Oklahoma Gas and Electric

ESN:675502

Shop Report
1/11/2019

Model GG4A-9

Turbo Services Job Number: T18.013

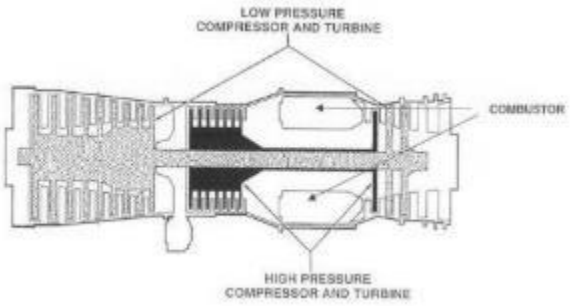
Initial Details:

Gas Generator ESN 675502 was received at Turbo Services on October 15, 2018. The Engine was sent to Turbo Services to investigate F.O.D. Engine is to be disassembled for inspection.

Initial Workscope:

The engine was sent to TSI to inspect damage:

- Disassemble engine and destack rotors to determine damage that was found during borescope inspection.



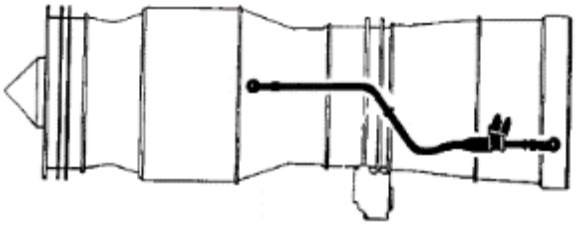
Findings:

Ignition System **2-1-4 fig. 2**

Initial Scope: Pressure test tubes for leaks and visually inspect for damage.
Findings: #6 scavenge tube had deep wear from chaffing.
Conducted: Weld repaired and blended tube.

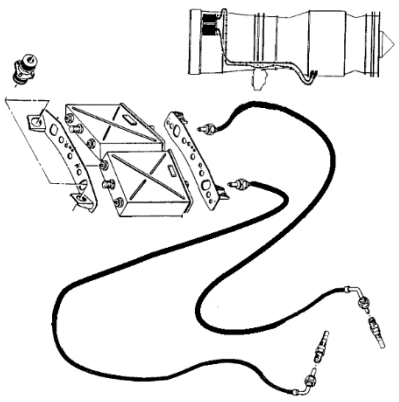
Anti Icing Tubes **2-1-9 fig. 1 and 2**

Initial Scope: Test anti-ice valve actuator
Findings: Anti ice tube was received with out actuator and valve assembly.
Conducted: Replaced missing anti ice valve and actuator assembly.



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 functioned.
Conducted: Right and left side ignition cables were tested and reinstalled on engine. Igniter boxes were tested and reinstalled on engine.

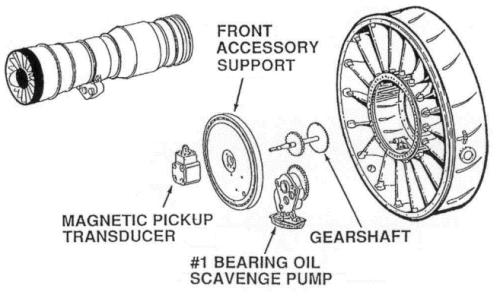


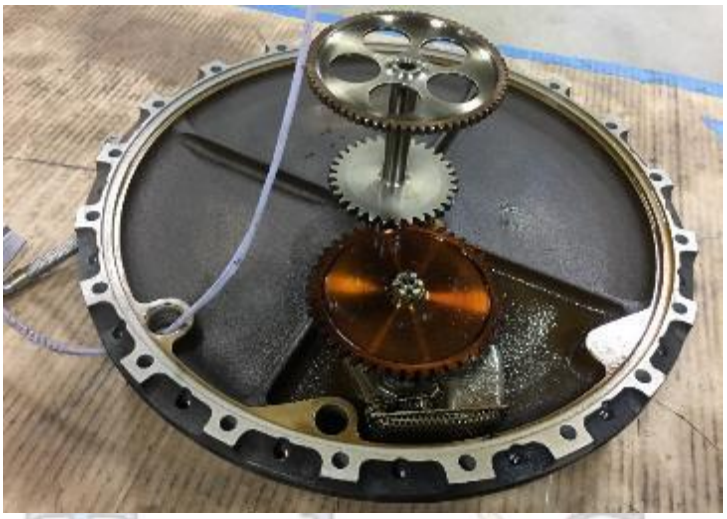
Inlet Case & #1 Housing Area **2-2-1 fig. 1**

Initial Scope: Inspect and report findings

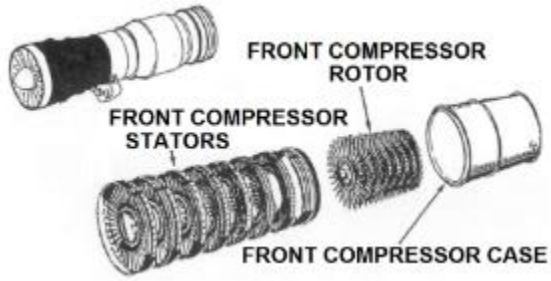
Findings: Front accessory dive was inspected with no findings. Inlet case had coating loss.

Conducted: Front accessory dive was cleaned and reassembled. Inlet case was stripped, NDT inspected and coated.

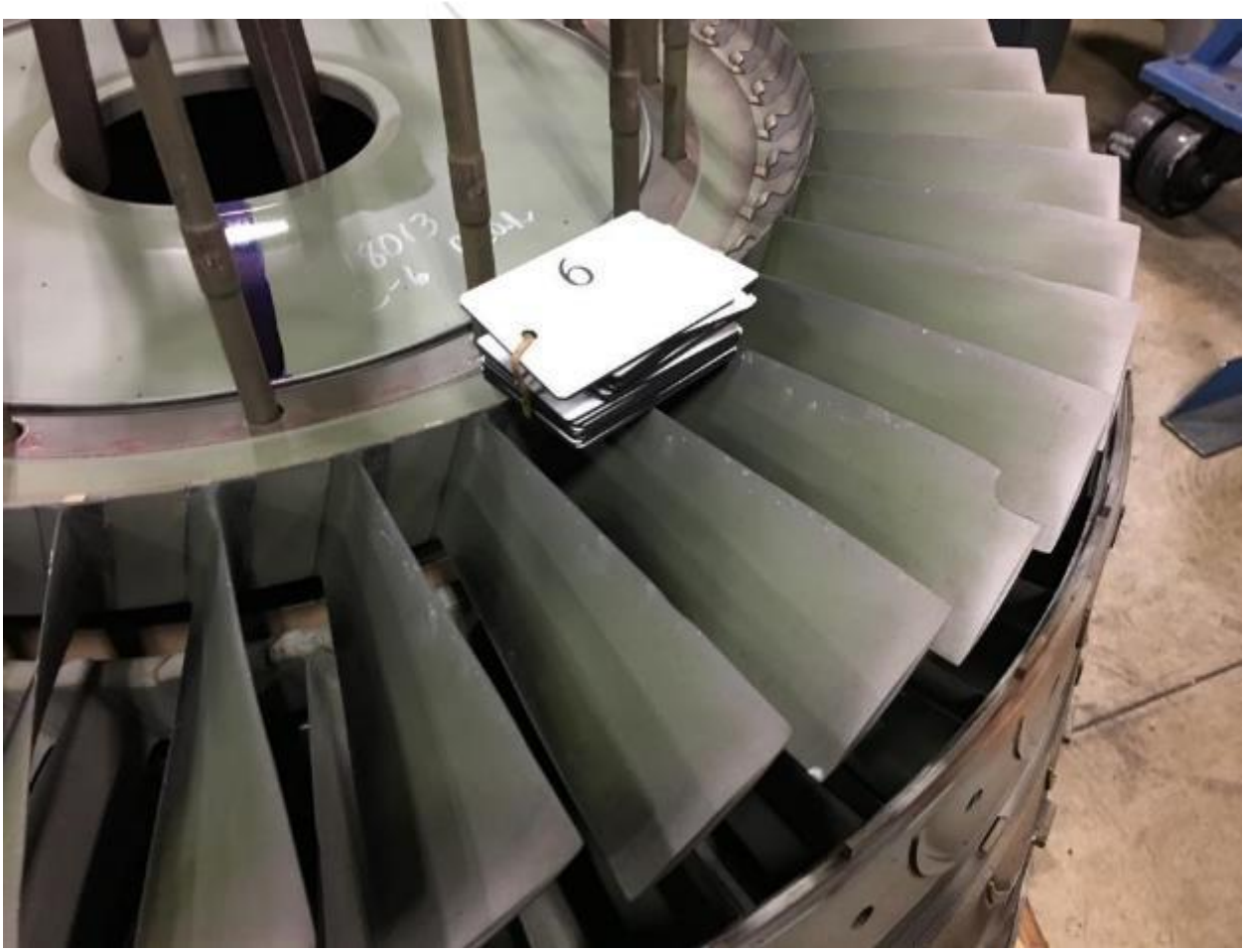




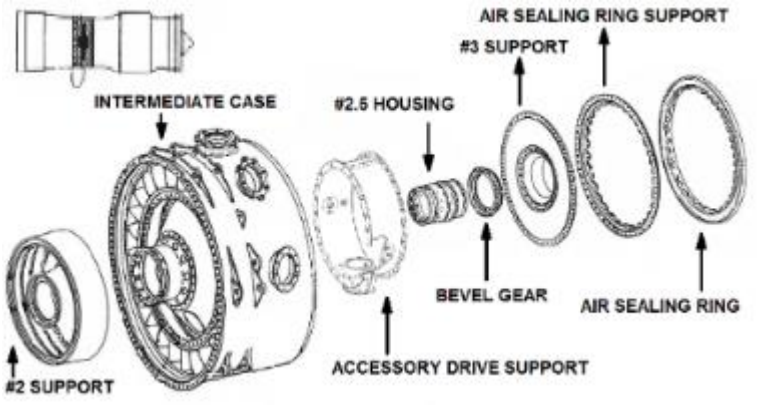
Low Pressure Compressor Rotor Package **2-2-3 fig 1 / 2-2-4 fig 1 / 2-2-5 fig 1**



Initial Scope: Inspect and report findings.
Findings: C-6 blade had a portion of the trailing edge break off.
Conducted: LPC rotor was exchanged with an overhauled module from TSI. The installed rotor had the following work completed.
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, inspected and cadmium plated. Disk C-5 to C-8 and rear hub were stripped, inspected and coated.
Spacers – Restored snaps to achieve proper fit to disk. 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-3 to C-6 were cut back per SB 72B6, stages C-7 and C-8 were cut back per SB 74B07. Blades C-5 to C-8 were, NDT inspected, and coated.
Tierods – Front and rear tierods were dimensionally inspected and the threads were anti galled.
LPT coupling – Installed cleaned and inspected parts including having restored plating on coupling, lock and lock plate
Rotor was assembled 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. Broken nut on one gang nut plate. #2 support has coating loss. #3 support and seal rings were cleaned and inspected with no findings. Heatshields for #3 support were old configuration which allowed for carbon build up in the compartment. #2.5 housing was worn.

Conducted: Intermediate case was dimensionally inspected, and pressure tested with no findings. Case was then stripped, NDT inspected and coated. Replaced damaged gang nut. #2 support was stripped, NDT inspected and coated. #3 support and seal rings were blasted to clean and inspected. Installed upgraded heat shields per SB72B19. #2.5 housing had the silver plating restored. Restored silver plating on bevel gear.

#3 Support

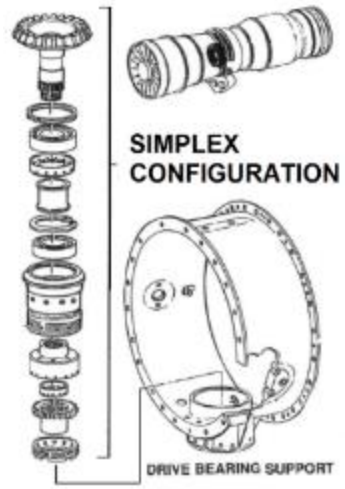
#3 Support

Accessory Drive

Intermediate Case

#2.5 Housing

Accessory Drive Area **2-2-8 fig. 1**

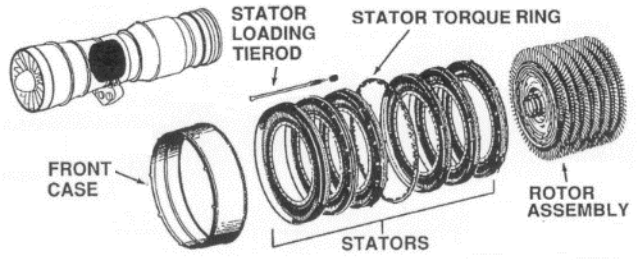


Initial Scope: Simplex configuration: inspect and report findings
Findings: Accessory drive housing and bushing should be dimensionally inspected. One broken nut on gang nut plate. Replace both tower shaft bearings.
Conducted: Accessory drive housing and bushing were dimensionally inspected. Replaced one gang nut channel. Upper and lower tower shaft bearings were replaced. Remaining parts were cleaned and inspected prior to use.

Accessory Drive

High Pressure Compressor Rotor Package

2-3-1 fig 1 / 2-3-2 fig 1



Initial Scope: Inspect and report findings.

Findings: Missing portion of C-6 blade is the most likely cause of impact damage that occurred in the HPC.

Conducted: HPC rotor was exchanged with an overhauled module from TSI. The installed rotor had the following work completed.

HPC rotor was a skinny 10 configuration. Upgraded to a fat 10 configuration per SB 73B15.

HPC case – Stripped and recoated.

Disk – Skinny C-10 hub was replaced with a fat C-10 hub 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.

Stators – C-9 to C-14 stator were stripped, NDT inspected and coated. C-9 and C-10 were zinc filled per SB 77M10. C-11 was zinc filled per SB 78M06

Spacers – Replaced skinny 9-10 and 10-11 spacers with fat configuration. 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 – Replaced skinny 10 blades with fat 10 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 – Replaced tierods with fat 10 configuration. Tierods were dimensionally inspected and the threads were anti galled.

Rotor was assembled and check balanced.

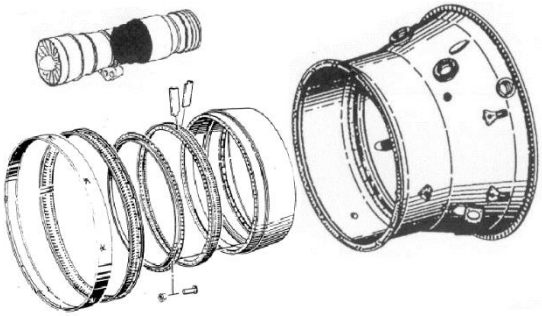
See Appendix A for balance data

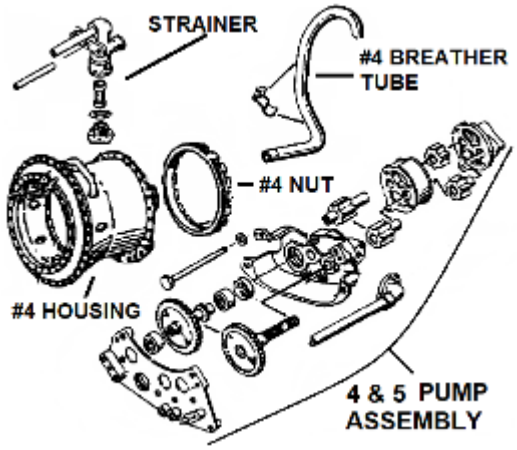
C-9 Stator

C-9 Stator

C-10 Blades

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

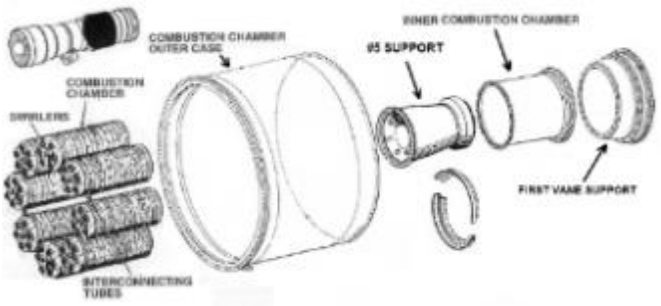




Initial Scope: Inspect and report findings.
Findings: Diffuser case had coating loss. C-15 stator and stator seat have coating loss.
Conducted: Diffuser case passed pressure test. Case was then stripped, NDT inspected and coated. C-15 stator and stator seat were stripped and coated. #4 housing was visually and dimensionally inspected with no findings. 4&5 pump was inspected with no findings. Upgraded scavenge tube per SB 80B14.

Combustion Outer Case **2-3-10 fig. 1**

Combustion Chambers **2-3-7 fig 1**



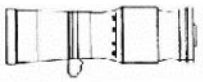
Initial Scope: Inspect and report findings.

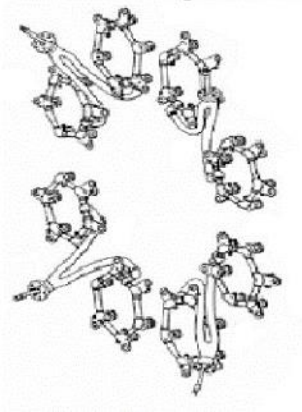
Findings:

Outer combustion case has coating loss. The number 3, 6, and 8 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 was missing rivets for the vane seats. 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 cleaned. 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 riveted and tack welded seats in place.

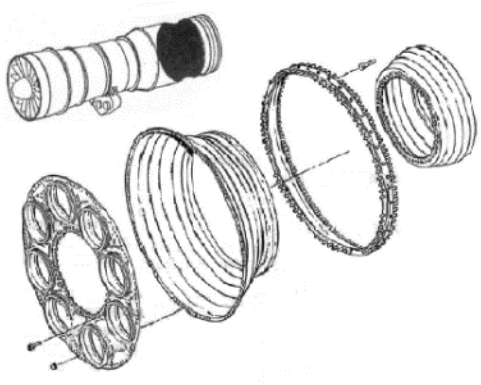
Fuel Manifolds **2-4-8 fig 3**





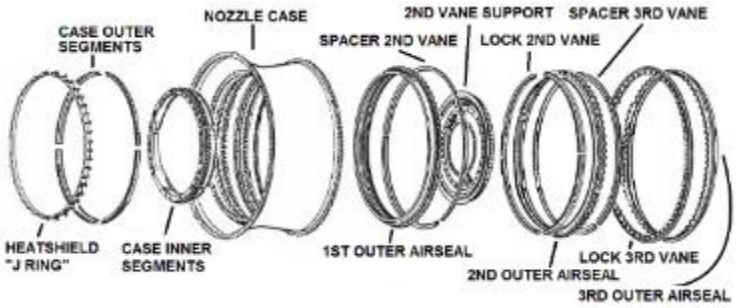
Initial Scope: Flow Check
Findings: Perform initial flow and pressure test, disassemble to clean and or make repair, remap nozzles.
Conducted: Fuel manifolds were overhauled.

Transition Ducts **2-3-9 fig 1**



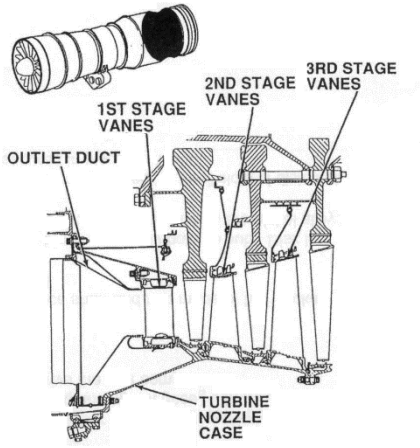
Initial Scope: Inspect and report findings.
Findings:. Loss of Mag Zirc coating, no cracks noted. T-duct plate and bolt ring were inspected with no findings.
Conducted: Inner and outer T-ducts were stripped and recoated with Mag Zirc. T-duct plate and bolt ring required no work.

Nozzle Case and Supports **2-3-11 fig 1**



Initial Scope: Inspect and report findings.
Findings: Case was visually inspected with no damage found.
All 5 inner ring segments were inspected with no findings.
2nd vane support had no damage.
1st stage outer air seal had no damage.
2nd stage outer air seal had damage to the rear knife edge.
3rd stage outer air seal had no damage.
3rd stage lock was inspected with no findings.
Conducted: Nozzle case did not require any of the 4 seats to be replaced. The case was grit blasted to clean
Grit blasted all 5 ring segments prior to assembly.
2nd vane support was grit blasted to clean.
1st stage outer air seal was stripped and coated.
2nd stage outer air seal restored the rear knife edge. Airseal was stripped and coated.
3rd stage outer air seal was stripped and coated.
3rd stage lock no work was performed.

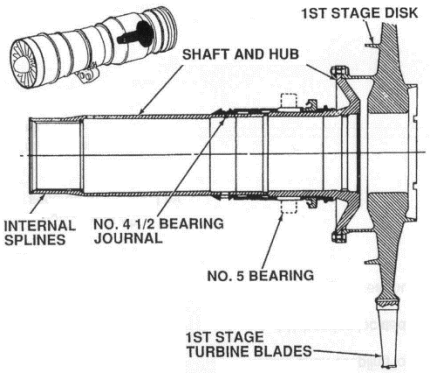
Nozzle Guide Vanes **2-3-11 fig 1**



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. Quantity 45 vanes were deemed scrap, the remaining 35 were overhauled. Issued overhauled T-1 vanes from TSI stock.
2nd stage vanes were sent out for overhaul. All 76 pieces were overhauled. Issued overhauled T-2 vanes from TSI stock.
3rd stage vanes were sent out for overhaul. All 68 pieces were overhauled. Issued overhauled T-3 vanes from TSI stock.


11
12
13
11

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



Initial Scope: Inspect and report findings.

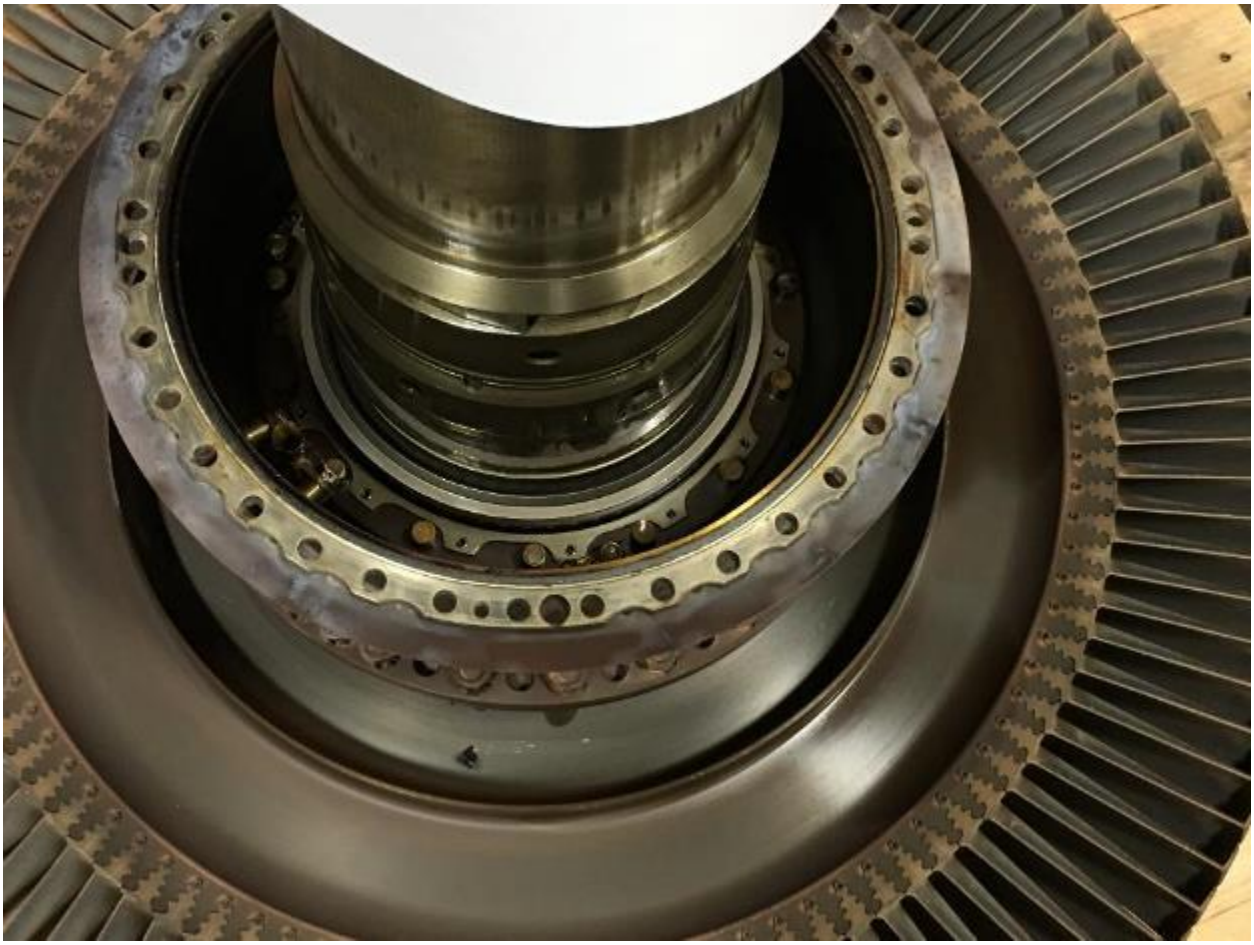
Findings: Disk and shaft were inspected with no findings. Overhaul T-1 blades.

Conducted: HPT rotor was exchanged with an overhauled module from TSI. The installed rotor had the following work completed.

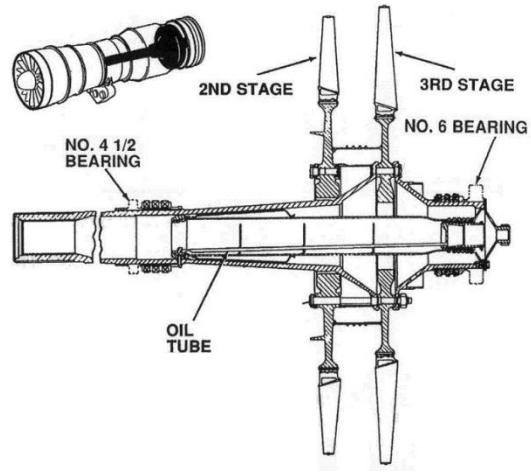
Cleaned and inspected HPT disk and shaft. T-1 blades were sent out for overhaul. All 108 pieces were deemed scrap. Issued overhauled T-1 blades from TSI stock

Rotor was assembled and check balanced.

See Appendix A for balance data



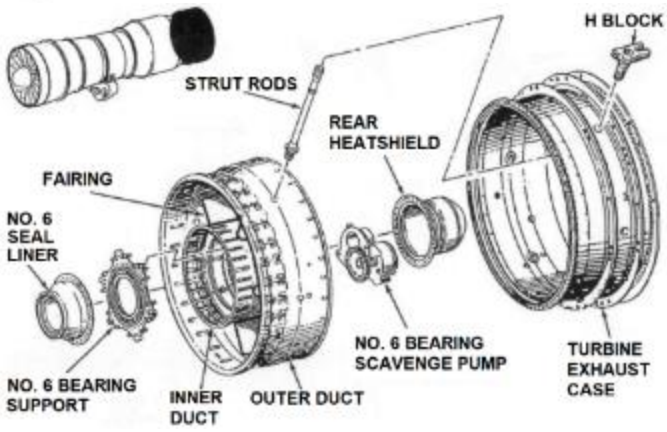
Low Pressure Turbine Rotor **2-3-13 fig 1**



Initial Scope: Inspect and report findings.
Findings: 2nd blades recommend to overhaul. 3rd blades recommend to overhaul. LPT shaft has coating loss. Rear hub has coating loss. 2nd and 3rd stage disk were cleaned and inspected with no findings. Inner airseal had a loose front snap and surface corrosion. 3rd vane support had wear on the vane seat. Tierod ring and support spacer were inspected with no findings. Tierods were visually and dimensionally inspected with no findings.
Conducted: LPT rotor was exchanged with an overhauled module from TSI. The installed rotor had the following work completed.
T-2 blades were sent for overhaul. Quantity 1 of the blades were deemed scrap. Quantity 99 were overhauled. Issued overhauled T-2 blades from TSI stock. T-3 blades were sent for overhaul. Quantity 16 of the blades were deemed scrap. Quantity 66 were overhauled. Issued overhauled T-3 blades from TSI stock. LPT shaft and rear hub were both stripped, NDT inspected and coated. Turbine disk were both cleaned and NDT inspected. Inner airseal was stripped and coated. 3rd vane support had the vane land machined and plasma sprayed then final machined. Tierod ring and support spacer were both cleaned and inspected. Tierods were dimensionally inspected and anti-galled.
Rotor was assembled and check balanced.
See Appendix A for balance data

Exhaust Case and #6 bearing Housing

2-3-11 fig 1



Initial Scope: Inspect and report findings.

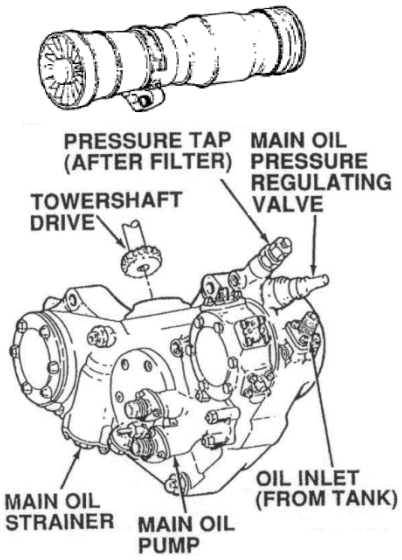
Findings: Case had hardface plasma loss on the I.D. and the O.D. Outer duct had no damage but did have hardface coating loss. Inner duct and fairing was inspected with no cracks found. H-blocks were inspected with no findings. Inner, center, and outer strut rods were inspected with no findings. #6 seals liner was worn Remaining items were inspected with no findings.

Conducted: Exhaust case assembly was exchanged with an overhauled module from TSI. The exhaust case assembly had the following work completed.

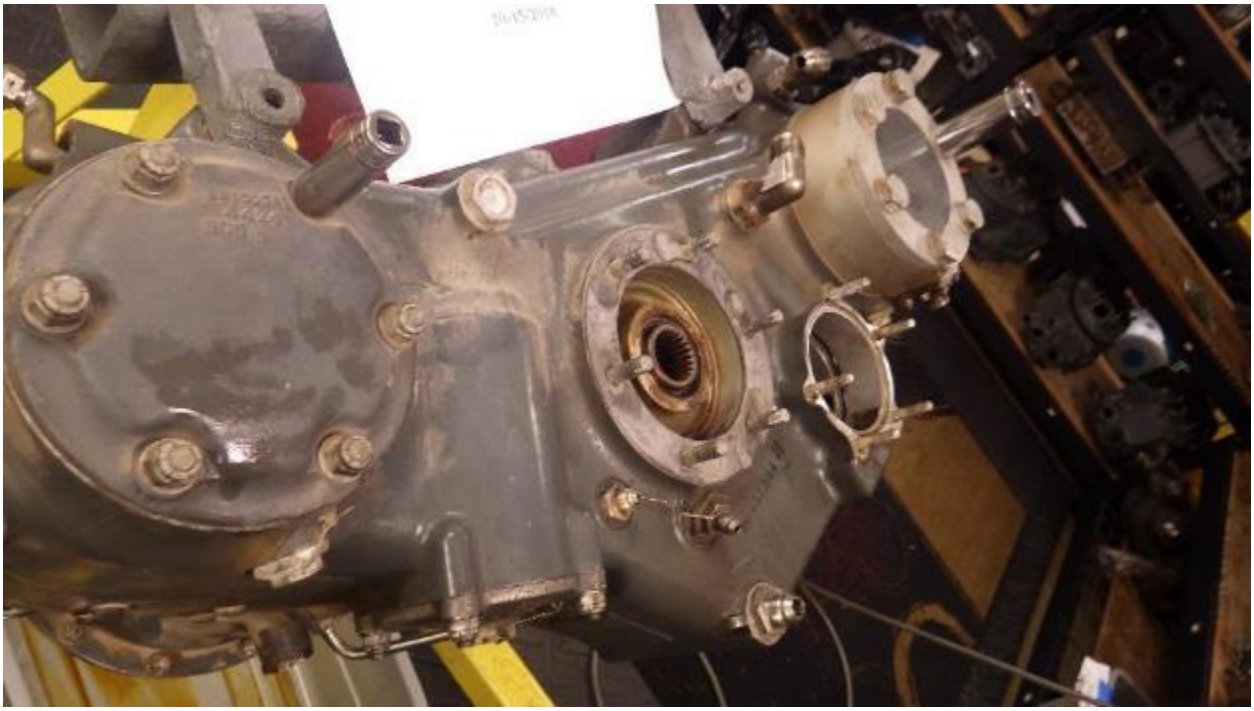
Exhaust case was grit blasted to clean and then had plasma band applied to outside of case per SB 71B26. Also applied plasma to I.D. of rear of case per SB 74L05. Outer duct was grit blasted to clean then had plasma band applied to O.D. of duct per SB 74L05. Inner duct and fairing assembly was grit blasted to clean. H-blocks and strut rods were cleaned and anti-galled. Installed overhauled #6 seals liner.

Corrected exhaust case run outs.

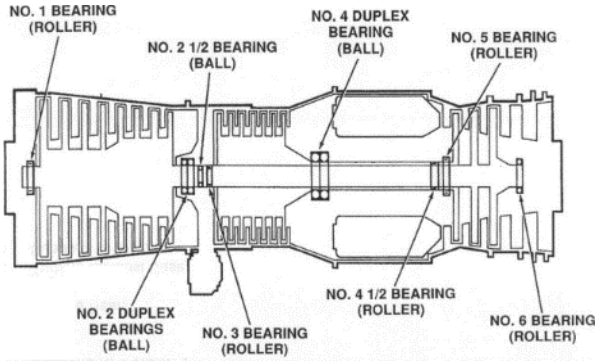
N2 Gearbox & Main Oil Pump Assy **2-4-1 through 2-4-5**



Initial Scope: Clean and flush case, inspect.
Findings: Gearbox was split and gears and bearings were inspected with no findings. Main oil pump 3 drive gears have wear on the journals. Scavenge housing has 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 3 drive gears had the journals restored. Scavenge housing was E-poly repaired. Strainer was cleaned and reassembled.



Main Line Bearings



Initial Scope: Inspect and report findings.
#1 Oil damp bearing inspected with no findings
#2 Bearing inspected with no findings
#2.5 Bearing inspected with no findings
#3 Bearing had scored rollers
#4 Bearing inspected with no findings
#4.5 Bearing inspected with no findings
#5 Bearing had a small portion of one of the rollers missing.
#6 Non oil damp bearing inspected with no findings

Conducted:
#1 Oil damp bearing overhaul inspected. Two seal rings for oil damp bearing were replaced
#2 Bearing overhaul inspected.
#2.5 Bearing overhaul inspected
#3 Bearing replaced.
#4 Bearing overhaul inspected.
#4.5 Bearing overhaul inspected
#5 Bearing overhaul inspected.
#6 Non oil damp bearing overhaul inspected.

Main Line Seal Assemblies

Initial Scope: Inspect and report findings.

Findings:
#1 Carbon rings replace with new
#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
#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 Carbon rings replaced 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
#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

Initial		Final		% of limit	Run outs	
Rear	Front	Rear	Front			
LPC Balance						
20gr	**29gr**	**.682gr**	**.973gr**	**% of limit**	front	back
13.29gr@287°	**21.76gr@ 248°**	**.220gr@227°**	**.412gr @227°**	**37%**	**.0005"**	**.0005"**
HPC Balance						
24gr	**28.8gr**	**.612gr**	**.887gr**	**% of limit**	front	back
12.16gr@204°	**16.65gr @ 70°**	**.274gr@274°**	**.741gr@251°**	**65%**	**.001"**	**.001"**
HPT Balance						
		.9gr		**% of limit**	**rivets**	**shaft**
21.50gr @ 297°		**.528gr @ 102°**		**59%**	**.005"**	**0.001"**
LPT Balance						
22.6gr		**1.13gr**		**% of limit**		
11.86gr @ 220°		**.636gr @ 94°**		**56%**		
spacer flatness	**spline concentricity**	**#4.5**	**#6**	**T-2**	**T-3**	
.001"	**.002"**	**.001"**	**.002"**	**.003"**	**.003"**	

Compartment Flow Checks					
#1	2 & 3	#4	4 & 5	#6	final
3.5 – 12.5pph	**37 - 52pph**		**60 - 80pph**	**15 - 21pph**	
9.5pph	**42pph**		**61pph**	**21 pph**	
Compartment Pressure Tests					
6pph max	**14pph max**	**6.5pph max**	**12pph max**	**0pph max**	**56pph max**
5.2pph	**14pph**	**6pph**	**11.2pph**	**0pph**	**50pph**
Exhaust Case Runouts					
concentricity	flatness				
.0005"	**.002"**				

Appendix A