. 6 bearing pressure tube to the pump housing. Remove the tube from the housing.

(8) If it will not be necessary to remove and replace the No. 6 bearing seal and spacer asssembly (NO. 6 BEARING SEALS AND SPACERS ASSEMBLY - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-53-40/401), remove the seal as follows:

NOTE: It is necessary to replace the oil tube seal when the oil pump is replaced. However, it is permitted to replace this seal during No. 6 bearing seal and spacer replacement in NO. 6 BEARING SEALS AND SPACERS ASSEMBLY - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-53-40/401.

(a) Bend away the key washers and remove the bolts that attach the No. 6 bearing scavenge pump gearshaft.

(b) Install the jaw of PWA 12292 puller around the gear end of the gearshaft. Remove the gearshaft with the puller.

(c) Remove the retaining ring that holds the seal in the end of the No. 4 1/2 and 6 bearing shield and tube assembly. Remove the seal from the tube.

2. No. 6 Bearing Oil Scavenge Pump Installation

A. Equipment and Materials

(1) Support Equipment

PWA 12702 Drift

PWA 46342 Wrench

(2) Consumables:

PMC 9609 Petrolatum

PWA 36500 Assembly Fluid

B. Procedure. See Figure 401, Table 401, Figure 402, and Table 402.

(1) If it was necessary to remove the No. 4 1/2 and 6 bearing tube seal (Paragraph 1.), install a new seal as follows:

(a) Lubricate the seal for the No. 4 1/2 and 6 bearing shield and tube assembly with oil. Install the seal, with the inner seal lip and spring forward, into the rear of the tube assembly with PWA 12702 drift. Install the retaining ring in the end of the tube assembly to hold the seal in position.

(b) Install the No. 6 bearing scavenge pump gearshaft with eight bolts (lubricated with engine oil) and new key washers. Torque the bolts to 95 - 105 lb-in. (10.734 - 11.863 N·m). Bend the tabs of the key washers to safety the bolts.

CAUTION: IF YOU APPLY PETROLATUM TO THE PRESSURE TUBE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(2) Install a new packing (lubricated with a thin layer of PWA 36500 assembly fluid or petrolatum) in the groove of the No. 6 bearing pressure tube.

(3) Install the tube on the No. 6 bearing scavenge pump and attach the tube loosely with two bolts (the tube must move).

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 assembly fluid, but it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

(4) Install the scavenge pump assembly in the bearing compartment. Holes in the pump bracket align with dowel pins in the No. 6 bearing retaining plate. Make sure that the No. 6 bearing pressure tube goes easily into the boss on the retaining plate. Install and torque the three pump bolts.

(5) Torque the No. 6 bearing pressure tube bolts and safety them with lockwire.

(6) Install the No. 6 bearing inner internal pressure tube (with a new packing, lubricated with PWA 36500 assembly fluid) in the exhaust case. Make sure that the spherical section on the upper part of the tube goes fully into the guide on the turbine exhaust case (Index 10 in Figure 401, Table 401). Put the inner end of the inner internal pressure tube in the pump housing bushing (make sure that the hex nut is around the end of the tube). Turn the nut to hold the inner internal tube in position but do not tighten the nut at this time.

(7) Install a new packing, lubricated with a thin layer of PWA 36500 assembly fluid or petrolatum, on the packing holder and install the packing holder over the internal pressure tube at the wall of the exhaust duct. Install bolts and sleeve spacers at the corners of the packing holder (do not tighten the bolts at this time).

(8) Turn the internal pressure tube to put the airfoil section of the tube parallel with the airflow in the fan duct.

(9) Tighten the packing holder bolts.

(10) Use PWA 46342 wrench to torque the nut that holds the inner end of the internal pressure tube to the No. 6 bearing compartment to 280-320 lb-in (31.64-36.16 N·m). Safety the nut with lockwire.

NOTE: Use a standard 3/8 inch drive torque wrench with PWA 46342 wrench to torque the nut. PWA 46342 wrench has an effective length of 5 inches (127 mm). Use this length to adjust the observed torque reading (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201).

(11) Install the No. 4 1/2 and 6 bearing rear pressure tube. Torque the tube nuts and safety them with lockwire.

(12) Install the clips that attach the rear tube to the duct.

(13) Put a new gasket in the rear flange of the No. 6 bearing compartment and install the cover.

(14) Install the No. 6 bearing heat shield and outer heat shield.

(15) Install bolts to attach the outer heat shield and cover. Torque the bolts.

C. Postrequisites

(1) Install the turbine exhaust cone. (TURBINE EXHAUST CONE ASSEMBLY - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-55-01/401)

Table 401

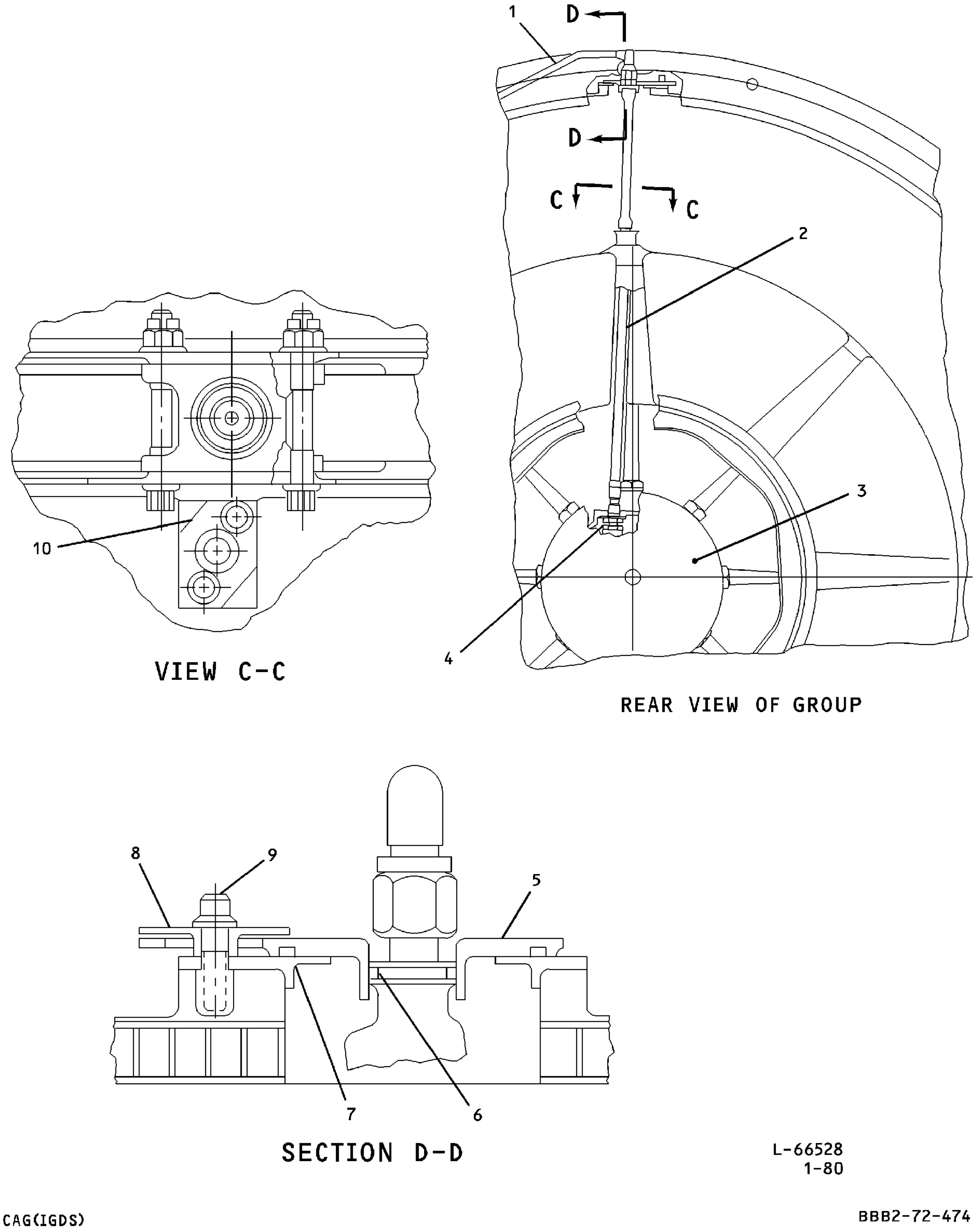
Key to Figure 401	
Index No.	**Nomenclature**
1	No. 4 1/2 And 6 Bearing Rear Pressure Tube
2	No. 4 1/2 And 6 Bearing Internal Pressure Tube
3	No. 6 Bearing Heat Shield
4	Internal Tube Hex Nut
5	Packing Holder
6	Preformed Packing
7	Preformed Packing
8	Sleeve Spacer (Four)
9	Bolt (Four)
10	Pressure Tube Guide

Table 402

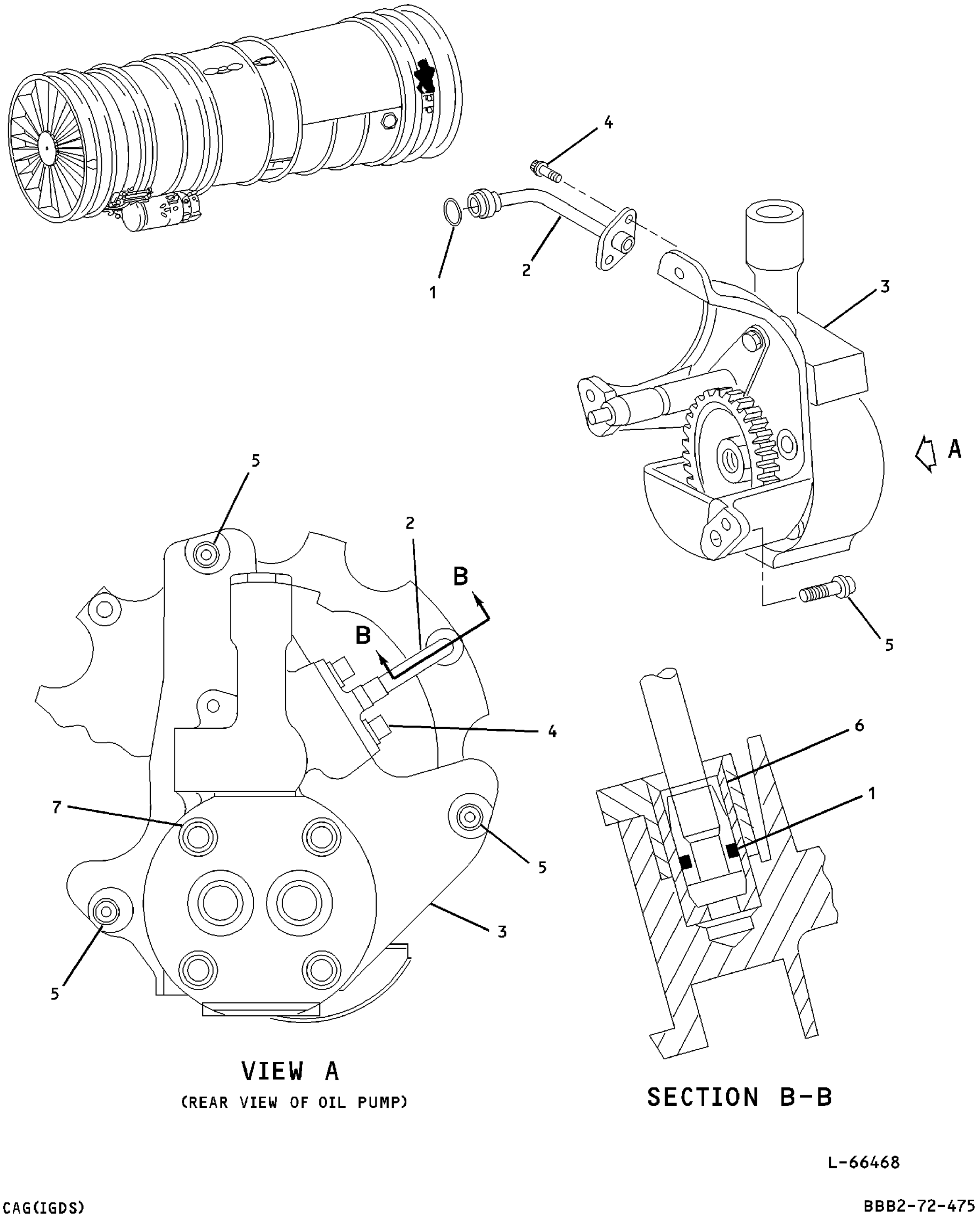
Key to Figure 402	
Index No.	**Nomenclature**
1	Packing
2	No. 6 Bearing Pressure Tube
3	No. 6 Bearing Scavenge Pump Assembly
4	Pressure Tube Mounting Bolt (Two)
5	Pump Assembly Mounting Bolt (Three)
6	No. 6 Bearing Retaining Plate Oil Transfer Port

Table 402 (Continued)

Key to Figure 402	
Index No.	**Nomenclature**
7	Pump Cover Bolts (Reference). Do Not Loosen When The Pump Is Removed.



No. 6 Bearing Area
Figure 401/72-54-25-990-801



No. 6 Bearing Scavenge Pump Removal
Figure 402/72-54-25-990-802

FAN EXHAUST SOUND ABSORBING LINER SEGMENTS - REPAIR

1. Repair Damaged Nut Inserts

A. Equipment And Materials

(1) Support Equipment

PWA 45564-3 Sonic Bond Test Standard

(2) Consumables - None

B. Procedure. (Figure 801, Table 801).

CAUTION: USE MINIMAL DRILL FEED PRESSURE TO AVOID DISBONDING INNER DIAMETER FACE SHEET AND TO PREVENT SPINNING NUT INSERT WHICH IS BONDED INTO LINER SEGMENT.

(1) Drill through nut insert and inner face sheet as shown.

(2) Inspect face sheet around hole for evidence of unbonding. Inspection may be visual or tap test but sonic inspection is preferred.

(a) Eddy-sonic inspect acoustical panel bonds, aluminum side as follows:

1) Use PWA 45564-3 Sonic Bond Test Standard to calibrate eddy-sonic test equipment.

NOTE: PWA 45564-3 Standard consists of marked bond and disbond areas. Scan standard with eddy-sonic probe to make required calibration settings.

2) Scan only ID of segments.

(b) Limits

1) Maximum unbonding permitted is 1.000 inch (25.40 mm) diameter centered on hole.

(3) Install screw and washer as shown.

NOTE: Access to ID of liner may be accomplished by either removing station 6 borescope access covers or by using long handled tools from rear of engine.

CAUTION: DO NOT OVER TORQUE OR PANEL MAY BE CRUSHED.

(4) Install nut and washer as shown using a torque of 20 - 30 lb-in. (2.260 - 3.390 N·m).

2. Repair Honeycomb Core to Face Sheet Void or Disbond

A. Equipment And Materials Required

NOTE: It is possible that some materials in the Equipment and Materials List cannot be used for some or all of their necessary applications. Before you use the materials, make sure the types, quantities, and applications of the materials necessary are legally permitted in your location. All persons must obey all applicable federal, state, local, and provincial laws and regulations when it is necessary to work with these materials.

(1) Support Equipment - None

(2) Consumables

Potting Compound (PWA 603) DPM 5877

B. Procedure. (Figure 802)

(1) If the face sheet has large tears or is broken into small pieces:

(a) Cut off all pieces which are not fully attached to the remaining face sheet.

NOTE: If there is honeycomb core in the repair area which is not fully bonded, let it stay there to hold the epoxy repair.

WARNING: THE SOLVENTS IN THIS PROCEDURE CAN BE DANGEROUS IF BREATHED OR LET TO STAY ON THE SKIN. USE THE CORRECT PRECAUTIONS AND USE PLASTIC GLOVES OVER COTTON GLOVES.

(2) Clean the repair area fully with an applicable solvent see SPOP 208 STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201. Do not get too much solvent in the spaces of the duct. Remove all dirt, oil, grease and other unwanted materials from the area.

(3) Clean the outer portion of the repair area with solvent (see SPOP 208).

WARNING: THE CLEANING MATERIALS ARE FLAMMABLE AND CAN BURN FROM THE HEAT OF A HEAT GUN. DO NOT USE A HEAT GUN UNTIL AFTER THE REPAIR AREA IS FULLY DRY.

CAUTION: TOO MUCH HEAT CAN DAMAGE THE DUCT LINERS. DO NOT GO ABOVE A MAXIMUM TEMPERATURE OF 220°F (104.4°C) ON THE PERFORATED LINER SKIN.

(4) Dry for 15 minutes or more at room temperature in a well-ventilated area. Then fully dry the repair area with a heat gun at 220°F (104.4°C) maximum. It is recommended that Tempilabel Tabs (available from Omega Engineering, Inc., P.O. Box 4047, Stamford, CT 06907), or equivalent, be used to make sure that the surface temperature is in limits.

(5) Use PWA 603 Potting Compound material. Thoroughly mix 100 parts by weight of Part A to nine parts by weight of Part B until a uniform mass of material is obtained.

NOTE: PWA 603 potting compound is available as Eccobond SF-40 from Emerson & Cuming, Inc., Division of W.R. Grace & Co., Grace Syntactics, 59 Walpole Street, Canton, MA 02021 U.S.A.

Use this material only at an ambient temperature of 65°F - 90°F (18° - 35°C). Shelf life limit is six months from the date of shipment, kept at a maximum temperature of 90°F (35°C).

(6) Apply the potting compound with an injection nozzle or a spatula. It is permitted to make face sheet perforations larger to 0.100 inch (2.540 mm) diameter if necessary to get a nozzle into the sheet.

(a) Potting compound put into the core with a nozzle must be sufficient to flow out of adjacent holes in the perforated sheet.

(b) Potting compound must have the form of a 0.025 inch (0.635 mm) crown over all the repair area as shown in the figure and must go on all tears in the sheet edges.

(c) The repair area must include two cells farther than the damaged area if the face sheet has large damaged areas.

(7) Cure the compound as follows:

(a) Cure at ambient temperature for six hours until the compound is dry when touched, then for 24 hours for the material to be fully cured.

(b) As an optional procedure cure at ambient temperature for six hours, then at 240° - 260°F (116° - 127°C) for two hours.

(8) Use sandpaper to put a smooth, continuous change of contour from the potting compound that extends above the face sheet to the sheet surface as shown in the figure.

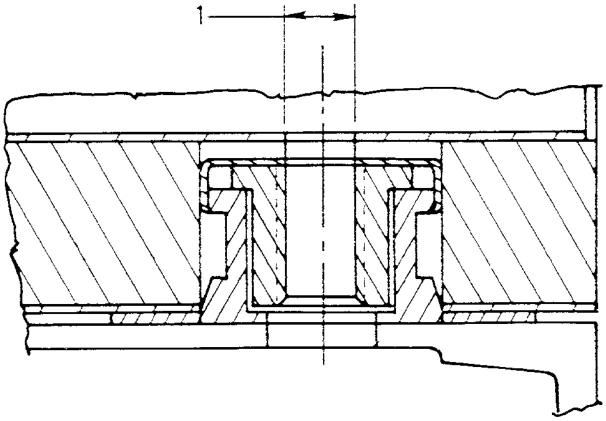
NOTE: The total area of all open cells or acoustic honeycomb core filled by this repair must not be more than 54 square inches (34,839 mm^2).

Look in the engine logbook to be sure that the engine can use all of the available sound absorbing liner limits for filled liner cell area. It is possible that some engines will have limits on how much added filled area in the sound liners is permitted.

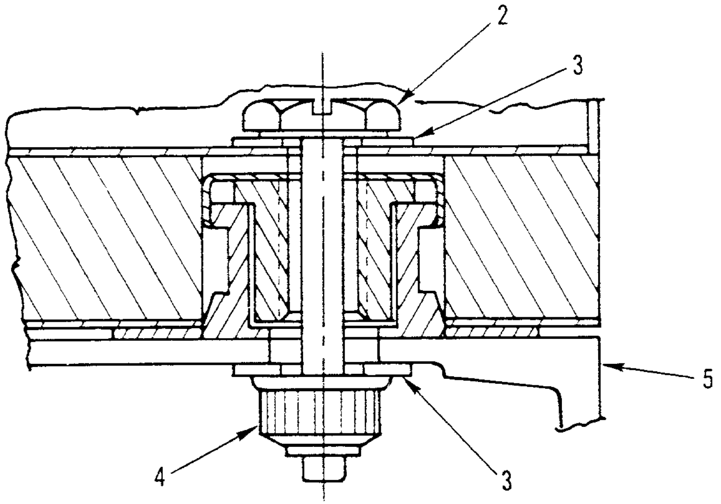
(9) Locally repair protective surface coating by SPOP 42 anodize touch-up. See Section 70-00-00, Standard Practices.

Table 801

Key to Figure 801	
Index No.	**Nomenclature**
1	0.216 - 0.226 Inch (5.49 - 5.74 mm) Diameter Through
2	Screw (PN 524505)
3	Washer (PN MS9320-09)
4	Nut Option (PN 489227)
5	Fan Exhaust Duct



VIEW OF NUT INSERT AFTER DRILLING



VIEW OF NUT INSERT AFTER REPAIR

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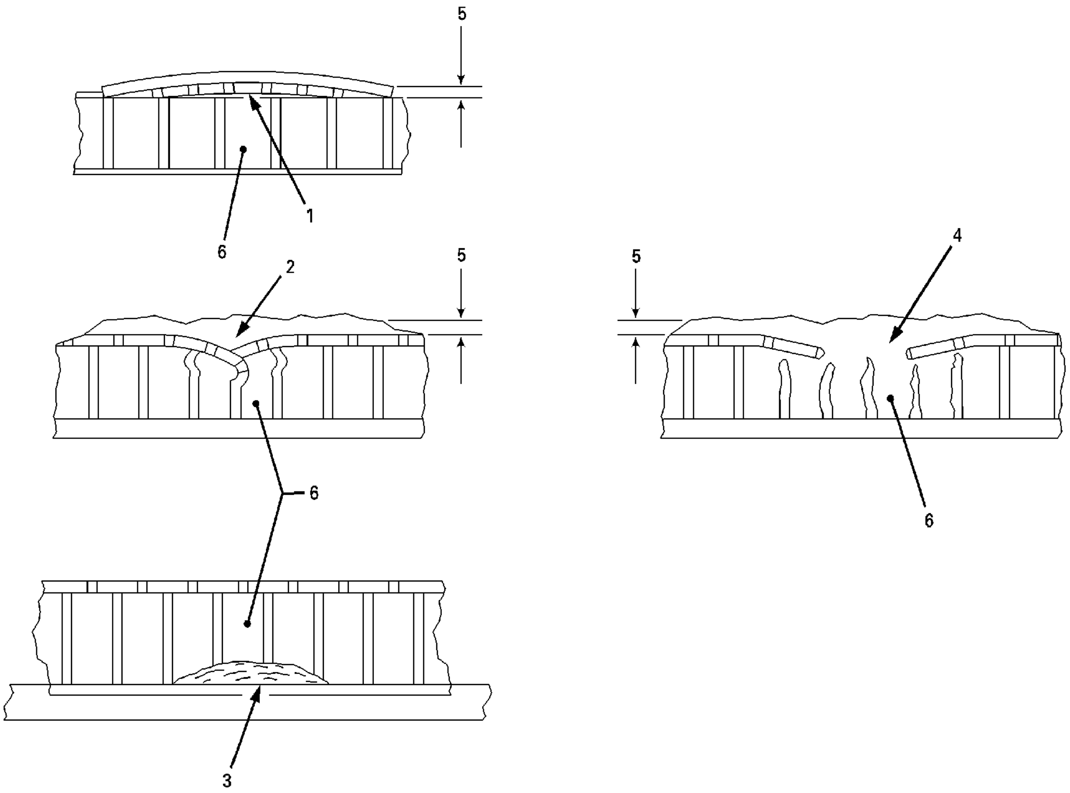
Liner Segment Nut Insert Repair
Figure 801/72-54-31-990-801



1. DISBOND OF PERFORATED FACE SHEET TO CORE.
2. SCRATCH OF PERFORATED FACE SHEET TO CORE.
3. DISBOND OF FIBERGLASS FACE SHEET TO CORE.
4. CRACKED OR TORN FACE SHEET AND/OR CRUSHED CORE.
5. 0.020 – 0.030 INCH (0.51 – 0.76 MM) CROWN.
6. FILL HONEYCOMB CELLS FULLY IN THE REPAIR AREA.

L-79458

CAG(IGDS) BBB2-72-454

Honeycomb Potting Compound Repair
Figure 802/72-54-31-990-802

FAN/TURBINE EXHAUST DUCT STRUTS - REPAIR-01

1. Blend Surface Damage

A. Equipment And Materials - None

B. Procedure

(1) Remove surface damage to struts in the area of the inner fan duct segments.

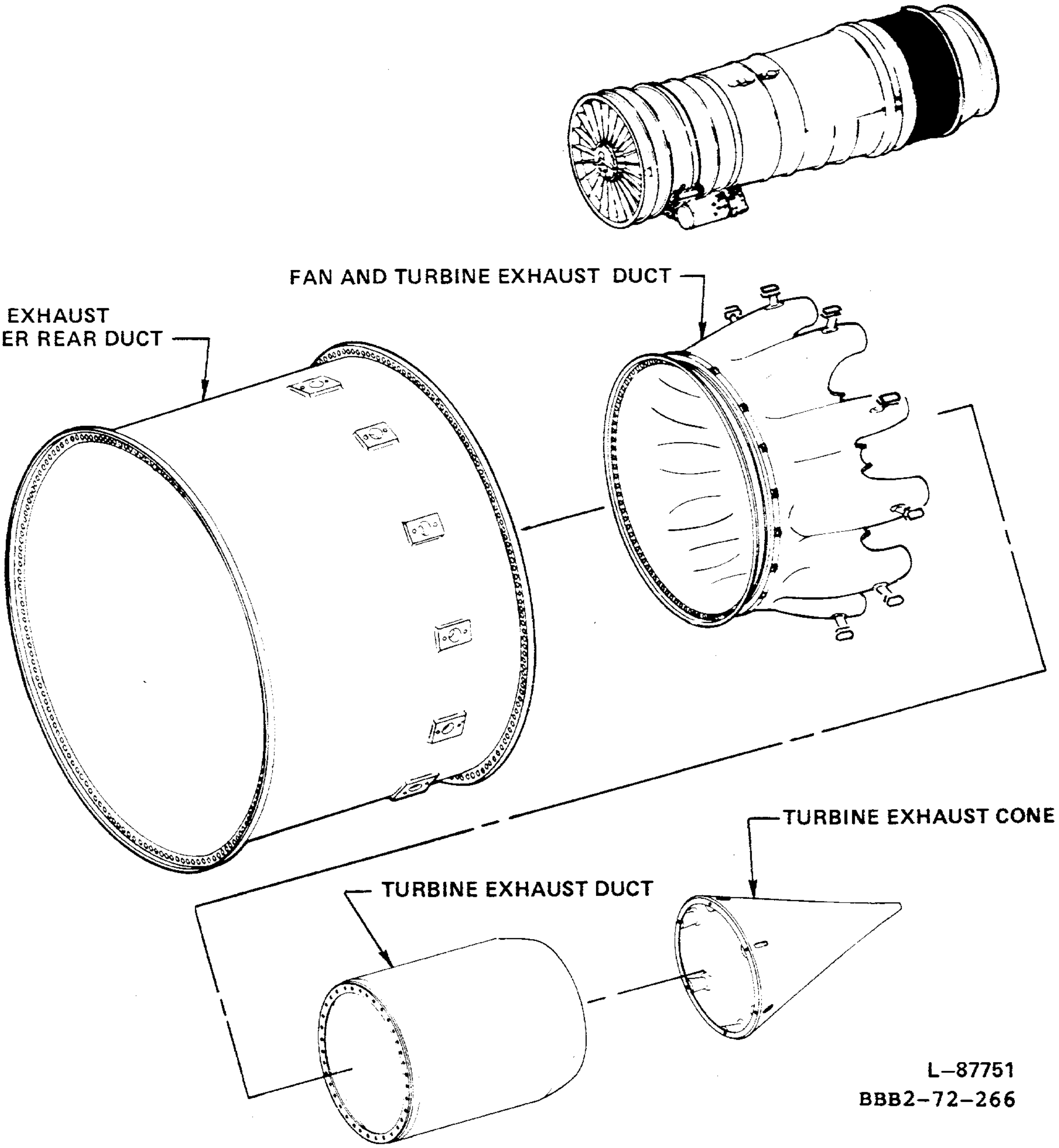
(2) Blend repair up to 0.075 inch (1.905 mm) depth is permitted. Use a 10:1 blend ratio of width to depth of the blend.

FAN AND TURBINE INTEGRATED EXHAUST (MIXER) SECTION - DESCRIPTION

1. Fan And Turbine Integrated Exhaust (Mixer)

Bolted to the rear of the fan exhaust outer duct and turbine exhaust case is the integrated exhaust unit, or mixer. This unit mixes the fan bypass and primary gaspath exhaust, resulting in exhaust noise reduction. The mixer accomplishes this by means of convoluted sheet metal sections arranged around a central exhaust cone.

The integrated exhaust unit is composed of an outer duct, the fan and turbine exhaust duct (mixer), the turbine exhaust duct, and the turbine exhaust cone. (Figure 1) Early fan and turbine exhaust ducts were equipped with both outer (OD) and inner (ID) mounting struts, the outer struts positioned against the outer duct and the inner struts positioned against the turbine exhaust duct. Current fan and turbine exhaust ducts are equipped only with outer (OD) mounting struts; with this type of duct a weighted turbine exhaust cone is required. The weighted cone may also be used with the earlier, ID/DD mounted mixer. Earlier mixers were made of titanium and later mixers are made of nickel alloy. Earlier turbine exhaust cones were made of titanium and later cones are made of stainless steel.



Fan And Turbine Integrated Exhaust Unit Parts
Figure 1/72-55-00-990-801

FAN AND TURBINE INTEGRATED EXHAUST (MIXER SECTION) - REMOVAL/INSTALLATION

1. General

A. This maintenance practice provides removal/installation instructions for the Fan and Turbine Integrated Exhaust (Mixer Section).

B. Access is through the thrust reverser.

2. Equipment and Material

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

Table 401

Name and Number	Manufacturer
PWA 550-3 (P06-021) Antigalling Compound	
PWA 36003-1 (P09-014) Sealant, Silicone Rubber RTV-159 (Red)	
PWA 45221 Lifting Eye	
PWA 46175 Wrench	
PWA 45398 Lifting Bracket	
PWA 75135 Safety Hook	

3. Removal/Installation Fan and Turbine Integrated Exhaust (Mixer Section)

A. Remove Fan Exhaust Outer Rear Duct (Rear) (Figure 401)

(1) Remove thrust reverser. (THRUST REVERSER - MAINTENANCE PRACTICES, PAGEBLOCK 78-30-01/201)

(2) Tag throttle/thrust reverser levers.

WARNING: MAKE CERTAIN CIRCUIT BREAKERS ARE OPEN BEFORE ATTEMPTING MAINTENANCE PROCEDURES. INADVERTENT ENGINE START OR REVERSER OPERATION COULD RESULT IN DEATH OR SERIOUS INJURY TO PERSONNEL.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(3) Open these circuit breakers and install safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	40	B1-40	ENGINE START PUMP
WJE 401-404, 412, 414, 875, 876, 878, 879, 881, 883			
U	42	B1-872	ENG START VALVE LEFT & RIGHT

WJE 401-404, 412, 414, 875, 876, 878, 879, 881, 883 (Continued)

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(4) At the 12 O'clock position of Flange N (6) remove sufficient nuts (9), washers (10), and bolts (11) to make it possible to install the dowel pins (7) and front bracket details (8) of PWA 45398 Lifting Bracket (2).

(5) Remove the capscrews (4) and washers from the rear bracket detail (3) of the bracket (2).

CAUTION: MAKE SURE THAT THE DOWEL PINS OF THE LIFTING BRACKET EXTEND THROUGH THE REINFORCING PLATE (IF USED) AND THE DUCT FLANGE (THIS IS IMPORTANT TO HOLD THE DUCT SAFELY).

(6) Install PWA 45398 Lifting Bracket (2) at the 12 o'clock position on the rear duct front flange N (6). Put the dowel pins (7) through the holes in the reinforcing plate (12) (pre SB 5300) and duct flange.

NOTE: A duct pre SB 5300 has reinforcing plates that are loose on the front flange and are removed when the bolts are removed. Post SB 5300 the plates are riveted to the flange. Current ducts have a thicker front flange, and reinforcing plates are not used.

(7) Lower the lifting bracket (2) to the rear flange and align the tapped holes in the rear bracket detail (3) with the holes in the duct rear flange.

(8) Attach the bracket (2) to the duct with capscrews (4) and washers.

(9) Attach PWA 75135 Safety Hook (1) to the eye of PWA 45398 Lifting Bracket (2), then attach a hoist and tighten it against the load of the duct (5).

(10) Loosen and remove the remaining nuts (9), washers (10), and bolts (11) that attach the rear duct at Flange N (6). Record the position of the duct in relation to the mixer outer duct with a mark on the rear duct to help with subsequent installation.

CAUTION: BE CAREFUL DURING DUCT REMOVAL NOT TO HIT THE EXHAUST CONE AND CAUSE DAMAGE.

(11) Remove the fan exhaust outer rear duct (rear) (5) from the engine and lower it to a pallet. Remove the PWA 45398 Lifting Bracket (2).

NOTE: If there are loose reinforcing plates on the duct flange (pre SB 5300), remove the plates after the PWA 45398 Lifting Bracket (2) is removed.

B. Remove Fan Exhaust Outer Rear Duct (Front)

(1) Remove Turbine Exhaust Cone. (EXHAUST CONE - MAINTENANCE PRACTICES, PAGEBLOCK 78-10-01/201)

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(2) Make sure that these circuit breakers are open and have safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	40	B1-40	ENGINE START PUMP
WJE 401-404, 412, 414, 875, 876, 878, 879, 881, 883			
U	42	B1-872	ENG START VALVE LEFT & RIGHT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(3) Remove the bolts (1) and washers (2) that attach the fan exhaust duct covers (3) to the fan exhaust outer rear duct (front) (4). (Figure 402)

(4) Remove the fan exhaust duct covers (3).

NOTE: Examine the covers when they are removed to see if there is RTV sealant remaining on the cover and mixer strut surfaces. If RTV was used at engine assembly at these positions, it will be permitted to use sealant again between the covers and the mixer struts at engine assembly (the sealant is used to decrease movement and wear of the strut feet against the covers during engine operation). If there is no indication of RTV at these positions, the sealant is not permitted at engine assembly (this sealant is permitted in a shop for the first time only when it is possible to do a thrust assurance check in a test cell).

(5) At the 12 O'clock position on the duct install PWA 45221 Lifting Eye (5). Connect the eye to a hoist with PWA 75135 Safety Hook (6) as shown in (Figure 402).

(6) Remove the nuts (7), washers (8) and bolts (9) that attach the fan exhaust outer rear duct (front) (4) to Flange M.

(7) Remove the duct (4) and lower it to a pallet.

(8) Remove the PWA 45221 Lifting Eye (5).

C. Remove Fan and Turbine Exhaust Duct (Mixer)

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(1) Make sure that these circuit breakers are open and have safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	40	B1-40	ENGINE START PUMP

(Continued)

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
WJE 401-404, 412, 414, 875, 876, 878, 879, 881, 883			
U	42	B1-872	ENG START VALVE LEFT & RIGHT

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(2) Remove the fan exhaust inner rear duct segments (5): (Figure 403)

(a) Remove the rivet pins (Pre SB 5613), socket-head screws (Post SB 5613) or bolts (Post SB 6048) (4) at the two axial seams and the rear edge of the fan exhaust inner rear duct segments (5) and remove the segments from the engine.

(b) Remove the clip nuts (3) from the duct sect segments and from the flange on the fan and turbine exhaust duct (1).

NOTE: Use PWA 46175 Wrench to remove rivet-pin type fasteners (with two pin recesses in the head), or Hi-Sear HLS41-6 driver. On socket-head screws (with a star recess) use a Torx T20 driver.

(c) Attach a strap or sling from above the exhaust duct to hold the duct.

(d) Pre SB 5310: Remove the nuts (8) that attach the twelve inner duct strut covers (9) at the inner surface of the turbine exhaust duct (1) and remove the covers. (Figure 403 (Sheet 1))

NOTE: Post SB 5310 the fan and turbine exhaust duct has only outer feet (the inner feet are removed). (Figure 403 (Sheet 2))

(e) Remove the nuts (6) and bolts (7) at the fan and turbine exhaust duct front flange and remove the duct from the exhaust case.

(f) Move the duct carefully to the rear and remove it from the engine.

D. Remove Turbine Exhaust Duct

NOTE: Removal of the inner turbine exhaust duct is optional and is not necessary if the duct is in good condition and access to exhaust case structures is not necessary.

WARNING: TAG AND USE SAFETY CLIPS TO SAFETY THE CIRCUIT BREAKERS. IF THE CIRCUIT BREAKERS ARE NOT OPENED, TAGGED, AND SAFETIED, INJURY TO PERSONS AND DAMAGE TO EQUIPMENT CAN OCCUR.

(1) Make sure that these circuit breakers are open and have safety tags:

LOWER EPC, DC TRANSFER BUS

Row	Col	Number	Name
U	40	B1-40	ENGINE START PUMP
WJE 401-404, 412, 414, 875, 876, 878, 879, 881, 883			
U	42	B1-872	ENG START VALVE LEFT & RIGHT

WJE 401-404, 412, 414, 875, 876, 878, 879, 881, 883 (Continued)

UPPER EPC, ENGINE - LEFT AC BUS

Row	Col	Number	Name
WJE ALL			
K	26	B1-424	LEFT ENGINE IGNITION

UPPER EPC, ENGINE - RIGHT AC BUS

Row	Col	Number	Name
L	26	B1-425	RIGHT ENGINE IGNITION

(2) Remove the bolts (2) that attach the duct (1) to the turbine exhaust case (Figure 404).

(3) Move the turbine exhaust duct (1) carefully to the rear and remove it from the engine.

E. Install Turbine Exhaust Duct (if removed)

(1) Put the inner turbine exhaust duct (1) carefully in position against the turbine exhaust case. Align the offset hole at the 12 o'clock position.

(2) Install and torque the bolts (2) that attach the duct to the turbine exhaust case. (Figure 404)

(3) Pre SB 5310: Install the twelve inner duct strut covers (4) and install the nuts (3). (Figure 404 (Sheet 1))

F. Install Fan And Turbine Exhaust Duct (Mixer)

(1) Lift the fan and turbine exhaust duct (mixer) (2) with a strap or sling and install it carefully into position against the turbine exhaust case. (Figure 403)

NOTE: If the duct assembly is pre SB 5310, there will be inner and outer feet on the duct assembly (post SB 5310 there are outer feet only). Make sure that the inner feet on a pre SB 5310 assembly go across the surface of the turbine exhaust duct without damage to either the feet or the duct.

(2) Engage the front flange of the duct assembly with the turbine exhaust case rear flange and attach the duct with bolts (7) and nuts (6). Torque the nuts (6).

(3) Remove the strap or sling from the fan and turbine exhaust duct (mixer) (2).

(4) Pre SB 5310: At each of 12 inner strut locations, install duct covers (9) at the inner surface of the turbine exhaust duct. Put the inner duct foot between the rails of the cover at each strut position. Attach the covers (9) with nuts (8) and torque the nuts. (Figure 403 (Sheet 1))

(5) Install the fan and turbine exhaust inner rear duct segments (5) around the front of the duct assembly and attach with rivet pins (pre SB 5613), socket-head screws (post SB 5613) or bolts (post SB 6048) (4) at the axial seams and rear edges and install clip nuts (3).

NOTE: Use PWA 46175 Wrench to install rivet-pin type fasteners (with two pin recesses in the head), or Hi-Shear HLS41-6 driver. On socket-head screws (with a star recess) use a Torx T20 driver.

G. Install Fan Exhaust Outer Rear Duct (Front)

(1) At the 12 o'clock position of the fan exhaust outer rear duct (front) (4) install PWA 45221 Lifting Eye (5) and connect the eye to a hoist with PWA 75135 Safety Hook (6). (Figure 402)

(2) Lift and move the duct carefully into position against the fan exhaust outer duct (Flange M). Attach the duct with bolts (9), washers (8), and nuts (7).

NOTE: Move the duct carefully across the outer feet of the fan and turbine exhaust duct (mixer) and make sure that the feet of the fan and turbine exhaust do not cause damage to the inner surface of the outer rear duct.

(3) At the 12 o'clock position of the fan exhaust outer rear duct (front) (4) disconnect PWA 75135 Safety Hook (6) from PWA 45221 Lifting Eye (5). (Figure 402)

(4) Remove bolts (1), washers (2) and remove PWA 452221 Lifting Eye (5).

WARNING: SEALANT IS AN AGENT THAT IS AN IRRITANT. MAKE SURE ALL PERSONS OBEY ALL OF THE PRECAUTIONS WHEN ADHESIVE SEALANT IS USED.

- USE IN AN AREA OPEN TO THE AIR.
- DO NOT GET ADHESIVE SEALANT IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIERS'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THESE HAZARDOUS AGENTS.

(5) To decrease wear and damage to the outer strut feet in engine service, it is permitted to apply PWA 36003-1 (P09-014) to the inner surfaces of the duct covers (4) (between the covers and the mixer strut feet) as shown in (Figure 405). The sealant must not be more than 0.020 inch (0.508 mm) thick between the covers (4) and strut feet. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

NOTE: It is permitted to apply sealant between the duct covers and the mixer strut feet only if this sealant was used when the engine was initially assembled (refer to the note in removal above). This is because when the sealant was initially applied in a shop, a thrust assurance test in a test cell was done to make sure that there was no important effect on the engine exhaust nozzle area or thrust.

WARNING: ANTI-GALLING COMPOUND IS AN AGENT THAT IS POISONOUS. MAKE SURE ALL PERSONS OBEY THE PRECAUTIONS WHEN ANTI-GALLING COMPOUND IS USED.

- DO NOT USE IN AREAS WHERE THERE IS HIGH HEAT, SPARKS, OR FLAMES.
- USE IN AN AREA OPEN TO THE AIR.
- CLOSE THE CONTAINER WHEN NOT USED.
- DO NOT GET ANTI-GALLING COMPOUND IN THE EYES, ON THE SKIN, OR ON YOUR CLOTHES.
- DO NOT BREATHE THE GAS.

WARNING: REFER TO THE APPLICABLE MANUFACTURER'S OR SUPPLIERS'S MSDS FOR:

- MORE PRECAUTIONARY DATA
- APPROVED SAFETY EQUIPMENT
- EMERGENCY MEDICAL AID.

TALK WITH THE LOCAL SAFETY DEPARTMENT OR AUTHORITIES FOR THE PROCEDURES TO DISCARD THESE HAZARDOUS AGENTS.

(WARNING PRECEDES)

(6) Install the duct covers (3) at 12 boss locations on the fan exhaust outer rear duct and engage the fan and turbine exhaust duct (mixer) feet with the rails of the strut covers (3). (Figure 402)Apply PWA 550-3 (P06-021) antigalling compound to the threads of the cover bolts (1) (cure time is waved). (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201) Attach each cover (3) with washers (2) and bolts (1) and torque the bolts.

(7) Apply PWA 36003-1 (P09-014) sealant to the inner bolt holes and the seams between the acoustic liners as shown in (Figure 405). (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

NOTE: Sealant applied to the bolt holes and liner seams is part of the usual engine assembly sequence, and no special engine tests are necessary.

H. Install Fan Exhaust Outer Rear Duct (Rear)

(1) Install the turbine exhaust cone. (EXHAUST CONE - MAINTENANCE PRACTICES, PAGEBLOCK 78-10-01/201)

(2) If the fan exhaust outer rear duct (rear) (5) is pre SB 5300 (Figure 401), put the duct face down on a pallet and put the reinforcing plates (1) and (3) in position on the rear face of the front flange. Align the bolt holes. (Figure 406)

NOTE: A duct pre SB 5300 has reinforcing plates that are loose on the front flange. It will be necessary to install these plates before the lifting bracket is installed and the duct is installed on the engine. Post SB 5300 the plates are riveted to the flange. Current ducts have a thicker front flange, and reinforcing plates are not used.

(3) Remove the capscrews (4) and washers from the rear bracket detail (3) of the lifting bracket (2). (Figure 401)

CAUTION: MAKE SURE THAT THE DOWEL PINS OF THE LIFTING BRACKET EXTEND THROUGH THE REINFORCING PLATE (IF USED) AND THE DUCT FLANGE (THIS IS IMPORTANT TO HOLD THE DUCT SAFELY).

(4) Install PWA 45398 Lifting Bracket (2) at the 12 o'clock position on the rear duct front flange N (6). Put the dowel pins (7) through the holes in the reinforcing plates (12) (pre SB 5300) and duct flange.

(5) Put the lifting bracket (2) in position against the rear flange of the duct and align the tapped holes in the rear bracket detail (3) with the holes in the duct rear flange.

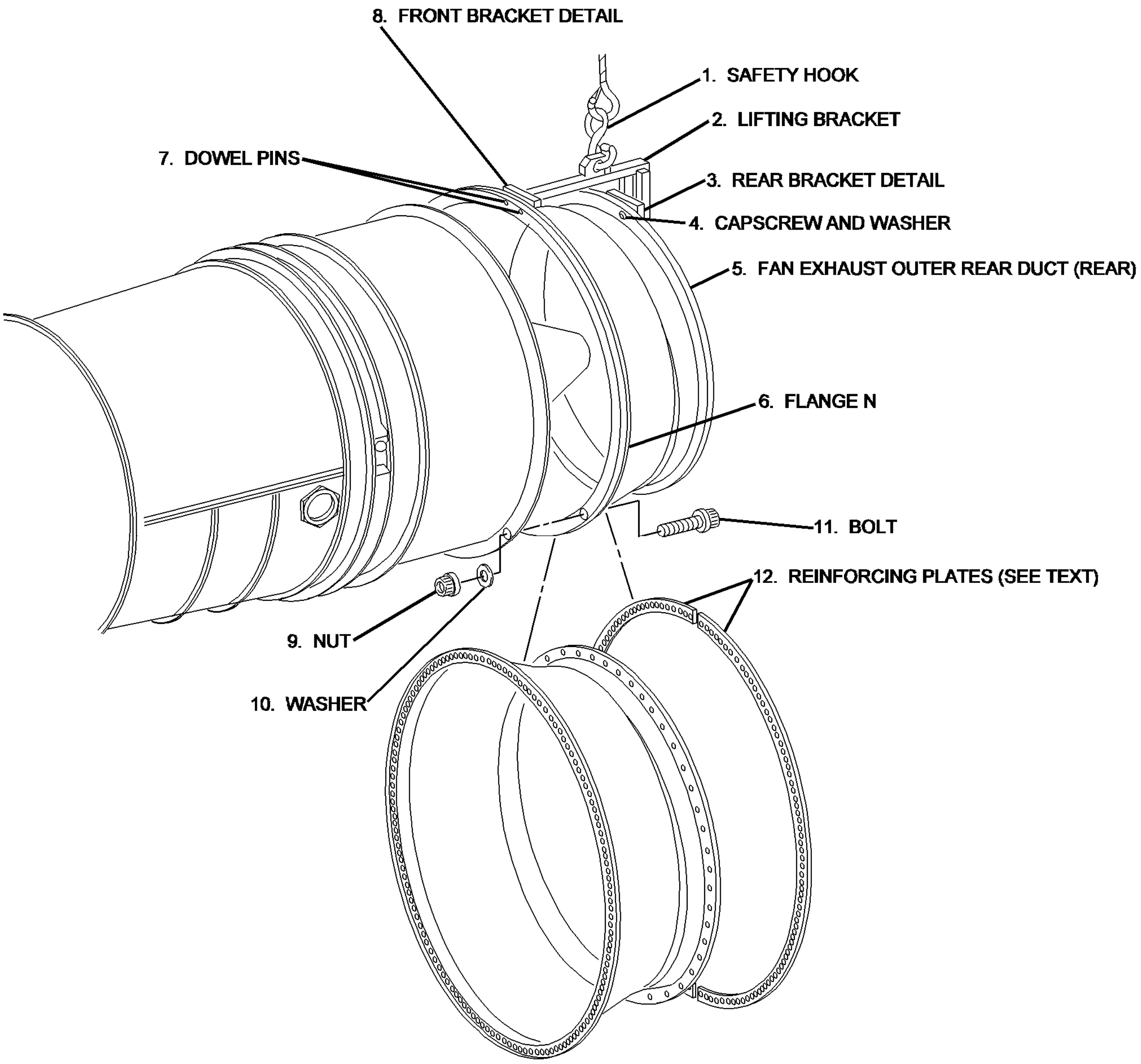
(6) Attach the bracket (2) to the duct with capscrews (4) and washers.

(7) Attach PWA 75135 Safety Hook (1) to the eye of PWA 45398 Lifting Bracket (2) and attach a hoist.

CAUTION: BE CAREFUL DURING DUCT INSTALLATION NOT TO HIT THE EXHAUST CONE AND CAUSE DAMAGE.

(8) Lift the duct and move it carefully into position against the fan exhaust outer rear duct (front), if marks were made at duct removal, be sure to align these marks. Attach the duct with bolts (11), washers (10), and nuts (9) and torque the nuts.

(9) Remove the PWA 45398 Lifting Bracket (2) and install the remaining bolts (11), washers (10) and nuts (9). Torque the nuts (9).



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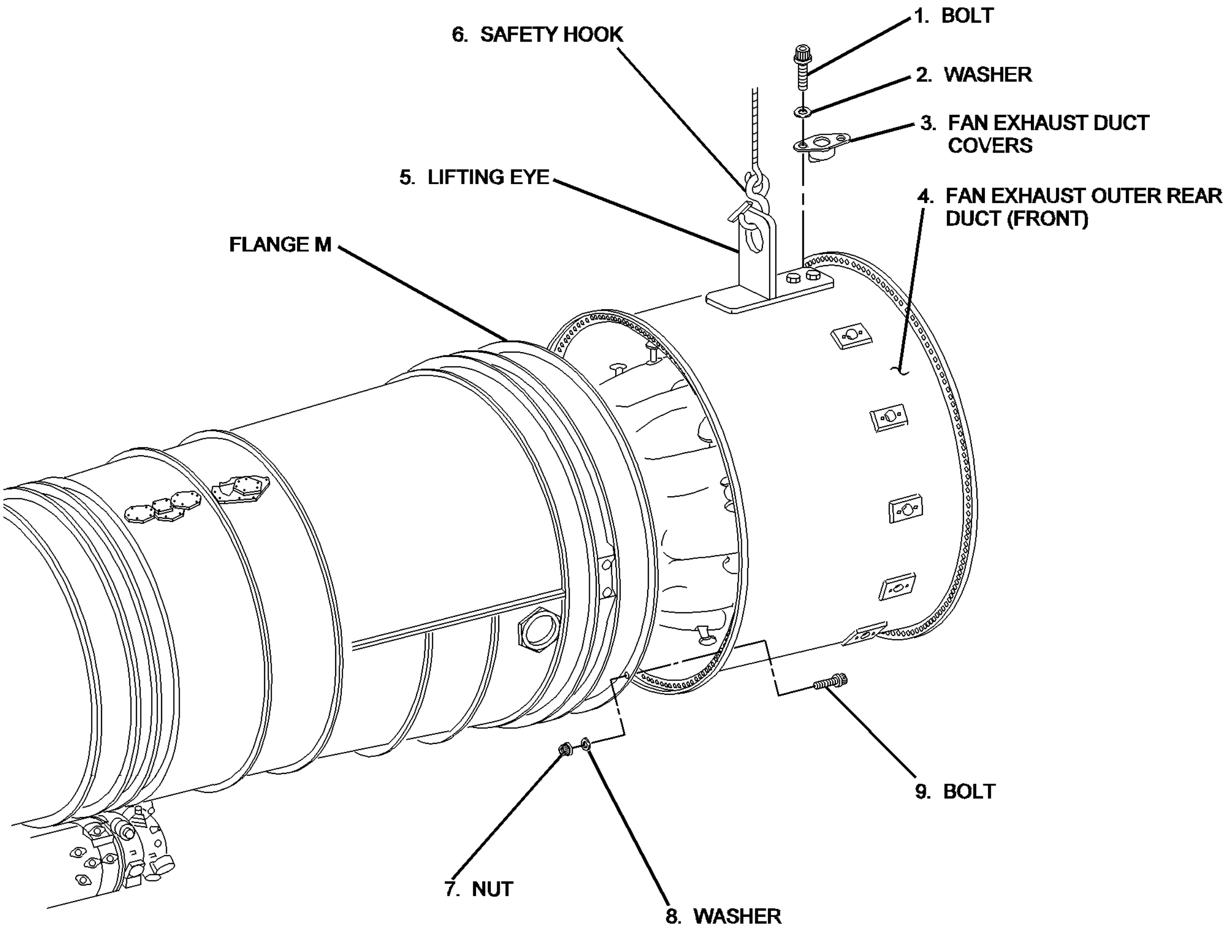
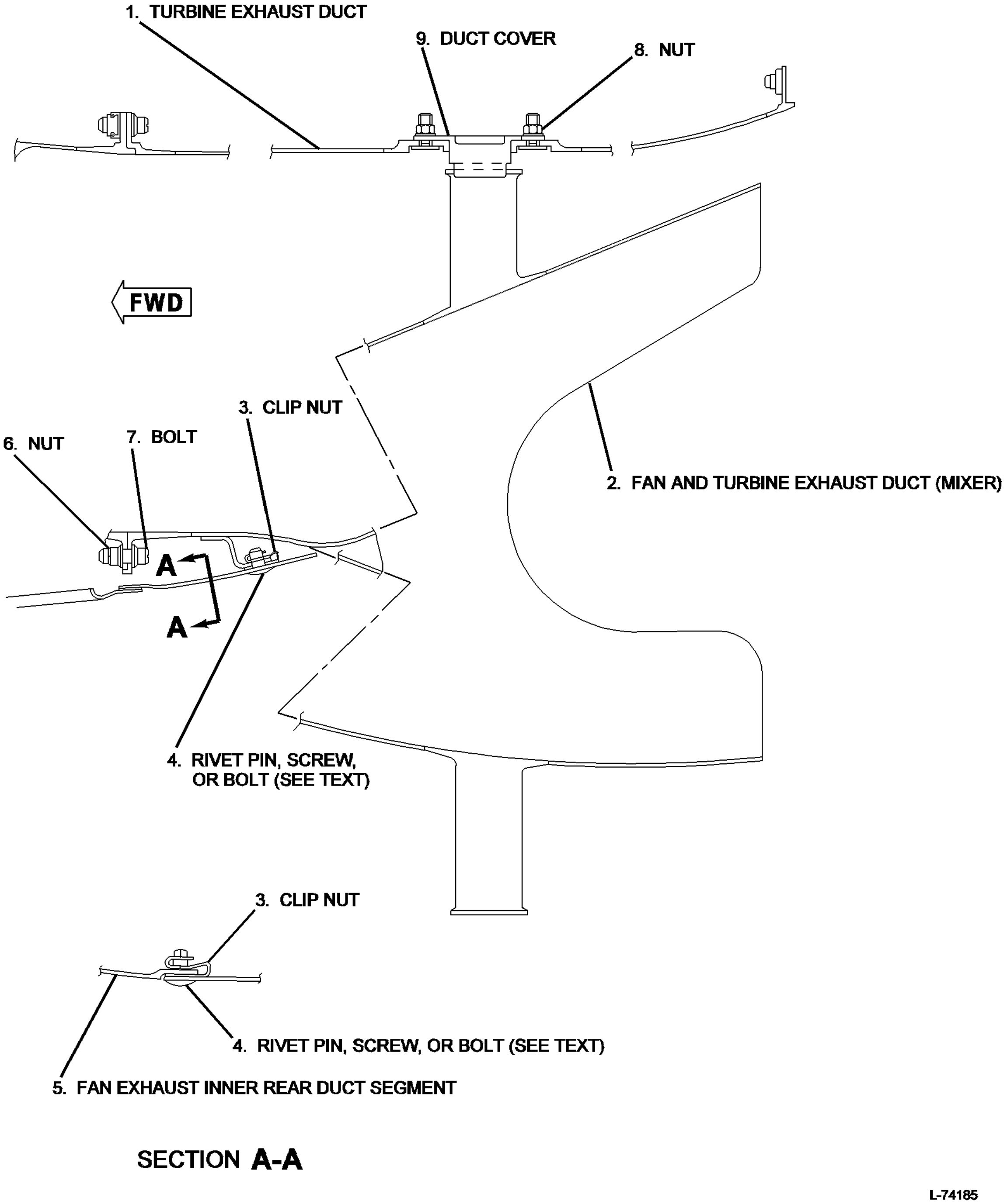
Fan Exhaust Outer Rear Duct (Rear) - Removal/Installation
Figure 401/72-55-00-990-804



Fan Exhaust Outer Rear Duct (Front) - Removal/Installation
Figure 402/72-55-00-990-805



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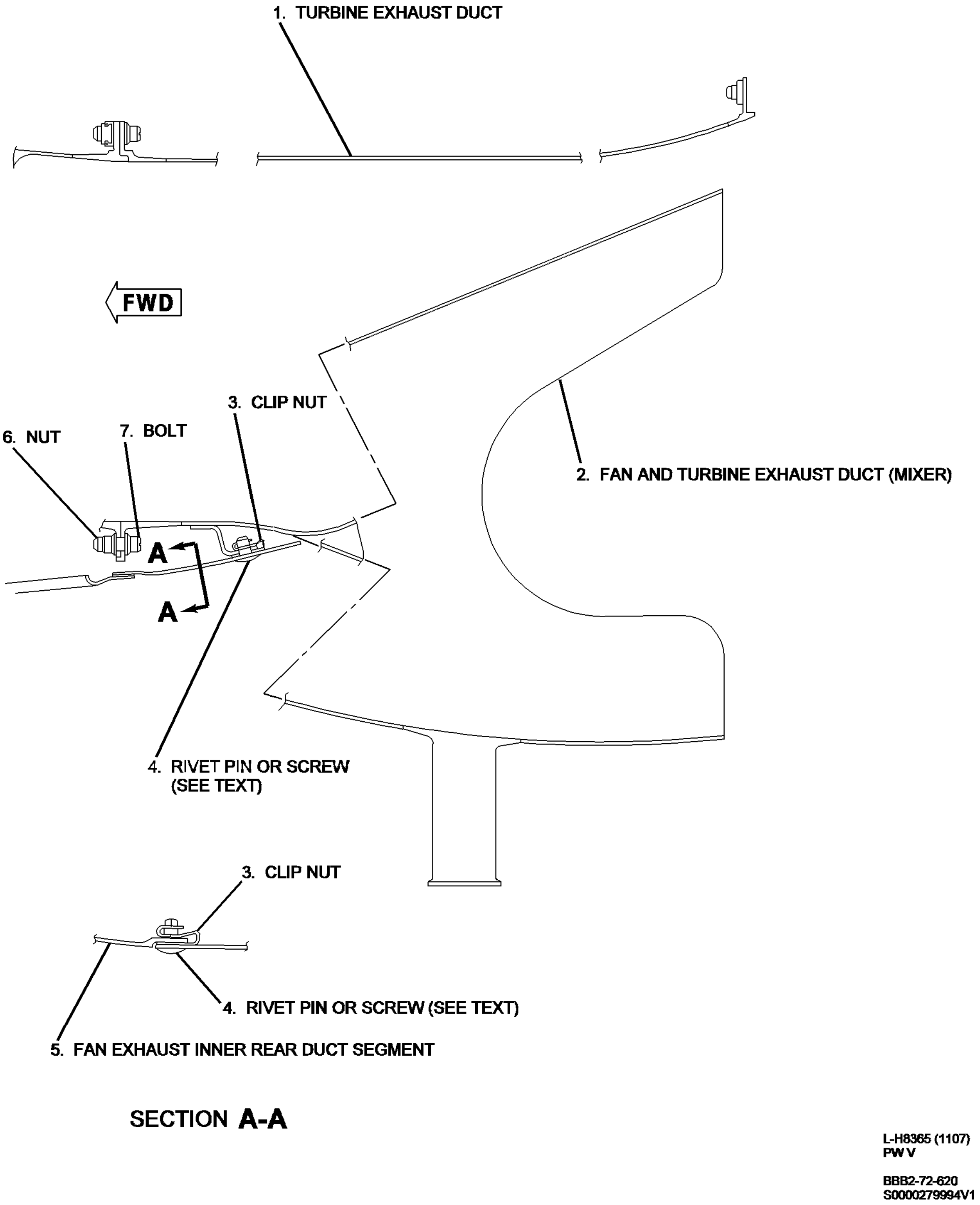
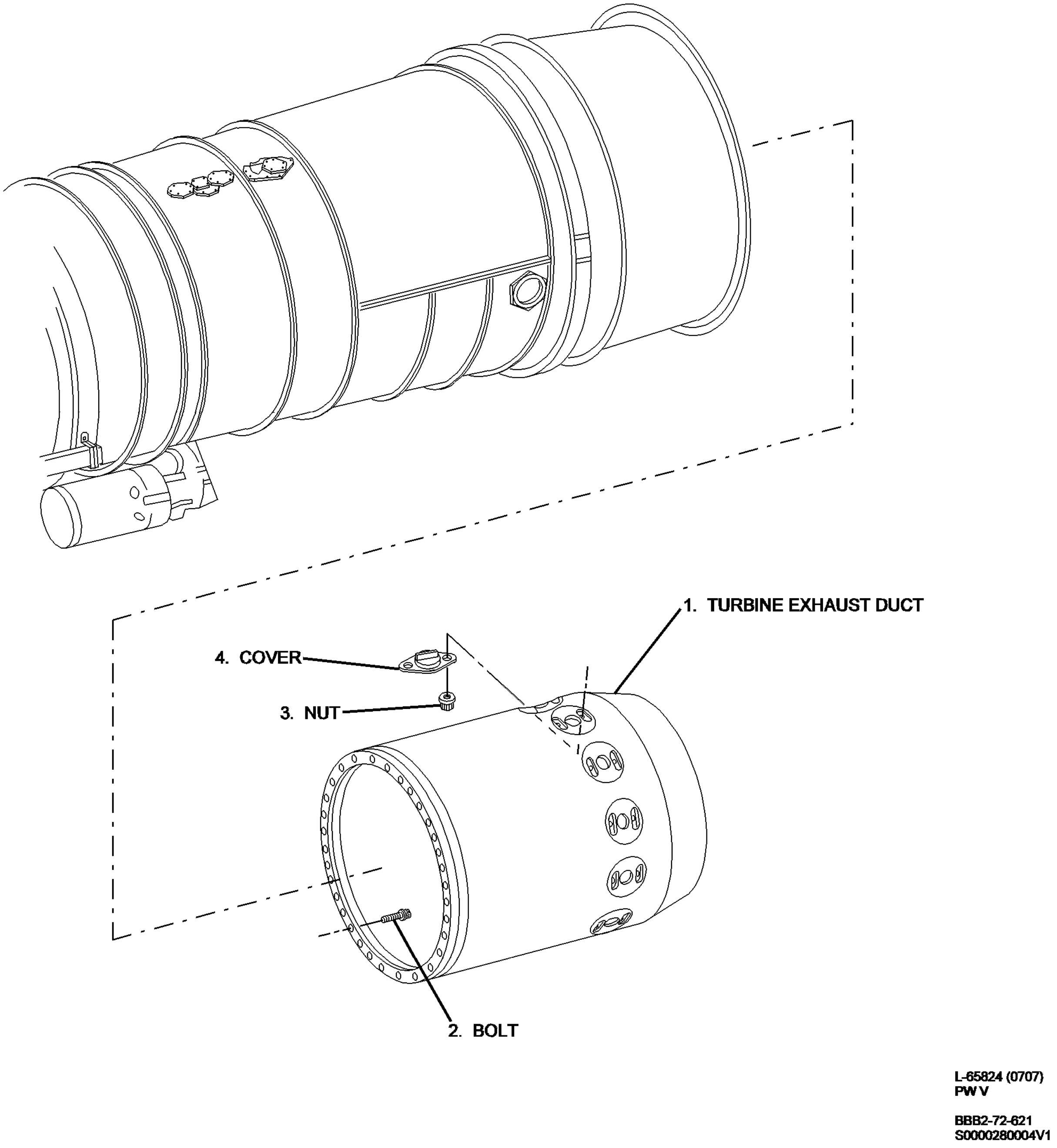
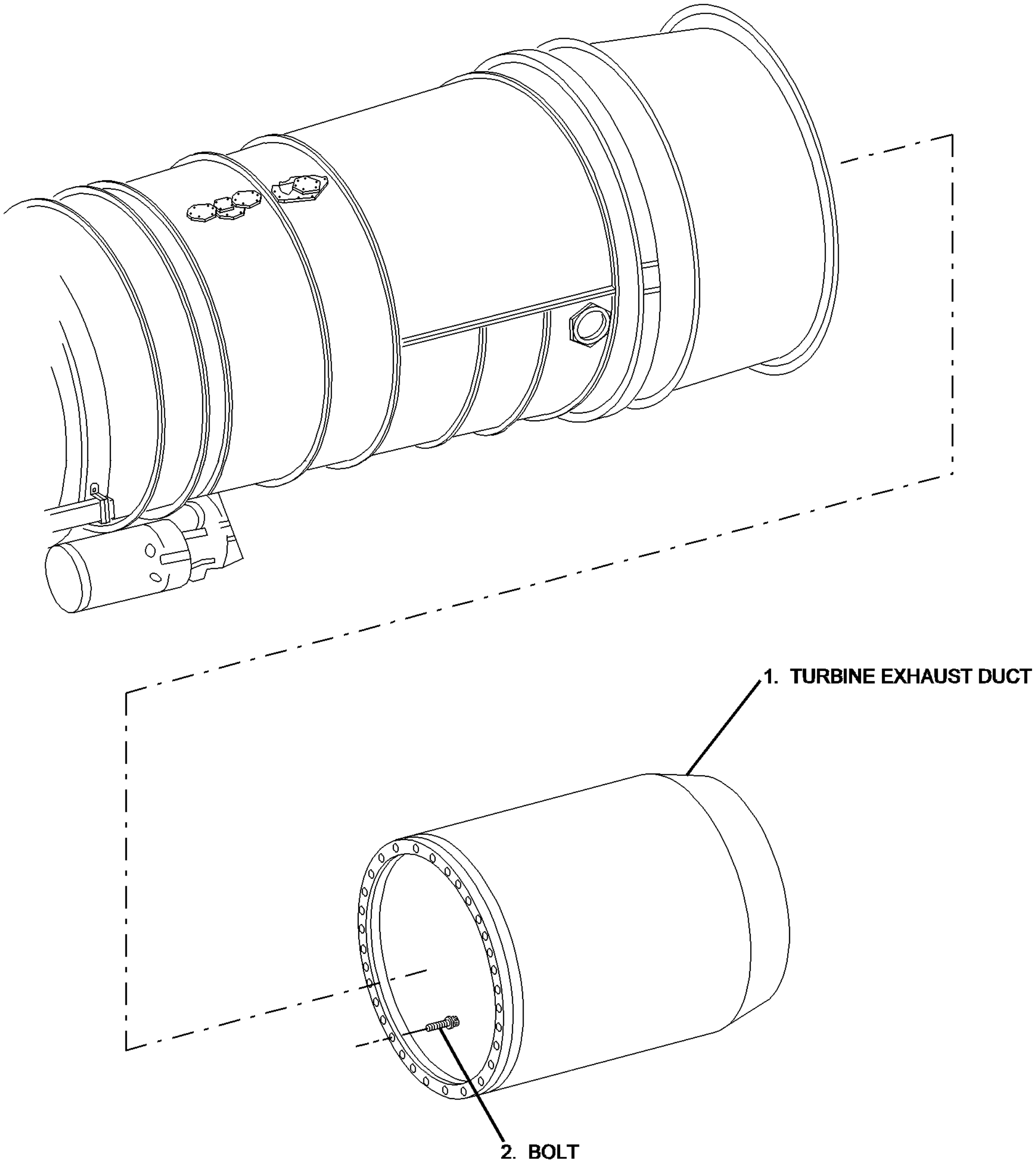
Fan And Turbine Exhaust Duct (Mixer) - Removal/Installation
Figure 403/72-55-00-990-806 (Sheet 1 of 2)



Fan And Turbine Exhaust Duct (Mixer) - Removal/Installation
Figure 403/72-55-00-990-806 (Sheet 2 of 2)



Turbine Exhaust Duct - Removal/Installation
Figure 404/72-55-00-990-807 (Sheet 1 of 2)



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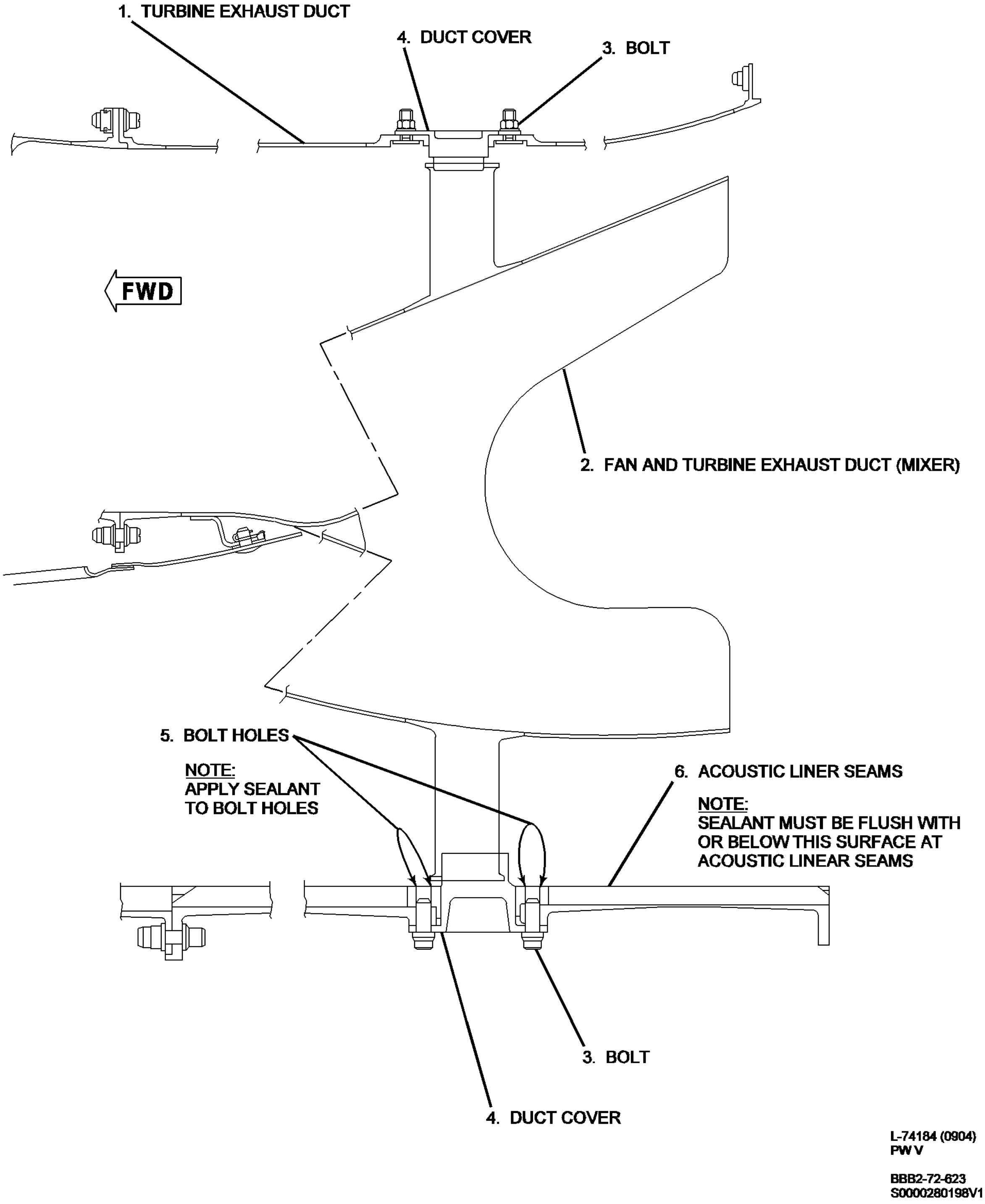
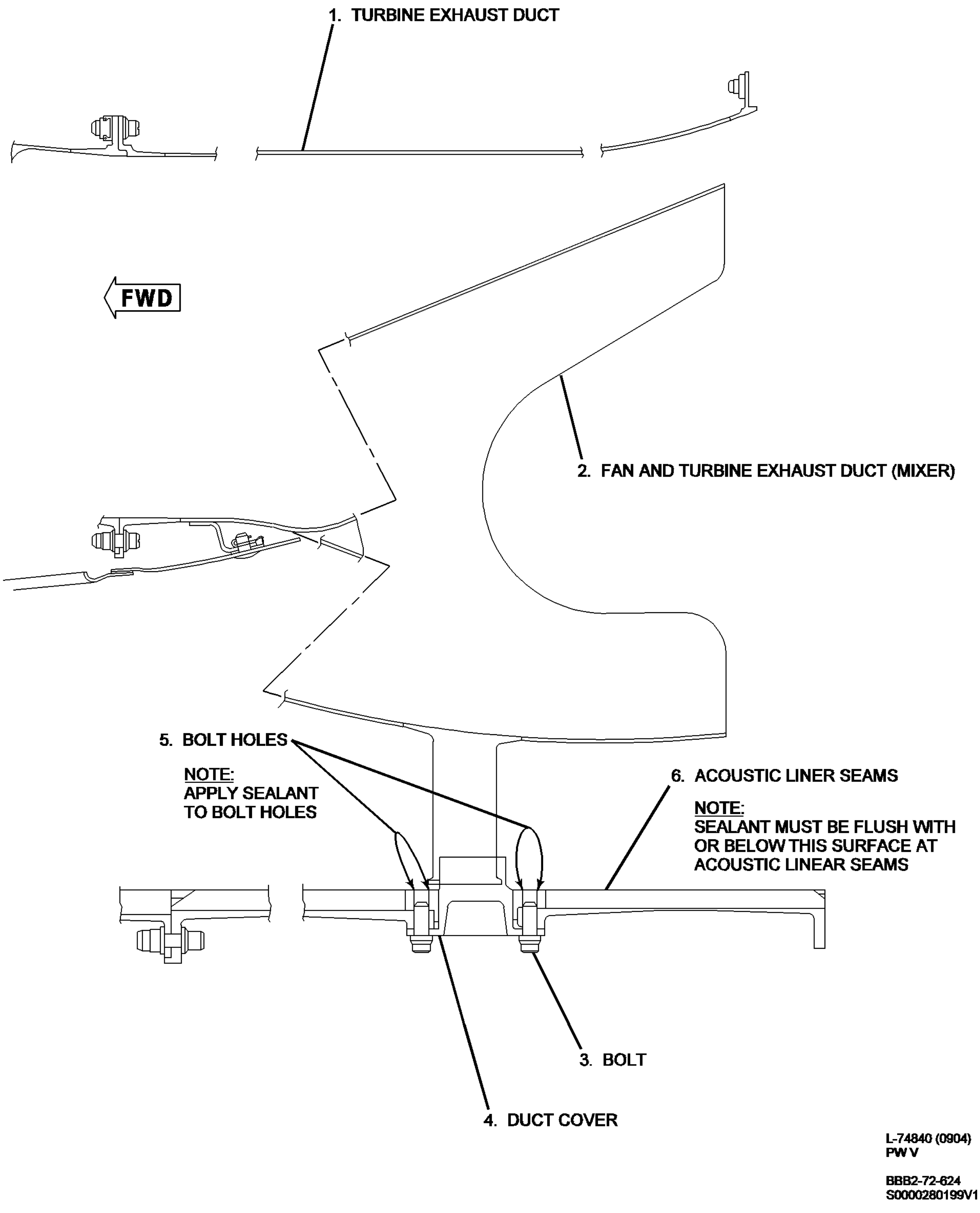
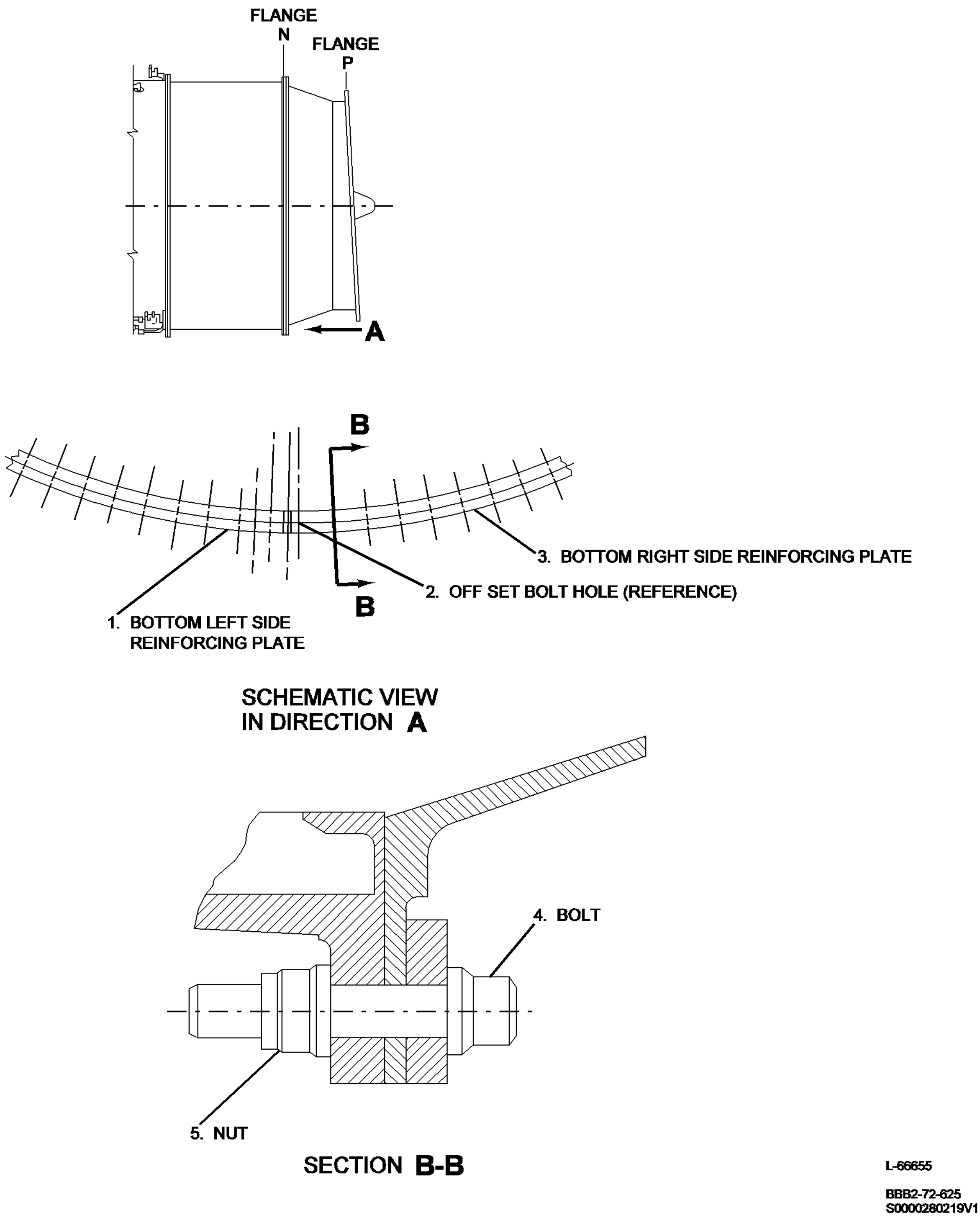
Turbine Exhaust Duct - Removal/Installation
Figure 404/72-55-00-990-807 (Sheet 2 of 2)



Fan Exhaust Outer Rear Duct (Front) - Installation
Figure 405/72-55-00-990-808 (Sheet 1 of 2)



Fan Exhaust Outer Rear Duct (Front) - Installation
Figure 405/72-55-00-990-808 (Sheet 2 of 2)



Fan Exhaust Outer Rear Duct (Rear) Reinforcing Plate - Installation
Figure 406/72-55-00-990-809

TURBINE EXHAUST CONE ASSEMBLY - REMOVAL/INSTALLATION-01

1. Turbine Exhaust Cone Removal

A. Equipment and Materials - None

B. Procedure. See Figure 401, Table 401.

(1) Remove the bolts that attach the turbine exhaust cone to the turbine exhaust duct.

NOTE: Exhaust cone assemblies post-SB 5687 have spacers installed under the heads of the bolts which are longer than those for the pre-SB 5687 configuration.

A turbine exhaust cone post-SB 6091 is attached to the turbine exhaust duct with 12 bolts through the side of the cone and duct. Post-SB 6121 configurations have a flat washer under each bolt head (Figure 401 (Sheet 2)).

(2) Remove the exhaust cone.

2. Turbine Exhaust Cone Installation

A. Equipment and Materials - None

B. Procedure. See Figure 401, Table 401.

(1) Install the cone against the turbine exhaust duct.

NOTE: Turbine exhaust cones pre-SB 6091 are three types: unweighted (sheet metal tip), weighted with bolted solid tip, and weighted with welded-on solid tip. An unweighted cone can only go on a mixer assembly pre-SB 5310; a weighted cone (bolted or welded type) can go on a mixer pre or post-SB 5310.

A cone post-SB 6091 is of the integral-weight type. This cone is attached to the duct with 12 bolts through the side. Post-SB 6121 configurations have a flat washer under each bolt head Figure 401 (Sheet 2).

(2) Pre-SB 6091: Install six (6) bolts to attach the turbine exhaust cone to the turbine exhaust duct as follows:

(a) Pre-SB 5687: Install and torque the bolts with standard torque limits.

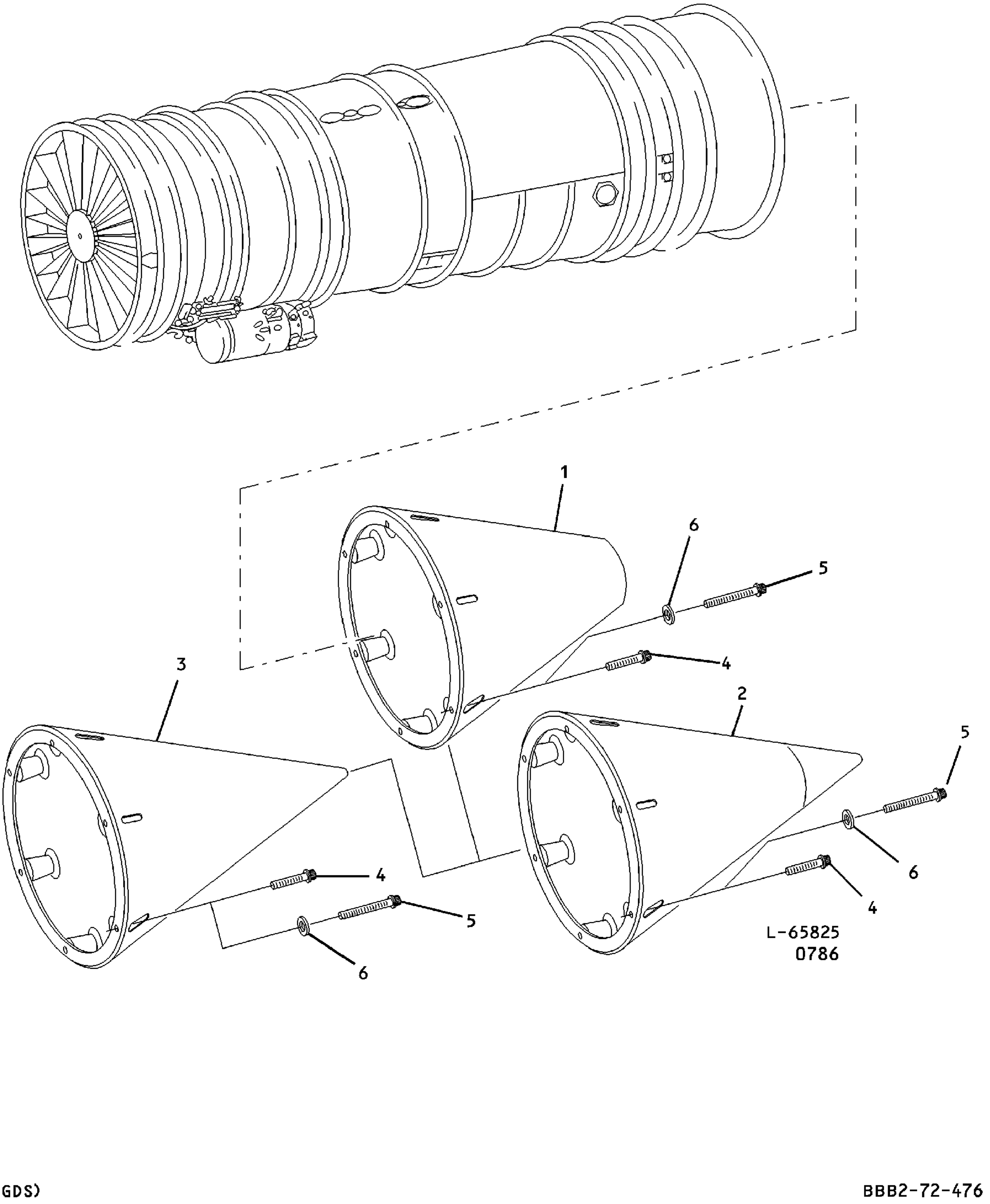
(b) Post-SB 5687: Install spacers under the heads of the bolts. Install the bolts and torque them to 100-115 lb-in. (11.298-12.993 N·m).

(3) Post-SB 6091: Attach the cone with 12 bolts as shown in the figure. Torque the bolts to 100-115 lb-in. (11.298-12.993 N·m).

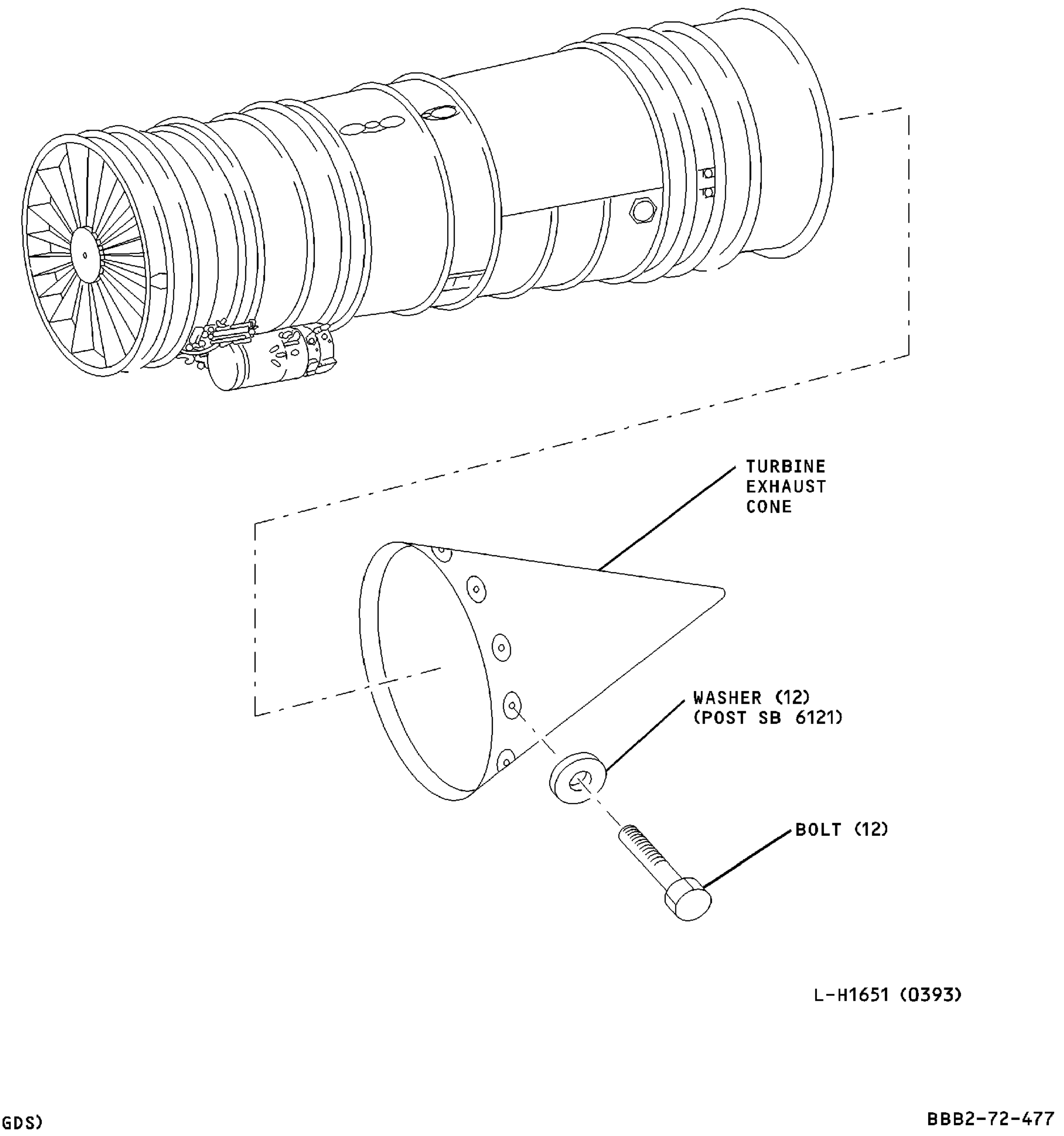
NOTE: Put one flat washer under each bolt head if the cone is post-SB 6121 Figure 401 (Sheet 2).

Table 401

Key to Figure 401 (Sheet 1)	
Index No.	**Nomenclature**
1	Turbine Exhaust Cone (One-Piece) (Unweighted)
2	Turbine Exhaust Cone (Two-Piece) (Weighted)
3	Turbine Exhaust Cone (One-Piece) (Weighted)
4	Bolt (6) (Pre-SB 5687)
5	Bolt (6) (Post-SB 5687)
6	Spacer (6) (Post-SB 5687)



Turbine Exhaust Cone Removal (Pre-SB 6091)
Figure 401/72-55-01-990-801 (Sheet 1 of 2)



Turbine Exhaust Cone Removal (Pre-SB 6091)
Figure 401/72-55-01-990-801 (Sheet 2 of 2)

MAIN ACCESSORY GEARBOX SECTION - DESCRIPTION

1. Main Accessory Gearbox

The main accessory gearbox consists of the gearbox front housing, the gearbox rear housing, and the internal gears and shaftgears. The gearbox assembly is mounted beneath the engine at the compressor intermediate case mount rail (Flanges F and G). Power is supplied to the gearbox assembly from a bevel gear splined to the rear compressor rotor front hub.

A main oil pump assembly is located on the bottom left of the gearbox; this pump contains both pressure and scavenge sections. Next to the pump is the oil pressure relief valve, and to the left of the valve is the main oil filter.

On the rear face of the gearbox rear housing there is a starter drive pad on the left, a 10 inch constant speed drive (CSD) pad in the center, and a hydraulic pump drive pad on the right. On the right end of the gearbox housing is a standard four-stud pad for the N2 tachometer drive.

At the front of the gearbox assembly are mounting provisions for the optional-equipment oil tank and for the fuel pump and control. The fuel pump drive in the gearbox emerges at the right front side, and a quick-disconnect nut is provided to secure the fuel pump housing to the gearbox.

2. Power Lever Cross Shafts And Linkage

Two concentric cross shafts run across the top of the main gearbox assembly. The outer shaft is for the power lever linkage, and the inner shaft is for the fuel shutoff linkage. Linkage mounting arms are attached to each of the cross shafts and connecting links run from these mounting arms to the actuating arms on the fuel control. The airframe control arms or pulleys may be mounted on either end of the cross shafts.

MAIN ACCESSORY GEARBOX SECTION - REMOVAL/INSTALLATION-01

1. MAIN ACCESSORY GEARBOX SECTION - REMOVAL/INSTALLATION-01

2. Main Accessory Gearbox Group Removal

A. Prerequisites

(1) Access for removal of gearbox group is through the lower forward cowl door.

(2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

(3) Remove the oil tank by the procedure in OIL TANK - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-65/401.

B. Equipment And Materials Required

(1) Support Equipment:

PWA 6580 Sling

PWA 24667 Jack (Replaced By PWA 80611)

PWA 45228 Adapter

PWA 45229 Bracket (2)

PWA 45230 Stand

PWA 45231 Adapter

PWA 45970 Adapter (Used with PWA 80611)

PWA 75135 Safety Hook

PWA 80611 Jack (Replaces PWA 24667)

(2) Consumables:

None

(3) Expendable Parts:

None

C. Procedure

NOTE: This procedure can be done with or without the accessories installed on the gearbox.

(1) Drain the oil from the gearbox (optional).

NOTE: It is possible to drain the oil from the gearbox before the gearbox is removed from the engine (this will decrease the weight of the assembly and prevent oil leakage, and make inspection of the oil at this time possible).

(a) Get a clean container which can hold two gallons. A container of Nalgene HPDE (a high-density polyethylene) is recommended.

(b) Remove the gearbox drain plug.

(c) Drain the oil into the container.

(d) Temporarily install the drain plug back in the gearbox.

(2) Remove the external parts that follow.

(a) Remove the No. 4 bearing oil breather tube from the diffuser section outer duct to gearbox.

NOTE: The elbow on the gearbox must be removed with the breather tube.

(b) Remove the No. 4 bearing oil scavenge tube from the diffuser section outer duct to gearbox.

(c) Remove the No. 2 and 3 bearing external oil pressure tubes from the oil pressure manifold to gearbox.

(d) Disconnect the No. 1 bearing drain tube, No. 2 bearing drain tube and the No. 3 bearing drain tube from the main bearing drain manifold assembly on the left side of gearbox. Remove the manifold assembly from the gearbox.

(e) Remove the No. 1 bearing oil scavenge tube from the inlet case and the forward face of the gearbox.

(f) Remove the No. 1 bearing oil breather tube from the inlet case and the forward face of the gearbox.

(g) Disconnect the Tt2 sensor bulb at the inlet case and coil the sensor cable at the fuel control.

(h) Remove the cooler inlet oil tube assembly from the fuel/ oil cooler and gearbox.

(i) Remove the fuel flowmeter inlet tube assembly from the fuel/oil cooler and fuel control

(j) Remove the oil cooler outlet sensing tube from the fuel/ oil cooler and gearbox.

(k) Disconnect the fuel control rear Pb tube at the condensation trap, fuel control side of the trap.

(l) Disconnect the deicing air (shut off valve-to-fuel heater) tube from the fuel deicing heater.

(3) Position a PWA 24667 Jack and a PWA 45228 Adapter under the gearbox or position a PWA 80611 Jack (formerly PWA 24667), PWA 45970 Adapter and a PWA 45228 Adapter under the gearbox. Support the weight of the gearbox with the jack.

(4) Unbolt the cantilever support from the front bracket of the fuel control (leave the adjuster links attached to the engine).

(5) Remove the bolts, lockplates and mount pins from the rear gearbox mount lugs.

(6) Remove the cotter pin, bolt, washer and nut from the front mount arm bracket.

(7) Carefully lower the gearbox, holding the accessory drive-shaft up, until the gearbox is clear of the engine. Remove the shaft and wrap it in protective paper.

(8) Remove the jack and gearbox group from beneath the engine.

(9) Remove the No. 2 and 3 bearing outer internal oil pressure tubes.

NOTE: The internal oil tubes may remain in the engine or may come with the gearbox.

(10) If they are installed, remove the starter (PNEUMATIC STARTER, SUBJECT 80-10-01, Page 201) and hydraulic pump (ENGINE-DRIVEN HYDRAULIC PUMP, SUBJECT 29-10-05).

(11) Install PWA 45229 Brackets to the starter drive pad and the hydraulic pump pad. Using a PWA 75135 Safety Hook and a PWA 6580 Sling, attach to the hoist and lift the gearbox from the jack.

(12) Remove the two bolts securing the left and right gearbox lugs to the top center pad on the gearbox and remove the lugs.

(13) Lift the gearbox group from the jack and install to a PWA 45231 Adapter in a PWA 45230 Stand. Secure the ball lock pins and bolts.

(14) Remove the sling and brackets from the starter and hydraulic pump pads.

3. Main Accessory Gearbox Group Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment:

PWA 6507 Flowmeter

PWA 6580 Sling

PWA 10408 Adapter

PWA 12210 Adapter, Pressure Test

PWA 24667 Jack (Replaced By PWA 80611)

PWA 45228 Adapter

PWA 45229 Bracket (2)

PWA 45970 Adapter (Used With PWA 80611)

PWA 75135 Safety Hook

PWA 80611 Jack (Replaces pwa 24667)

(2) Consumables:

PMC 9609 Petrolatum

PWA 36003 Sealant

PWA 36500 Assembly Fluid

(3) Expendable Parts:

Table 401

Part Name	Quantity	Parts Catalog Reference		
		Section	Fig.	Item
Packing	1	72-61-00	5	30
Packing	1	72-61-00	6	1
Packing	1	73-15-00	1	90
Packing	1	73-15-00	1	110
Retainer	1	73-15-00	1	120
Key Washer	1	73-15-00	1	140
Cotter Pin	4	73-21-00	1	270
Key Washer	4	73-21-00	1	300
Packing	2	75-20-00	1	80
Retainer	2	75-20-00	1	90
Retainer	1	75-20-00	1	130
Packing	1	75-20-00	1	140
Packing	1	75-20-00	1	200

Table 401 (Continued)

Part Name	Quantity	Parts Catalog Reference		
		Section	Fig.	Item
Packing	1	79-23-00	1	290
Retainer	1	79-23-00	1	300
Packing	2	79-23-00	2	70
Retainer	2	79-23-00	2	80
Packing	1	79-23-00	2	200
Retainer	1	79-23-00	2	210
Packing	1	79-23-00	2	220
Packing	2	79-23-00	3	70
Retainer	2	79-23-00	3	80
Packing	1	79-23-00	3	160
Packing	1	79-23-00	3	190
Retainer	1	79-23-00	3	200

B. Procedure

NOTE: If the original gearbox is being replaced with a new gearbox, retain the original data plate and attach to the new gearbox.

This procedure can be done with or without the accessories installed on the gearbox except the starter and hydraulic pump must be removed.

(1) Lubricate the splines on the smaller end of the gearbox driveshaft with a small quantity of PWA 36500 Assembly Fluid or petrolatum. Install the driveshaft in the 6 o'clock strut of the compressor intermediate case.

CAUTION: WHEN YOU APPLY PETROLATUM TO PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(2) Install a new packing, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, at each end of the No. 2 and 3 bearing outer internal oil pressure tube. Install this tube in the 6 o'clock strut of the intermediate case.

NOTE: The current (PN 791911) tube has a stop at the upper and a pilot section on the lower ferrule to help in tube installation.

It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid, but it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

(3) Install PWA 45229 Brackets to the starter drive pad and the hydraulic pump pad. Using a PWA 75235 Safety Hook and a PWA 6580 Sling attached to the hoist, remove the pins and bolts and lift the gearbox group from the stand.

(4) Install the gearbox group to a PWA 45228 Adapter on a PWA 24667 Jack in the flight position, or install the gearbox group to the PWA 45228 Adapter attached to a PWA 45970 Adapter on the PWA 80611 Jack (formerly PWA 34667) in the flight position.

(5) Remove the sling, safety hook and brackets from the gearbox.

(6) Install a new packing, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, in the groove of the gearbox-to-compressor intermediate fan case mating boss.

(7) Install a 14 inch (35.5 cm) length of flexible plastic tube small enough in diameter to slip easily into the gearbox oil pressure tube. (Figure 401)

(8) Put the gearbox left and right positioning lugs on the top of the gearbox rear housing. Install two bolts fingertight.

NOTE: Bolts are torqued and lockwired after the required clearances are measured. See Paragraph 3.B.(13).

(9) Put the gearbox under the 6 o'clock strut of the intermediate case.

(10) Carefully install the gearbox so that the driveshaft mates with the gearbox driveshaft adapter, and the oil pressure tube locates in the gearbox passage (aligned by plastic tube inserted into oil tube). The gearbox mount flanges must touch the engine mount bracket and bushings.

(11) Remove the flexible plastic tube.

(12) Install a bolt, washer and nut to attach the front mount arm to the bracket. Torque the nut to 50 - 100 in-lbs. (5.649 - 11.298 N·m) and attach with a cotter pin.

(13) Install the gearbox mounting pins as follows. (Figure 402), (Table 402)

(a) Align the gearbox to the compressor case rear mounting brackets. Install the mounting pins. Attach the pins in place with lockplates and attach the plates with bolts. Torque the bolts.

NOTE: Make sure that the drilled head bolt is used when the support bracket has a lockwire hole. Lockwire this type of bolt after torquing.

Support brackets prior to SB 5509 do not have lockwire holes. On these brackets solid-head bolts are threaded into a self-locking insert in the bracket.

(b) Adjust the gearbox positioning lugs. See Figure 403, Indexes 3 and 4. Torque and lockwire the bolts to keep the condition shown.

(14) Install a PWA 10408 Adapter into the starter drive spline (left end pad). Turn the rear compressor and turbine drive rotors through the gearbox. Turn in the correct direction.

(15) Remove the adapter. Install a gasket and the starter drive cover. Attach with washers and locknuts.

(16) Do an installed gearbox air pressure check of the No. 2, No. 3 and tower shaft bearing section.

(a) Use a PWA 12210 Adapter and a PWA 6507 Flowmeter and apply 10 psi (68.9 kPa) air pressure to the No. 2 and the No. 3 bearing oil line fitting on the gearbox upper rear. The airflow through this line into the No. 2 and 3 bearing compartment should be 20 - 30 pounds (9.07 - 13.61 kg) per hour.

(b) If the flow is greater, remove the gearbox and do a check to make sure all the tubes and packings are installed correctly.

(c) Reinstall the gearbox and repeat the air check.

(17) Remove the jack and adapter (or adapters) from the gearbox.

(18) Connect and adjust fuel control front cantilever support as follows: (Figure 404)

(a) Remove the cotter pins from each nut that hold the support rods to the engine brackets and loosen the nuts.

(b) Unthread and remove each adjuster. Reinstall each adjuster with a new key washer between the jamnuts and adjuster. Center each adjuster on the support rod threads within 0.080 inch (2.032 mm). Back off each jamnut from each end of the adjusters to allow the adjusters to be turned.

(c) Connect assembled support rods and adjusters to the fuel control bracket with two bolts and nuts (do not torque bolts at this time).

(d) Torque each adjuster to 5 - 10 lb-in. (0.565 - 1.130 N·m).

(e) Torque each jamnut against the adjusters and bend the tabs of the key washers to secure the jamnuts (bend one set of tabs onto the adjuster and the other set onto the jamnut).

(f) Torque the nuts at the engine brackets and at the fuel control bracket. Secure with cotter pins.

(19) Install the external parts as follows: (Figure 405), (Table 403)

NOTE: The minimum clearance between any two adjacent tubes or between one single tube and any other adjacent engine part shall be 0.125 inch (3.175 mm) unless otherwise specified. Exceptions to this clearance requirement are permitted at specific locations where adjacent tubes are clipped together or where other local constraints will prevent tube contact.

The minimum clearance refers only to the tube clearance and not to the fittings or the other attached hardware.

(a) Attach the lower end of the deicing air shutoff valve to fuel heater tube to the pad on the fuel heater assembly with bolts and locknuts. Torque the locknuts.

(b) Connect the Pb tube to the fuel control condensation trap at the lower (front) end. Torque this nut and lockwire.

(c) Install the oil pressure sensing tube as follows:

1) Using new packings (coated with PWA 36500 Assembly Fluid) and retainers, install the oil pressure sensing tube from the oil cooler connector (7 o'clock position) to the pressure relief valve elbow at the rear of the gearbox. Torque and lockwire the tube coupling nuts.

2) Attach the tube to the adjacent tubes with clips, spacers, screws and nuts. Torque all the screws.

(d) Install the fuel flowmeter inlet tube as follows:

1) Using ferrule, packings, retainer, nut, and key washer, install the flowmeter inlet tube between the fuel control and the flowmeter adapter. Attach with the three bolts and the coupling nut. Torque the bolts and coupling nut and lockwire.

2) Tighten the stop nut against the stop on the tube fingertight. Back off one-half turn, then turn to the next slot on the stop nut and bend the tabs of the key washer to clinch the stop nut.

3) Check the thread engagement between the stop nut and the coupling nut. Make sure that no more than eight threads are visible on the coupling nut. If the stop nut incorporates witness holes, you must not be able to install a No. 60 wire through.

4) Attach the tube with clips, spacers, screws, and nuts. Torque all the screws.

(e) Using new packings (coated with PWA 36500 Assembly Fluid) and retainers, install the No. 1 bearing oil scavenge tube from the connector on the inlet case (6 o'clock) to the elbow on the left, front side of the gearbox. Torque and lockwire all the nuts.

(f) Using new packings (coated with PWA 36500 Assembly Fluid) and retainers, install the No. 1 bearing oil breather tube from the connector on the inlet case (6 o'clock) to the connector on the left, front side of the gearbox. Torque the nuts to 110 - 120 lb-in. (12.429 - 13.558 N·m). Lockwire all the nuts.

(g) Install the Tt2 sensor line as follows:

1) Clean the surfaces of the probe and the probe port, at the inlet case, by the SPOP 208 solvent wipe procedure. STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201

2) Install the probe in the inlet case and attach with bolts. Torque the bolts.

3) Apply PWA 36003 Sealant to the inner surface of the inlet case around the probe to fill the gap all around the probe. (Figure 406)

NOTE: PWA 36003 Sealant is available as RTV-159 from General Electric Co., Waterford, NY 12188, U.S.A.

(h) Install the last installed tubes with clips, grommet, screws, and nuts. Torque the screws.

(i) Install the No. 2 and 3 Bearing external oil pressure tubes as follows:

1) Install the nut, a new packing (coated with PWA 36500 Assembly Fluid) and a retainer at the brazed ferrule end. Install a nut, a ferrule, a new packing (coated with PWA 36500 Assembly Fluid) and a retainer at the other end.

2) Install this tube between the main bearing oil pressure manifold and the upper rear gearbox elbow. Torque and lockwire the nuts.

(j) Using new packings (coated with PWA 36500 Assembly Fluid), ferrule, and retainer, install the No. 4 bearing oil scavenge tube between the elbow on the diffuser section outer duct and the gearbox. Secure the gearbox end with two bolts. Torque and lockwire.

NOTE: Do a check to make sure that the No. 4 bearing scavenge tube has adequate clearance with the elbow of the oil cooler inlet tube as shown in Figure 405, (Table 403).

(k) Attach the tube to the adjacent tube with clips, spacers, screws, and nuts. Torque the screws.

(l) Using nut, ferrule, new packings (coated with PWA 36500 Assembly Fluid), and retainer, install the gearbox-to-oil cooler tube between the elbow on the upper rear of the fuel/oil cooler to the gearbox. Attach the gearbox end with two bolts. Torque the tube nut to 130 - 140 lb-in. (14.688 - 15.818 N·m) and lockwire.

(m) Install the No. 4 bearing breather tube as follows:

1) Install the plate, nut, ferrule, new packings (coated with PWA 36500 Assembly Fluid) and retainers on the tube. Install the elbow to the tube. Install the other end of the tube to the elbow on the diffuser case section outer duct and the elbow end to the pad on the upper left side of the gearbox.

2) Attach the rear end of the tube with bolts (heads to the rear), washers (under boltheads) and nuts. Torque the nuts.

3) Attach the elbow to the gearbox with washers and nuts. Torque the nuts. Torque the tube nut to 200 - 220 lb-in. (22.597 - 24.857 N·m) and lockwire the tube nut.

(n) Connect the main bearing drain manifold between the No. 1 bearing drain tube and the No. 2 bearing tube connector. Install the No. 2 bearing drain tube between the compressor intermediate case and the No. 2 bearing tube connector. Torque the manifold and tube connections and lockwire.

C. Postrequisites

(1) Install the oil tank by the procedure in OIL TANK - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-65/401

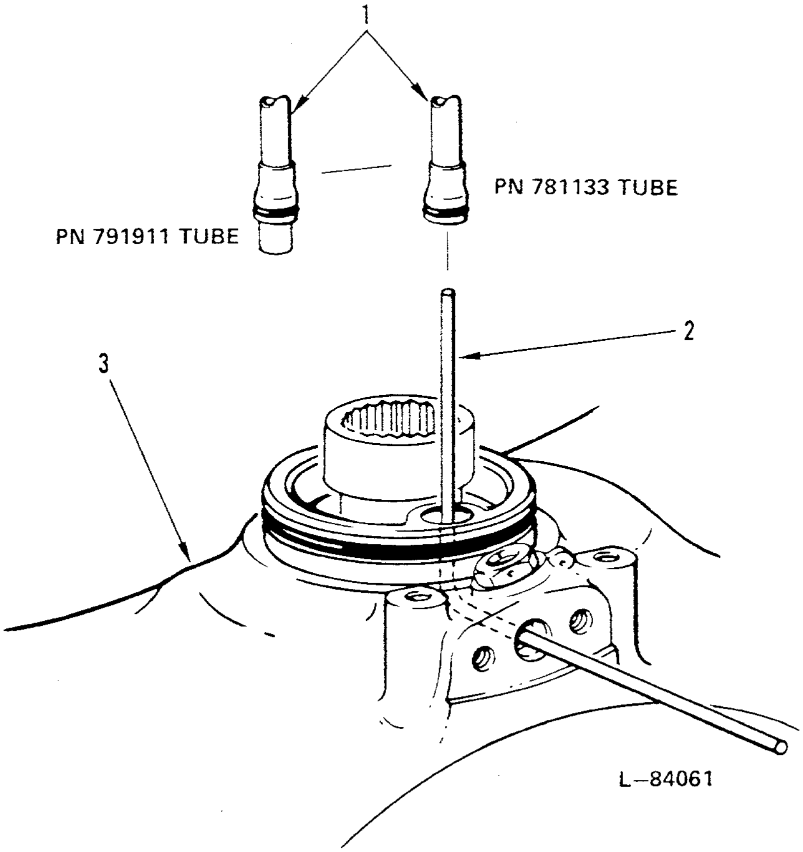
(2) For procedures to close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201

Table 402 Key To Figure 402

Index No.	Nomenclature
1	Compressor Intermediate Case Rear Flange
2	Mounting Pin Lockplate
3	Drilled Head Bolt And Lockwire
4	Mounting Pin
5	Mounting Bracket
6	Bracket Spacer
7	Lockwire Hole
8	Insert
9	Solid Head Bolt

Table 403 Key To Figure 405

Index No.	Nomenclature
1	No. 4 Bearing Scavenge Tube
2	0.060 Inch (1.524 mm) Minimum
3	Oil Cooler Inlet Tube Elbow
4	Primary Fuel Supply Manifold
5	Secondary Fuel Supply Manifold
6	No. 4 Bearing Breather Tube
7	No. 2 and 3 Bearing Oil Pressure Tube
8	Oil Pressure Sensing Tube
9	Fuel Oil Cooler Outlet Tube
10	No. 2 Bearing Drain Tube
11	No. 2 Bearing Tube Connector
12	Main Bearing Drain Manifold
13	No. 1 Bearing Breather Tube
14	No. 1 Bearing Scavenge Tube
15	Fuel Flowmeter Inlet Tube



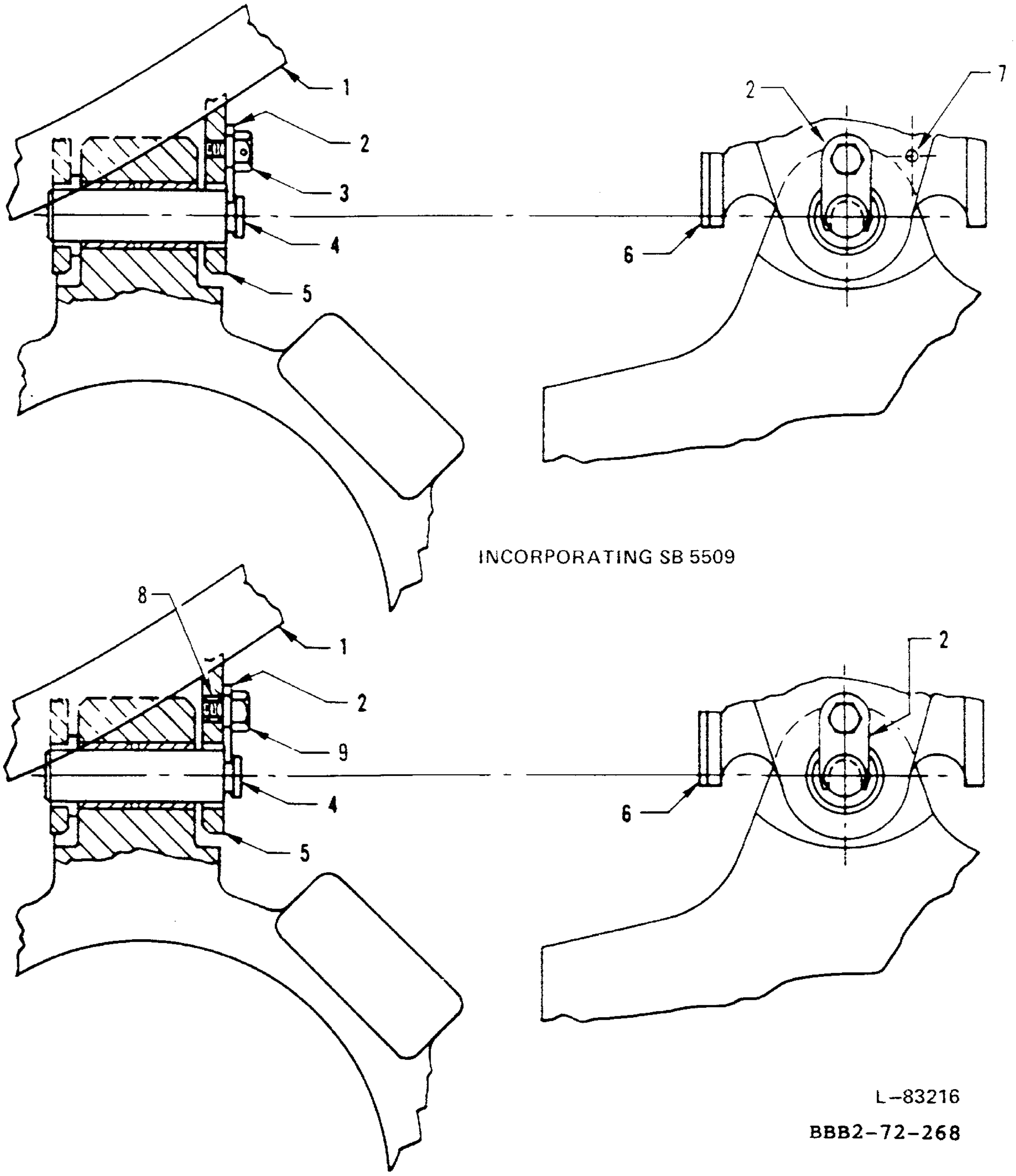
1. No. 2 And 3 Bearing Outer Internal Oil Pressure Tube

2. Flexible Guide, Locally Fabricated (OD Small Enough To Enter Oil Tube).

3. Gearbox Assembly

BBB2-72-267

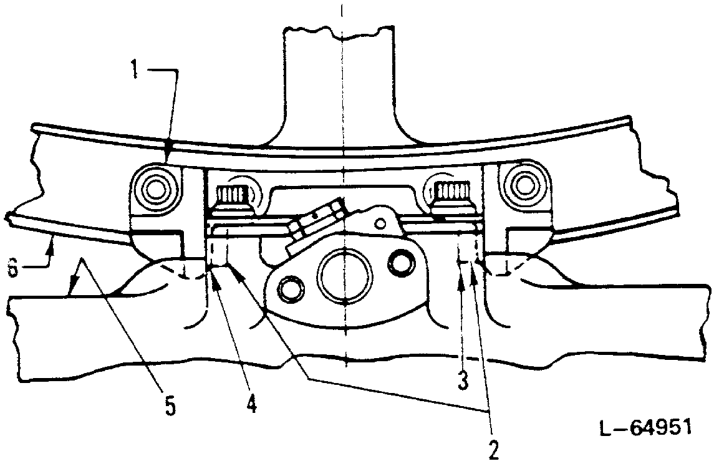
Gearbox Internal Oil Tube Alignment
Figure 401/72-61-00-990-807



INCORPORATING SB 5509

PRIOR TO SB 5509

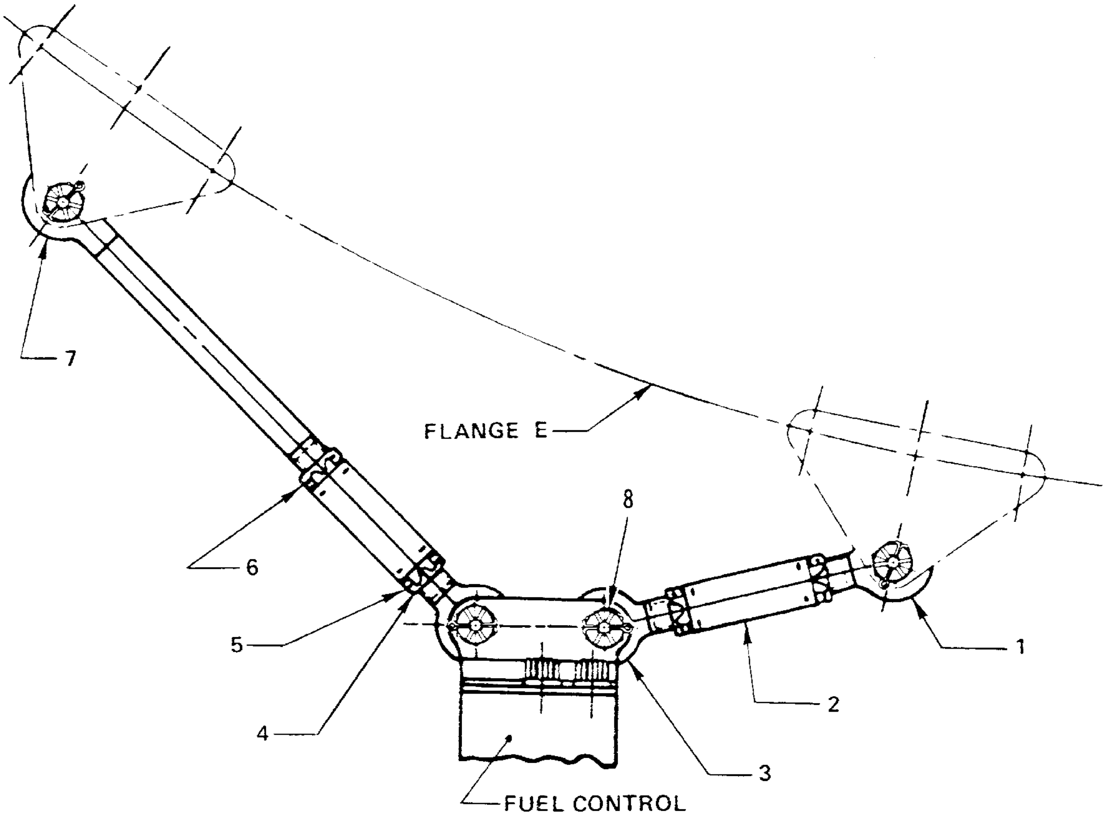
Gearbox Rear Support Bracket Mounting
Figure 402/72-61-00-990-808



1. Gearbox Lug Guide
2. Left And Right Gearbox Lug
3. Gearbox Lug Guide. Inner Face Must Be Tight To Gearbox Mating Face At Assembly.
4. Gearbox Lug Guide. Outer Face Must Be Within 0.005 - 0.015 Inch (0.127 - 0.381 mm) To Bracket.
5. Gearbox
6. Compressor Intermediate Case

BBB2-72-269

Gearbox Center Guide Adjustment
Figure 403/72-61-00-990-809



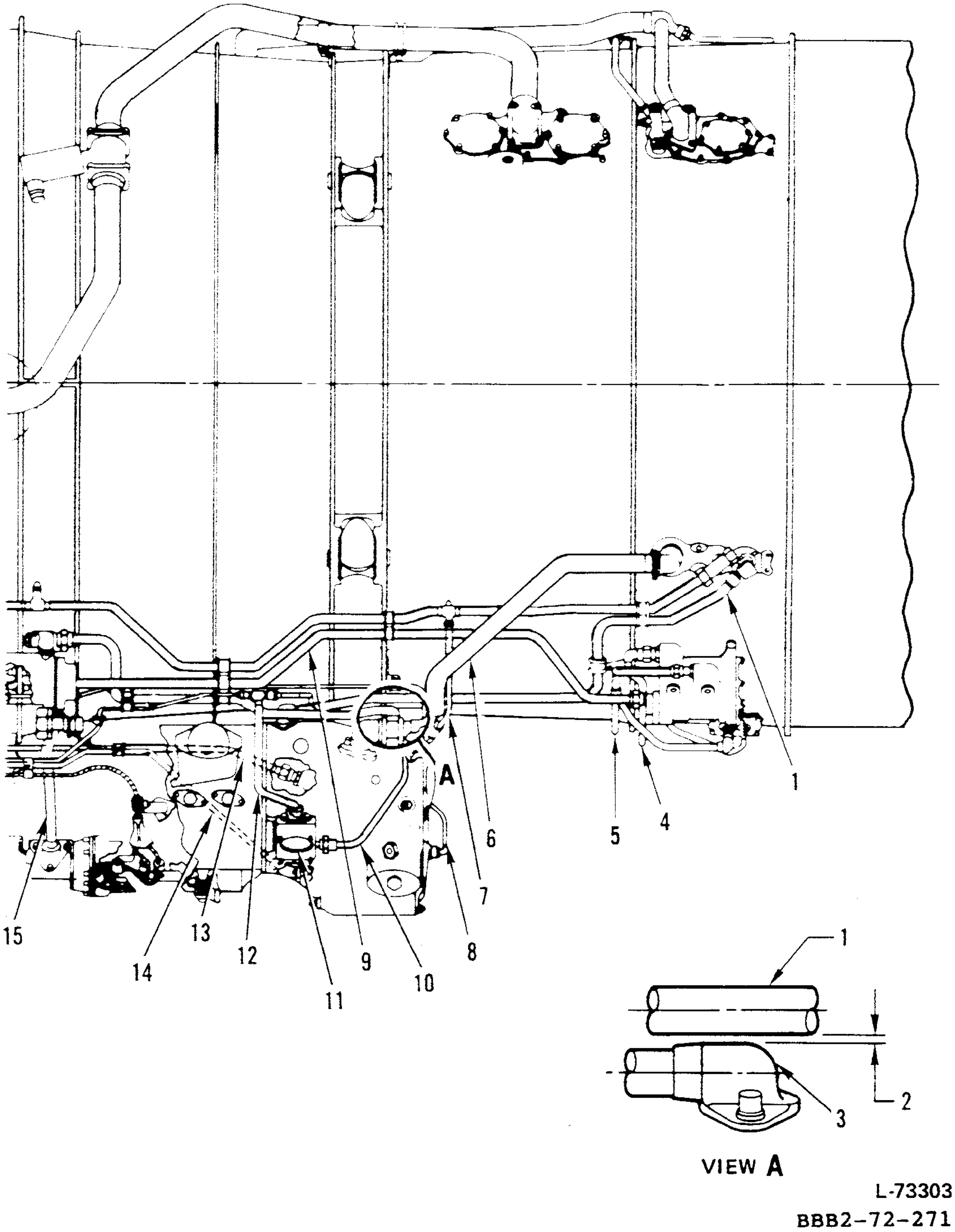
FRONT VIEW OF FUEL CONTROL

L-61686
0883

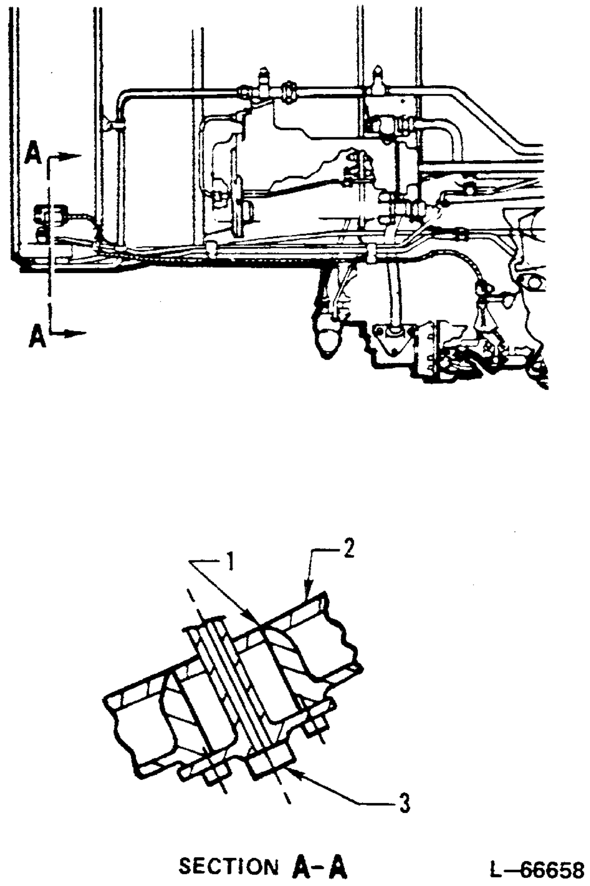
1. Support Rod End Bearing (Left Side)
2. Adjuster (Two)
3. Support Rod End Bearing (Lower) (Two)
4. Jamnut (Lower) (Two Required)
5. Key Washer
6. Jamnut (Upper)
7. Support Rod End Bearing (Right Side)
8. Bolt, Nut, And Cotter Pin (Four Places)

BBB2-72-270

Fuel Control Cantilever Support Installation
Figure 404/72-61-00-990-810



External Tubing Installation
Figure 405/72-61-00-990-811



1. Apply Sealant Here (See Text)

2. Inlet Case

3. TT2 Probe

BBB2-72-235

Tt2 Sensor Probe Sealant Application
Figure 406/72-61-00-990-812

MAIN ACCESSORY GEARBOX SECTION - INSPECTION/CHECK-01

1. Fuel Pump Pad Concentricity And Squareness Check

A. Prerequisites

(1) Remove the fuel pump and fuel control from the gearbox. (FUEL PUMP AND FUEL CONTROL, SUBJECT 73-12-02, Page 201)

B. Equipment And Materials Required

(1) Support Equipment

PWA 10408 Adapter

PWA 33713 Spline Adapter

(2) Consumables

None

C. Procedure. See Figure 601, Table 601, Figure 602, Table 602 and Figure 603.

NOTE: This procedure measures the concentricity and squareness of the gearbox fuel pump drive pad in relation to the fuel pump mating internal spline of the gearshaft in the gearbox. The inspection is done with two assembly conditions, one with the quick-disconnect coupling assembled to the gearbox fuel pump pad, and one with the coupling assembly removed. For each of these conditions the inspection is done with the internal gearshaft pulled outward (out of the gearbox) and again with the gearshaft pushed inward (into the gearbox). The first inspection is done with the quick-disconnect coupling assembly on the gearbox. If the results of this inspection are not in the limits specified, then the inspection is done again with the quick-disconnect coupling removed (with outward and inward shaft loads). This is to find if the problem is with the quick-disconnect coupling or with the gearbox. All inspection surfaces must be clean.

CAUTION: AS WITH ALL INSPECTION TOOLS, IT IS IMPORTANT THAT THE PWA 33713 SPLINE ADAPTER BE IN SERVICEABLE CONDITION, NOT DAMAGED, AND TO DRAWING SPECIFICATIONS. IT IS ALSO NECESSARY THAT THE ADAPTER BE TO THE CURRENT DESIGN LEVEL (AS SPECIFIED BY TOOL BULLETINS). IT WILL BE NECESSARY TO OBEY THE INSTRUCTIONS BELOW TO MAKE SURE THAT THE READINGS ARE CORRECT. TRAINING, EXPERIENCE, AND TECHNIQUE ARE NECESSARY TO USE THIS TOOL CORRECTLY AND GET ACCURATE READINGS.

(1) With the quick-disconnect rear coupling installed on the gearbox, measure the coupling concentricity and squareness with PWA 33713 Adapter. (Figure 602)

(a) Remove the quick-disconnect front coupling and nut from the fuel pump and install them on the rear coupling on the gearbox. (FUEL PUMP, SUBJECT 73-12-01 Page 201) Make sure that two bolts used used to attach the front coupling to the fuel pump extend adjacent to each other forward from the top of the front coupling (it will be necessary to use these bolts to attach the PWA tool to the gearbox).

(b) When you install the front coupling and nut against the rear coupling, engage and tighten the threads with the same procedure used for installation of the fuel pump and control. (FUEL PUMP AND FUEL CONTROL - MAINTENANCE PRACTICES, PAGEBLOCK 73-12-02/201)

(c) Remove the tool ball lock pin that attaches the tool arm assembly to the tool bracket. Install the tool bracket on the two bolts that extend forward from the front coupling. Use the tool nuts to hold the bracket in position at the slotted holes in the tool bracket.

NOTE: In the end of the gearshaft you will see that there are two positions 180 degrees apart where there are short splines which do not extend as far outward as other splines. It will be important to have the two detail pins in the expandable tool segments engage a full-length section of the spline, so be sure to install the tool post with these two detail pins 90 degrees away from the two short splines. Examine the splines for damage that will not let the two detail pins engage the splines.

(d) Turn back the detail nut on the tool (post and nut) to pull in the expandable post segments. Put the post and nut in the fuel pump gearshaft spline with the two detail pins of the expandable post segments engaged in the spline.

NOTE: Use a 3/16 inch open-end wrench on the flats of the tool post to make sure that the post does not turn. Tighten the knurled tool nut by hand to make sure that the two pins are tight against the full-length splines in the gearshaft. If the tool nut does not hold the pins tight against the spline, the readings will not be correct and and will not have constant values.

(e) Use the knurled nut to make sure that the assembly is tight. Make sure that the adapter does not touch the end of the fuel pump gearshaft (you can use a 0.010 inch (0.254 mm) feeler gage between the end of the gearshaft and the adjacent nut to make sure that they do not touch). Do not make this clearance too large (keep it to less than 0.030 inch/0.762 mm).

(f) Outward load of the fuel pump gearshaft (away from the gear box):

1) Put the tool guide assembly detail through the elongated slot in the tool detail arm with the two balls in the yoke end outward, away from the gearbox. Put the tool spring on the guide and install the yoke into the groove of the tool nut. Attach the tool spring and guide to the gearbox through the hole in the bracket assembly.

NOTE: Use the internally threaded guide during an inspection with the quick-disconnect coupling installed on the gearbox. Turn this guide onto the bolt that comes through the hole in the bracket assembly.

2) Use the detail ball lock pin to attach the fulcrum slot of the tool arm to the fulcrum post of the tool. Tighten the guide against the tool bracket.

CAUTION: THE TOOL RANGE WILL BE APPROXIMATELY 300 DEGREES. DO NOT TURN THE INDICATOR THROUGH MORE THAN THIS RANGE (THIS WILL CAUSE DAMAGE TO THE TOOL).

3) Attach a standard swivel and extension rod to the tool post. Attach a dial indicator correct for this operation to the the extension rod. Set the dial indicator to zero against the larger (forward) inner diameter (the diameter that is the mating surface for the outer diameter of the fuel pump flange). Use a PWA 10408 Adapter in the starter drive spline to slowly turn the gearbox drives and turn the indicator through the full available range. Record the full indicator reading (refer to Figure 603 for a typical recording sheet). (Figure 603)

4) Put the stem of the indicator where it can move along the bolt hole circle centerline during the squareness check. Use a PWA 10408 Adapter in the starter drive spline to slowly turn the gearbox drives and turn the indicator through the full available range (refer to the CAUTION above). Record the full indicator reading on the recording sheet. (Figure 603)

5) Remove the swivel, extension rod, and dial indicator. Remove the tool guide, tool ball lock pin, and tool arm.

(g) Inward load of the fuel pump gearshaft (into the gearbox):

1) Put the tool spring on the guide. Install the tool guide assembly detail through the elongated slot in the tool detail arm with the two balls on the yoke end inward, toward the gearbox. Install the yoke into the groove of the tool nut. Attach the tool spring and guide assembly to the bolt that extends through the hole in the bracket assembly.

NOTE: Use the internally threaded guide during an inspection with the quick-disconnect coupling installed on the gearbox. Turn this guide onto the bolt that comes through the hole in the bracket assembly.

CAUTION: THE TOOL RANGE WILL BE APPROXIMATELY 300 DEGREES. DO NOT TURN THE INDICATOR THROUGH MORE THAN THIS RANGE (THIS WILL CAUSE DAMAGE TO THE TOOL).

2) Attach a standard swivel and extension rod to the tool post. Attach a dial indicator correct for this operation to the the extension rod. Set the dial indicator to zero against the larger (forward) inner diameter (the diameter that is the mating surface for the outer diameter of the fuel pump flange). Use a PWA 10408 Adapter in the starter drive spline to slowly turn the gearbox drives and turn the indicator through the full available range. Record the full indicator reading on the recording sheet. (Figure 603)

3) Put the stem of the indicator where it can move along the bolt hole circle centerline during the squareness check. Use a PWA 10408 Adapter in the starter drive spline to slowly turn the gearbox drives and turn the indicator through the full available range (refer to the CAUTION above). Record the full indicator reading on the recording sheet. (Figure 603)

4) Remove the swivel, extension rod, and dial indicator. Remove the tool guide, tool ball lock pin, and tool arm.

(h) The concentricity and squareness limits (with the quick-disconnect coupling assembly installed on the gearbox and inward and outward loads on the fuel pump gearshaft) are:

1) Concentricity: 0.008 inch (0.203 mm) maximum.

2) Squareness: 0.006 inch (0.152 mm) maximum.

(i) If the fuel pump quick-disconnect coupling readings are in these limits, this check is completed, and no more inspection is necessary. Put the front coupling and nut back on the fuel pump as specified in FUEL PUMP, SUBJECT 73-12-01, Page 201. Install the fuel pump and control package on the gearbox as specified in FUEL PUMP AND FUEL CONTROL - MAINTENANCE PRACTICES, PAGEBLOCK 73-12-02/201.

(j) If the fuel pump quick-disconnect coupling readings are not in limits, go on to the inspection procedure with the quick-disconnect rear coupling removed from the gearbox. (Paragraph 1.C.(2))

(2) With the quick-disconnect rear coupling removed from the gearbox, measure the fuel pump drive pad concentricity and squareness with PWA 33713 Adapter. (Figure 601)

(a) Remove the fuel pump quick-disconnect rear coupling from the gearbox fuel pump pad. (FUEL PUMP REAR COUPLING - REMOVAL/INSTALLATION, PAGEBLOCK 72-61-62/401)

(b) Remove the tool ball lock pin that attaches the tool arm assembly to the tool bracket. Put the tool spacer, then the tool bracket on the first two bolts clockwise from the larger-diameter dowel pin on the gearbox pad. Attach the bracket with the tool bolt at the slotted hole in the tool bracket.

NOTE: In the end of the gearshaft you will see that there are positions 180 degrees apart where there are short splines which do not extend as far outward as other splines. It will be important to have the two detail pins in the expandable tool segments engage a full-length section of the spline, so be sure to install the tool post with these two detail pins 90 degrees away from the two short splines. Examine the splines for damage that will not let the two detail pins engage the splines.

(c) Turn back the detail nut on the tool (post and nut) to pull in the expandable post segments. Put the post and nut in the fuel pump gearshaft spline with the two detail pins of the expandable post segments engaged in the spline.

NOTE: Use a 3/16 inch open-end wrench on the flats of the tool post to make sure that the post does not turn. Tighten the knurled tool nut by hand to make sure that the two pins are tight against the full-length splines in the gearshaft. If the tool nut does not hold the pins tight against the spline, the readings will not be correct and and will not have constant values.

(d) Use the knurled nut to make sure that the assembly is tight. Make sure that the adapter does not touch the end of the fuel pump gearshaft (you can use a 0.010 inch (0.254 mm) feeler gage between the end of the gearshaft and the adjacent nut to make sure that they do not touch). Do not make this clearance too large (keep it to less than 0.030 inch/0.762 mm).

(e) Outward load of the fuel pump gearshaft (away from the gearbox):

1) Put the tool guide assembly detail through the elongated slot in the tool detail arm with the two balls in the yoke end outward, away from the gearbox. Put the tool spring on the guide and install the yoke into the groove of the tool nut. Attach the tool spring and guide to the gearbox through the hole in the bracket assembly.

NOTE: Use the externally threaded guide during an inspection with the quick-disconnect coupling removed from the gearbox. Turn this guide onto the bolt that comes through the hole in the bracket assembly.

2) Use the detail ball lock pin to attach the fulcrum slot of the tool arm to the fulcrum post of the tool. Tighten the guide against the tool bracket.

CAUTION: THE TOOL RANGE WILL BE APPROXIMATELY 300 DEGREES. DO NOT TURN THE INDICATOR THROUGH MORE THAN THIS RANGE (THIS WILL CAUSE DAMAGE TO THE TOOL).

3) Attach a standard swivel and extension rod to the tool post. Attach a dial indicator correct for this operation to the the extension rod. Set the dial indicator to zero against the inner diameter of the gearbox fuel pump pad. Use a PWA 10408 Adapter in the starter drive spline to slowly turn the gearbox drives and turn the indicator through the full available range. Record the full indicator reading on the recording sheet. (Figure 603)

4) Put the stem of the indicator where it can move along the bolt hole circle centerline during the squareness check. Use a PWA 10408 Adapter in the starter drive spline to slowly turn the gearbox drives and turn the indicator through the full available range (refer to the CAUTION above). Record the full indicator reading on the recording sheet. (Figure 603)

5) Remove the swivel, extension rod, and dial indicator. Remove the tool guide, tool ball lock pin, and tool arm.

(f) Inward load of the fuel pump gearshaft (into the gearbox):

1) Put the tool guide assembly detail through the elongated slot in the tool detail arm with the two balls in the yoke end inward, toward the gearbox. Put the tool spring on the guide and install the yoke into the groove of the tool nut. Attach the tool spring and guide to the gearbox through the hole in the bracket assembly.

NOTE: Use the externally threaded guide during an inspection with the quick-disconnect coupling removed from the gearbox. Turn this guide onto the bolt that comes through the hole in the bracket assembly.

2) Use the detail ball lock pin to attach the fulcrum slot of the tool arm to the fulcrum post of the tool. Tighten the guide against the tool bracket.

CAUTION: THE TOOL RANGE WILL BE APPROXIMATELY 300 DEGREES. DO NOT TURN THE INDICATOR THROUGH MORE THAN THIS RANGE (THIS WILL CAUSE DAMAGE TO THE TOOL).

3) Attach a standard swivel and extension rod to the tool post. Attach a dial indicator correct for this operation to the the extension rod. Set the dial indicator to zero against the inner diameter of the gearbox fuel pump pad. Use a PWA 10408 Adapter in the starter drive spline to slowly turn the gearbox drives and turn the indicator through the full available range. Record the full indicator reading on the recording sheet. (Figure 603)

4) Put the stem of the indicator where it can move along the bolt hole circle centerline during the squareness check. Use a PWA 10408 Adapter in the starter drive spline to slowly turn the gearbox drives and turn the indicator through the full available range (refer to the CAUTION above). Record the full indicator reading on the recording sheet. (Figure 603)

5) Remove the swivel, extension rod, and dial indicator. Remove the tool guide, tool ball lock pin, and tool arm.

(g) The concentricity and squareness limits (with the quick-disconnect coupling assembly removed from the gearbox and inward and outward loads on the fuel pump gearshaft) are:

1) Concentricity: 0.008 inch (0.203 mm) maximum.

2) Squareness: 0.006 inch (0.152 mm) maximum.

(h) If the fuel pump pad readings are in these limits, and the readings from inspection with the quick-disconnect coupling assembly installed were not in limits, replace the coupling assembly as specified in FUEL PUMP REAR COUPLING - REMOVAL/INSTALLATION, PAGEBLOCK 72-61-62/401 and FUEL PUMP, SUBJECT 73-12-01, Page 201 (this will usually correct the problem).

(i) If the readings from the quick-disconnect coupling and from the gearbox fuel pump pad are not in limits, remove the gearbox MAIN ACCESSORY GEARBOX SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-00/401 for corrective action. It is possible that the condition of the quick-disconnect coupling assembly will be satisfactory, and it is recommended to give the coupling assembly a full inspection befor it is installed back on a gearbox. Refer to the coupling inspection in this section. If the rear coupling is serviceable, install the the coupling. (FUEL PUMP REAR COUPLING - REMOVAL/ INSTALLATION, PAGEBLOCK 72-61-62/401)

(j) Where applicable, install the front coupling assembly on the flange of the fuel pump. (FUEL PUMP, SUBJECT 73-12-01, Page 201)

(k) Where applicable, install the fuel pump and control package on the gearbox. (FUEL PUMP AND FUEL CONTROL - MAINTENANCE PRACTICES, PAGEBLOCK 73-12-02/201)

2. Hydraulic Pump Drive Pad Concentricity And Squareness Check

A. Equipment And Materials Required

(1) Support Equipment

PWA 10408 Adapter

PWA 33788 Gage

(2) Consumables

None

B. Procedure. See Figure 604 and Table 603.

(1) Position detail bracket of PWA 33788 Gage on any two studs on hydraulic pump drive and secure with detail nut at slotted hole.

(2) Insert detail gage assembly into hydraulic pump drive so that detail pin on expendable segments engage spline ID.

(3) With gage contacting end of hydraulic pump gearshaft, tighten knurl nut.

(a) Use a suitable wrench on flats of post to hold post from turning.

(4) Load hydraulic pump drive gearshaft outward.

(a) Place detail guide through elongated slot in detail arm assembly with two balls up. Place detail spring over guide and insert yoke end of arm into neck of gage.

(b) Thread guide onto stud coming through hole in bracket.

(c) Secure fulcrum slot of detail arm to fulcrum post of detail bracket with detail ball lock pin. Tighten guide if necessary.

(5) Load hydraulic pump drive gearshaft inward.

(a) Place detail spring over guide and insert into elongated slot of detail arm assembly with two balls down on yoke end. Insert yoke into neck of gage.

(b) Thread guide onto stud coming through hole in bracket.

(c) Secure fulcrum slot of detail arm to fulcrum post of detail bracket with detail ball lock pin. Tighten guide if necessary.

CAUTION: TOOL SWING IS APPROXIMATELY 300 DEGREES. DO NOT DAMAGE TOOL BY OVER-ROTATING DRIVES.

(6) Attach a suitable swivel and extension rod to center post of gage. Attach a suitable dial indicator to extension rod. Zero dial indicator to hydraulic pump pad ID and face. Rotate gearbox using PWA 10408 Adapter to check concentricity and squareness.

(a) Concentricity limit is 0.000 - 0.008 inch (0.000 - 0.203 mm) FIR, squareness limit is 0.000 - 0.006 inch (0.000 - 0.152 mm) FIR.

(b) If hydraulic pump drive is not within above limits, replace gearbox assembly.

3. N2 Tachometer Drive Pad Concentricity And Squareness Check

A. Equipment And Materials Required

(1) Support Equipment

PWA 10408 Adapter

PWA 33789 Gage

(2) Consumables

None

B. Procedure. See Figure 605 and Table 604.

(1) Position detail hollow shaft of PWA 33789 Gage with split ring and clamp assembled, split ring end down over tachometer drive until it bottoms.

(2) Using suitable wrenches on flats of hollow shaft and clamp, tighten until split ring is secured to protruding end of N2 tachometer drive to withstand a 15 - 20 lb. (6.80 - 9.07 kg) pull.

(3) Loan N2 tachometer drive outward.

(a) Slide detail flanged collar over hollow shaft with flange end down until seated on seal housing retaining ring.

(b) Assemble detail thrust bearing, washer, and spring in this order over hollow shaft.

(c) Install small detail knurl nut to hollow shaft and tighten.

(4) Load N2 tachometer drive inward.

(a) Slide detail sleeve over hollow shaft with lug end down.

(b) Assemble detail spring, washer, and thrust bearing inside of sleeve in this order. Secure with large detail knurl nut.

(c) Push assembled sleeve down over hollow shaft, aligning washer and thrust bearing, into seal housing and turn one quarter turn to align sleeve lugs under seal housing lugs.

(5) Insert detail tube assembled with square collet, threaded shaft, and knurl nut with post into hollow shaft engaging square tachometer drive. Tighten knurl nut to secure square collet in tachometer drive.

(6) Attach a standard swivel and extension rod to post on knurl nut. Attach a suitable dial indicator to extension rod, zero dial indicator and turn gearbox using PWA 10408 Adapter to check concentricity and squareness.

(a) Concentricity limit is 0.000 - 0.010 inch (0.000 - 0.254 mm) FIR, squareness limit is 0.000 - 0.010 inch (0.000 - 0.254 mm) FIR.

(b) If concentricity or squareness are not within limits, replace gearbox assembly.

4. Fuel Pump Coupling Check

A. Equipment and Materials - None

B. Procedure. See Figure 606.

(1) Fuel Pump Front Coupling Inspection

(a) Examine the outer edge of the fuel pump coupling for damage or worn areas.

(b) Measure Dimension A and Dimension B as shown in Sheet 1 of the figure. If Dimension A or B is not in the limits shown, replace the coupling.

(2) Fuel Pump Rear Coupling Check

(a) Examine the front face of the fuel pump rear coupling for damage or worn areas.

(b) Measure Dimension C as shown in Sheet 1 of the figure. Dimension C is more than the limit shown, replace the coupling.

(c) Examine the threads for worn areas as shown in Sheet 3 of the figure. Dimension C is more than the limit shown, replace the coupling.

(3) Fuel Pump Quick-Disconnect Nut Locking Bolt

(a) Examine the bolt for damage or worn areas. Replace a bolt which has damage which will prevent safe installation.

(4) Quick-Disconnect Nut

(a) Examine the area shown in Sheet 1 of the figure for damage or worn areas.

(b) Measure Dimension D shown in the figure. If Dimension D is below the limits shown, replace the nut.

(c) Examine the threads for damage or worn areas as shown in Sheet 2 of the figure. If a wear step is found which is more than the limits given, replace the nut.

5. Main Gearbox CSD Drive Gear Movement Check

A. Equipment and Materials - None

B. General (Figure 607).

NOTE: This check is recommended when the CSD is removed from the engine and the rear surface of the gearbox is open for inspection.

(1) The main accessory gearshaft (which sends power to the CSD) is held in position by a ball bearing at the rear end and supported by a roller bearing at the front end. Both bearings are installed in bushing pressed into the gearbox housing. If the rear bushing becomes worn or damaged and starts to move forward in the gearbox housing, the gearshaft will move forward also. If this movement goes too far, it can cause the bevel gear teeth to be disengaged from the teeth of the towershaft bevel gear, and tooth damage and gear failure can follow.

(2) Inspections have found up to approximately 0.125 inch (3 mm) of movement is possible. This condition has been difficult to measure on assembled gearboxes but is easy to find during gearbox rear housing inspection.

(3) The purpose of the inspection procedure that follows is to make it possible to see if this movement has occurred in an assembled gearbox. Two checks are given, one a distance measured from the rear face of the gearbox to the end of the CSD coupling, the other measured from the gearbox rear face to the rear surface of the gearshaft ball bearing. If the first distance is not in limits, the second inspection is recommended.

(4) It is now recommended that operators measure the two important gearshaft positions at gearbox assembly and keep these numbers with the engine records. If the distance is measured at gearbox assembly, it will be possible to compare the initial assembly distance with the distance seen after engine operation.

(5) If the gearshaft position inspection was done and the record is available, compare the gearshaft position in the inspection procedure that follows with the distances from the engine record to calculate gearshaft movement. If the inspection was not done before, or the record is not available, use the limits specified below. If the inspection distance increases after gearbox assembly and a period of engine operation, there is gearshaft movement.

C. Procedure

(1) Measure the distance (distance 1) from the rear (CSD mating) flange surface of the gearbox housing to the end face of the CSD coupling as shown in Figure 607.

(a) If an engine record of gearshaft position is available:

1) Compare the distance from the gearbox CSD mating flange to end of the CSD coupling with the recorded dimension from engine records (dimension 1).

2) If the measure distance is more than the recorded distance, it is possible that gearshaft movement occurred. Go to Paragraph 5.C.(2).

(b) If there is no record of gearshaft position:

1) If the gearbox parts are in good condition, distance 1 will be 0.304 - 0.336 inch (7.72 - 8.53 mm) (with 0.320 inch (8.128 mm) as an average). If this distance is more than 0.336 inch (8.53 mm), worn or damaged internal parts let the gearshaft move forward more than is permitted. Go to Paragraph 5.C.(2).

(2) If the distance measure in Paragraph 5.C.(1) is not in limits, or is more than the distance at gearbox assembly, remove the seal assembly from the CSD drive (MAIN ACCESSORY GEARBOX SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-00/401). Measure the distance (distance 2) from the gearbox rear face to the rear face of the ball bearing outer race as shown in the figure.

(a) If an engine record of gearshaft position is available:

1) Compare the distance from the gearbox CSD mating flange to the rear of the CSD gearshaft ball bearing outer race with the recorded dimension from engine records.

2) If the measure distance is more than the recorded distance, then the gearshaft moved.

(b) If there is no record of gearshaft position:

1) If the gearbox parts are in good condition, this distance is usually 1.606 - 1.623 inch (40.79 - 41.2 mm). If the distance measured is more than 1.623 inch (41.22 mm), it is possible that there is damage to the internal parts which causes movement of the gearshaft.

(3) When the inspection is completed, install the seal and seal housing assembly (MAIN ACCESSORY GEARBOX SECTION - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-00/401).

Table 601 Key to Figure 601

Index No.	Nomenclature
1	Nut
2	Post
3	Guide Assembly, Internally Threaded For Use With Quick-Disconnect Coupling Removed From Gearbox Assembly.
4	Spring, Over Index 8 Arm Assembly When Inward Loading, Under Index 8 Arm Assembly When Outward Loading.
5	Bracket Assembly
6	Spacer
7	Standard Swivel, Extension Rod, And Suitable Dial Indicator
8	Arm Assembly, Use With Two Balls Upward For Outward Loading, Use With Two Balls Downward For Inward Loading.
9	Ball-Lock Pin
10	Post Pin (2)

Table 602 Key to Figure 602

Index No.	Nomenclature
1	Nut

Table 602 Key to Figure 602 (Continued)

Index No.	Nomenclature
2	Post
3	Guide Assembly, Internally Threaded For Use With Quick-Disconnect Coupling Installed On Gearbox Assembly.
4	Spring, Over Index 7 Arm Assembly When Inward Loading, Under Index 7 Arm Assembly When Outward Loading.
5	Bracket Assembly
6	Standard Swivel, Extension Rod, And Suitable Dial Indicator, Reference
7	Arm Assembly, Use With Two Balls Upward For Outward Loading, Use With Two Balls Downward For Inward Loading.
8	Ball-Lock Pin
9	Fuel Pump Bolt (2)
10	Post pin (2)

Table 603 Key to Figure 603

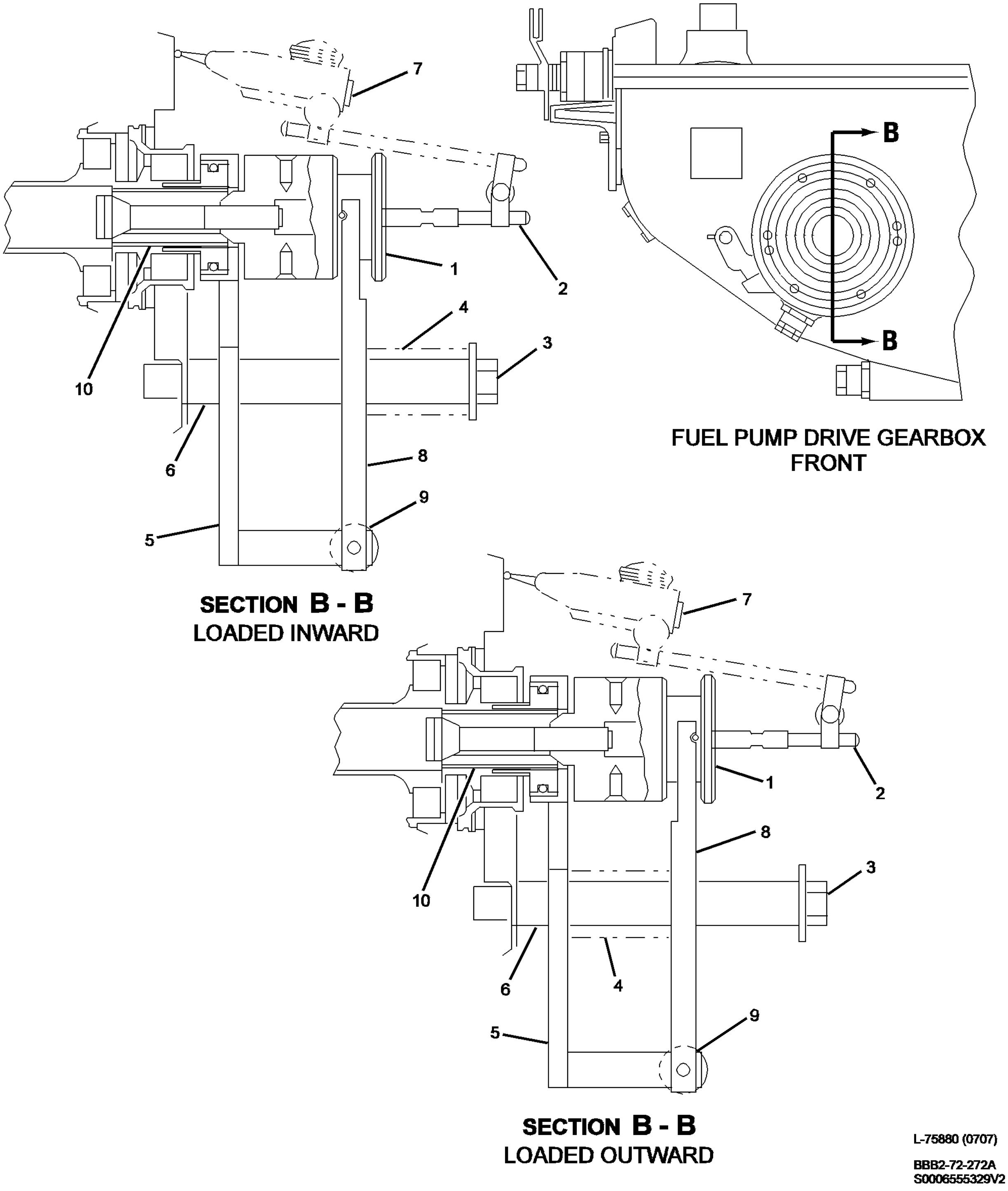
Index No.	Nomenclature
1	Post
2	Gage
3	Guide
4	Arm Assembly, Two Balls Up For Outward Loading, Two Balls Down For Inward Loading.
5	Spring, Between Index 4 Arm And Index 7 Bracket For Outward Loading, On Top Of Index 4 Arm For Inward Loading.
6	Suitable Swivel, Extension Shaft, And Dial Indicator.
7	Bracket Assembly

Table 604 Key to Figure 604

Index No.	Nomenclature
1	Clamp
2	Split Ring
3	Square Collet
4	Shaft
5	Tube
6	Thurst Bearing
7	Washer
8	Spring
9	Small Knurl Nut
10	Large Knurl Nut
11	Knurl Nut, With Post

Table 604 Key to Figure 604 (Continued)

Index No.	Nomenclature
12	Hollow Shaft
13	Standard Swivel And Extension



FUEL PUMP DRIVE GEARBOX
FRONT

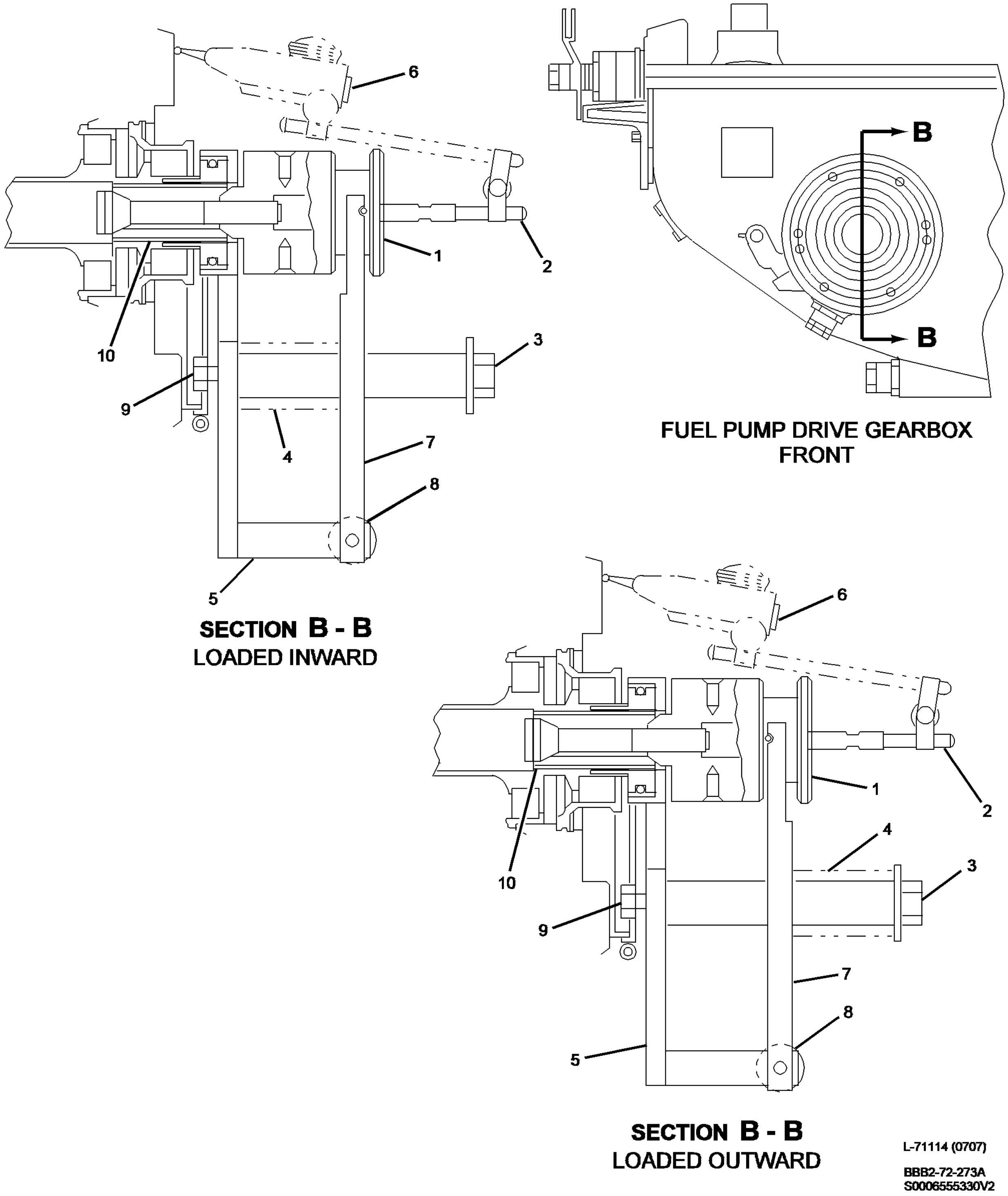
SECTION B - B
LOADED INWARD

SECTION B - B
LOADED OUTWARD

L-75880 (0707)

BBB2-72-272A
S0006555329V2

Concentricity And Squareness Check With Quick-Disconnect Removed
Figure 601/72-61-00-990-801



FUEL PUMP DRIVE GEARBOX
FRONT

SECTION B - B
LOADED INWARD

SECTION B - B
LOADED OUTWARD

Concentricity And Squareness Check With Quick-Disconnect Installed
Figure 602/72-61-00-990-802

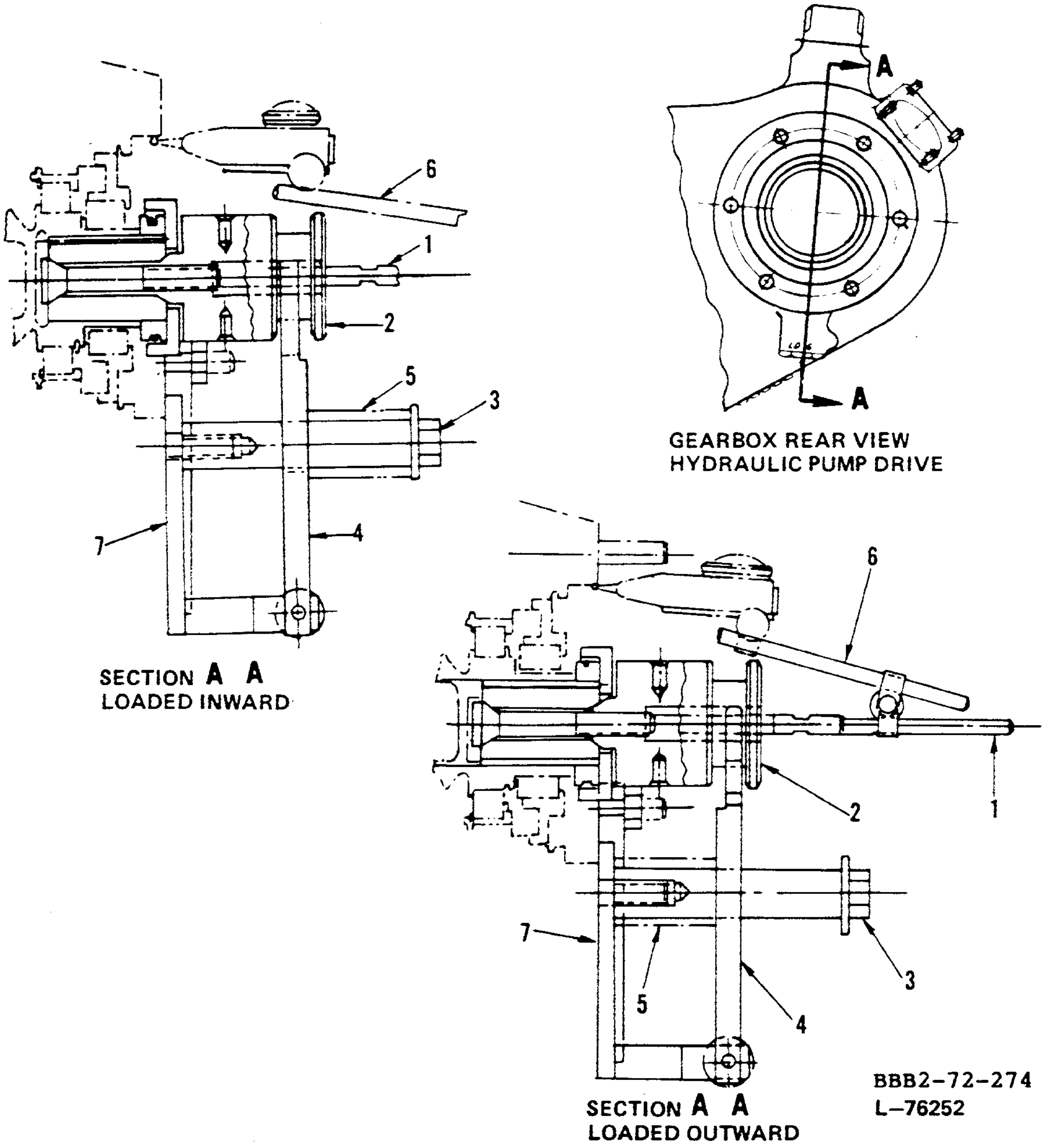
FUEL PUMP PAD CONCENTRICITY/SQUARENESS RECORDING SHEET

	CONCENTRICITY (INCH OR mm)	SQUARENESS (INCH OR mm)
A. WITH QUICK DISCONNECT COUPLING ASSEMBLED TO GEARBOX		
GEARSHAFT LOADED OUTWARD (AWAY FROM GEARBOX)	______________	______________
GEARSHAFT LOADED INWARD (TOWARD GEARBOX)	______________	______________
B. WITH QUICK-DISCONNECT COUPLING REMOVED FROM GEARBOX		
GEARSHAFT LOADED OUTWARD (AWAY FROM GEARBOX)	______________	______________
GEARSHAFT LOADED INWARD (TOWARD GEARBOX)	______________	______________
C. INSPECTION LIMITS (MAXIMUM)	0.008 INCH (0.203 mm)	0.006 INCH (0.152 mm)

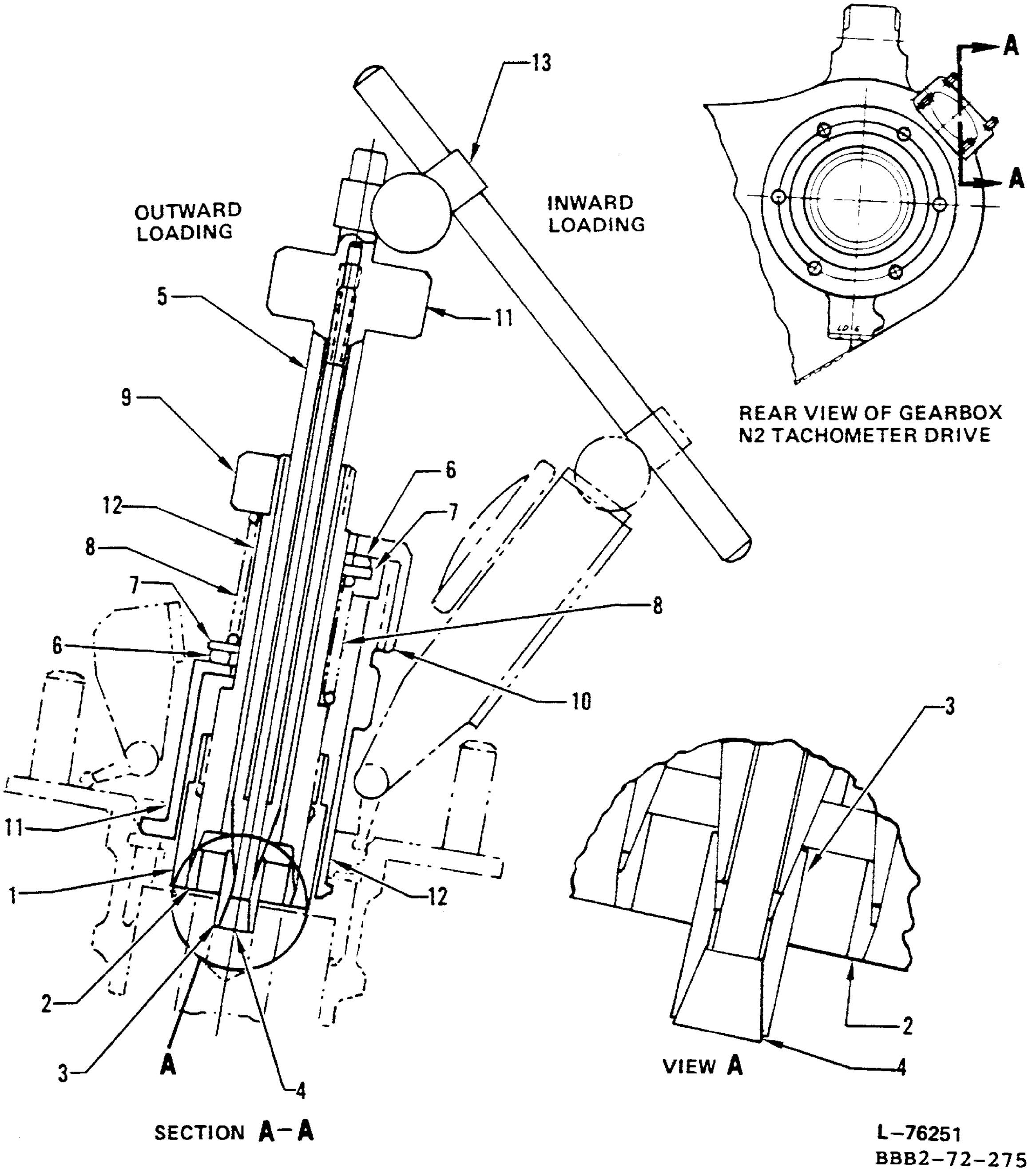
L-H8136 (0707)

BBB2-72-627
S0000285189V1

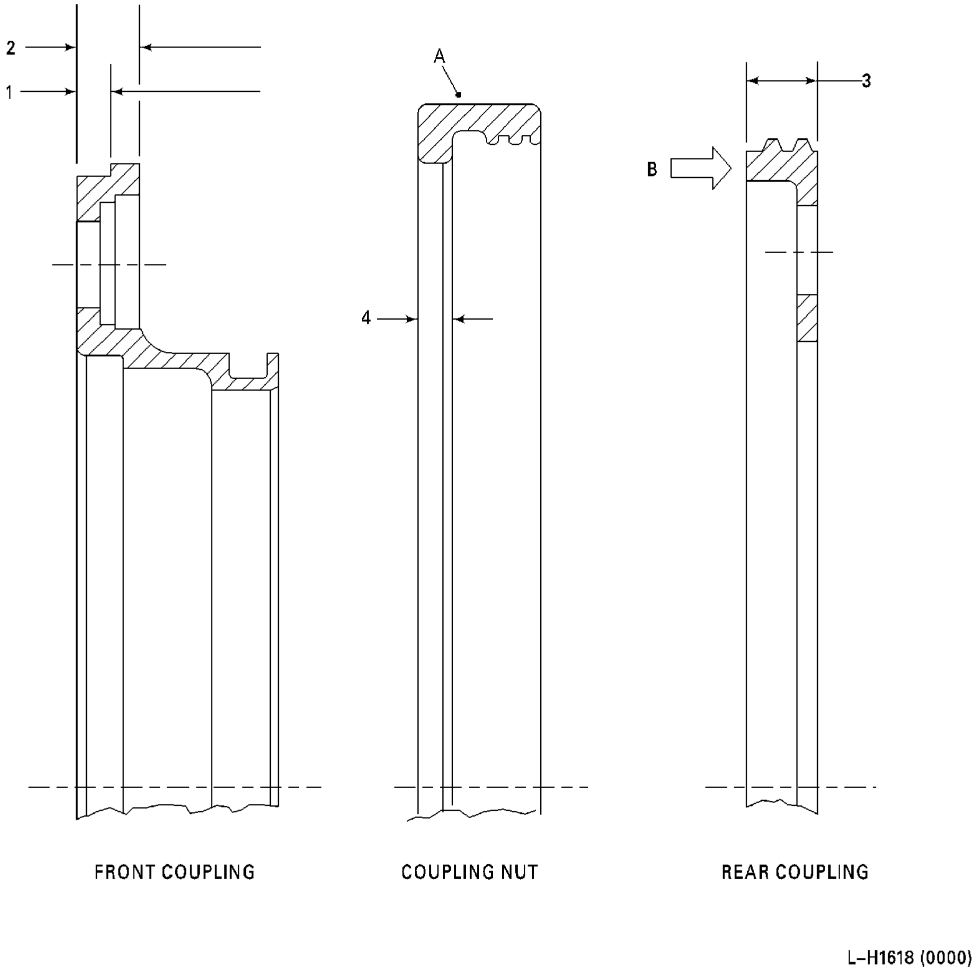
Fuel Pump Pad Concentricity/Squareness - Recording Sheet
Figure 603/72-61-00-990-819



Hydraulic Pump Drive Concentricity And Squareness Check - PWA 33788
Figure 604/72-61-00-990-803



Concentricity And Squareness Check N2 Tachometer Drive - PWA 33789
Figure 605/72-61-00-990-804

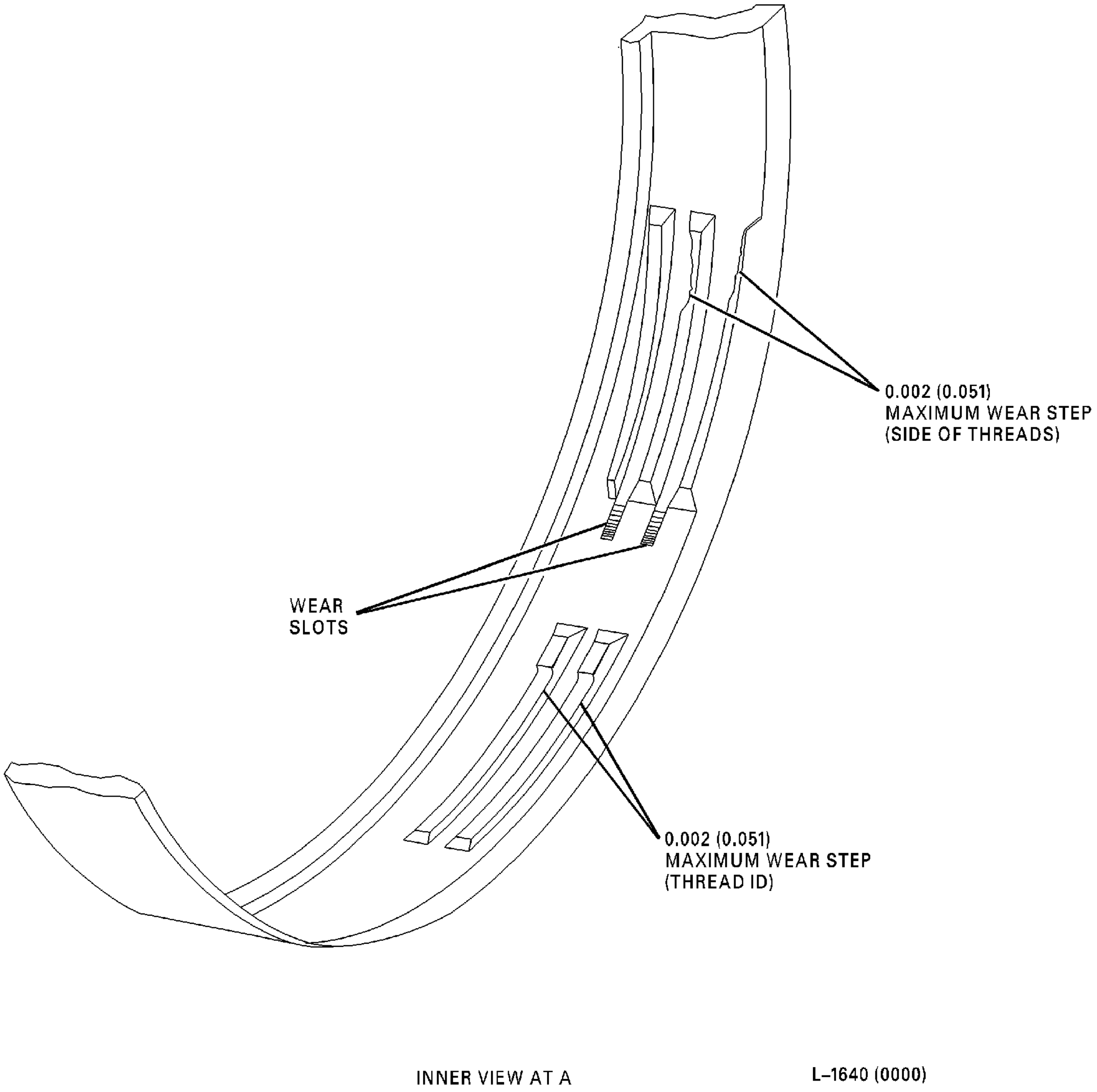


1. DIMENSION A, 0.159 INCH (4.039 MM) MAXIMUM
2. DIMENSION B, 0.277 INCH (7.036 MM) MINIMUM
3. DIMENSION C, 0.307 INCH (7.798 MM) MINIMUM
4. DIMENSION D, 0.147 INCH (3.734 MM) MINIMUM

CAG(IGDS)

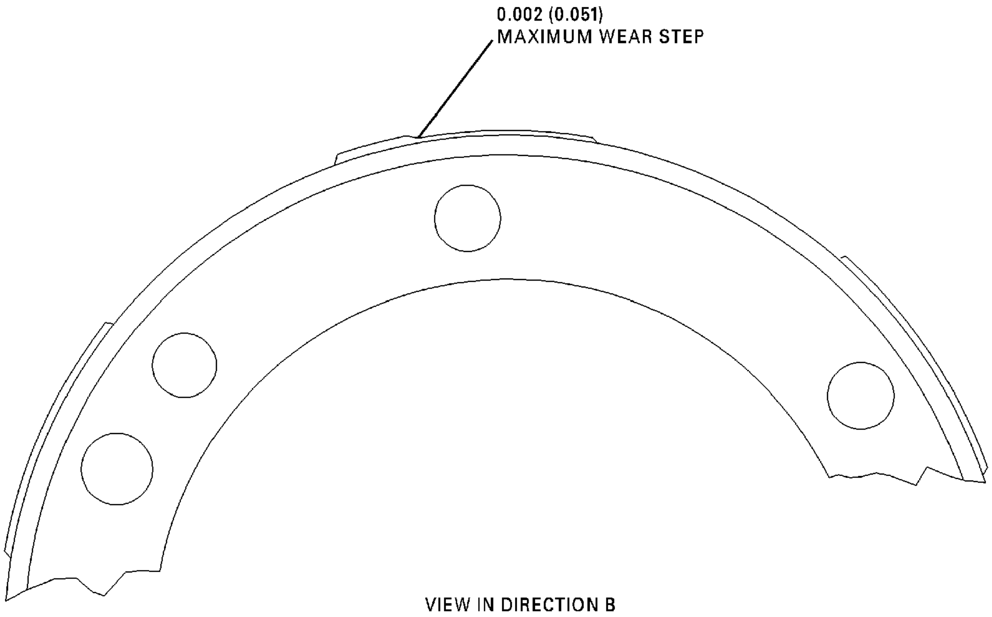
BBB2–72–421A

Fuel Pump Coupling Check
Figure 606/72-61-00-990-805 (Sheet 1 of 3)



CAG(IGDS) BBB2–72–422

Fuel Pump Coupling Check
Figure 606/72-61-00-990-805 (Sheet 2 of 3)

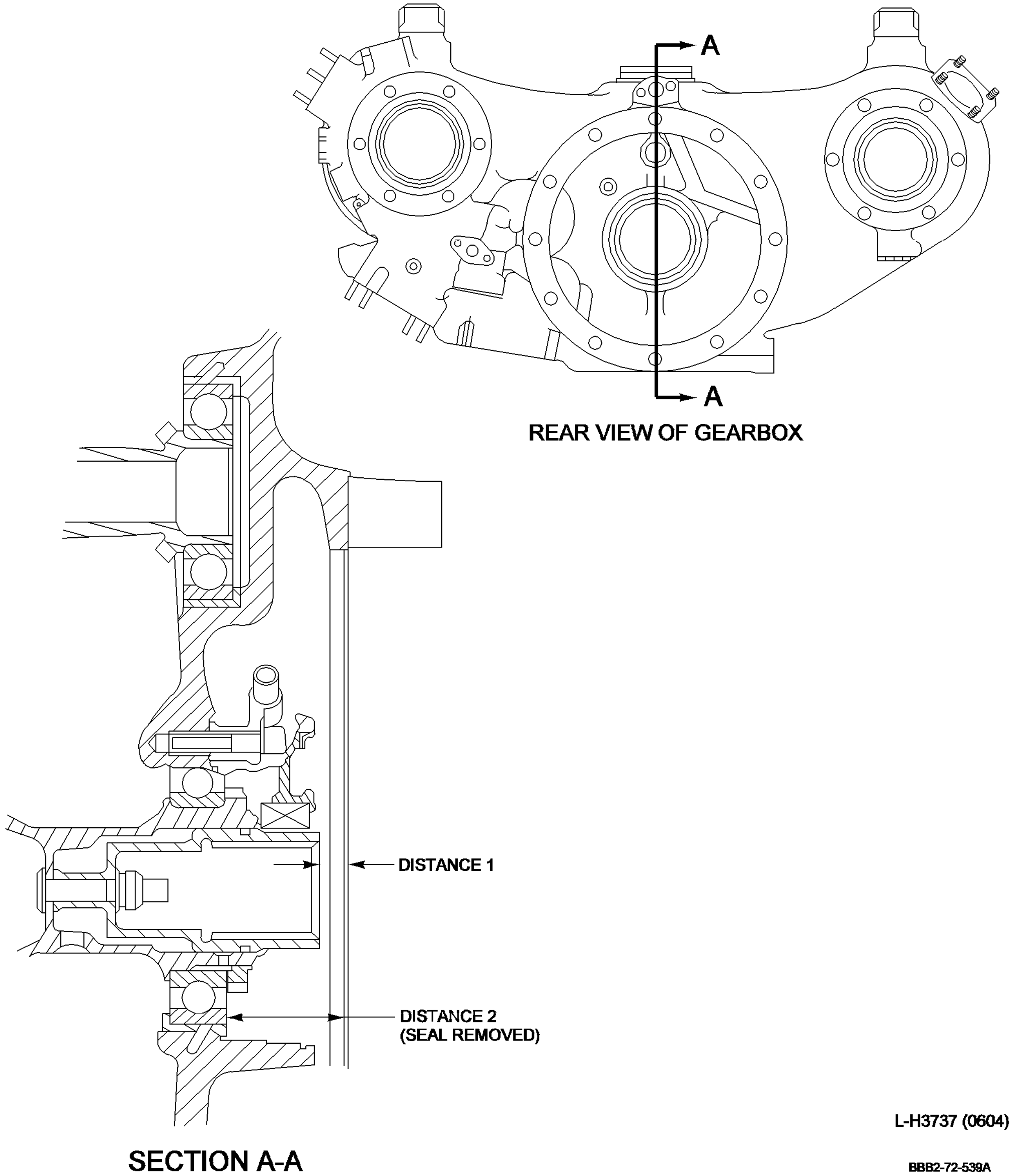


L-H1619 (0000)

CAG(IGDS)

BBB2-72-423

Fuel Pump Coupling Check
Figure 606/72-61-00-990-805 (Sheet 3 of 3)



Main Accessory Gearbox CSD Drive Gear Movement Check
Figure 607/72-61-00-990-806

MAIN ACCESSORY GEARBOX SECTION - INSPECTION/CHECK

1. General

A. This procedure contains MSG-3 task card data.

TASK 72-61-00-211-801

2. Inspect Magnetic Chip Detector

A. Prepare for the Inspection of the Magnetic Chip Detector

SUBTASK 72-61-00-010-001

WARNING: MAKE SURE THAT THE HOLD-OPEN RODS ARE FULLY EXTENDED AND LOCKED WHEN THE FAN COWL PANEL IS OPEN. THE HOLD-OPEN RODS ARE NOT LOCKED IF YOU SEE THE RED STRIPE WITH THE WORD "UNLOCKED" ON THE LOCK COLLAR. IF THE RODS ARE NOT LOCKED, THE FAN COWL PANEL CAN FALL. THIS CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.

(1) Open engine cowling.

B. Inspect Magnetic Chip Detector

SUBTASK 72-61-00-211-001

(1) Do an inspection of the engine main accessory gearbox magnetic chip detectors.

  (a) Remove plug from self-closing valve body.

  (b) Check plug and valve for foreign particles and contaminants.

  (c) Check plug O-rings for damage (replace if necessary).

  (d) Check self-closing valve for freedom of movement and proper seating.

  NOTE: Magnetic chip detector plug should be replaced if self-closing valve sticks or does not seat.

  (e) Check plug for bent pins and proper engagement with self-closing valve.

  (f) Reinstall magnetic chip detector.

C. Job Close-up

SUBTASK 72-61-00-410-001

(1) Close engine cowling.

——— END OF TASK ———

STARTER DRIVE GEARSHAFT COUPLING - REMOVAL/INSTALLATION-01

1. Starter Drive Gearshaft Coupling Removal

A. Prerequisites

(1) Access for removal of starter drive gearshaft coupling is through the lower forward cowl door.

(2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

B. Equipment And Materials Required

(1) Support Equipment

PWA 3790-55 Puller

PWA 10570 Puller

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Remove starter per PNEUMATIC STARTER, SUBJECT 80-10-01, Page 201, or shipping cover from starter drive pad.

(2) Remove locknut from anchor bolt inside starter drive gearshaft coupling.

NOTE: If coupling has sheared inboard of spline section, remove remainder using PWA 10570 Puller. Position puller jaws behind ID flange and remove coupling with knocker action.

(3) Insert PWA 3790-55 Puller into inner groove and remove worn or damaged gearshaft coupling from starter drive gearshaft.

2. Starter Drive Gearshaft Coupling Installation

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

B. Procedure. (Figure 401)

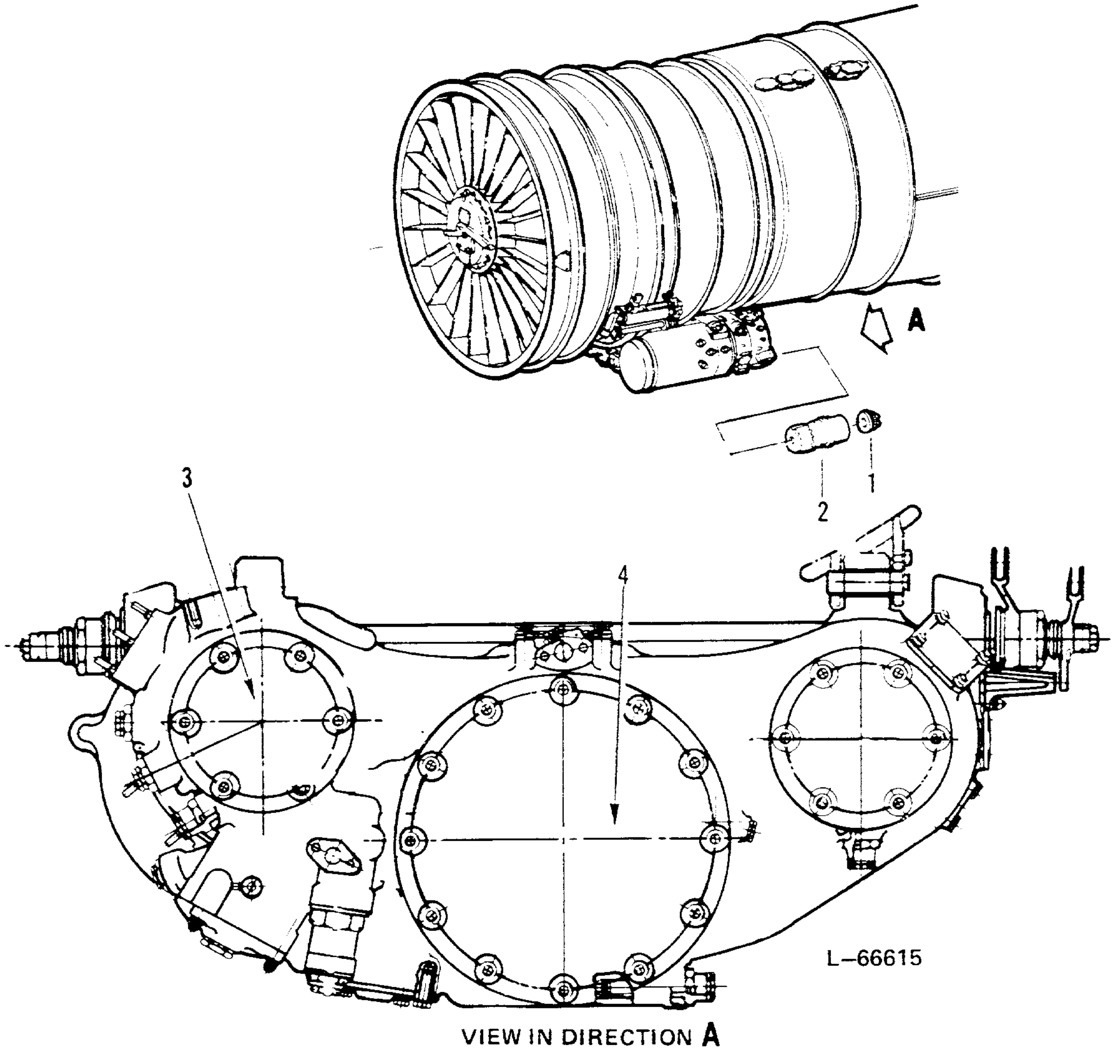
(1) Install new starter drive gearshaft coupling into splines of starter drive gearshaft.

(2) Install locknut inside adapter and tighten to recommended torque.

(3) Install starter per PNEUMATIC STARTER, SUBJECT 80-10-01, Page 201, or starter pad cover.

C. Postrequisites

(1) For procedures to close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.



1. Nut
2. Starter Drive Gearshaft Coupling
3. Starter Drive Pad (Reference)
4. CSD Pad (Reference)

BBB2-72-276

Starter Drive Gearshaft Coupling Replacement
Figure 401/72-61-14-990-801

GEARBOX COUPLING (CSD) - REMOVAL/INSTALLATION-01

1. Gearbox Coupling (Constant Speed Drive) Removal

A. Prerequisites

(1) Access for removal of CSD is through the lower forward cowl door.

(2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

(3) Remove CSD drive oil seal per ACCESSORY DRIVE FACE-TYPE OIL SEALS - REMOVAL/INSTALLATION, PAGEBLOCK 72-61-59/401.

B. Equipment And Materials Required

(1) Support Equipment

PWA 3790-55 Puller

(2) Consumables

None

C. Procedure

(1) Remove locknut which secures gearbox coupling (CSD) to gearshaft.

(2) Remove gearbox coupling (CSD) from gearshaft using PWA 3790-55 Puller.

2. Gearbox Coupling (Constant Speed Drive) Installation

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

B. Procedure. (Figure 401)

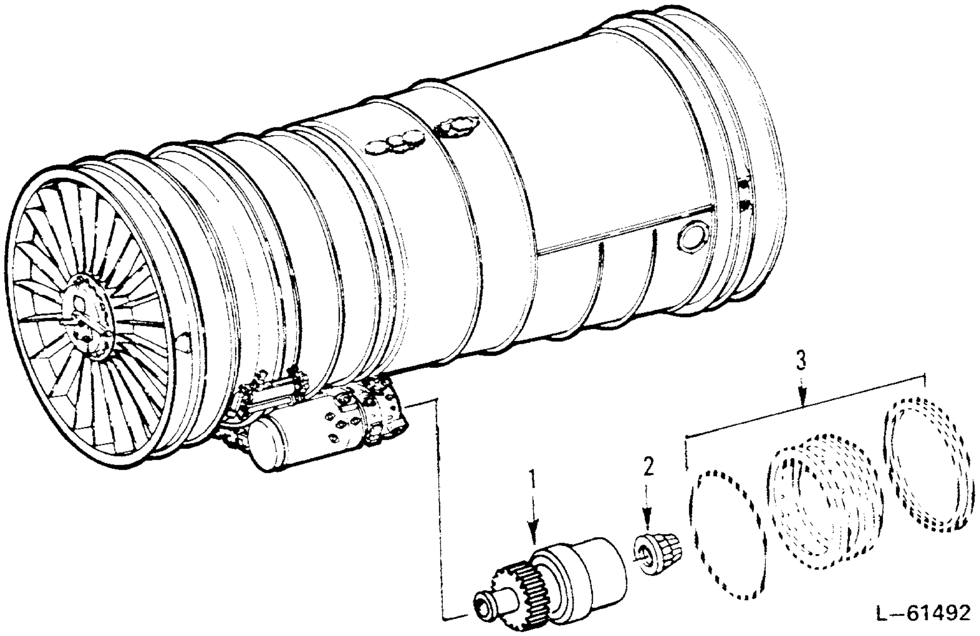
(1) Install coupling in end of CSD gearshaft, meshing OD spline of coupling with ID spline of gearshaft.

(2) Install locknut and tighten to specified torque.

C. Postrequisites

(1) Install CSD drive oil seal per ACCESSORY DRIVE FACE-TYPE OIL SEALS - REMOVAL/INSTALLATION, PAGEBLOCK 72-61-59/401.

(2) For procedures to close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.



1. Gearshaft Coupling
2. Locknut
3. Seal And Housing Assembly, Packing, And Retaining Ring

BBB2-72-277

Gearbox CSD Coupling Replacement
Figure 401/72-61-23-990-801

TACHOMETER DRIVE OIL SEAL HOUSING AND SEAL - REMOVAL/INSTALLATION-01

1. N2 Tachometer Drive Gearshaft Seal Removal

A. Prerequisites

(1) Access for removal of N2 tachometer drive gearshaft seal is through the lower forward cowl door.

(2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

B. Equipment And Materials Required

(1) Support Equipment

PWA 9519 Puller

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Remove nuts and washers, then remove tachometer generator or tachometer drive pad cover from gearbox.

(2) Remove snapring.

(3) Using PWA 9519 Puller, remove tachometer gearshaft drive seal housing from accessory drives gearbox housing.

2. N2 Tachometer Drive Gearshaft Seal Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 10016 Guide

(2) Consumables

Petrolatum (PMC 9609)

B. Procedure

(1) Position new packing, lubricated with petrolatum, on seal housing.

(2) Position assembled seal and housing over PWA 10016 Guide and install (metal side of seal outward) into assembled shaft and housing.

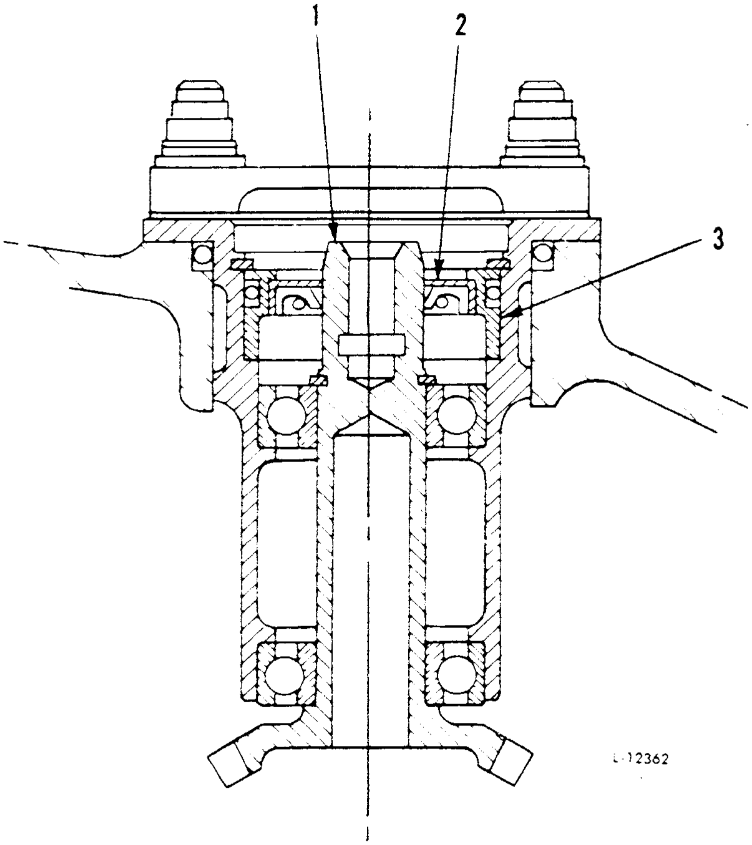
(3) Tap to seat and secure with snapring.

(4) Using new gasket, reinstall tachometer generator or tachometer drive pad cover and secure with washers and nuts.

(5) Tighten nuts to recommended torque.

C. Postrequisites

(1) For procedures to close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.



1. Tachometer Drive Gearshaft
2. Oil Seal
3. Oil Seal Housing

BBB2-72-278

N2 Tachometer Drive Gear
Figure 401/72-61-44-990-801

MAIN OIL PUMP ASSEMBLY - REMOVAL/INSTALLATION-01

1. Main Oil Pump Removal

A. Prerequisites

(1) Access for removal of main oil pump is through the lower forward cowl door.

(2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

B. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

C. Procedure. (Figure 401).

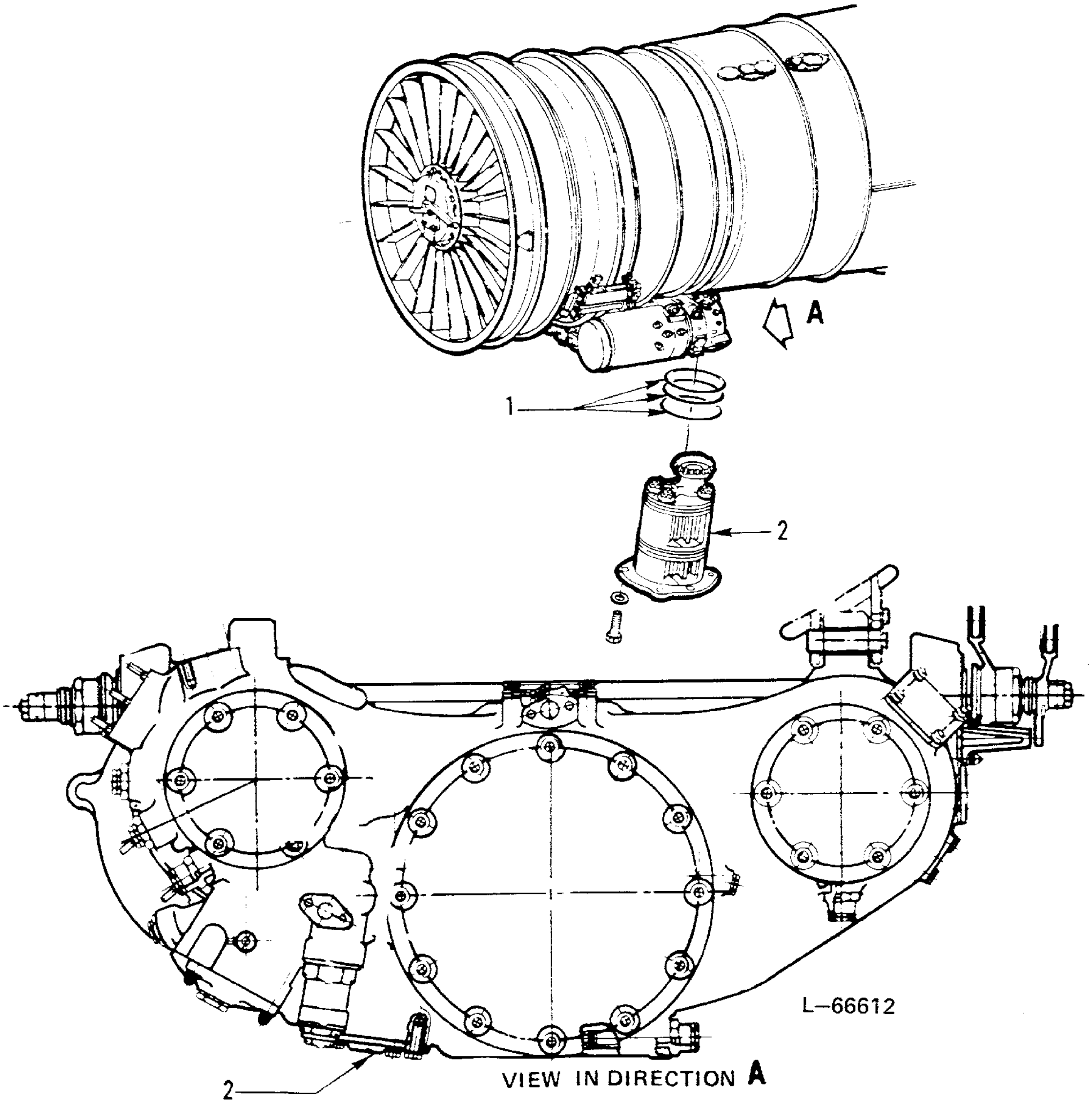
(1) Drain oil from gearbox.

CAUTION: IF THROUGH BOLTS ARE INADVERTENTLY REMOVED, LOCKWIRE MAY FALL INTO THE GEARBOX HOUSING. REMOVE ONLY BOLTS ON OUTER EDGE OF OIL PUMP COVER.

PROTECT PERSONNEL AND EQUIPMENT FROM SPILLED OIL WHEN REMOVING OIL PUMP, ESPECIALLY IF OIL IS HOT. HOLD SUITABLE CONTAINER UNDER PUMP WHILE REMOVING PUMP FROM GEARBOX.

(2) Remove bolts and washers securing main oil pump to accessory drives gearbox.

(3) Separate oil pump from gearbox using standard jackscrews.



1. Packings (Three)
2. Main Oil Pump

BBB2-72-279

Main Oil Pump Replacement
Figure 401/72-61-50-990-801

2. Main Oil Pump Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

B. Procedure. (Figure 401).

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKINGS, USE ONLY A SMALL QUANTITY ON THE PACKINGS TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Install new packings, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, in the three OD grooves of the pump assembly.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(2) Secure main oil pump to accessory drives gearbox with bolts and washers. Torque and lockwire.

(3) Refill oil system.

C. Postrequisites

(1) For procedures to close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

OIL PRESSURE RELIEF VALVE ASSEMBLY - REMOVAL/INSTALLATION-01

1. Oil Pressure Relief Valve Assembly Removal

A. Prerequisites

(1) Open lower forward cowl door per COWL DOORS, SUBJECT 71-10-03, Page 201.

B. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

C. Procedure. (Figure 401).

CAUTION: PROTECT PERSONNEL AND EQUIPMENT FROM SPILLED OIL WHEN REMOVING PRESSURE RELIEF VALVE, ESPECIALLY IF OIL IS HOT. HOLD SUITABLE CONTAINER UNDER VALVE WHILE REMOVING VALVE FROM GEARBOX.

(1) Unscrew and remove oil pressure relief valve assembly from gearbox.

2. Oil Pressure Relief Valve Assembly Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Petrolatum (PMC 9609)

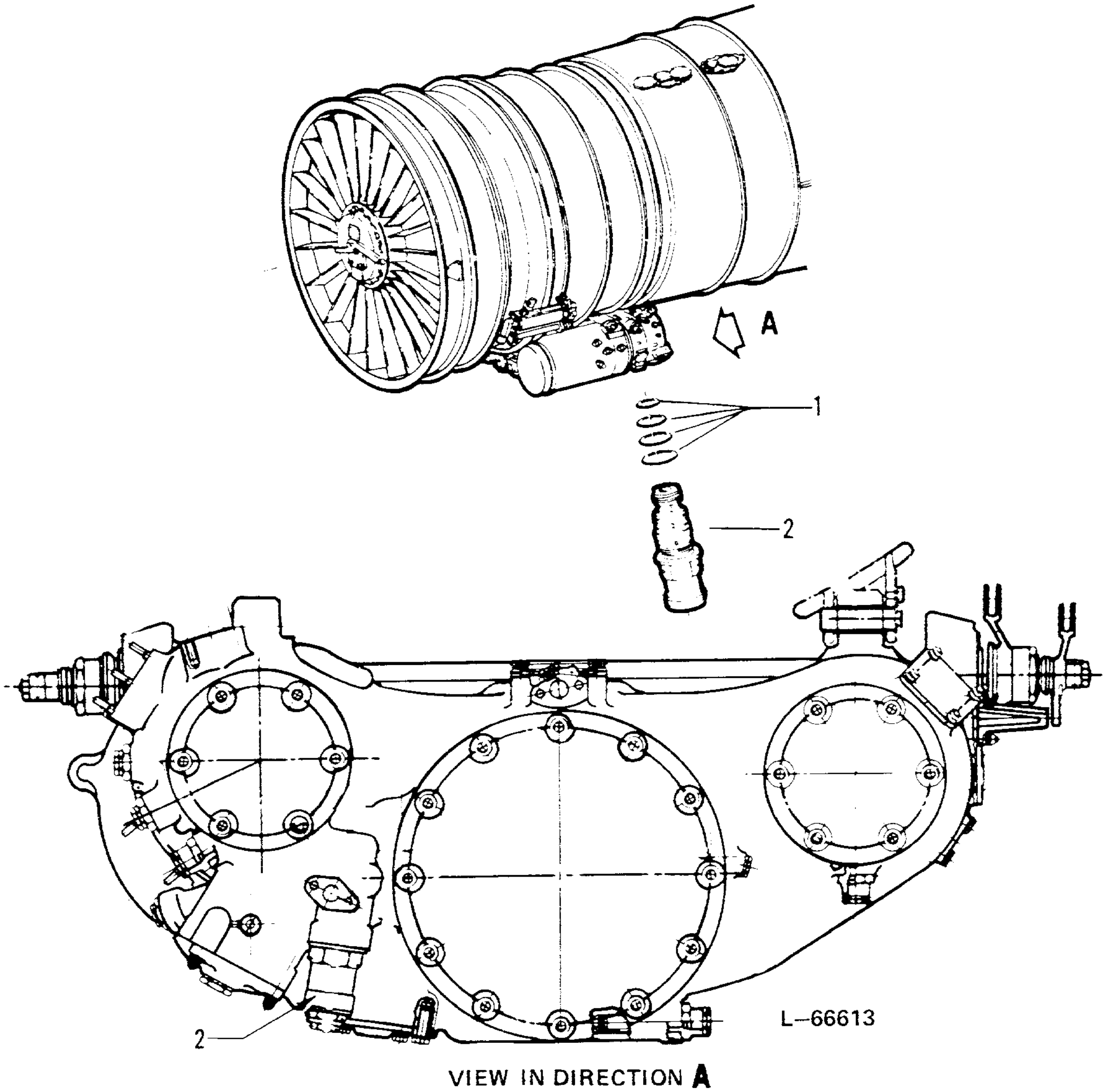
B. Procedure. (Figure 401).

(1) Install lubricated packing in each groove and next to flange at thread of pressure relief valve assembly.

(2) Install pressure relief valve assembly into relief valve port of gearbox and torque to 550 - 650 lb-in. (62.142 - 73.440 N·m). Lockwire valve housing to gearbox.

C. Postrequisites

(1) Close lower forward cowl door per COWL DOORS, SUBJECT 71-10-03, Page 201.



1. Packings
2. Oil Pressure Relief Valve

BBB2–72–280

Oil Pressure Relief Valve Replacement
Figure 401/72-61-51-990-801

OIL PRESSURE RELIEF VALVE ASSEMBLY - REPAIR-01

1. Repair Oil Pressure Relief Valve Assembly

A. Equipment And Materials

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Assembly Fluid (PWA 36500)

No. 400 Crocus Cloth

Petrolatum (PMC 9609)

Petroleum Solvent (PMC 9010)

B. Procedure

(1) Disassembly

(a) Remove hexhead plug, packing, and housing plug (with adjusting screw and locknut) from oil pressure relief valve housing.

(b) Remove helical retainer, string, and valve assembly from oil pressure relief valve housing.

(2) Cleaning

(a) If abnormally low oil pressure has occurred during engine operation, inspect component parts for obvious defects.

(b) Polish sliding surfaces of valve assembly and spring retainer with No. 400 Crocus Cloth soaked in oil.

(c) After polishing, clean thoroughly with petroleum solvent and check operation after installation.

(3) Oil Pressure Relief Valve - Strainer Replacement. (Figure 802)

(a) Remove pin and strainer from housing.

(b) Install new strainer into housing.

(c) Drill 0.060 - 0.062 inch (1.524 - 1.574 mm) diameter pin hole using existing hole in housing as guide.

(d) Install and stake pin as shown.

(4) Assembly. (Figure 801)

(a) Install valve assembly into housing, small end inboard.

(b) Position valve spring over OD of valve assembly.

(c) Install helical retainer into ID of valve assembly and over valve spring.

CAUTION: IF YOU APPLY PETROLATUM TO PACKINGS, USE ONLY A SMALL QUANTITY ON THE PACKINGS TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

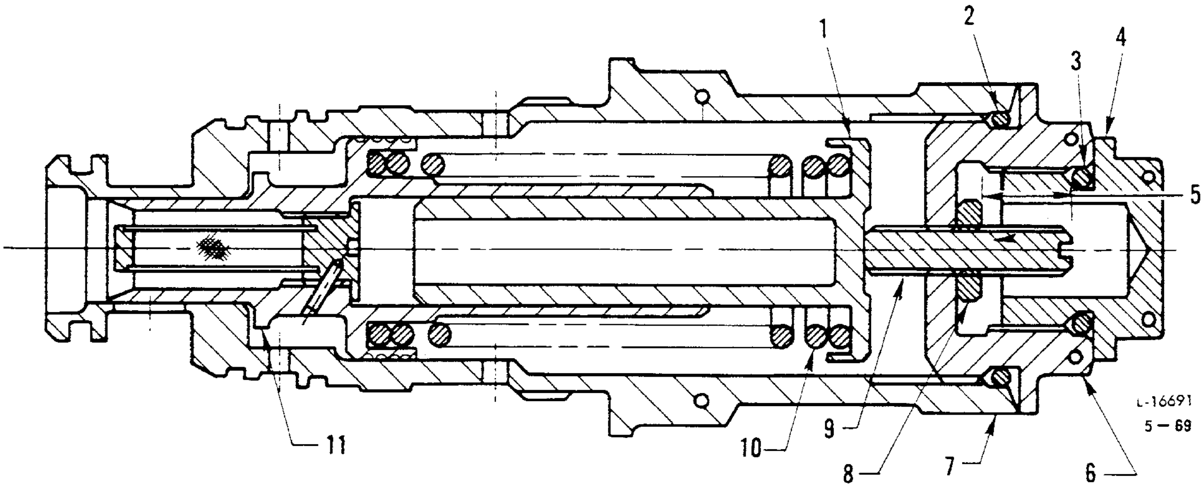
(d) Install a new preformed packing (lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum) next to the flange on the housing plug OD, then thread the plug into the valve housing. Tighten the plug and the lock-wire to valve housing.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid, but it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid #1 from Ultrachem Inc., Wilmington, DE 19899.

(e) Thread adjusting screw into housing plug with screw slot to outside of housing. Install jamnut on screw and adjust screw to initial setting as shown in figure, and tighten jamnut.

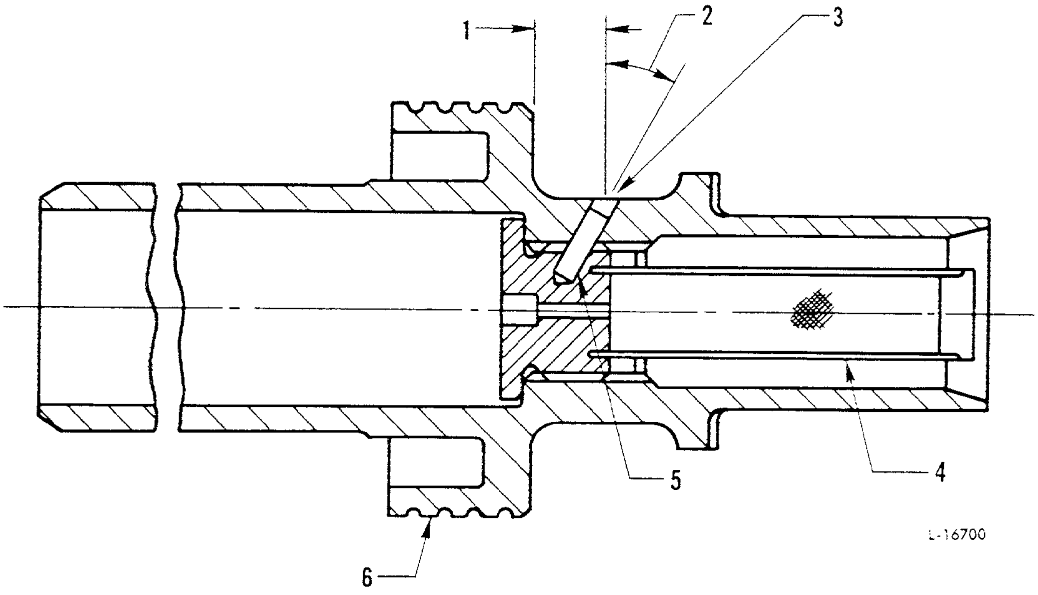
(f) Install a new preformed packing (lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum) next to the flange on the hexhead cover plug (Index 4 in figure). Thread the cover plug into the housing plug (Index 5 in figure) and torque the cover plug to 150 - 160 lb-in. (16-948 - 18.078 N·m). Lockwire the cover plug to the housing plug.



1. Helical Spring Retainer
2. Packing
3. Packing
4. Plug
5. 0.375 - 0.475 Inch (9.5 - 12.1 mm)
   (Initial Setting)
6. Plug
7. Housing
8. Nut
9. Adjusting Screw
10. Spring
11. Oil Pressure Relief Valve

BBB2-72-281

Oil Pressure Relief Valve Assembly
Figure 801/72-61-51-990-802



1. 0.210 Inch (5.334 mm)

2. 30 Degrees ± 2

3. 0.060 - 0.062 Inch (1.524 - 1.574 mm) Diameter To 0.240 - 0.260 Inch (6.10 - 6.60 mm) Depth Located Within 0.030 Inch (0.762 mm) Of True Position.

4. Strainer

5. Pin. Stake To Places Approximately 180 Degrees Apart.

6. Oil Pressure Relief Valve

BBB2-72-282

Oil Pressure Relief Valve Strainer Replacement
Figure 802/72-61-51-990-803

OIL FILTER PRESSURE RELIEF VALVE - REMOVAL/INSTALLATION-01

1. Oil Filter Pressure Relief Valve Removal

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

(2) Remove main oil filter element (15-micron type). (MAIN OIL FILTER - 15/70 MICRON - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-54/401)

B. Equipment And Materials Required

(1) Support Equipment

PWA 16477 Drift

PWA 33201 Base

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Depress key washer from slots in bypass valve and remove cover.

(2) Place element and bypass valve on PWA 33201 Base (bypass valve end up). Remove element from valve assembly using PWA 16477 Drift.

2. Oil Filter Pressure Relief Valve Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Assembly Fluid (PWA 36500)

Petrolatum (PMC 9609)

B. Procedure

(1) Install pressure relief valve over key washer. Ensure that tabs of key washer engage slots in pressure relief valve.

CAUTION: WHEN YOU APPLY PETROLATUM TO PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(2) Install a packing lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, in groove on the outside of the pressure relief valve.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

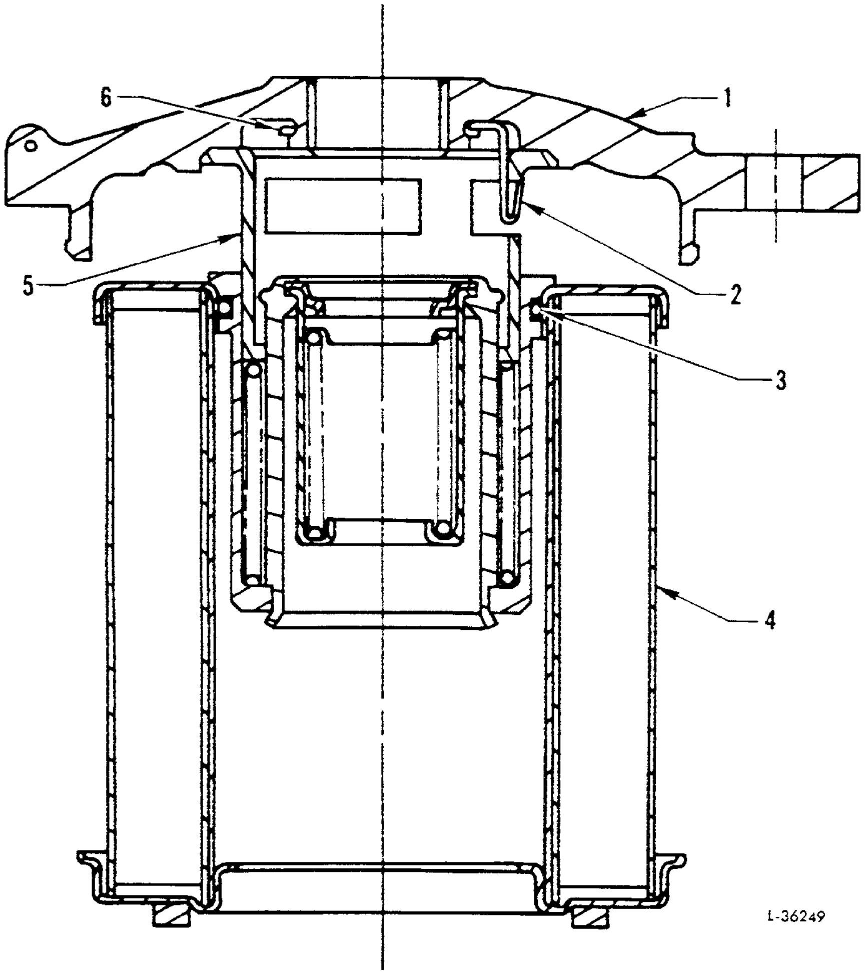
PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(3) Install strainer element in pressure relief valve with larger OD flange away from valve.

C. Postrequisites

(1) Install main oil filter element (15-micron type). (MAIN OIL FILTER - 15/70 MICRON - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-54/401)

(2) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)



1. Cover
2. Key Washer
3. Packing
4. Filter Element Assembly
5. Pressure Relief Valve
6. Retaining Ring

BBB2-72-283

Main Oil Strainer 15 Micron-Type
Figure 401/72-61-52-990-801

MAIN OIL FILTER - 15/70 MICRON - REMOVAL/INSTALLATION-01

1. Main Oil Filter Element (15/70 Micron) Removal

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

B. Equipment And Materials Required

(1) Support Equipment

PWA 16477 Drift

PWA 33201 Base

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Drain oil from gearbox.

(2) Remove locknuts and washers securing main oil strainer cover to main gearbox.

(3) Remove cover and oil filter pressure relief valve assembly and main oil filter element.

(4) Remove main oil filter element from oil filter pressure relief valve.

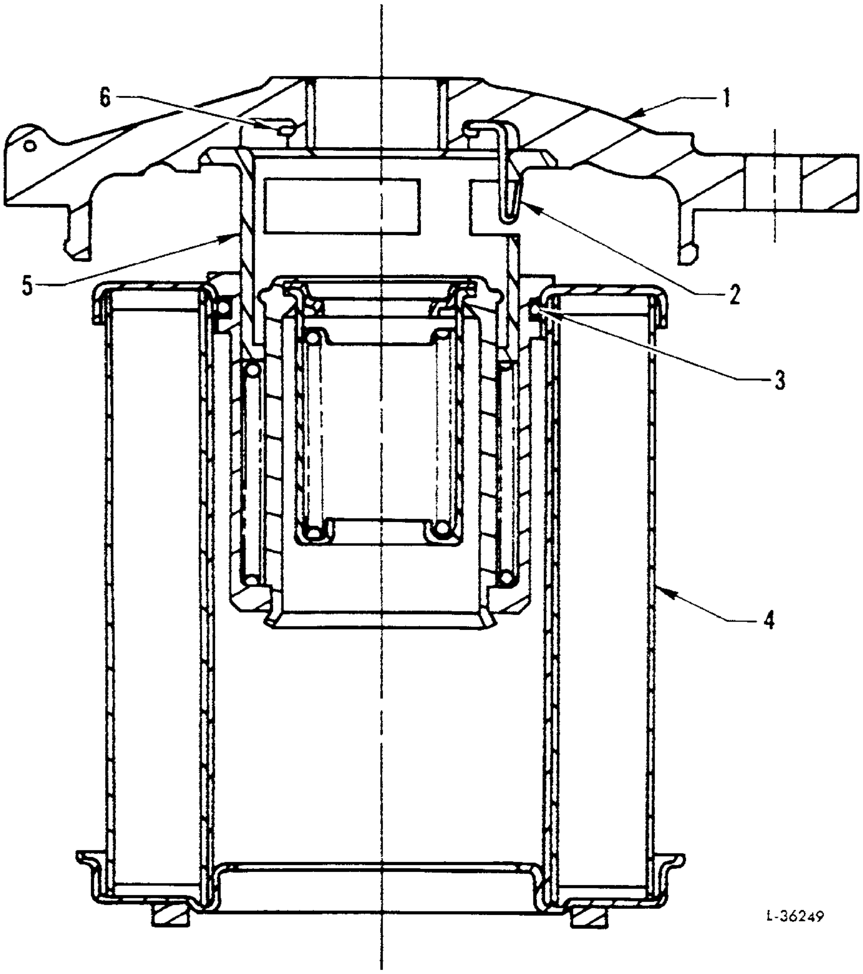
(5) If oil filter element is difficult to remove from pressure relief valve, separate filter element and valve as follows:

(a) Depress key washer from slots in relief valve and remove oil filter cover.

(b) Place filter element and relief valve on PWA 33201 Base (valve end up).

(c) Remove filter element from relief valve using PWA 16477 Drift.

(6) Remove packing from oil filter pressure relief valve OD and cover mount pad.



1. Cover
2. Key Washer
3. Packing
4. Filter Element Assembly
5. Pressure Relief Valve
6. Retaining Ring

BBB2-72-283

Main Oil Filter Element, Relief Valve, And Cover Assembly
Figure 401/72-61-54-990-801

2. Main Oil Filter Element (15/70 Micron) Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

B. Procedure. (Figure 401)

(1) Install a new packing (lubricated with a thin layer of PWA 36500 Assembly Fluid) on the oil filter pressure relief valve OD and cover mount pad.

(2) If it was necessary to remove oil filter pressure relief valve from cover in order to remove oil filter element, install relief valve on cover so that tabs of cover key washer engage slots in valve.

(3) Install new main oil filter element on oil pressure relief valve.

NOTE: Pre-SB 6209 the oil filter has a 15 micron nominal (30 micron absolute) rating. Post-SB 6209 the filter has a 40 micron nominal (70 micron absolute) rating. These procedures are applicable to either filter.

(4) Install main oil filter element, cover and oil pressure relief valve assembly on main gearbox.

(5) Secure cover assembly to gearbox with washers and locknuts. Torque locknuts to 25 - 30 lb.-in. (2.825 - 3.390 N·m) and lockwire.

(6) Refill oil system.

C. Postrequisites

(1) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

MAIN OIL FILTER - 40 MICRON - REMOVAL/INSTALLATION-01

1. Remove Main Oil Strainer Element (40 Micron)(Optional)

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03)

B. Equipment And Materials Required

(1) Support Equipment

PWA 10014 Wrench

PWA 14406 Fixture

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Drain oil from gearbox.

CAUTION: HOLD COVER TO PREVENT IT FROM FLYING OFF UNDER SPRING PRESSURE.

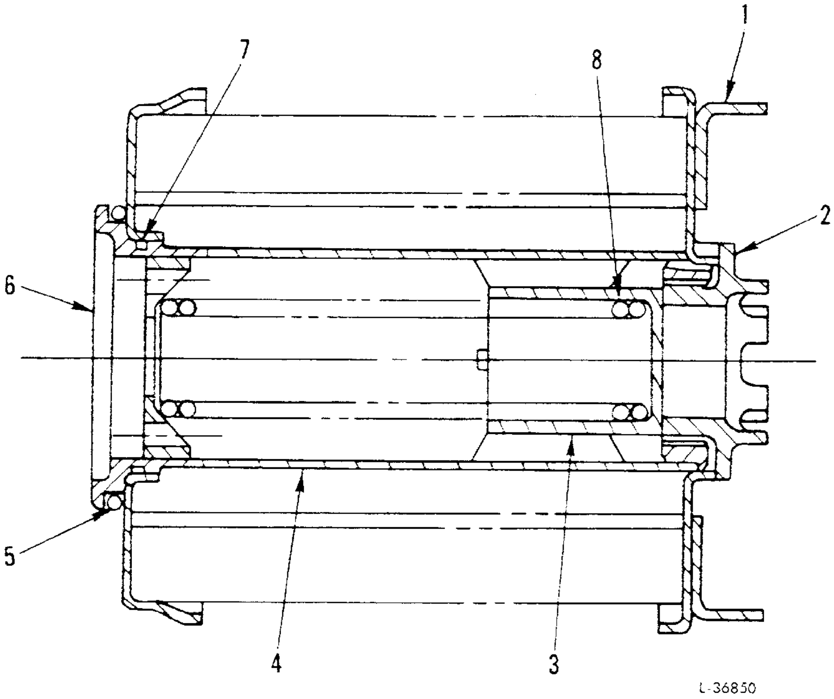
(2) Remove locknuts and washers securing main oil strainer cover to main gearbox.

(3) Remove cover and oil strainer and pressure relief valve assembly.

(4) Position oil strainer assembly in PWA 14406 Fixture and remove threaded ring using PWA 10014 Wrench.

(5) Lift out strainer element, bypass valve, and spring. Remove sleeve strainer element from fixture.

(6) Remove and discard packings.



1. Strainer Element
2. Threaded Ring (Element Retaining Nut)
3. Bypass Valve
4. Strainer Sleeve
5. Packing
6. Strainer Sleeve Element Assembly
7. Packing
8. Bypass Valve Spring

BBB2-72-284

Oil Strainer Element Replacement
Figure 401/72-61-55-990-801

2. Install Main Oil Strainer Element (40 Miron)(Optional)

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 10014 Wrench

PWA 14406 Fixture

(2) Consumables Assembly

Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

B. Procedure. (Figure 401)

CAUTION: IF PETROLATUM IS APPLIED TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Install new packings, lubricated with a thin layer of PWA 36500 Assembly Fluid, or petrolatum, on the sleeve strainer element.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid, but it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(2) Install sleeve strainer element in PWA 14406 Fixture.

(3) Install spring, bypass valve, and strainer element.

(4) Depress bypass valve and install threaded ring in sleeve.

(5) Using PWA 10014 Wrench, torque threaded ring to 40 - 50 lb-in. (4.519 - 5.649 N·m).

(6) Install strainer assembly in gearbox cavity and secure with cover and spring assembly.

(7) Install washers and locknuts and torque locknuts to 25 - 30 lb.-in. (2.825 - 3.390 N·m) and lockwire.

C. Postrequisites

(1) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03)

POWER LEVER CROSS SHAFTS - REMOVAL/INSTALLATION-01

1. Power Lever Cross Shafts Removal

A. Prerequisites

- (1) Access for removal of power lever cross shafts is through the lower forward cowl door.
- (2) For procedures to open cowl doors on all engines, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

B. Equipment And Materials Required

- (1) Support Equipment

  PWA 12153 Holder

  PWA 12154 Wrench

  PWA 12155 Holder

  PWA 12156 Wrench

- (2) Consumables

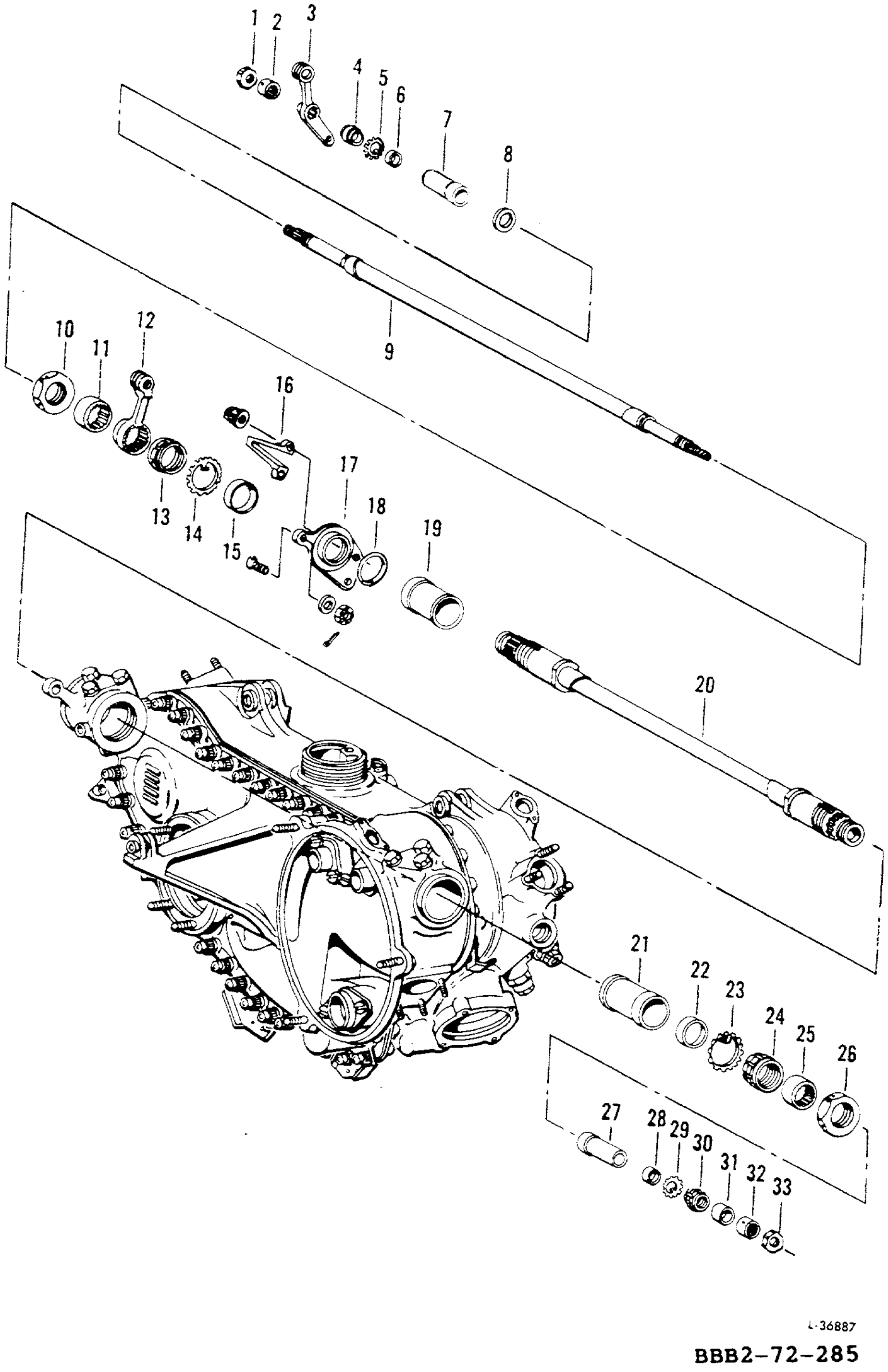
  None

C. Procedure. See Figure 401, Table 401.

- (1) Remove power lever cross shafts assembly as follows:
  - (a) Remove fuel control shutoff linkage arm and fuel control power linkage arm from power lever cross shafts.
  - (b) Unclinch tabwasher. Using PWA 12155 Holder, and PWA 12156 Wrench, remove bearing retaining nut from outer shaft at linkage arm side.
  - (c) Slide short sleeve spacer out. Pull power lever cross shafts assembly out from left hand side of gearbox cover.

    NOTE: If necessary, tap gently on inner cross shaft to aid in removal.
  - (d) Remove linkage arm stop and power lever shaft plate. Pull out bearing.
- (2) Disassemble power lever cross shafts assembly as follows:
  - (a) Secure outer power lever cross shaft in fixture or vise with lead lined jaws.
  - (b) Remove nut and spacer from outer shaft.
  - (c) Unclinch tabwasher. Using PWA 12156 Wrench, remove bearing retaining nut from outer shaft. Pull off tabwasher and spacer.
  - (d) Remove bearing from outer shaft.
  - (e) Using PWA 12153 Holder and standard wrench, remove nut and spacers from inner shaft.
  - (f) Unclinch tabwashers. Using holder and PWA 12154 Wrench, remove one of bearing retaining nuts, then pull out inner shaft from opposite end. Remove bearing from inside outer shaft.

    NOTE: If necessary, tap gently on inner shaft to aid removal.
  - (g) Using wrench and holder, remove bearing retaining nut. Remove bearing from inner shaft.



Power Lever Cross Shafts
Figure 401/72-61-58-990-801

2. Power Lever Cross Shafts Installation

A. Equipment And Materials Required

(1) Support Equipment

PWA 12153 Holder

PWA 12154 Wrench

PWA 12155 Holder

PWA 12156 Wrench

(2) Consumables

None

B. Procedure

(1) Assemble power lever cross shafts assembly as follows:

(a) Secure inner power cross shaft (9) in fixture or vise with lead lined jaws.

(b) Install bearing (27), with larger OD in, and seat.

(c) Position short sleeve spacer (28) over shaft. Position key washer (29) on shaft and thread nut (30) on hand-tight. Using PWA 12154 Wrench, torque to 100 lb-in. (11.298 N·m) then turn to next locking position. Bend key washer tab.

(d) Install spacer (31), spacer (32) and nut (33). Torque nut to 65 - 100 lb-in (7.3244 - 11.298 N·m) and lockwire. Remove shaft from vise.

(e) Secure outer power control shaft (20) in fixture or vise with lead lined jaws, long spline end in vise.

(f) Install assembled inner shaft into ID of outer shaft from short spline end.

(g) Install bearing (7), with larger OD in, and seat with draft.

(h) Position short sleeve spacer (6) over shaft. Place key washer (5) on shaft and thread nut (4) on handtight. Using PWA 12153 Holder and wrench, torque to 100 lb-in (11.298 N·m), then turn to next locking position.

(i) Install shim (or shims) (8) behind bearing as necessary to obtain shaft end play of 0.005 - 0.010 inch (0.13 - 0.25 mm). Use PN 596558 shim of sufficient classified thickness. Bend key washer tab.

(j) Install bearing (21), with OD groove in, and seat or smaller spline end of outer shaft.

(k) Position short sleeve spacer (22) over shaft. Place key washer (23) on shaft and thread nut (24) on handtight. Using PWA 12156 Wrench, tighten to 375 lb-in. (42.369 N·m), then turn to next locking position. Bend key washer tab.

(l) Install spacer (25) and nut (26) on shaft. Torque nut to 225 - 300 lb-in. (25.422 - 33.895 N·m) and lockwire. Remove shafts from vise.

(2) Install power lever cross shafts assembly as follows:

(a) Install bearing (19) into right hand side of gearbox cover.

(b) Insert longer spline end of assembled power lever cross shafts into left side of gearbox cover, carefully guiding it through bearing (19).

NOTE: Hold bearing to keep it from falling out.

(c) Install power lever shaft plate (17), over shaft, and fuel control linkage arm stop (16), secure with nuts. Install screw in remaining hole and secure with washer, nut, and cotter pin.

(d) Position short sleeve spacer (15) over shaft to seat against bearing. Place key washer (14) on shaft and thread nut (13) on hand tight. Using PWA 12155 Holder and PWA 12156 Wrench, torque to 375 lb-in. (42.369 N·m), then turn to next locking position.

(e) Select and install proper class shim (18) to obtain shaft end play of 0.003 - 0.010 inch (0.08 - 0.25 mm). Bend key washer tab.

(f) Install the fuel control power linkage arm (12) into the outer shaft, offset clevis toward the gearbox. Install spacer (11) and nut (10). Torque to 225 - 300 lb-in (25.422 - 33.895 N·m) and lockwire.

(g) Install the fuel control shut-off linkage arm (3) onto the inner shaft, offset clevis away from the gearbox. Install spacer (2) and nut (1). Torque to 65 - 100 lb-in. (7.344 - 11.298 N·m) and lockwire.

C. Postrequisites

(1) For procedures to close lower forward cowl door, refer to COWL DOORS, SUBJECT 71-10-03, Page 201.

Table 401 Key to Figure 401

Index No.	Nomenclature
1	Nut
2	Spacer
3	Arm - Fuel Control Shutoff
4	Nut
5	Key Washer
6	Spacer
7	Bearing
8	Shim
9	Shaft - Inner
10	Nut
11	Spacer
12	Arm - Fuel Control Power Linkage
13	Nut
14	Key Washer
15	Spacer
16	Stop
17	Plate
18	Shim
19	Bearing
20	Shaft - Outer
21	Bearing
22	Spacer
23	Key Washer

Table 401 Key to Figure 401 (Continued)

Index No.	Nomenclature
24	Nut
25	Spacer
26	Nut
27	Bearing
28	Spacer
29	Key Washer
30	Nut
31	Spacer
32	Spacer
33	Nut

ACCESSORY DRIVE FACE-TYPE OIL SEALS - REMOVAL/INSTALLATION

1. REMOVAL/INSTALLATION-01

2. Starter Drive Oil Seal Removal

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

B. Equipment And Materials Required

(1) Support Equipment

PWA 12034 Puller

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Remove drain plug and drain gearbox.

(2) Remove starter per PNEUMATIC STARTER, SUBJECT 80-10-01, Page 201, or drive pad cover, from gearbox.

(3) Remove retaining ring securing starter drive seal housing in gearbox.

(4) Using PWA 12034 Puller, remove seal housing.

3. Starter Drive Oil Seal Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

B. Procedure. (Figure 401)

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Install a new packing, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, in the OD groove of the seal housing. Install the seal housing into the starter drive opening in the gearbox.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(2) Secure housing with retaining ring.

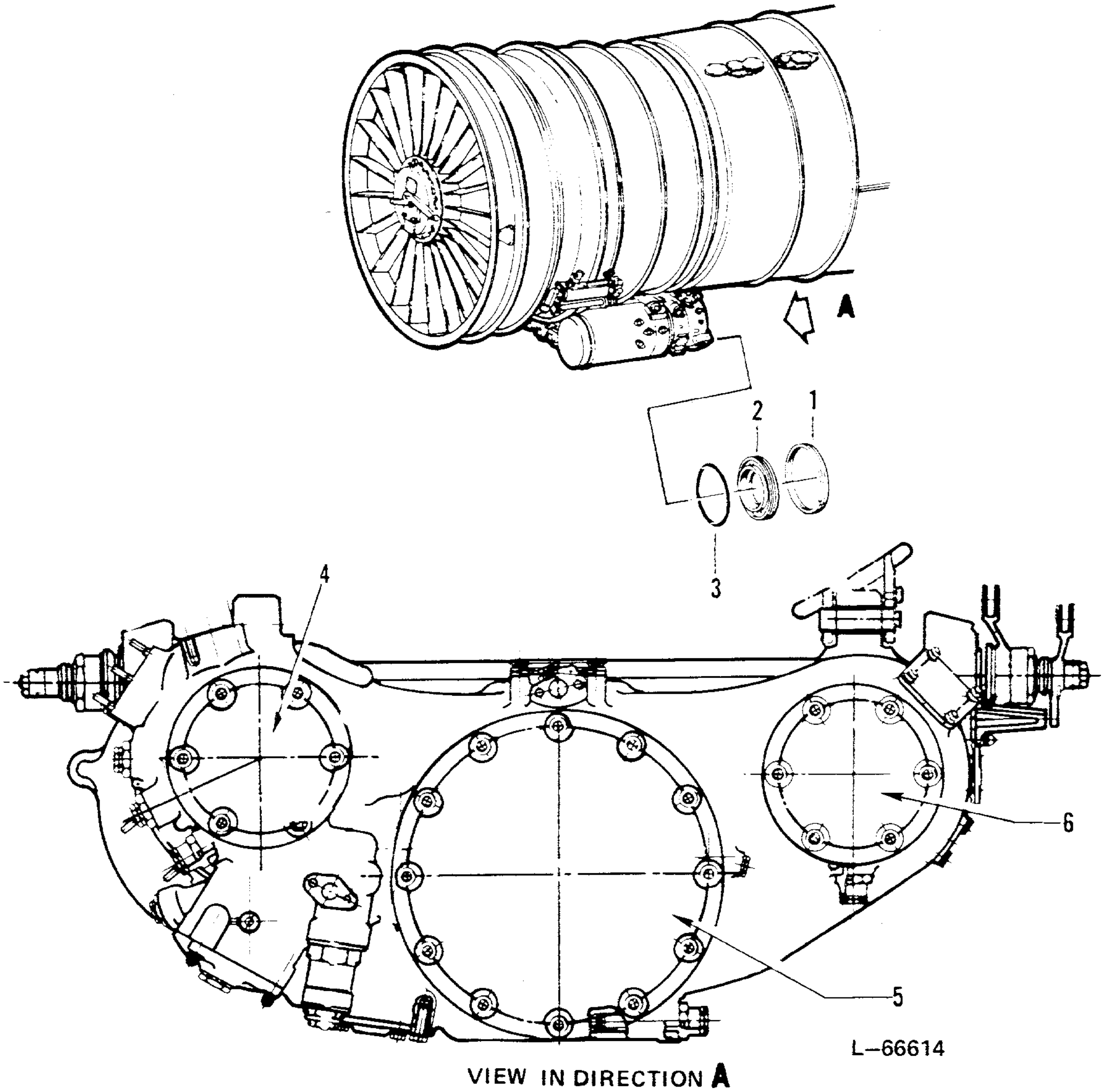
(3) Using new gasket install starter. (PNEUMATIC STARTER, SUBJECT 80-10-01, Page 201)

(4) Install drain plug with new seal into gearbox. Torque and lockwire.

(5) Refill oil system to correct level.

C. Postrequisites

(1) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)



1. Retaining Ring
2. Seal And Seal Housing Assembly
3. Packing
4. Starter Drive Pad (Reference)
5. CSD Pad (Reference)
6. Hydraulic Pump Drive Pad (Reference)

BBB2-72-286

Starter Drive Oil Seal
Figure 401/72-61-59-990-801

4. REMOVAL/INSTALLATION-02

5. Hydraulic Pump Drive Oil Seal Removal

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

B. Equipment And Materials Required

(1) Support Equipment

PWA 12034 Puller

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Remove drain plug and drain gearbox.

(2) Remove hydraulic pump per ENGINE-DRIVEN HYDRAULIC PUMP, SUBJECT 29-10-05, or pump pad cover, from gearbox.

(3) Remove retaining ring securing hydraulic pump drive seal housing in gearbox.

(4) Using PWA 12034 Puller, remove seal housing.

6. Hydraulic Pump Oil Seal Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

B. Procedure. (Figure 401)

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Install a new packing, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, in the OD groove of the seal housing. Install the seal housing into the starter drive opening in the gearbox.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(2) Secure housing with retaining ring.

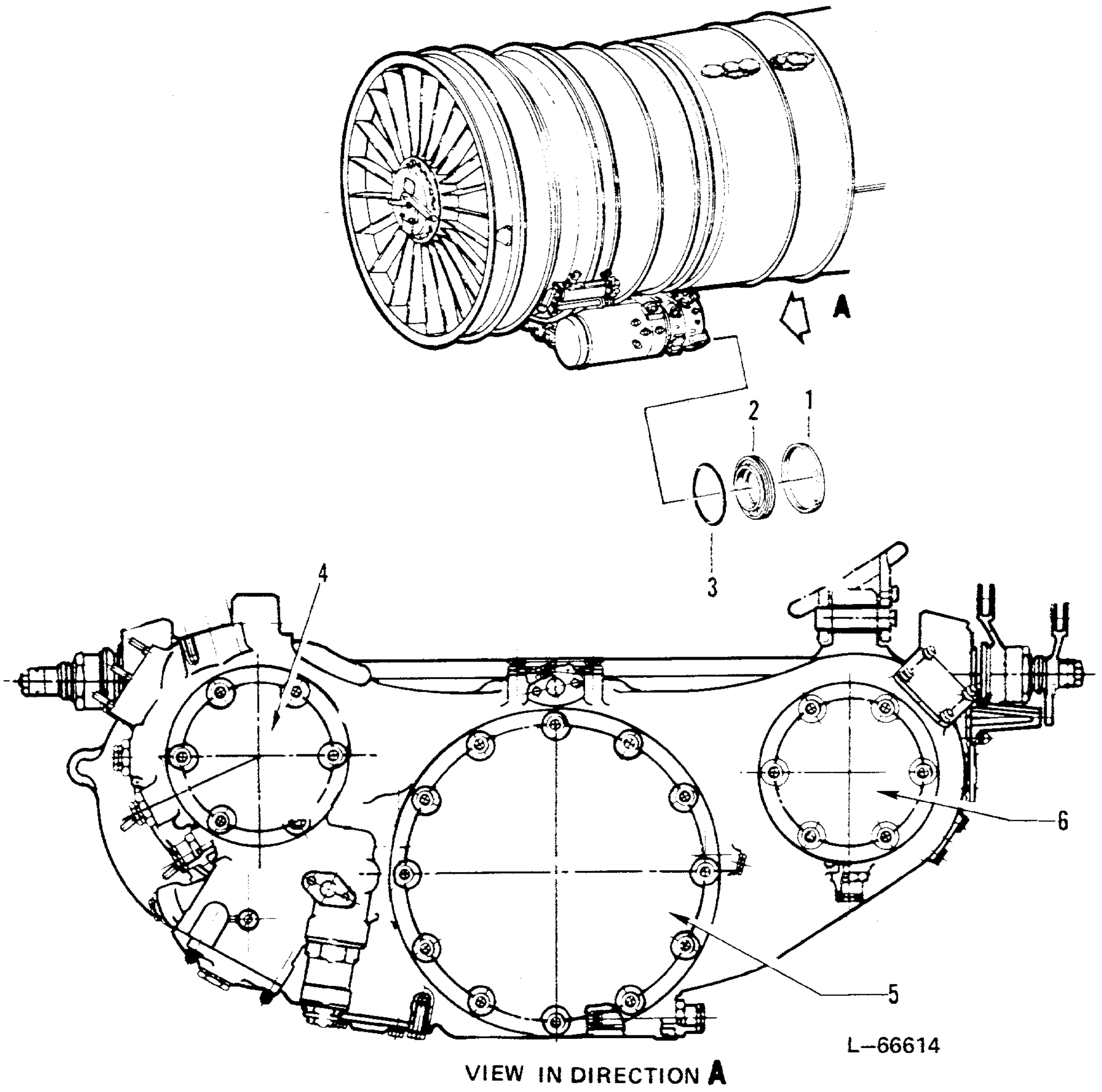
(3) Using new gasket install hydraulic pump per ENGINE-DRIVEN HYDRAULIC PUMP, SUBJECT 29-10-05 (or pad cover).

(4) Install drain plug with new seal into gearbox. Torque and lockwire.

(5) Refill oil system to correct level.

C. Postrequisites

(1) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)



1. Retaining Ring
2. Seal And Seal Housing Assembly
3. Packing
4. Starter Drive Pad (Reference)
5. CSD Pad (Reference)
6. Hydraulic Pump Drive Pad (Reference)

BBB2-72-286

Hydraulic Pump Drive Oil Seal Replacement
Figure 402/72-61-59-990-803

7. REMOVAL/INSTALLATION-03

8. CSD Oil Seal Removal

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

B. Equipment And Materials Required

(1) Support Equipment

PWA 12034 Puller

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Remove CSD from gearbox.

(2) Remove drain plug and drain gearbox.

(3) Remove retaining ring securing seal housing in gearbox.

(4) Using PWA 12034 Puller, remove seal housing from gearbox.

9. CSD Oil Seal Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

B. Procedure. (Figure 401)

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Install a new packing, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, in the OD groove of the seal housing and install the seal housing into the CSD opening in the gearbox. Secure the housing with a retaining ring.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

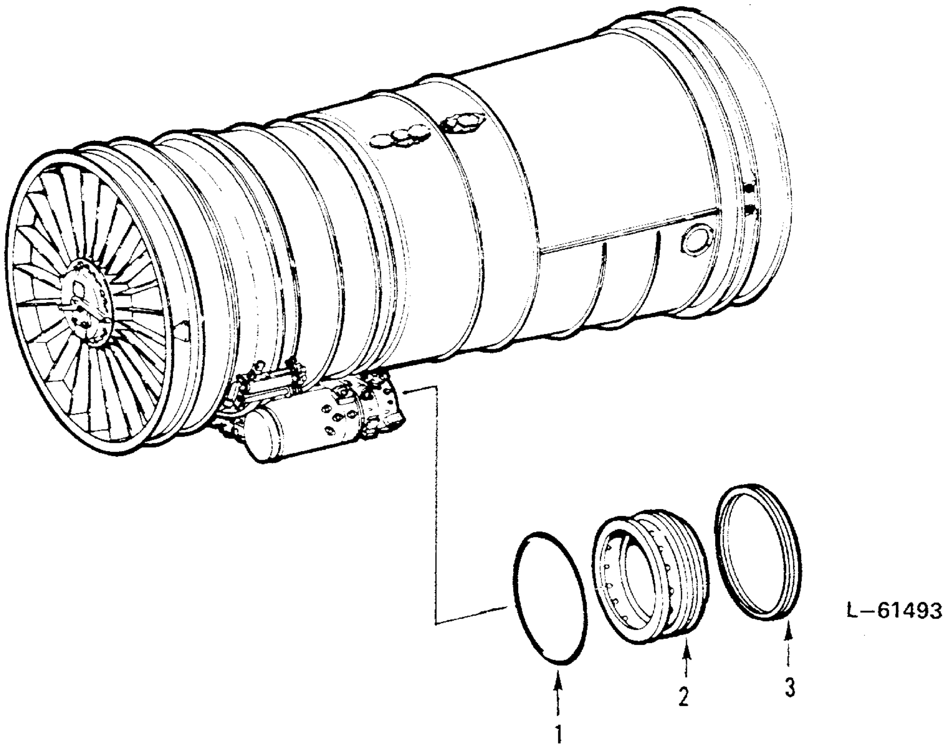
(2) Using new gasket install CSD and secure.

(3) Install drain plug with new seal into gearbox. Torque and lockwire.

(4) Refill oil system to correct level.

C. Postrequisites

(1) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)



1. Packing
2. Gearshaft Seal And Housing Assembly
3. Seal Housing Retaining Ring

BBB2-72-287

CSD Oil Seal Replacement
Figure 403/72-61-59-990-804

10. REMOVAL/INSTALLATION-04

11. Fuel Pump Drive Oil Seal Removal

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

(2) Remove fuel pump and fuel control package. (FUEL PUMP, SUBJECT 73-12-01, Page 201)

B. Equipment And Materials Required

(1) Support Equipment

PWA 12033 Puller

(2) Consumables

None

C. Procedure. (Figure 401)

(1) Remove drain plug and drain gearbox.

(2) Remove retaining ring securing seal housing, then, using PWA 12033 Puller, remove seal housing from gearbox.

12. Fuel Pump Drive Oil Seal Installation

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

B. Procedure. (Figure 401)

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(1) Install a new packing, lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum, in the OD groove of the seal housing and install the seal housing into the CSD opening in the gearbox. Secure the housing with a retaining ring.

NOTE: It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultrachem Inc., Wilmington, DE 19899.

(2) Secure housing with retaining ring.

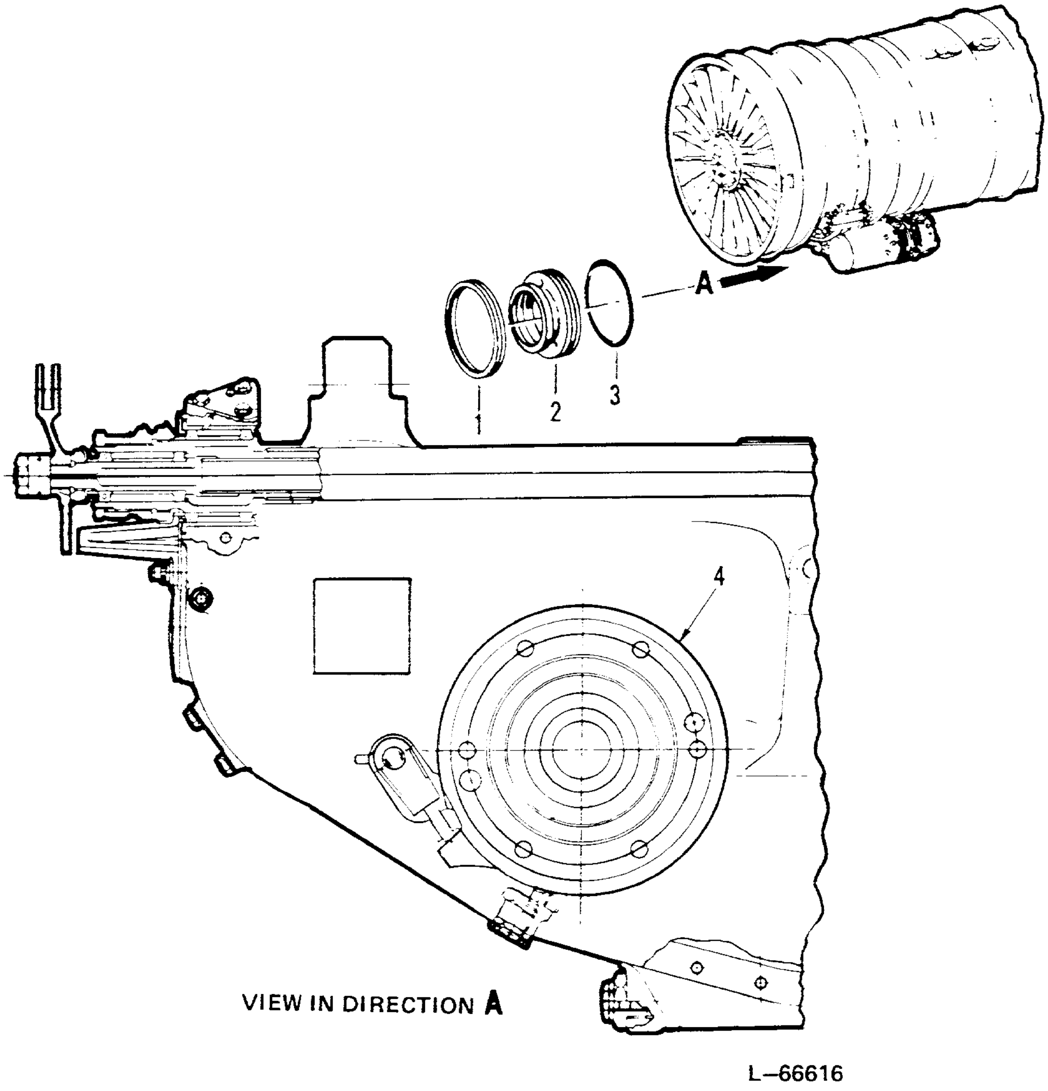
(3) Install drain plug with new seal into gearbox. Torque and lockwire.

(4) Refill oil system to correct level.

C. Postrequisites

(1) Install fuel pump and fuel control package. (FUEL PUMP, SUBJECT 73-12-01, Page 201)

(2) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)



1. Retaining Ring
2. Seal And Seal Housing Assembly
3. Packing
4. Fuel Pump Drive Pad (Reference)

BBB2-72-288

Fuel Pump Drive Oil Seal Replacement
Figure 404/72-61-59-990-805

13. REMOVAL/INSTALLATION-05

14. Gearbox Deoiler Seal Removal (Engines Post - SB 4539)

NOTE: A gearbox post-SB 4539 has an external access plug on the front face of the gearbox where the oil tank is installed. There is a bolted plate behind the plug which is possible to see through the breather passage. Replacement of the deoiler seal is possible after removal of the access plug and the bolted plate. If there is no access plug and bolted plate, the gearbox is pre-SB 4539, and replacement of the deoiler seal is not possible without gearbox disassembly.

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

(2) Remove the engine oil tank. (OIL TANK - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-65/401)

B. Equipment And Materials Required

(1) Support Equipment

PWA 12034 Puller/Pusher

PWA 33308 Puller (Early Assemblies)

PWA 46103 Puller (Current Assemblies)

(2) Consumables

None

C. Procedure

(1) Remove the retaining ring which attaches the plug in the gearbox cover.

(2) With PWA 3572 Puller/Pusher, remove the plug.

(3) Remove the two screws or three bolts that hold the retaining plate and remove the plate.

(4) Remove the deoiler seal as follows:

NOTE: For demountable carbon seals (ACCESSORY DRIVE FACE-TYPE OIL SEALS -REPAIR-01, PAGEBLOCK 72-61-59/801)

(a) If the plate removed in Paragraph 14.C.(3) has three holes, use PWA 46103 Puller and do Paragraph 14.C.(4)(c) thru Paragraph 14.C.(4)(g).

(b) If the plate removed in Paragraph 14.C.(3) has two holes, use PWA 33308 Puller and do Paragraph 14.C.(4)(c) thru Paragraph 14.C.(4)(g).

(c) Remove the large hex nut, washer, and bung from the holder assembly.

(d) Loosen the expander rod nut to retract the segments of the puller.

(e) Position the puller on the seal through the gearbox cover and expand the segments with the expander rod and nut to make the segments engage the steel lip of the seal.

(f) Install the bung (small OD in) over the holder assembly so that it enters the gearbox cover busing, and install the washer and nut.

(g) Tighten the larger nut to remove the seal.

15. Gearbox Deoiler Seal Installation (Engines Post - SB 4539)

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

PWA 3572 Puller/Pusher

PWA 33307 Drift

(2) Consumables

Assembly Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

B. Procedure. (Figure 401)

CAUTION: BE CAREFUL NOT TO COCK THE SEAL DURING INSTALLATION AND KEEP ANY SUDDEN, HARD IMPACT TO A MINIMUM TO PREVENT SEAL DAMAGE.

(1) Position the replacement seal on PWA 33307 Drift so that the carbon element faces inward when installed. Install the seal through the gearbox cover access port and drift it into position as shown in Figure 401.

NOTE: Before installing the carbon seal in any gearbox location, work the seal thoroughly in engine oil to make sure of free movement of the carbon element. The seal ring must have free axial movement so that it is not found to bind, through its full travel in the seal carrier after it is in engine oil, immediately before installation in the gearbox assembly.

(2) Install the retaining plate over the seal and attach it with two screws or three bolts. If two screws are used, safety the screws with lockwire.

(3) Install a packing, lubricated with PWA 36500 Assembly Fluid or petrolatum, in the OD groove of the access port plug.

NOTE: PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid No. 1 from Ultracmen Inc., Wilmington, DE 19899.

(4) Install the plug in the access port busing of the gearbox cover with PWA 3572 Puller/Pusher.

(5) Lock the plug with the retaining ring (tapered side out).

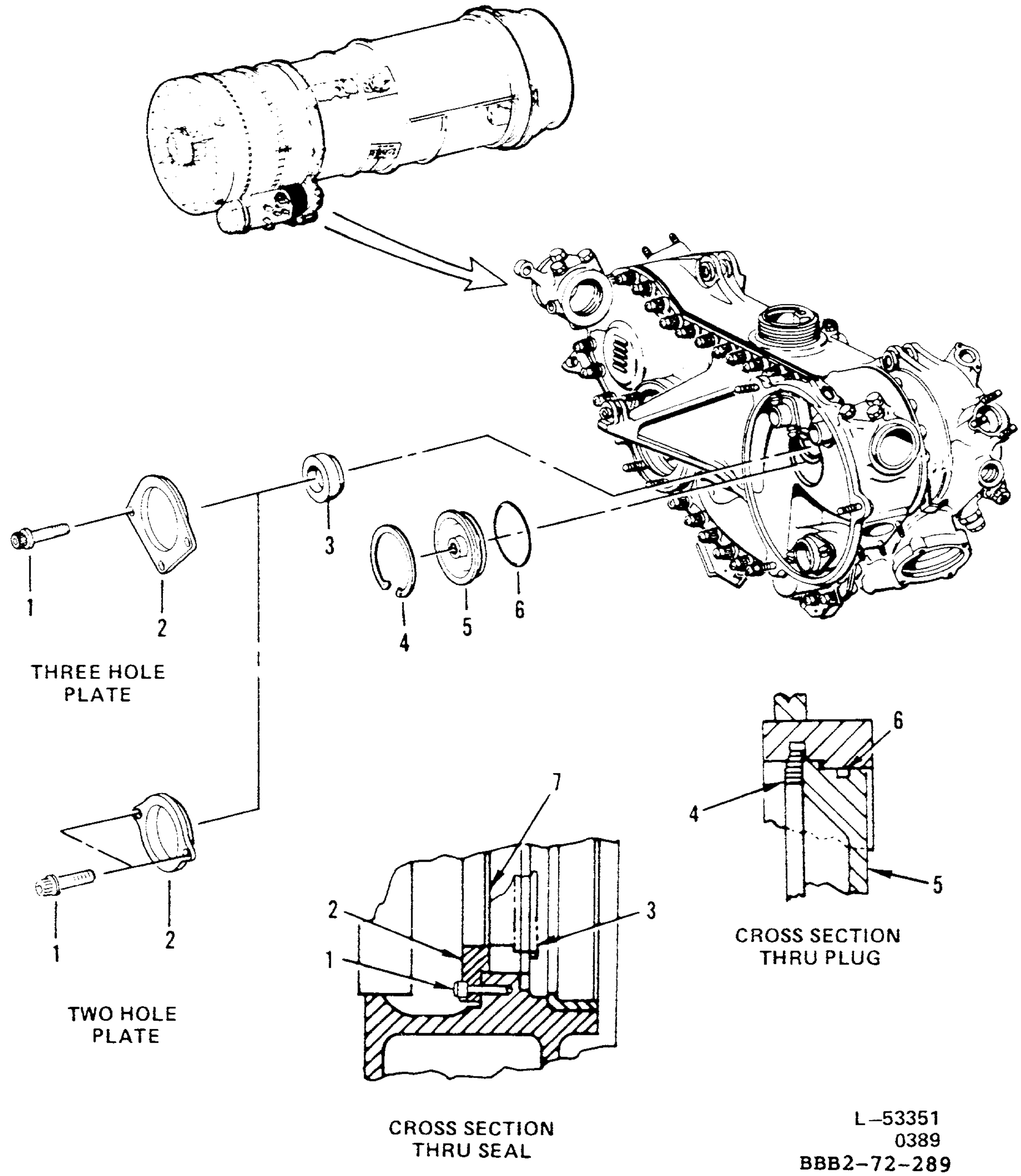
C. Postrequisites

(1) Install the engine oil tank. (OIL TANK - REMOVAL/INSTALLATION-01, PAGEBLOCK 72-61-65/401)

(2) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

Table 401

Index No.	Nomenclature
1	Screw (Two Required) Or Bolt (Three Required)
2	Retaining Plate (Two Or Three Hole)
3	Deoiler Seal
4	Snapring
5	Plum
6	Preformed Packing
7	The Seal Must Bottom On This Surface (Inner Face of Index 2 Plate).



Gearbox Deoiler Seal Replacement (SB 4539)
Figure 405/72-61-59-990-806

ACCESSORY DRIVE FACE-TYPE OIL SEALS - CLEANING-01

1. Clean Accessory Drive Face-Type Oil Seals

A. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

Engine Oil (PWA 521)

B. Procedure

CAUTION: DO NOT WASH SEALS WITH ANY TYPE OF CARBON SOLVENT. USE OF CARBON SOLVENT CAN REMOVE IMPREGNATING AGENT AND CAUSE SUBSEQUENT ABNORMAL WEAR OF CARBON ELEMENT.

(1) Seals which appear dirty should be cleaned by washing them with clean engine oil (never degreasing fluid) which is blown off with light blasts of air. Never wipe the seals with a cloth.

(2) Each seal should be individually boxed, with a cardboard collar around the carbon portion of the seal.

(3) Do not remove the seals from their boxes until they are ready to be used.

(4) Seals once removed from their protective covering must not be handled so that there is any possibility of damage to their carbon faces. Seals should never be stacked.

(5) Seals must not be exposed to foreign material such as grit, dirt, or lint.

NOTE: The above recommendations apply also to those engine parts which are to contact carbon faces of seals.

ACCESSORY DRIVE FACE-TYPE OIL SEALS -REPAIR-01

1. Repair Accessory Drive Face-Type Oil Seals

A. Equipment And Materials Required

NOTE: Some materials in the Equipment and Materials list may not be permitted to be used in your location. Persons in each location must make sure they are permitted to use these materials. All persons must obey all applicable federal, state, local, and provincial regulations for their location.

(1) Support Equipment

None

(2) Consumables Assembly

Fluid (PWA 36500)

Engine Oil (PWA 521)

Petrolatum (PMC 9609)

Petroleum Solvent (PMC 9001) or Trichlorethylene (PMC 9004)

B. Procedure. See (Figure 801), Table 801.

(1) Disassemble seals by removing retaining ring and pulling carbon element, preformed packing, washer, and wave washer from seal housing.

NOTE: To prevent damage to carbon seal element, depress element with fingers while disengaging retaining ring.

CAUTION: IN FOLLOWING CLEANING PROCEDURE DO NOT SCRAPE INSIDE OF SEAL HOUSING WITH ANY SHARP INSTRUMENT: HOUSING IS COATED WITH FLUOROCARBON PLASTIC WHICH WILL BE DAMAGED BY SCRAPING.

(2) Clean seal housing thoroughly in petroleum solvent or trichlorethylene. Clean other seal details by washing in clean engine oil. (See Cleaning.)

CAUTION: IF YOU APPLY PETROLATUM TO THE PACKING, USE ONLY A SMALL QUANTITY ON THE PACKING TO PREVENT POSSIBLE CONTAMINATION OF THE OIL SYSTEM.

(3) Assemble the wave washer, new preformed packing (lubricated with a thin layer of PWA 36500 Assembly Fluid or petrolatum) and carbon element inside the seal housing and secure with the retaining ring. Ensure that the retaining ring (or snapring, as applicable) is fully engaged in the seal housing.

Table 801 Key to Figure 801

Index No.	Nomenclature
1	Retaining Ring
2	Carbon Seal Element
3	Preformed Packing
4	Washer
5	Wave Washer
6	Seal Housing

Table 801 Key to Figure 801 (Continued)

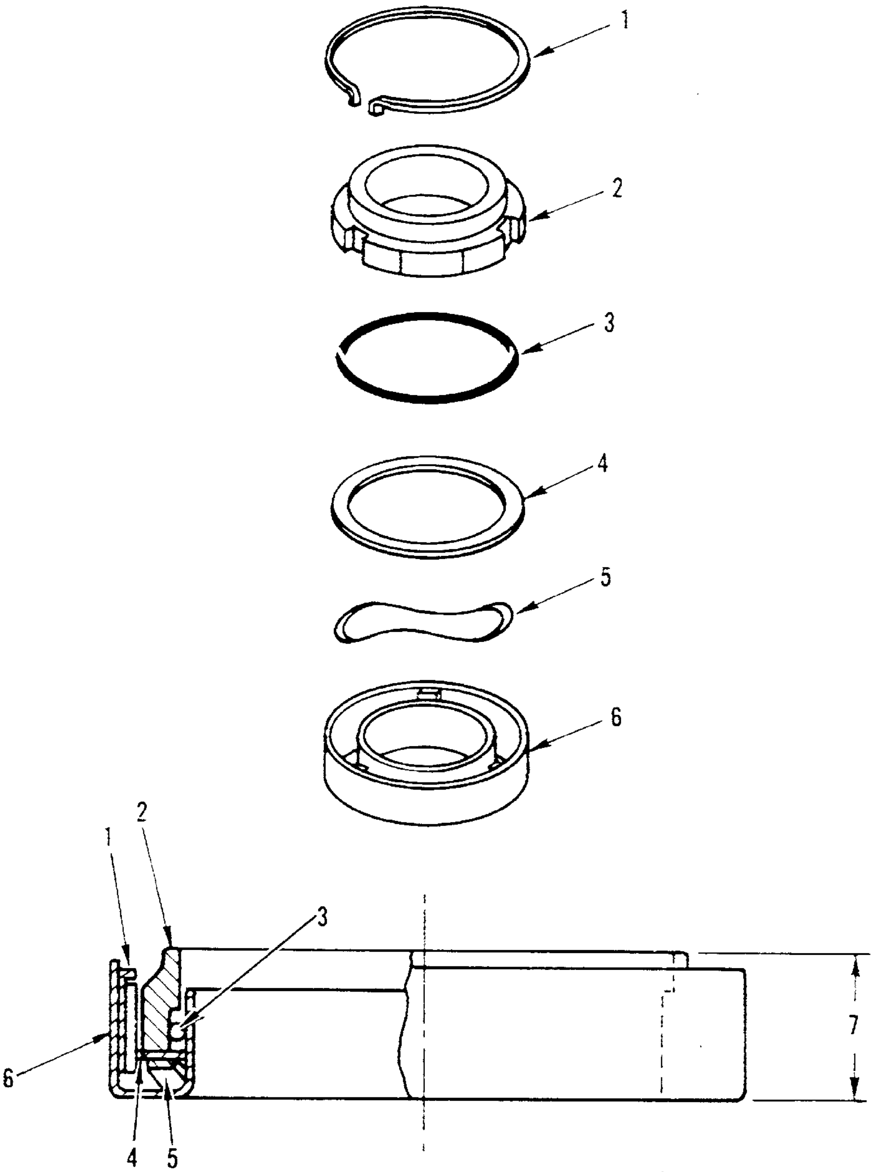
Index No.	Nomenclature
7	Fuel Pump Drive Spur Gearshaft Seal (PN 749842, 749843, 773980, 803646, 803647) 0.730 Inch (18.542 mm) Minimum. Hydraulic Pump Drive Gearshaft Seal And Starter Drive Gearshaft Seal (PN 749838, 749839, 767919, 773982, 773983, 803687, 803688) 0.725 Inch (18.415 mm) Minimum. Impeller Seal (PN 749832, 749833, 773979, 774337, 803643, 803644) 8.670 Inch (17.018 mm) Minimum. Accessory And Component Drive Spur Gearshaft Seal (PN 749835, 749836, 773984, 803690, 803691) 0.725 Inch (18.415 mm) Minimum.

NOTE: Seal details (wave washer, washer, carbon element, and retaining ring) are interchangeable only between seals of identical part number.

Seal option number (e.g. PN 749834IC) will encompass several part numbers, for which details are not interchangeable. Detail parts of seal assemblies are color-coded to prevent improper parts mixing.

It is optional to use petrolatum as a replacement for PWA 36500 Assembly Fluid. But it is better to use the assembly fluid. Use petrolatum only if assembly fluid becomes unavailable.

PWA 36500 Assembly Fluid is available as Ultrachem Assembly Fluid #1 from Ultrachem Inc., Wilmington, DE 19899.



Accessory Drive Seal Assembly
Figure 801/72-61-59-990-802

FUEL CONTROL LINKAGE - REMOVAL/INSTALLATION-01

1. Remove Fuel Control Linkage

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

B. Equipment And Materials Required

(1) Support Equipment

None

(2) Consumables

None

C. Procedure. See Figure 401, Table 401.

(1) Remove cotter pins, bolts, nuts and washers which secure linkages to gearbox cross shaft shutoff arm and power arm.

(2) Remove cotter pins, bolts, nuts and washers which secure linkages to fuel control levers and remove linkages from engine.

2. Install Fuel Control Linkage

A. Equipment And Materials Required

(1) Support Equipment

PWA 12882 Pin - Index

PWA 12884 Pin - Alignment

PWA 45238 Locator, Power Lever

PWA 45239 Locator, Shutoff Lever

(2) Consumables

None

B. Procedure. See Figure 401, Table 401, Figure 402, Figure 403.

NOTE: See Figure 402 for appearance of each link in properly installed position.

(1) Power Lever Linkage Adjustment And Installation

(a) Position PWA 45238 Locator on engine with thumbscrews facing outward, inserting rearward pointer in pilot hole of gearbox cross shaft and forward pointer in pilot hole of fuel control actuation shaft.

(b) Fit locator pins into power lever arms at cross shaft and fuel control shaft. Tighten thumbscrews to lock locator in set position.

(c) Try PWA 12882 Index Pin in idle index positioning slot on fuel control. If pin does not fit, remove fuel control and reset indexing.

(d) Remove locator from engine and place on workbench, pins facing up. Position power lever linkage assembly over locator pins and adjust length of linkage arm as necessary using clevis and jamnut. Secure jamnut fingertight.

(e) Install linkage on fuel control levers per Paragraph 2.B.(3). Torque and lockwire jamnut.

(2) Fuel Shutoff Lever Linkage Adjustment And Installation

(a) Position PWA 45239 Locator on engine with thumbscrews facing outward, inserting rearward locating pin in pilot hole of gearbox cross shaft and forward locating pin in pilot hole of fuel control actuation shaft. Tighten thumbscrews to lock locator in set position.

(b) Remove locator from engine and place on workbench, pins facing up. Position fuel shutoff linkage over locator pins and adjust length of linkage arm as necessary using clevis and jamnut. Secure jamnut fingertight.

(c) Install linkage assembly on engine per Paragraph 2.B.(3).

(d) Check alignment (after installing connecting linkage) per Figure 402 and Paragraph 2.B.(4) below. Torque and lockwire jamnut.

(3) Installation

(a) Position connecting links and secure to fuel control levers using bolts, washers, nuts and cotter pins.

(b) Secure links to gearbox cross-shaft shutoff arm and power arm using bolts, washers, nuts and cotter pins.

(4) Fuel Shutoff Linkage Final Alignment Check

(a) Check alignment (after installing connecting linkage) per the following:

1) Insert 0.015 inch (0.381 mm) thick gage between fuel control shutoff lever and its stop when lever is rotated counterclockwise and insert PWA 12884 Alignment Pin through hole at end of cross-shaft shutoff lever and into holes of gearbox-mounted bracket.

2) If necessary, loosen nuts that hold bracket to gearbox and move bracket within clearance of stud holes.

3) If pin will not fit into bracket, then Paragraph 2.B.(2), Paragraph 2.B.(2)(a) through Paragraph 2.B.(2)(c) must be repeated.

(5) Check fit of power lever and fuel shutoff links in relation to gearbox cross shaft and fuel control levers as follows (Figure 403, Figure 404):

(a) Insert 0.006 inch (0.152 mm) shims at locations marked A in figure.

(b) Gap at fuel control lever end, marked B in figure, shall be 0.040 inch (1.016 mm).

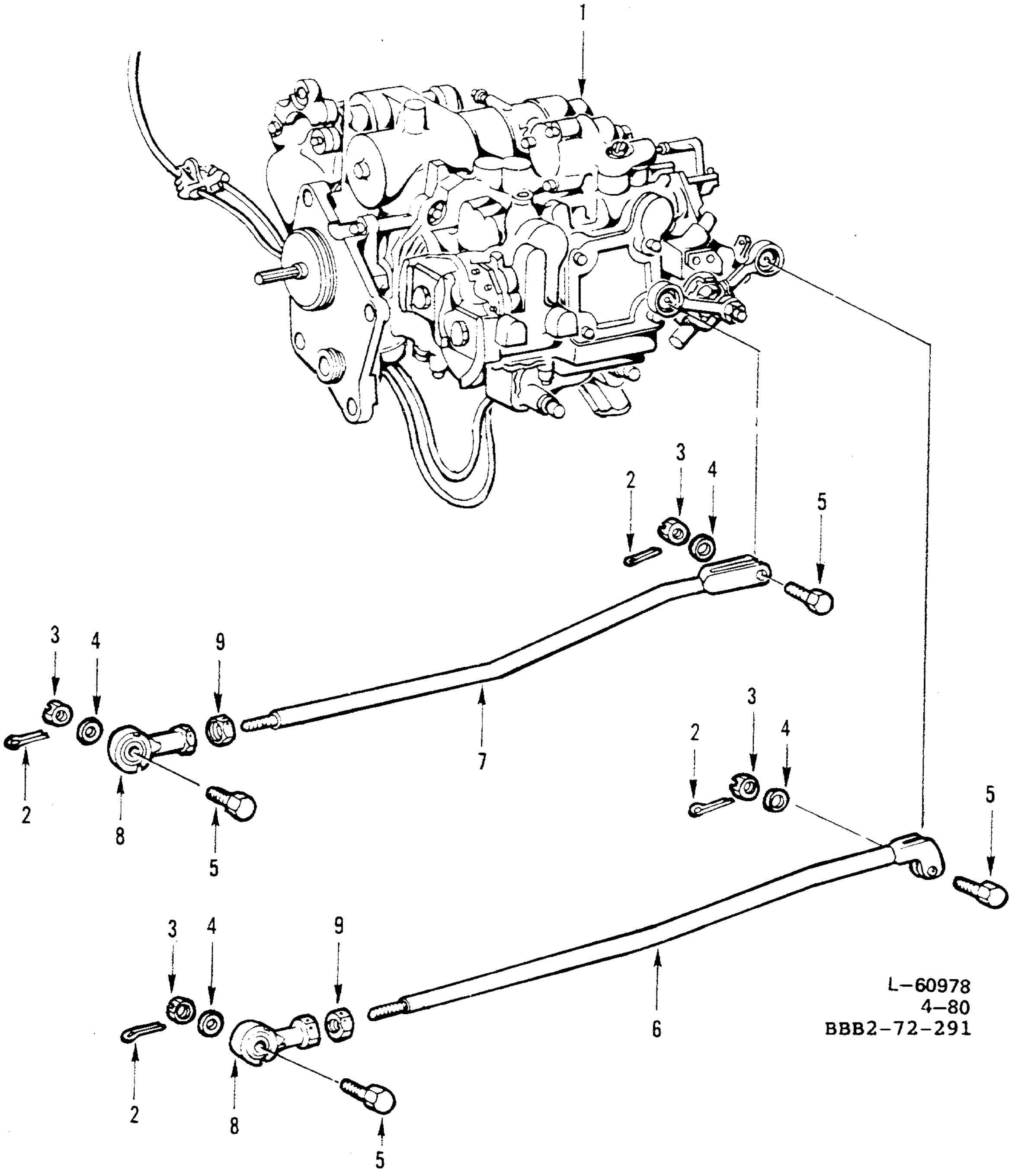
NOTE: At both Locations A and B in figure, maintain gaps on both sides simultaneously, and after both ends of levers are installed on engine, for full travel of linkage.

C. Postrequisites

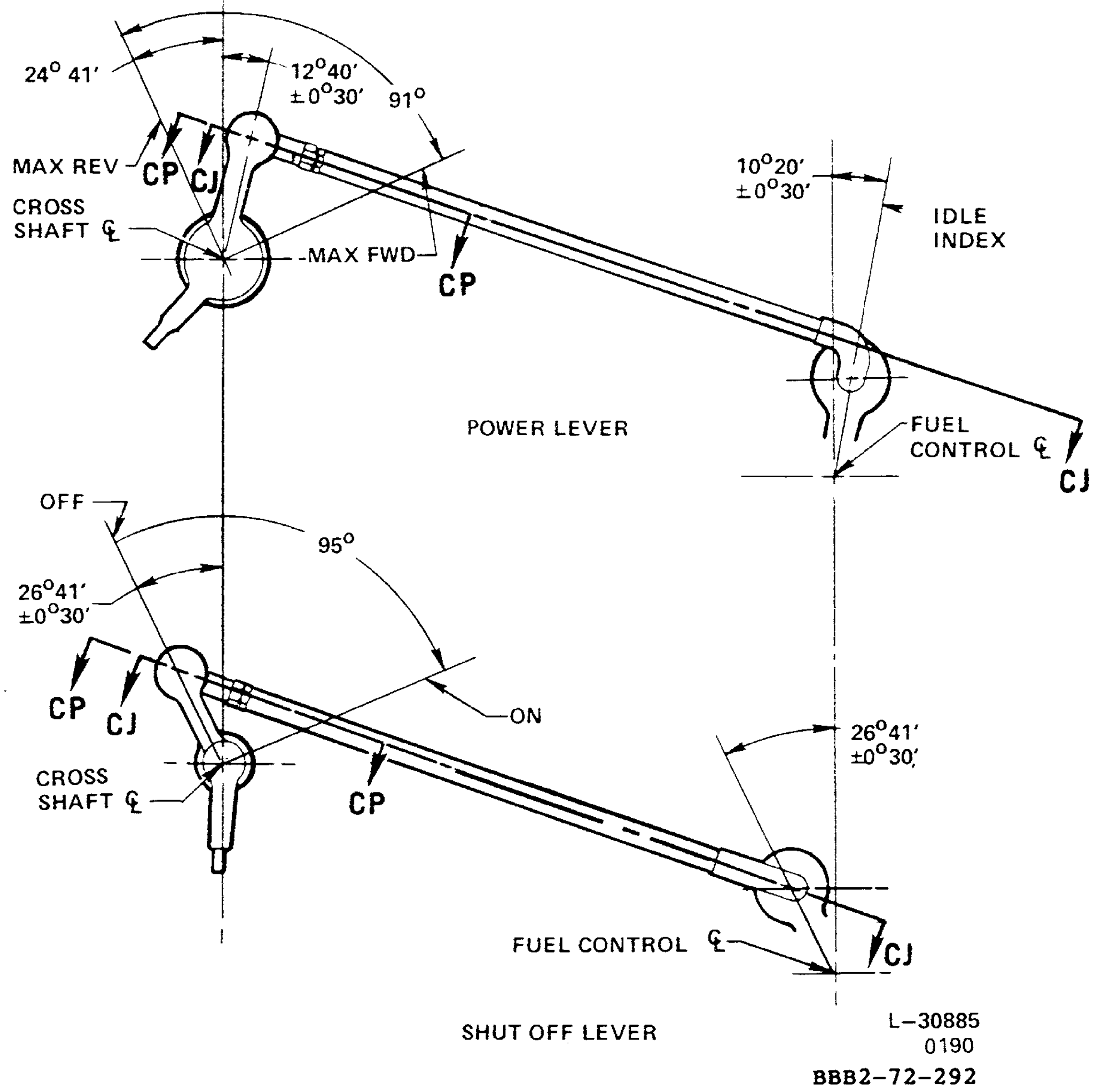
(1) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201).

Table 401 Key to Figure 401

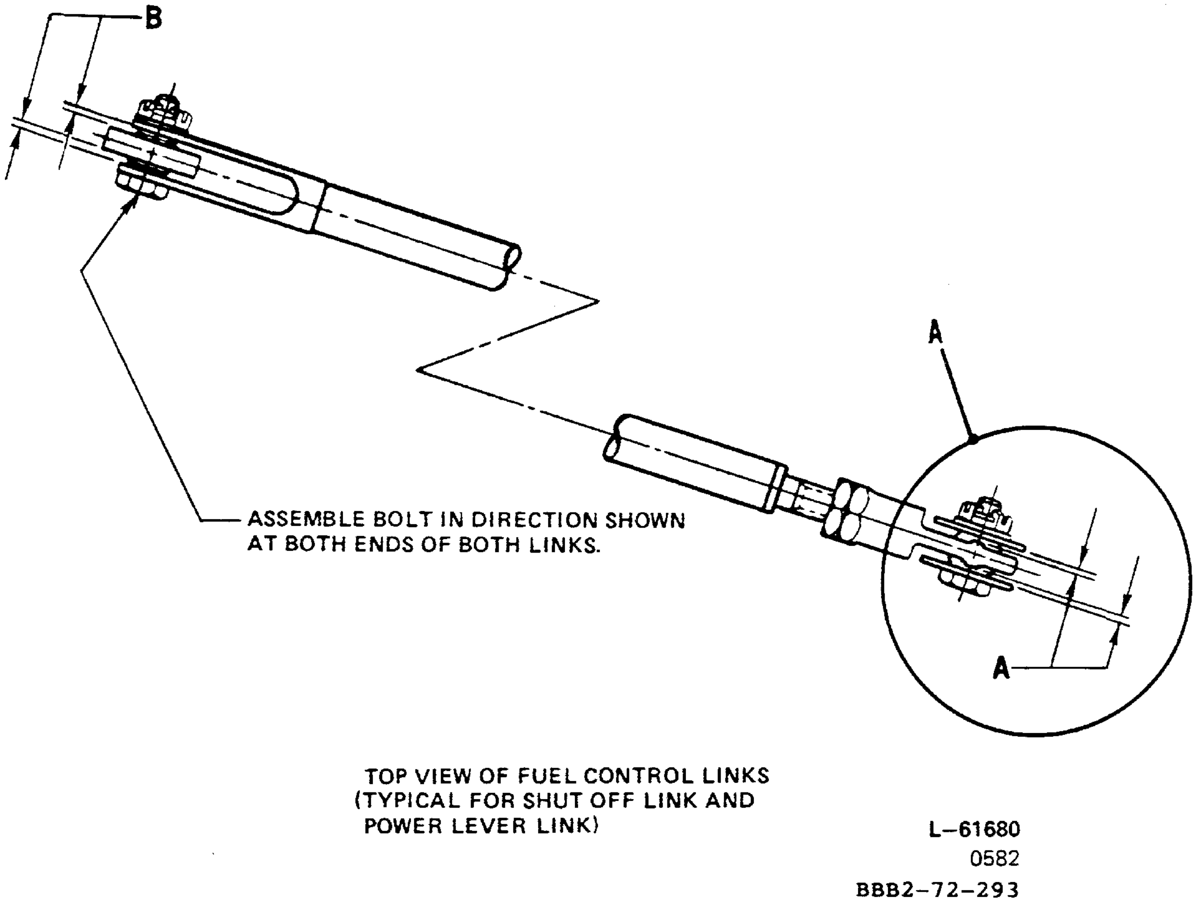
Index No.	Nomenclature
1	Fuel Control (Reference)
2	Cotter Pin
3	Hex Nut
4	Washer
5	Bolt
6	Power Lever Connecting Link
7	Fuel Shutoff Connecting Link
8	Bearing
9	Hex Nut



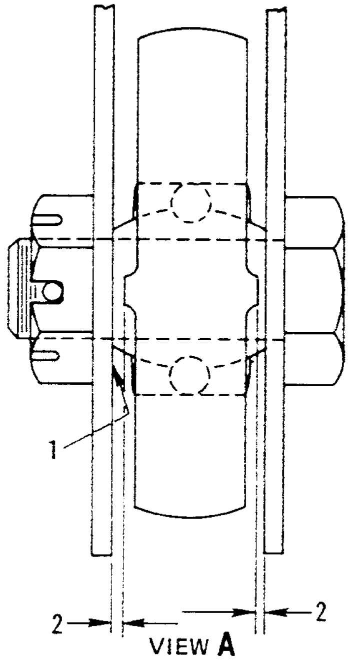
Fuel Control Linkage Removal/Installation
Figure 401/72-61-60-990-804



Fuel Control Linkage Position Check
Figure 402/72-61-60-990-801



Fuel Control Linkage End Gap Measurement
Figure 403/72-61-60-990-802



VIEW A
FUEL CONTROL LINKS
(TYPICAL POWER LINK AND SHUTOFF LINK)
L-78270

1. Nut Torque Should Provide Firm Contact Between Linkage Arm And Rod End "Uniball", Both Sides.
2. 0.006 Inch (0.152 mm) Minimum Gap Between "Bumper" And Linkage Arm, Both Sides Simultaneously.

BBB2-72-294

Fuel Control Linkage Position Check
Figure 404/72-61-60-990-803

FUEL PUMP REAR COUPLING - REMOVAL/INSTALLATION

1. General

A. This maintenance practice provides removal/installation instruction for the fuel pump rear coupling.

B. Access to the fuel pump is through the forward lower cowling.

2. Equipment and Material

NOTE: Equivalent substitutes may be used instead of the following listed items.

Table 401

Name and Number	Manufacturer
PWA 14152 drift	

3. Removal/Installation Fuel Pump Rear Coupling-01

A. Remove Fuel Pump Rear Coupling

CAUTION: BE CAREFUL DURING LOCK REMOVAL NOT TO CAUSE DAMAGE TO THE FUEL PUMP REAR COUPLING OR TO THE FUEL PUMP DRIVE PAD OF THE GEAR BOX.

(1) Use a small prybar to remove the six locks (2) that safety the six bolts (3) that attach the fuel pump rear coupling (1) to the gearbox. Discard the locks (2). (Figure 401)

(2) Remove the six bolts (3) that attach the coupling (1) to the gearbox fuel pump pad and remove the coupling (1) from the gearbox.

(3) If necessary remove the bracket adjacent to the fuel pump drive pad.

B. Install Fuel Pump Rear Coupling

(1) Install the fuel pump rear coupling (1) against the gearbox fuel pump pad. Align the six boltholes in the coupling (1) with the boltholes in the fuel pump pad. (Figure 401)

(2) Install six bolts (3) to attach the coupling (1) to the gearbox fuel pump pad and torque the bolts (3) to recommended torque. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)

(3) Install the six locks (2) to safety the six bolts (3) as follows:

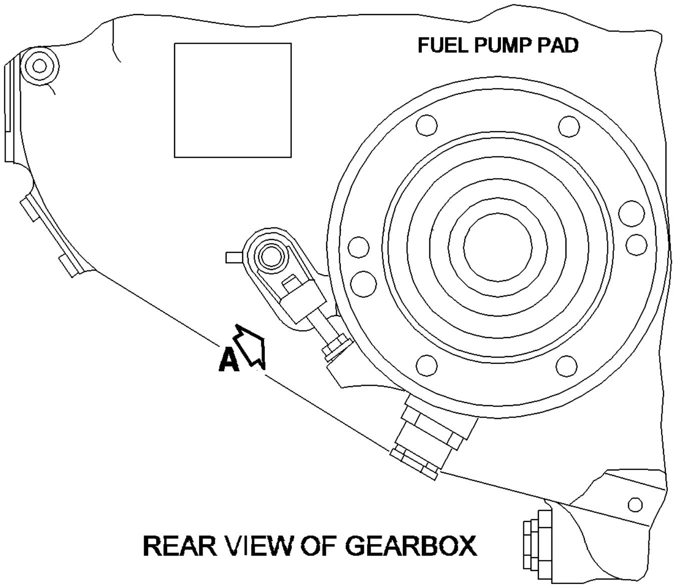
(a) Put a lock (2) on the first of the bolts (3).

(b) Put drift (PWA 14152) on the head of the bolt (3) and hit it with a fiber mallet to push the lock (2) down around the points of the bolthead (3).

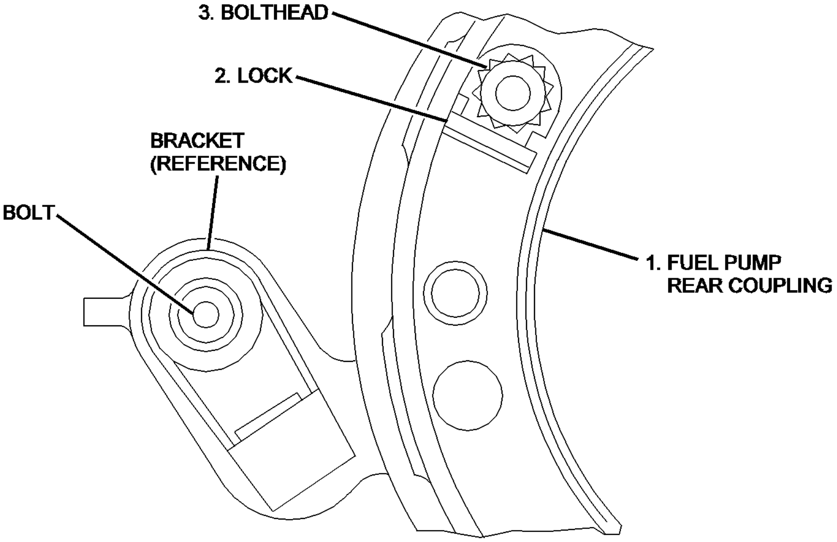
NOTE: When the lock (2) is pushed fully down onto the bolthead (3), the spring tension of the lock (2) will hold it against the face of the coupling (1). Keep the edge of the lock (2) against the wall of the coupling (1). (Figure 401)

(c) Install locks (2) on the remaining bolts (3) with the same procedure.

(4) If the bracket adjacent to the fuel pump drive pad was removed, install bracket and attach with a bolt, torque to the recommended torque. (STANDARD PRACTICES - ENGINE - MAINTENANCE PRACTICES, PAGEBLOCK 70-00-00/201)



REAR VIEW OF GEARBOX



VIEW A

Fuel Pump Rear Coupling - Removal/Installation
Figure 401/72-61-62-990-801

OIL TANK DESCRIPTION

1. Description

The engine is provided with a cylindrical-shaped oil tank which mounts on the left front face of the gearbox and is secured at the front with a strap. The oil tank is provided with a self-locking cap and a dip stick gage, connected to the cap. The sump cavity is provided with a drain connection for attaching a drain line overboard. The tank is equipped with a filler strainer and, in the bottom, an outlet strainer.

The tank is constructed of stainless steel. This material is capable of withstanding, without permanent deformation, the stresses imposed by pressure, vibration, and shock loads such as may occur during landing, rough flight conditions, etc. A baffle serves to minimize sloshing of the oil in the tank.

This oil tank when installed in a normal position on an unrotated engine holds a total of 5.0 U.S. gallons (4.16 Imperial gallons or 18.93 liters), and the usable quantity of oil is about 4.0 U.S. gallons (3.33 Imperial gallons of 15.14 liters). The oil deaerator is an integral part of the oil tank.

The oil tank is provided with three indicator bosses. One, a quantity indicator, is located at the bottom of the tank. The other two bosses, one a minimum level indicator and the other a full level indicator, are located on the outer wall of the tank.

Short, straight oil and breather transfer tubes with packings accommodate the oil flow between the tank and the gearbox.

OIL TANK - REMOVAL/INSTALLATION-01

1. Remove Oil Tank

A. Prerequisites

(1) Open lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

B. Equipment And Materials Required

Support Equipment

None

Consumables

C. Procedure. (Figure 401)

(1) Drain oil from tank prior to removal of opening drain valve on bottom of tank.

(2) Remove locknuts holding tank to gearbox.

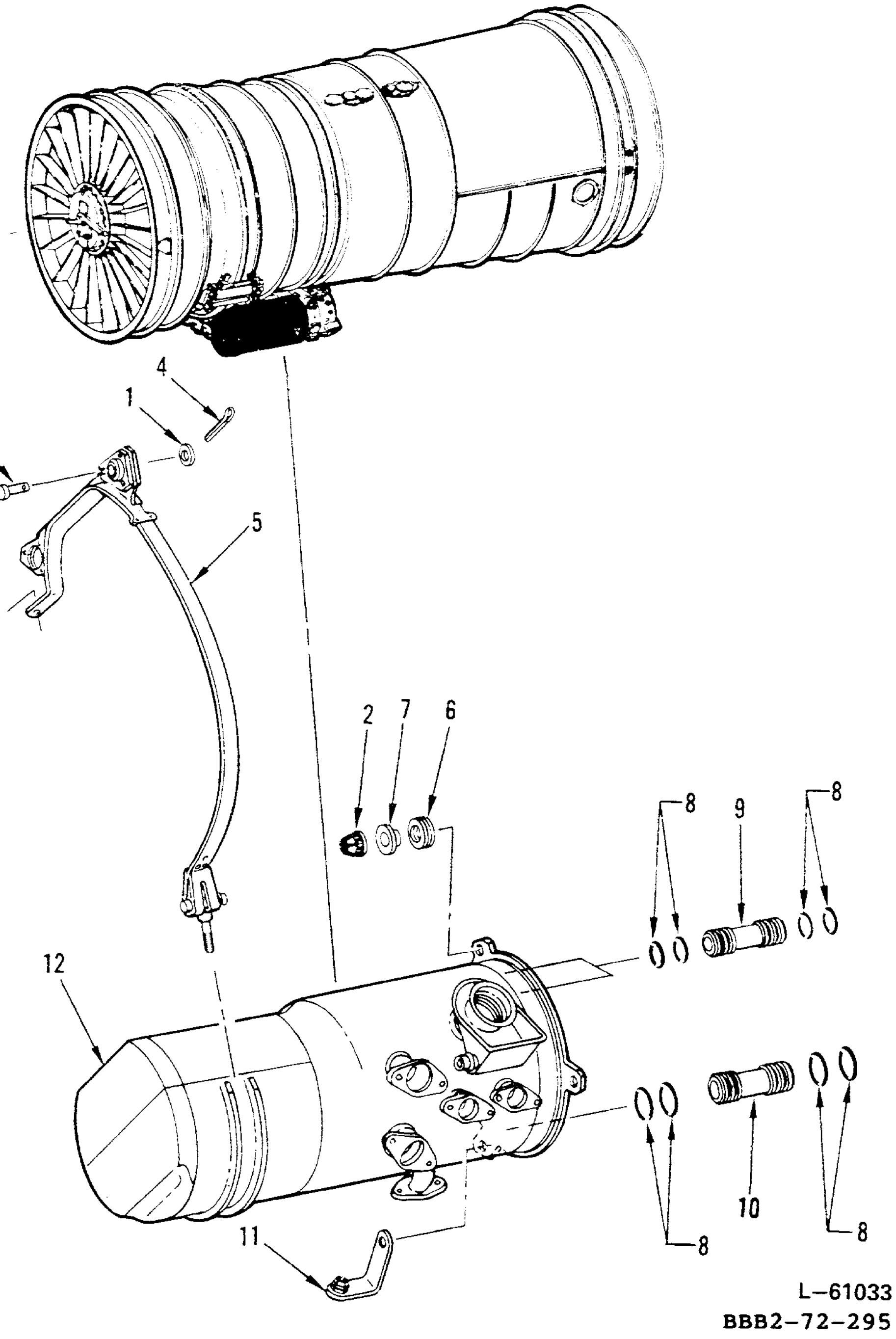
(3) While supporting tank, remove locknut from tank strap turnbuckle and open strap 1.

CAUTION: USE CARE WHILE REMOVING OIL TANK TO AVOID DAMAGE TO TRANSFER TUBES BETWEEN TANK AND GEARBOX.

(4) Pull tank straight forward off gearbox studs and remove from engine.

(5) Remove three transfer tubes and cover openings.

NOTE: If oil tank strap removal is necessary, unfasten cotter pins and remove strap retaining pins from engine flange. Remove strap.



Oil Tank Removal/Installation
Figure 401/72-61-65-990-801

2. Install Oil Tank

A. Equipment And Materials Required

Support Equipment

None

Consumables

Engine Oil (PWA 521)

B. Procedure. (Figure 401)

NOTE: If oil tank strap was removed, install strap on engine at Flange C, securing with retaining pins, washers and cotter pins at two locations. Bend cotter pins to secure.

(1) Install four new packings on each of three straight trans-fer tubes. Coat packings lightly with engine oil.

(2) Install three transfer tubes in their openings in front of gearbox.

CAUTION: USE EXTREME CARE WHILE INSTALLING OIL TANK TO AVOID DAMAGING OR DISRUPTING TUBES AND/OR PACKINGS.

(3) Position tank, drain valve down, in front of gearbox. Move rearward into position, engaging bushings over studs and mating tubes with openings in rear of tank.

(4) Install washers and locknuts on two studs and bracket and locknut on third stud (see figure). Torque locknuts evenly.

(5) Wrap oil tank strap around tank and insert turnbuckle bolt through eye of strap bracket.

(6) Install spherical washer and locknut on bolt and tighten strap around tank as follows:

  (a) Tighten nut until just before nut begins to tighten strap. Check nut torque at this point.

  (b) Continue tightening nut until 3-5 lb-in. (0.339 - 0.565 N·m) above previous torque has been reached.

  NOTE: Bolt threads must be flush with or protruding past outer face of locknut.

(7) Ensure that oil tank drain valve is closed, and refill tank to correct level.

C. Postrequisites

(1) Close lower forward cowl door. (COWL DOORS, SUBJECT 71-10-03, Page 201)

Key to Figure 401

Index No.	Nomenclature
1	Washer
2	Locknut
3	Strap Retaining Pin (Two Required)
4	Cotter Pin
5	Oil Tank Strap
6	Mount
7	Washer
8	Preformed Packing
9	Transfer Tube (Two Required)
10	Transfer Tube

Key to Figure 401 (Continued)

Index No.	Nomenclature
11	Bracket
12	Oil Tank (Reference)

FAN DISCHARGE SECTION - DESCRIPTION

1. Fan Discharge Ducts

The fan bypass is streamlined at the diffuser and turbine nozzle case by inner duct segments which straighten the airflow over these areas. The diffuser sound absorbing liner segments fit around the outside of the diffuser case and smooth the fan bypass airflow over the fuel manifolds and the diffuser annulus. These liners also reduce noise level. The fan discharge turbine inner duct segments fit around the turbine rear case and streamline the airflow past the case.

2. Combustion Chamber And Turbine Fan Duct

Between Flanges J and K the combustion chamber and turbine fan duct extends over the combustion section and 1st stage turbine areas of the engine and encloses the fan bypass stream. This duct is in two halves, separating midway up either side of the engine, and the two halves form a matched set. The lower half of the duct set carries openings for the igniter plugs and, at the bottom, the fuel drain boss through which the fuel drain manifold from the combustion section exits. Airframe bleed pads are provided on either side and the bottom of the lower duct. The upper duct half has a boss on the right hand side which carries the fuel control burner pressure tube leading from the combustion section to the fuel control.

COMBUSTION CHAMBER AND TURBINE FAN DUCT - REPAIR-01

1. Cracked J1 Flange Doubler Repair

A. Procedure. (Figure 801) (Table 801)

NOTE: Cracks are repairable provided they do not extend more than 3.500 inches (88.900 mm) in length and are out-board of flange radius. Cracks extending beyond these limits are not repairable.

(1) Remove distressed material to dimensions show.

(2) Blend rough edges of repair surface.

(3) Anodize touch-up repair surface.

(4) Locally manufacture a doubler of 18-8 or 316 stainless steel, 0.105 inch (2.667 mm) thick and large enough to pick up two holes adjacent to removed portion of flange and four holes on left side of flange. (Figure 801 (Sheet 2)) (Table 801)

(5) Position doubler centrally over rear face of flange and drill rivet holes as shown. Deburr holes in doubler and flange and countersink rivet holes to allow rivet heads to fit flush both sides as shown.

(6) Rivet doubler in place as shown.

(7) Transfer drill bolt holes as required.

(8) To fill void created by removal of distressed material and to provide adequate backup for mating support, locally manufacture a spacer of 18-8 or 316 stainless steel, 0.125 inch (3.175 mm) thick.

(9) Position spacer on doubler and drill rivet holes as shown. Deburr holes in spacer and doubler and countersink rivet holes to allow rivet heads to fit flush both sides as shown.

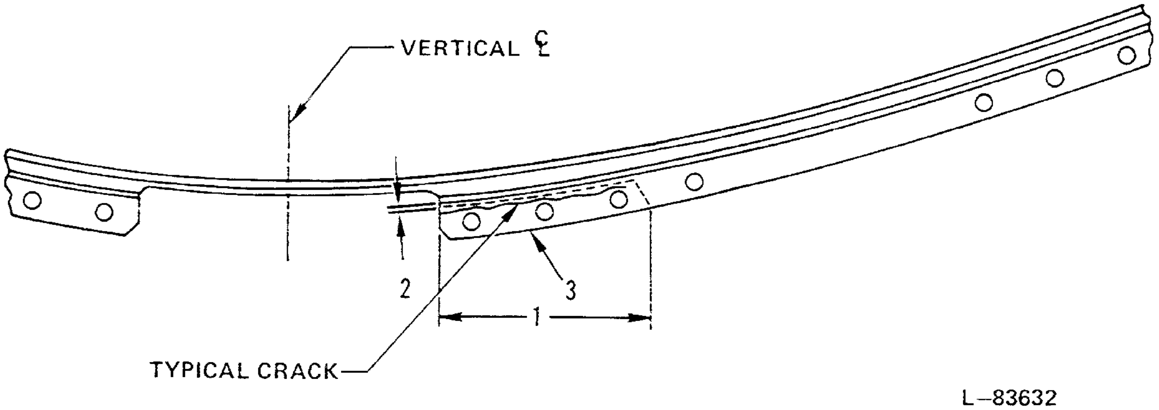
(10) Rivet spacer in place as shown.

(11) Transfer drill bolt holes as required.

(12) At installation of starter duct support assembly on doubler repaired flange use bolts 0.125 inch (3.175 mm) longer than normal and 0.063 inch (1.600 mm) thick washers as required.

Table 801 Key To Figure 801 (Sheet 2)

Index No.	Nomenclature
1	Rivet Heads Must Be 0.000 - 0.005 Inch (0.000 - 0.127 mm) Below This Surface, Both Sides.
2	J1 Flange
3	Doubler Plate
4	Holes In Plate Must Be Concentric With Holes In Flange Within 0.010 Inch (0.254 mm) Full Indicator Reading.
5	Nine Rivets Required Per Doubler Plate At Locations D. Five Rivets Located Approximately Midway Between Bolt Holes And Four Rivets Equally Spaced Over Arc C (Index 8).
6	Spacer
7	1° 21'49"
8	8°10'54", Arc C



J1 FLANGE
(REAR VIEW)

1. 3.500 Inches (88.900 mm) Maximum
2. 0.010 Inch (0.254 mm)
3. Flange Material Removed

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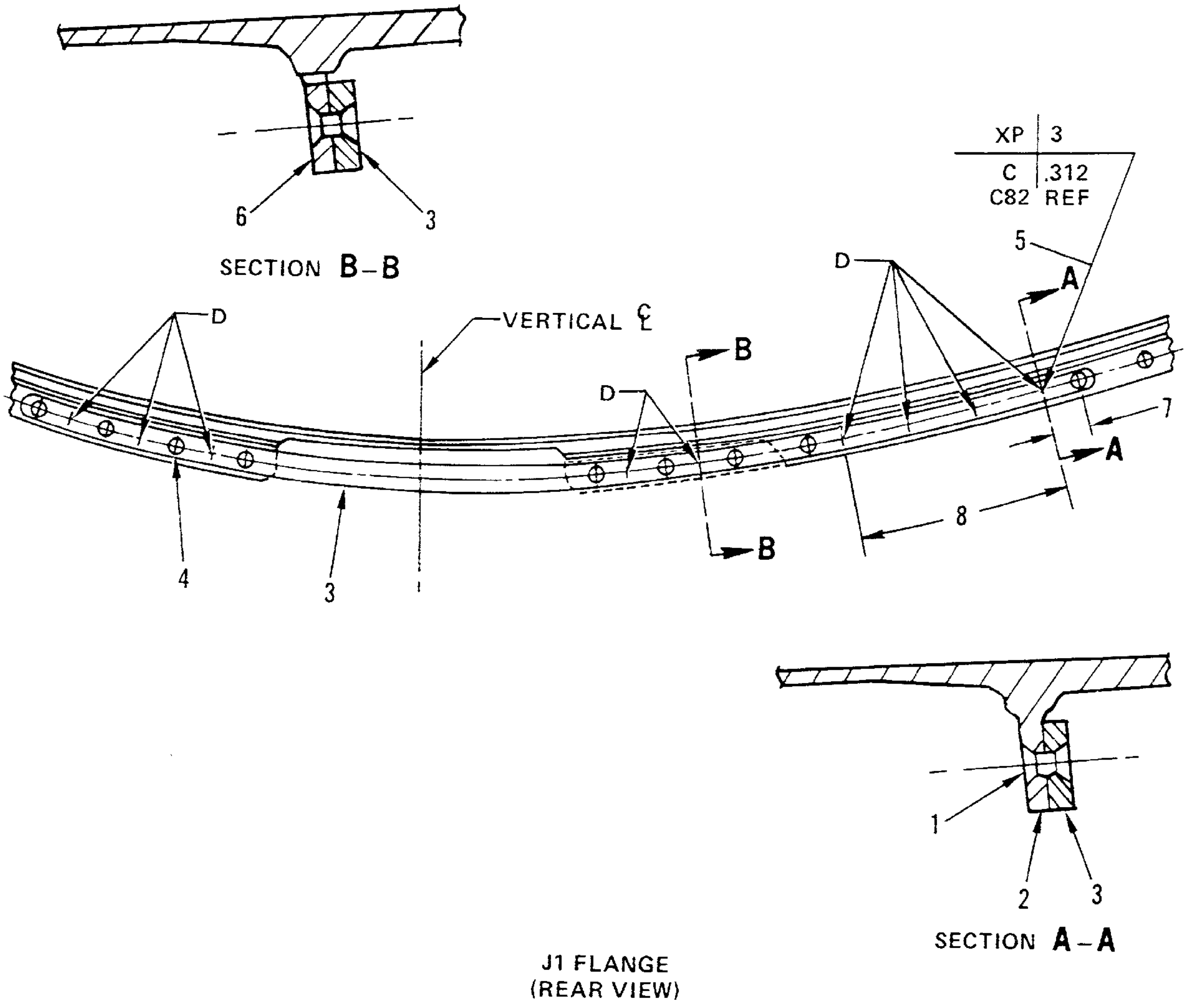
J1 Flange Doubler Repair
Figure 801/72-71-03-990-801 (Sheet 1 of 2)



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J1 Flange Doubler Repair
Figure 801/72-71-03-990-801 (Sheet 2 of 2)

2. Duct Wall Or Duct Flange Blend Repair

A. Procedure. (Figure 802)

CAUTION: DURING BLEND OPERATIONS, CARE SHOULD BE USED TO PREVENT METAL HEATING TO TEMPERATURES MORE THAN 350°F (177°C) WHICH COULD CAUSE DISBONDS.

(1) Dents, nicks and scratches in the duct wall or flange may be blended to the limits in Table 802 and Figure 802.

(2) The blend radii must be 0.062 inch (1.575 mm) or greater.

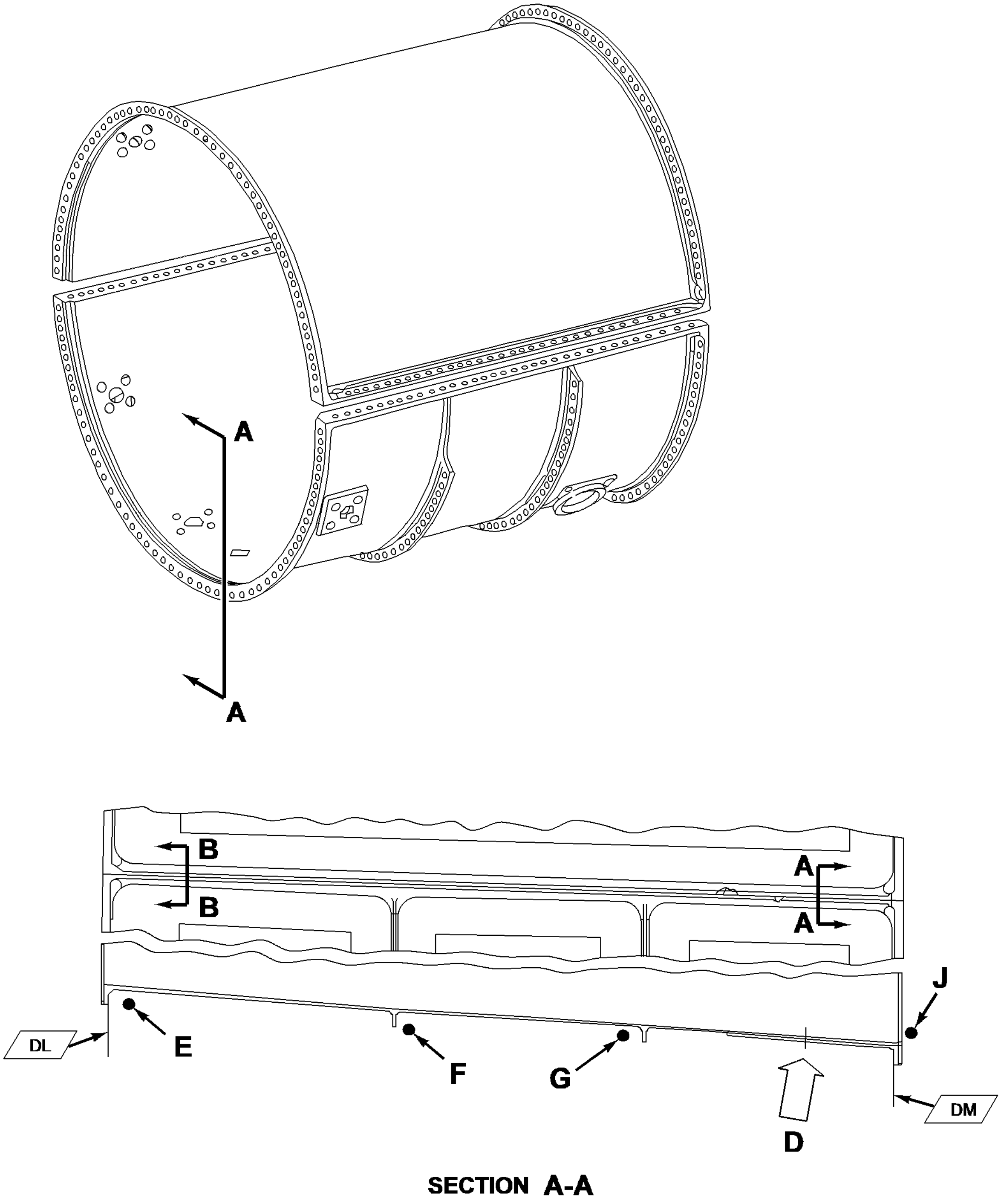
(3) Locally repair surface coating by SPOP 42, Anodize Touch Up. Refer to Repair-10 (Task 70-00-00-380-010) in the Boeing Standard Practices Manual, PN 52A323.

Table 802 Duct Wall and Duct Flange Blend Limits

Examine	Blend Depth Limit
Area K	0.012 inch (0.305 mm) Maximum
Area H	0.009 inch (0.229 mm) Maximum
Area L	0.016 inch (0.406 mm) Maximum
Area N	0.012 inch (0.305 mm) Maximum
Surface DW	0.018 inch (0.457 mm) Maximum
All other surfaces	0.006 inch (0.152 mm) Maximum

NOTE: Blend is not permitted on the fillet radii at the flanges.

NOTE: Blend between tapers must be smooth and continuous at all places.



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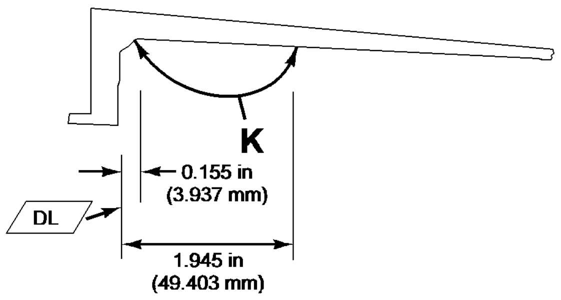
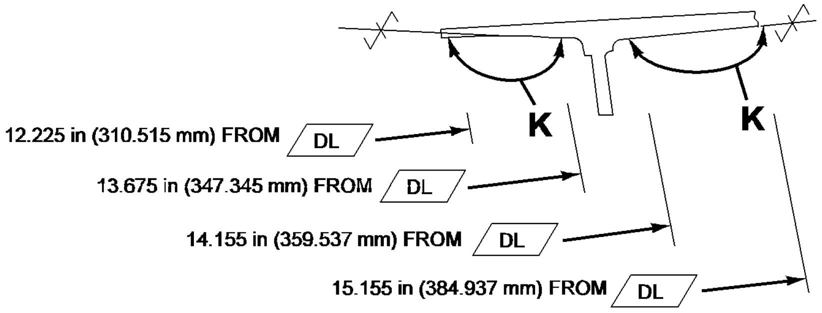
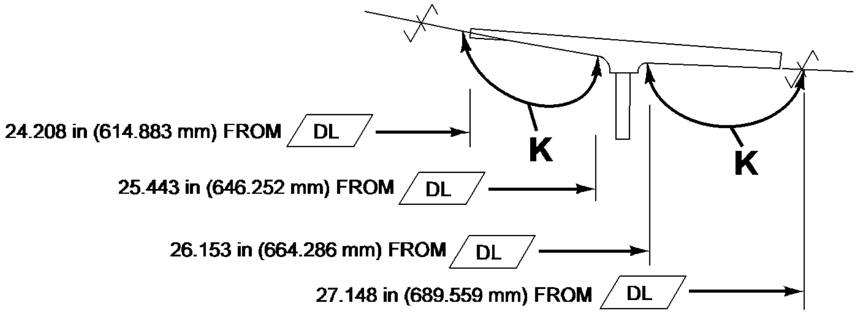
Duct Wall And Flange Blend Depth Limits
Figure 802/72-71-03-990-803 (Sheet 1 of 4)



VIEW E
(J FLANGE - UPPER AND LOWER HALVES)



VIEW F
(J1 FLANGE)



VIEW G
(J2 FLANGE)

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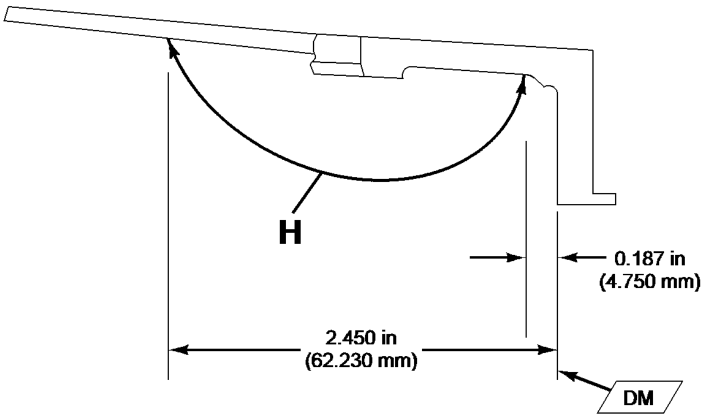
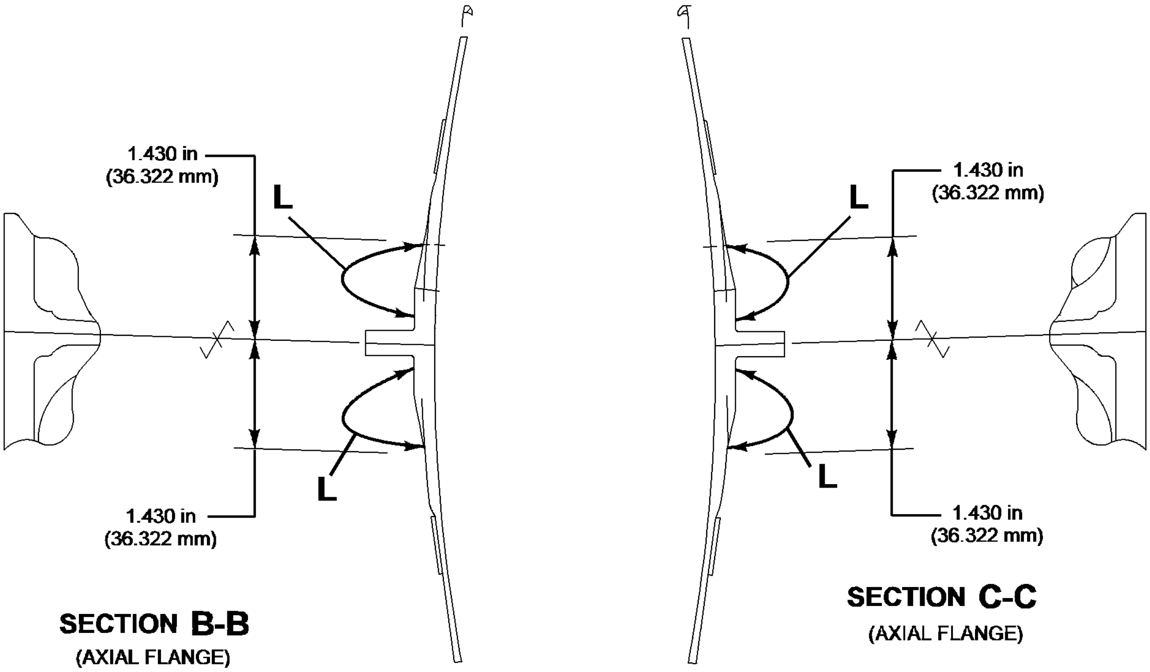
Duct Wall And Flange Blend Depth Limits
Figure 802/72-71-03-990-803 (Sheet 2 of 4)



VIEW J

(K FLANGE - UPPER AND LOWER HALVES)



SECTION B-B

(AXIAL FLANGE)

SECTION C-C

(AXIAL FLANGE)

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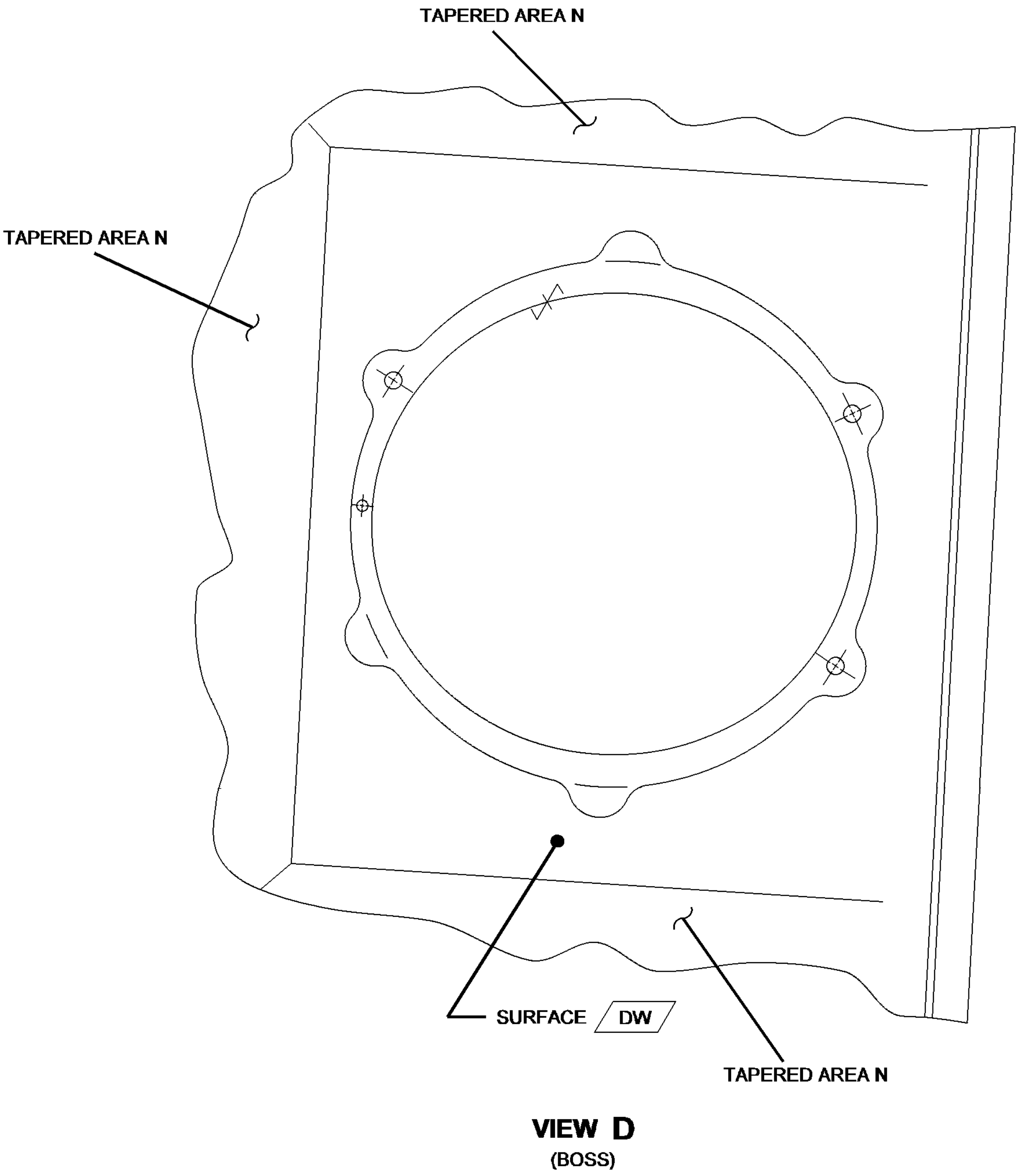
Duct Wall And Flange Blend Depth Limits
Figure 802/72-71-03-990-803 (Sheet 3 of 4)



Duct Wall And Flange Blend Depth Limits
Figure 802/72-71-03-990-803 (Sheet 4 of 4)