

Oklahoma Gas and Electric

ESN: 675498



Shop Report

Model: GG4A-9

Sulzer Job Number: P200394

Initial Details:

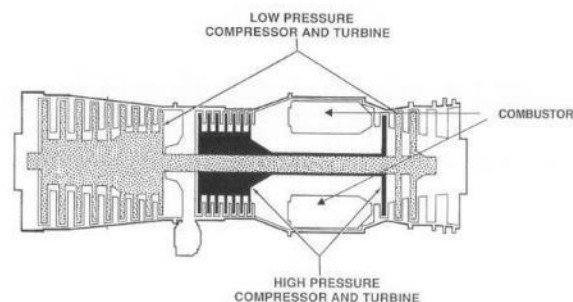
Gas Generator ESN 675498 was received at Sulzer on October 29, 2021. The Engine was sent to Sulzer for disassembly and inspection. Report findings and determine scope of repairs. Swap of BCD & BLD modules. The following report is formatted with the FINDINGS representing the “as found” of the removed engine. The CONDUCTED represents the tasks that were conducted on the modules that were supplied.

History:

ESN 675498 had never been repaired at Turbo Services prior to this scope of work.

Initial Workscope:

- Engine was to be disassembled and inspected.
- Provide scope of repairs and estimate to customer to determine scope of work.
- Engine is to be tested after assembly



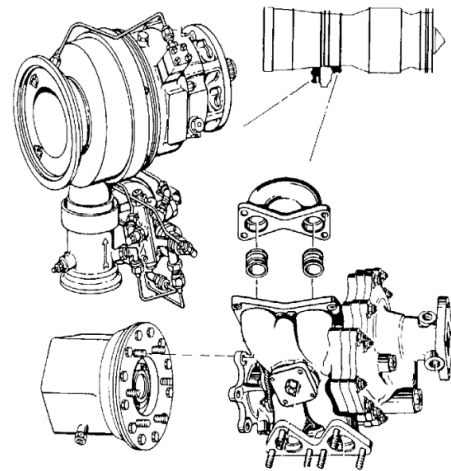
Findings:

Starter, Fuel Pump and Clutch 2-1-3 fig. 4

Initial Scope: Inspect and report findings. Engine was equipped with a TDI starter, clutch, and a fuel pump.

Findings: TDI starter had no visible damage and passed function test. Fuel pump was disassembled and replaced the internal packings. No other visible damage to fuel pump. Clutch had a bad bearing which caused the drive shaft to have play side to side. Clutch housing had coating loss.

Conducted: Starter was serviced and installed back onto the engine. Fuel pump was disassembled and inspected then the packings were replaced. Pump was assembled and pressure tested. Pump was used to run engine at test cell. Painted fuel pump. Replaced bearing in clutch. Clutch pack was energized and torqued tested prior to assembly. Painted clutch housing.





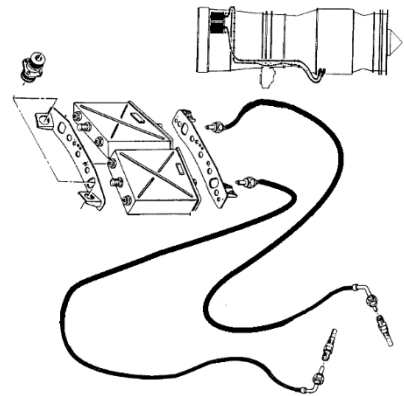


Ignition System 2-1-5 & 2-1-6 fig. 1

Initial Scope: Test igniter boxes, cables and igniter plugs.

Findings: Igniter boxes were tested and found to be in serviceable condition. Cables were tested and both sides worked.

Conducted: Igniter boxes passed function test and were used at the test cell to start and run the engine. Ignitor cables passed function test and were used at the test cell to start and run the engine.

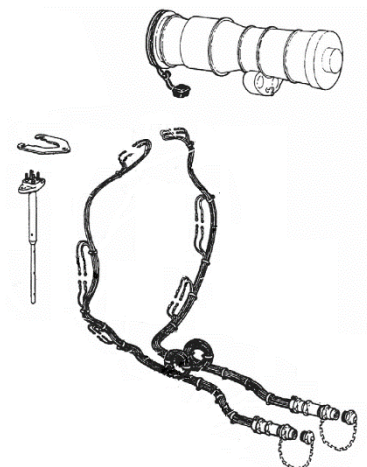


Thermocouple System 2-1-7 fig. 1

Initial Scope: Test thermocouples.

Findings: Thermocouples were function tested and found to be in serviceable condition. Cables were not received with the engine.

Conducted: Thermocouples passed function test and were used on run the engine during test.

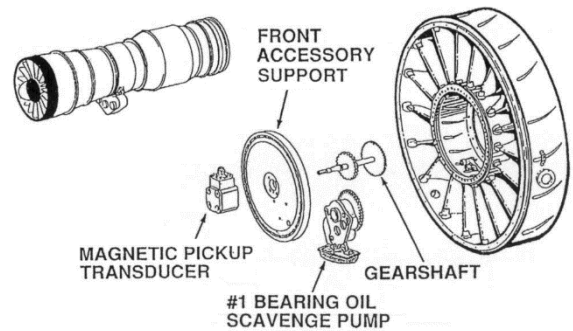


Inlet Case & #1 Housing Area 2-2-1 fig. 1

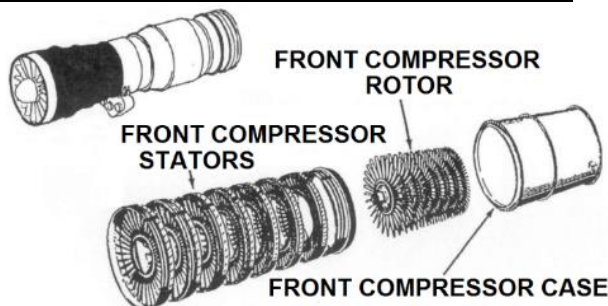
Initial Scope: Inspect and report findings

Findings: Front accessory drive was inspected with no findings. Oil scavenge pump spins freely with no binding. Transducer passed OHM check. N1 tach cable wires need to be extended. Inlet case had coating loss.

Conducted: Front accessory drive was cleaned and reassembled. Oil pump was cleaned and assembled. Transducer was OHM checked. Replaced N1 tach wires. Inlet case was stripped, NDT inspected and coated.



Low Pressure Compressor Rotor Package



2-2-3 fig 1 / 2-2-4 fig 1 / 2-2-5 fig 1

Initial Scope: Inspect and report findings.

Findings: LPC Case – Coating loss.

C-8 duct – Coating loss.

Stators – All stators have coating loss and corrosion.

Disk C-1 to C-8 and rear hub – Coating loss and corrosion. LPC rear hub has service bulletin 475 performed.

Spacers 1-2 to 7-8 – Coating loss and

corrosion on all LPC spacers. Snap fits to disk were good.

Blades C-1 to C-8 – Blades C-1 to C-4 require cleaning and inspection. Blades C5 to C-8 have coating loss and minor pitting. No visual indication of any blade tips rubbing.

Tierods – The front and rear tierods were dimensionally inspected and were within stretch limits. Tierod nuts should be cleaned and plated.

LPT coupling has coating loss.

Conducted: LPC case – Stripped, inspected and coated.

C-8 duct – Stripped, inspected and coated.

Stator – Stator C-1 to C-7 were stripped, NDT inspected and coated.

Disk C-1 to C-8 – C-1 to C-4 disk were stripped, NDT inspected, and cadmium plated. Disk C-5 to C-8 and rear hub were stripped, NDT inspected and coated.

Spacers – Stripped, NDT inspected, and coated.

Blades C-1 to C-8 – Blades C-1 to C-4 were cleaned, blended, NDT inspected and replaced bumpers. Blades C-5 and C-8 were cleaned, NDT inspected and coated.

Tierods – Front and rear tierods were cleaned and dimensionally inspected. Tierod nuts were stripped and plated.

LPT coupling – Restored plating on coupling, lock, and lock plate

Rebuilt rotor and check balanced.

See Appendix A for balance data.

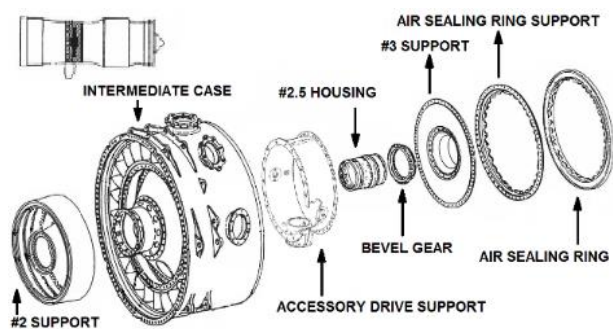
Intermediate Case & #2 Support 2-2-7 fig 1

Initial Scope: Inspect and report findings.

Findings: Intermediate case had coating loss.

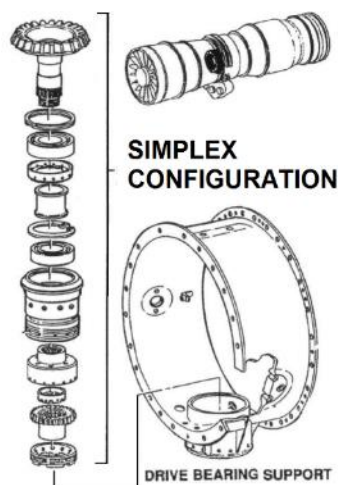
Gearbox mount bushings were in a good condition. #2 support has coating loss. #3 support and air sealing rings had no damage. #2.5 housing the chrome sealing surface was worn. Bevel gear need the silver plating restored.

Conducted: Intermediate case passed pressure tested. Case was then stripped, NDT inspected and coated. #2 support was stripped, NDT inspected and coated. #3 support and air sealing rings were blasted to clean and inspected prior to assembly. #2.5 housing had the chrome plating restored. Restored silver plating on bevel gear.



Accessory Drive Area

2-2-8 fig. 1



Initial Scope: Simplex configuration: inspect and report findings

Findings: Accessory drive housing and bushing were dimensionally inspected to check for proper fit per service bulletin 97B03. Replace both tower shaft bearings. Remaining parts were inspected with no visible damage found.

Conducted: Accessory drive housing and bushing were dimensionally inspected and had the proper fits per service bulletin 97B03. Upper and lower tower shaft bearings were replaced. Remaining parts were cleaned and inspected prior to use.

High Pressure Compressor Rotor Package 2-3-1 fig 1 / 2-3-2 fig 1

Initial Scope: Inspect and report findings.

Findings: HPC case – Case had coating loss. Stators – C-9 to C-14 stators have coating loss but vanes do not have signs of foreign object damage or blade tip rubs. Torque ring has no broken bolts. Tiestraps were removed and inspected with no damage found.

Disk – C-9 to C-12 disk have coating loss. C-10 hub is Fat 10 configurations. C-10 hub requires silver flash on the splines and the land. Disk C-13 to C-15 have no visible damage. Rear hub has no damage, but the center bellows tube is undersized at fits to hubs.

Spacers – 9-10 to 11-12 have coating loss. Spacer 12-13 to 14-15 require cleaning and inspection. Snap fits to disk were loose and require plasma spray and final machining to restore to proper size. Blades – C-9 blades are skinny midspan configuration. C-9 blades are loose due to having worn midspans. C-10 blades are a fat 10 configuration. C-10 to C-15 blades all require overhaul to include coating of stages C-12 to C-15.

Tierods – Passed visual and dimensional inspection

Conducted: HPC case – Stripped and recoated.

Disk – C-9 to C-12 disk were stripped, NDT inspected and recoated. Disk C-13 to C-15 were cleaned and NDT inspected. Rear hub and center tube were cleaned and inspected. Center tube had the fits to the hubs restored to proper size.

Stators – C-9 to C-14 stator were stripped, NDT inspected and coated.

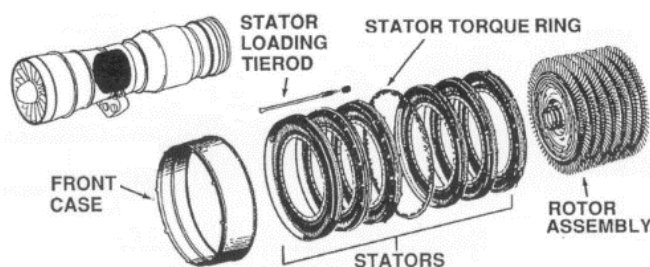
Spacers – Restored snaps to achieve proper fit to disk. 9-10 to 11-12 were stripped, NDT inspected and recoated. Spacer 12-13 to 14-15 were cleaned and inspected.

Blades – C-9 blades were overhauled including weld repair on midspan. C-10 to C-15 blades were overhauled. Stages C-12 to C-15 were recoated.

Tierods – Were dimensionally inspected and the threads were anti galled.

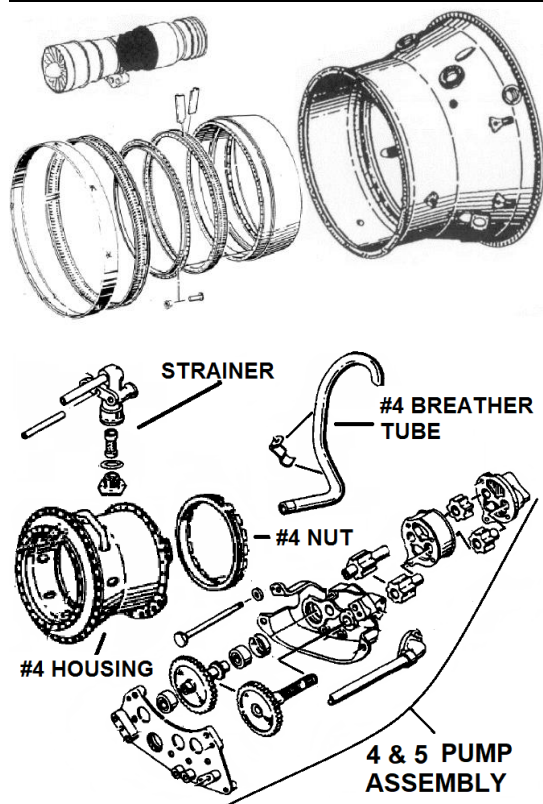
Rotor was assembled and check balanced.

See Appendix A for balance data





Diffuser Case, 15th stator, #4 Sump Area 2-3-3 fig 1 / 2-3-5 fig 1 / 2-3-6 fig 1



Initial Scope: Inspect and report findings.

Findings: Diffuser case has coating loss and was visually inspected with no cracks found at the struts. Case did not show sign of leaking from the breather ports. C-15 stator was found to have coating loss on the vanes. No FOD was found on the C-15 stator vanes. C-15 stator seat has coating loss. Pump was inspected with no findings and pump spun freely with no binding. #4 housing was visually and dimensionally inspected with no findings. Strainer was cleaned with no findings. Breather tube had no cracks.

Conducted: Case was stripped, pressure tested sump with no leaks found. Case was then NDT inspected, then coated. Strip and coat C-15 stator and seat. Pump was cleaned and installed back on engine. #4 housing passed dimensional inspection and was installed in the engine. Installed cleaned strainer on engine. Cleaned breather tube prior to assembly.

Combustion Outer Case 2-3-10 fig. 1

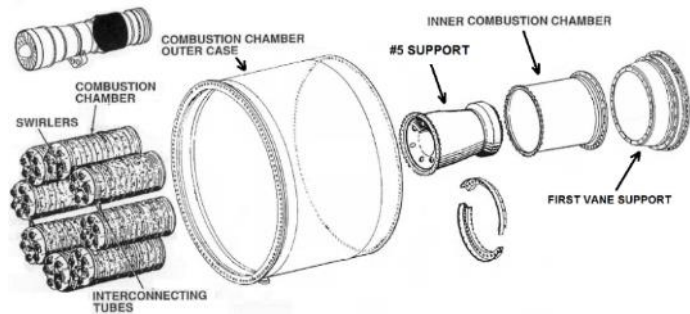
Combustion Chambers 2-3-7 fig 1

Initial Scope: Inspect and report findings.

Findings: Outer combustion case has coating loss. The number 1, 3, 6, and 5 combustion chambers all require weld repair and cleaning. The remaining five combustion chambers each require cleaning. Combustion chamber clamps were inspected with no findings. Inner combustion case was inspected with no findings.

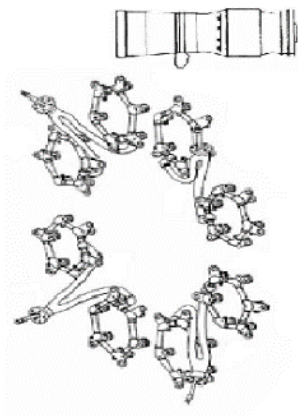
#5 support passed pressure test. Half moon heatshields were both cracked and had coating loss. 1st vane support all 12 vane segment seats were worn.

Conducted: Outer combustion case was stripped and coated. Combustion chambers were weld repaired as required and grit blasted to clean. Inner combustion case was cleaned and inspected. #5 support passed pressure test and was grit blasted to clean. Half moon heatshields were both weld repaired and coated per SB 73B36. 1st vane support replaced all 12 vane segment seats and tack welded.



Fuel Manifolds

2-4-8 fig 3



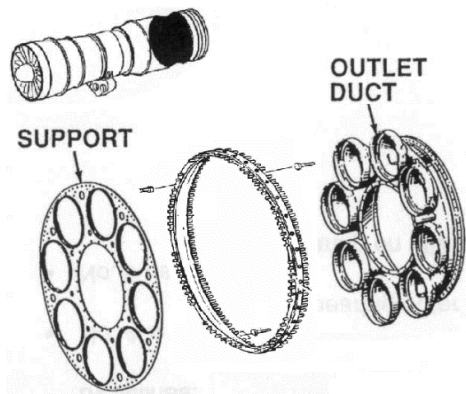
Initial Scope: Engine had dual fuel manifolds installed. Flow check.

Findings: Performed initial flow and pressure test. Bodies passed pressure test but failed flow test. Manifolds were disassembled to clean bodies and all nozzle components.

Conducted: Fuel manifolds bodies were grit blasted to clean. Bodies were ultrasonic cleaned and flushed. Fuel nozzles were ultrasonic cleaned and individually flow tested to eliminate streaks and obtain proper cone angle. Nozzle were remapped and installed and bodies were flow tested. Manifolds were installed in engine after test.



Transition Ducts 2-3-9 fig 1



Initial Scope: T-duct is an 8 hole split configuration. Inspect and report findings.

Findings: T-duct is a split configuration. Loss of Mag Zirc coating, minor cracks noted. T-duct plate and bolt ring were inspected with no findings.

Conducted: T-duct has been stripped, weld repaired, and recoated with Mag Zirc. T-duct plate and bolt ring had no repairs performed.

Nozzle Case and Supports 2-3-11 fig 1

Initial Scope: Inspect and report findings.

Findings: Case was visually inspected with no damage to the case itself.

J ring is in serviceable condition.

All 4 outer segments that are riveted to the case had little wear and no cracks.

Inner ring segments were inspected and had no cracks and little wear to the teeth.

2nd vane support was inspected and found to be in serviceable condition.

1st stage outer air seal was inspected with no findings.

2nd stage outer air seal was inspected with no findings.

3rd stage outer air seal was inspected with no findings.

2nd vane spacers all 3 were visually inspected and deemed serviceable.

3rd vane spacers all 3 were visually inspected and deemed serviceable.

2nd stage vane locks all 4 were visually inspected and deemed serviceable.

3rd stage lock was damaged and deemed scrap.

Conducted: Nozzle case was grit blasted to clean.

J ring was cleaned prior to assembly.

Performed no repairs to outer segments.

Inner ring segments were visually inspected, and grit blasted to clean.

2nd vane support replaced 32 worn bushing per SB 400 to restore vane slots fit. Also, machined vane land surface and plasma repaired to have a flat surface.

1st stage outer air seal no repairs were performed.

2nd stage outer air seal no repairs were performed.

3rd stage outer air seal no repairs were performed.

2nd and 3rd vane spacers and locks. Replaced scrap 2nd and 3rd vane spacers. can be installed with no work performed.

2nd stage vane locks can be installed with no work performed.

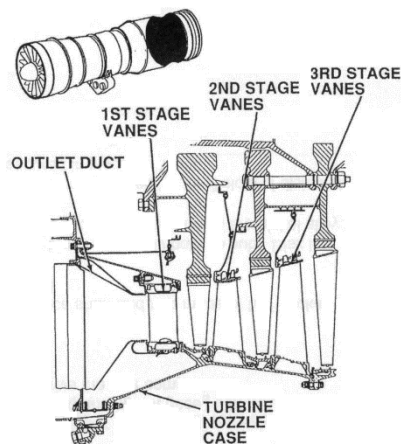
2nd vane spacers can be installed with no repairs performed.

3rd vane spacers can be installed with no repairs performed.

2nd stage vane locks can be installed with no repairs performed.

3rd stage lock was replaced.

Nozzle Guide Vanes 2-3-11 fig 1



Initial Scope: Inspect and report findings.

Findings: 1st stage vanes had some bowing to the airfoil.

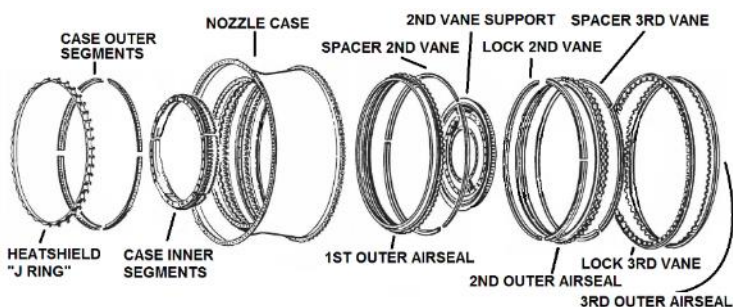
2nd stage vanes recommend to overhaul vanes.

3rd stage vanes recommend to overhaul vanes.

Conducted: 1st stage vanes were sent out for overhaul. Issued overhauled T-1 vanes from Sulzer stock.

2nd stage vanes were sent out for overhaul. Issued overhauled T-2 vanes from Sulzer stock.

3rd stage vanes were sent out for overhaul. Issued overhauled T-3 vanes from Sulzer stock.





High Pressure Turbine Rotor **2-3-12 fig 1**

Initial Scope: Inspect and report findings. T-1 blades and a Fat notch configuration.

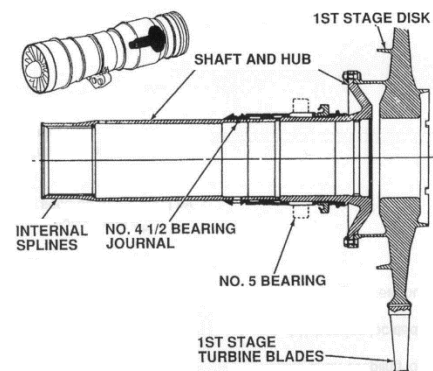
Findings: Disk and shaft were inspected with no findings. T-1 blades and a Fat notch configuration. Overhaul T-1 blades.

Conducted: Cleaned and inspected HPT disk and shaft.

T-1 blades were sent out for overhaul.. Issued overhauled T-1 blades from Sulzer stock.

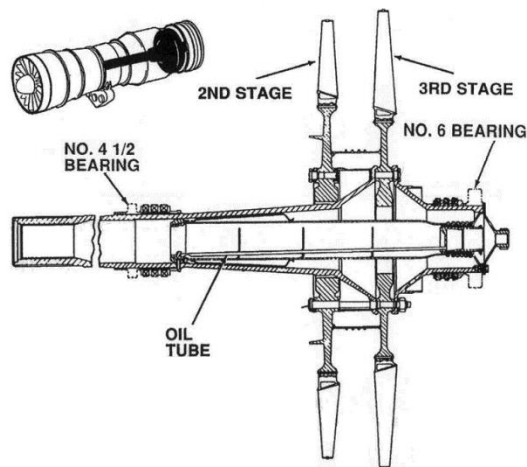
Rebuilt rotor and check balanced

See Appendix A for balance data.



Low Pressure Turbine Rotor

2-3-13 fig 1



Initial Scope: Inspect and report findings. T-2 and T-3 blades are both fat notch configuration.

Findings: 2nd blades require overhaul. 3rd blades require overhaul. LPT shaft has coating loss. Rear hub has coating loss and requires heli-coil replacement for four counterweight holes. 2nd and 3rd stage disk were cleaned and inspected with no findings. Inner airseal had no damage to the knife edges and the snap fits were a good fit to the disk. 3rd vane support was inspected with no findings. Tierod ring and support spacer were inspected with no findings. Tierods were visually and dimensionally inspected with no findings.

Conducted: T-2 blades were sent out for overhaul.

Issued overhauled T-2 blades from Sulzer stock. T-3 blades were sent out for overhaul. Issued

overhauled T-3 blades from Sulzer stock. LPT shaft and rear hub were both stripped, inspected and coated. The rear hub also had four counterweight holes heli-coiled repaired. Turbine disk were both cleaned and inspected. Inner airseal was stripped and coated. 3rd vane support was cleaned and inspected. Tierod ring and support spacer were both cleaned and inspected. Tierods were dimensionally inspected and anti-galled.

Rebuilt rotor and check balanced

See Appendix A for balance data.





Exhaust Case and #6 bearing Housing

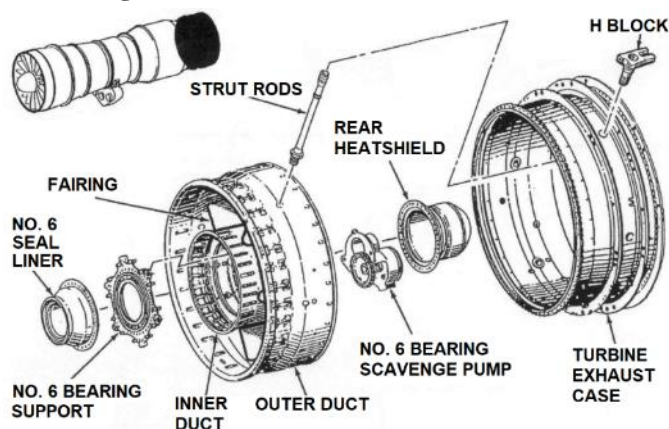
Initial Scope: Inspect and report findings.

Findings: Case had hard face plasma loss on the I.D. and the O.D. Outer duct had no damage but did have hard face coating loss. Inner duct and fairing were inspected with no cracks found. H-blocks were inspected with no findings. Inner, center, and outer strut rods had wear on the land surfaces. #6 N.O.D. seals liner was worn. #6 pump was inspected with no findings and pump spun freely with no binding.

Conducted: Exhaust case was grit blasted to clean and then had plasma band applied to outside of case per SB 71B26. Also applied plasma to I.D. of rear of case per SB 74L05. Outer duct was grit blasted to clean then had plasma band applied to O.D. of duct per SB 74L05. Inner duct and fairing assembly was grit blasted to clean. H-blocks were cleaned and applied anti gallant during assembly. Inner, center, and outer strut rods had the worn land surfaces plasma sprayed and machined to size. Applied anti gallant to strut rods during assembly. Installed overhauled #6 N.O.D. seals liner. #6 pump was cleaned and installed back on engine.

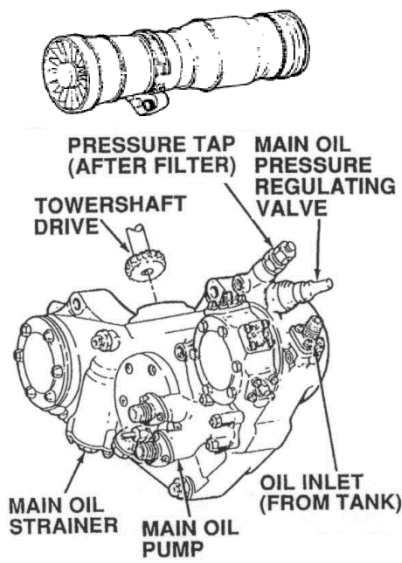
Exhaust case was reassembled and run outs were corrected.

2-3-11 fig 1



N2 Gearbox & Main Oil Pump Assy

2-4-1 through 2-4-5



Initial Scope: Clean and flush case, inspect.

Findings: Gearbox was split, and gears and bearings were inspected with no findings. Main oil pump 2 drive gears have wear on the journals. Scavenge housing had scored walls.

Strainer was inspected with no findings.

Conducted: Gearbox case was split open flushed and inspected. Replaced carbon seals with new parts. Main oil pump 2 drive gears had the journals restored. Scavenge housing was E-poly repaired. Strainer was cleaned and reassembled. Gearbox was stripped and coated.

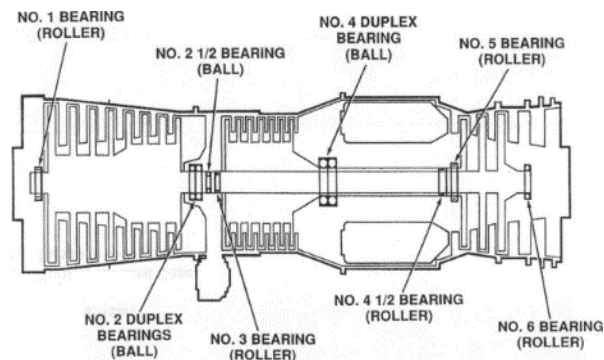
Main Line Bearings

Initial Scope: Inspect and report findings.

- #1 Oil damp bearing required overhaul
- #2 Bearing required overhaul
- #2.5 Bearing required overhaul
- #3 Bearing required overhaul
- #4 Bearing required overhaul
- #4.5 Bearing required overhaul
- #5 Bearing required overhaul
- #6 Non oil damp bearing required overhaul

Conducted:

- #1 Oil damp bearing was overhauled. Installed two new seal rings for oil damp bearing.
- #2 Bearing was overhauled
- #2.5 Bearing was overhauled
- #3 Bearing was overhauled
- #4 Bearing was overhauled
- #4.5 Bearing was overhauled
- #5 Bearing was overhauled
- #6 Non oil damp bearing was overhauled



Main Line Seal Assemblies

Initial Scope: Inspect and report findings.

Findings:

- #1 Seal face assembly recommend overhaul

#2 Seal face assembly recommend overhaul
#3 Seal face assembly recommend overhaul
#4 Seal face assembly recommend overhaul
#4.5 Carbon rings replace with new
#5 Seal face assembly recommend overhaul
#6 Carbon rings replace with new
#1 Seal plate (skinny) was worn
#1 Seal plate (thick) was worn
#1 Seals liner was worn
#2 Seal plate was worn
#3 Seal plate was worn
#4 Seal plate was worn
#4.5 Seal plates (flat) qty 3 were worn
#4.5 Seal plate (end) was worn
#4.5 Seals liner was worn
#5 Seal plate (fwd) was worn
#5 Seal plate (rear) was worn
#6 Seal plates (flat) qty 2 were worn
#6 seal plate (large) was worn

Conducted:

#1 Seal face assembly overhauled and replaced seal rings and springs with new
#2 Seal face assembly overhauled and replaced seal rings and springs with new
#3 Seal face assembly overhauled and replaced seal ring and springs with new
#4 Seal face assembly overhauled and replaced seal rings and springs with new
#4.5 Carbon rings replaced with new
#5 Seal face assembly overhauled and replaced seal ring and springs with new
#6 Carbon rings replaced with new
#1 Seal plate (skinny) was overhauled
#1 Seal plate (thick) was overhauled
#1 Seals liner was overhauled
#2 Seal plate was overhauled
#3 Seal plate was overhauled
#4 Seal plate was overhauled
#4.5 Seal plates (flat) qty 3 were overhauled
#4.5 Seal plate (end) was overhauled
#4.5 Seals liner was overhauled
#5 Seal plate (fwd) was overhauled
#5 Seal plate (rear) was overhauled
#6 Seal plates (flat) qty 2 were overhauled
#6 seal plate (large) was overhauled

OG&E		ESN 675498		January 31, 2022		
Initial		Final		% of limit	Runouts	
Rear	Front	Rear	Front			
LPC Balance						
20 gr	29 gr	.682 gr	.973 gr	% of limit	front	back
8.10gr @ 309°	13.67gr @ 316°	.450gr @ 113°	.679gr @ 54°	68%	.001"	.0005"
HPC Balance						
24 gr	28.8 gr	.612 gr	.887 gr	% of limit	front	back
7.08gr @ 69°	9.86gr @ 0°	.359gr @ 24°	.195gr @ 287°	41%	.001"	.001"
HPT Balance						
		.900 gr		% of limit	rivets	shaft
21.41gr @ 15°		.117gr @ 174°		13%	.005"	.001"
LPT Balance						
22.6 gr		1.134 gr		% of limit		
8.91gr @ 117°		.311gr @ 74°		27%		
spacer flatness	spline concentricity	#4.5	#6	T-2	T-3	
.001"	.004"	.001"	.001"	.003"	.003"	
Compartment Flow Checks						
#1	2 & 3	#4	4 & 5	#6	final	
3.5 - 12.5pph	37 - 52pph		60 - 80pph	15 - 21pph		
9pph	46pph		62pph	18pph		
Compartment Pressure Tests						
6pph max	14pph max	6.5pph max	12pph max	0pph max	56pph max	
5pph	9pph	6.1pph	10pph	0pph	51pph	
Exhaust Case Runouts						
concentricity	flatness					
.001"	.002"					

Appendix A