

Semi Annual Inspection

July 2024

For



Den Haag

Unit 52

ESN 192-229

Under

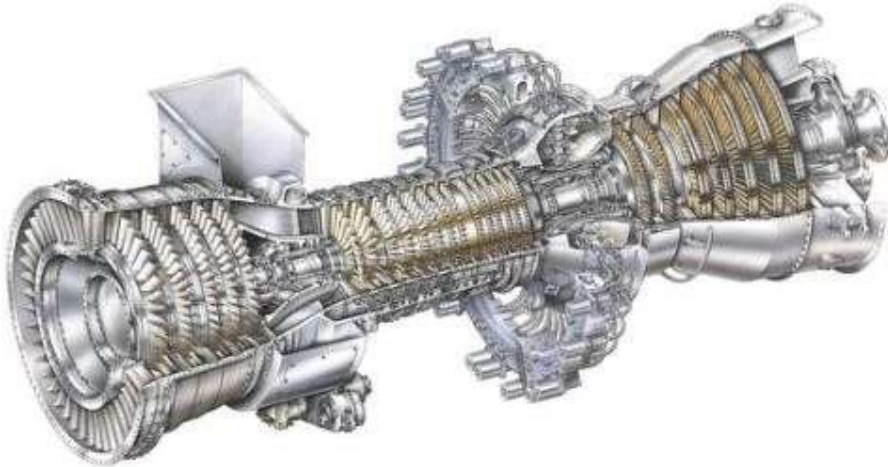
PMX# I01-101416

Customer Representative:

Max Bavelaar

GE Field Service Representative:

Mark van Malsen & Leonardo Ciccacci



All technical recommendations and information contained in this report are based on GE manuals that have been developed and approved for use with GE engines and parts that have been operated and maintained in accordance with GE technical documentation and recommendations.

GE has no technical knowledge of, nor obligation for, non GE-approved parts and repairs. Accordingly, this report is not intended to apply to non GE-approved parts and repairs, nor to any parts that may be directly or indirectly affected by non GE approved parts and repairs.

1 SUMMARY

The purpose of this visit was to perform:

- Semi Annual Inspection - BSI
- VSV Sleeves stage IGV, 1 and 2 replacement and
- Bearing replacement Lever Arm stage 5

This work scope was completed in accordance with GEK105059.

The unit **is** available for continued operation.

2 Outage Data

2.1 Engine Data ESN 192-229 as or 16/06/2024

ESN	192-229
Model	LM6000PD
Total Package Operating Hours	71143
Total package Starts	2759
Total Engine Operating Hours	71143
Total Engine Starts	2759
Since last depot visit for HSE, Hours	17900
Since last Depot visit for HSE, Starts	961

2.2 Maintenance Data:

WP, SB, SL, PB, PL Performed	Description	Sign Outs Date	Comments (fill with WP result)
WP4015 00	Borescope inspection	3 July 24	See findings BSI report
WP4010 00	Inlet and Coupling Inspection	3 July 24	Found Inlet bit dirty and dirty VIGV Inlet Guide Vanes
WP 4012 00	External Engine Inspection	3 July 24	See findings VBV system
WP 4020 00	L&S pump screen Check	2 July 24	All clean and no metal or debris
WP 4017 00	L&S pump Chip Detector Check	2 July 24	No Metal
WP 1113 00	VIGV System Check	2 July 24	OK
WP 1312 00	VBV System Check	2 July 24	OK
WP 4021 00	VG Pump/HCU Filter Check	3 July 24	Filter Changed
WP 1516 00	Igniter Plug Inspection	3 July 24	OK
WP 1711 00	T48 Inspection	3 July 24	OK
WP 1712 00	P48 Inspection	3 July 24	OK
WP 4014 00	GT Water Wash	3 July 24	Carried out by the customer
WP 4013 00	GT Exhaust System Inspection	4 July 24	Found cracks in welding and Dirty stage % Blades
O&M	D/E Sump Interface Cleaning	3 July 24	Was clean
LM6000-04-01 R2	PCC forward Mount Bolt Wear	3 July 24	Bolts are in good condition

2.3 Parts Data

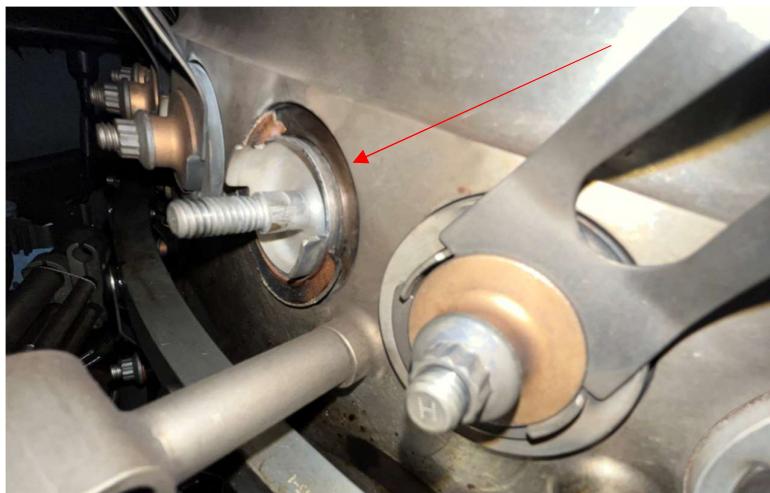
Description	PN Removed	Qty	PN Installed
Bushings	9207M68P13	11	9207M68P13
Sleeves	9146M80P05	96	9146M80P05
HCU Filter	AC-B244F-244OY1	1	AC-B244F-244OY1
Bearing	1333M67P01	1	1333M67P01

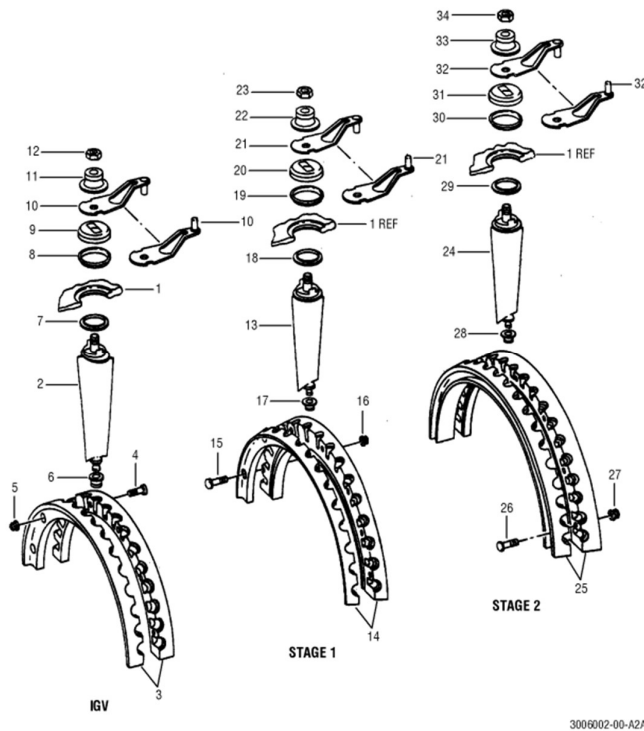
2.5 Open CSL Action Items - Findings

1. Replace VSV bushings Stage IGV, 1 and 2. (Fig. 18 item 7 and 8, 18 and 19, 20 and 30).

We have changes 11 Bushings on the outside where it was metal to metal. (inside is not possible when casing are installed)

- LH side Lower Casing, stage 1 position 7 and 8 below splitline.
- LH side Lower Casing, stage 2 position 4, 6, 7 and 11 below splitline.
- RH side Lower Casing, stage 1 position 6 below splitline.
- RH side Lower Casing, stage 2 position 4, 6 and 7 below splitline.

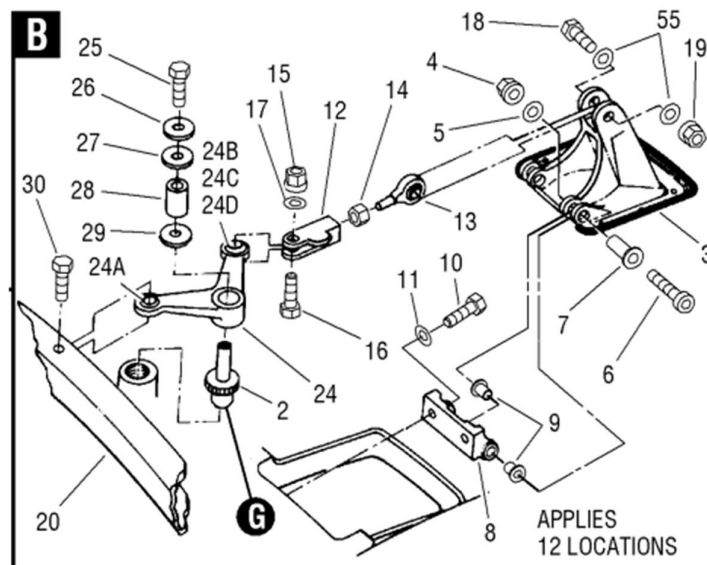




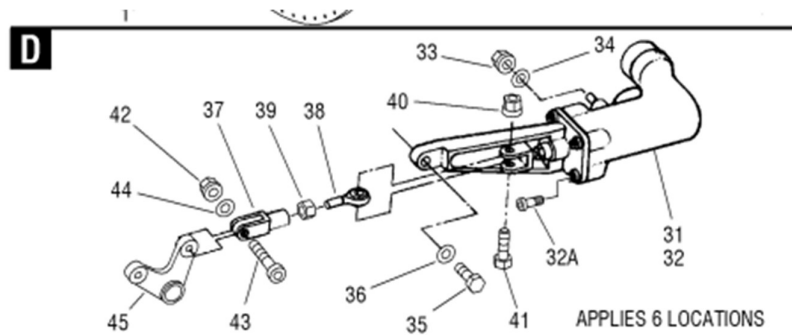
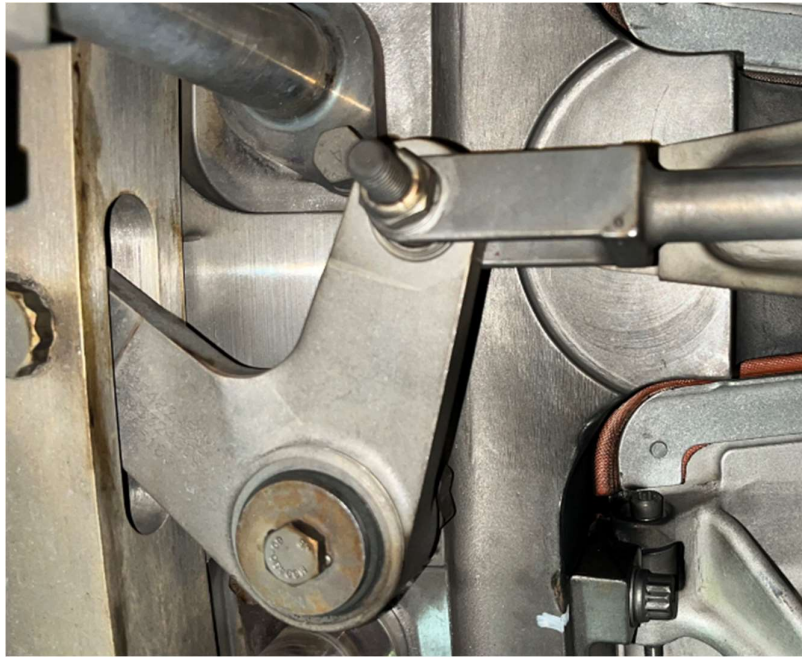
2. Open item from last year and year before. (fig. 3 item 24)

Before the next outage it is advisable to order the parts required for the VBV bellcrank bearing replacements. These were mentioned as being worn in the April 2022 outage and they seem to have deteriorated since then. (Photo taken from the April 2022 report)

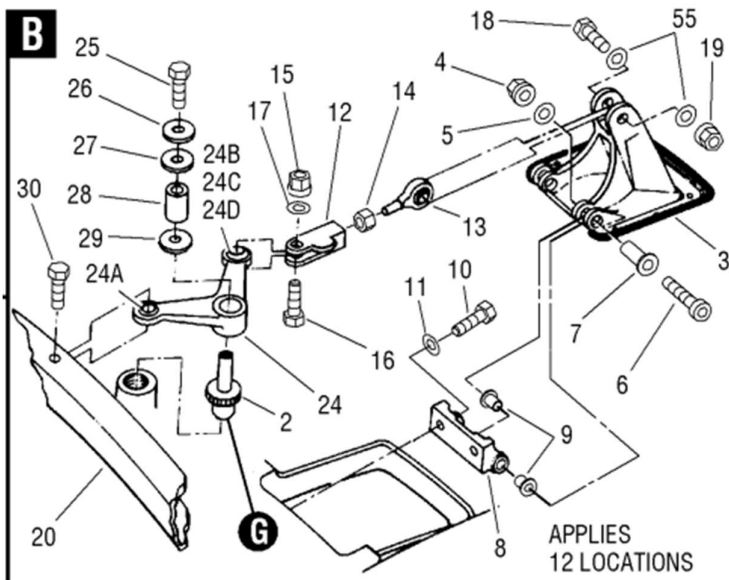




3. Also advisable to replace VBV Actuator Bellcrank Bearings (Fig.3 item 45).



4. VBV door Bushings found with cracks again, replaced also last year (Fig. 3 item 7)



3 DETAILS AND DATA

The purpose of this visit was to perform:

- Semi Annual Inspection - BSI
- VSV Sleeves stage IGV, 1 and 2 replacement and
- Bearing replacement Lever Arm stage 5

Jobs performed

1. Borescoped GT.
2. Inspected GT external.
3. Inspected VIGV, VBV and VSV and performed open close rigging check.
4. Inspected screens and chip detectors.
5. Inspected HCU filter and installed new HCU filter.
6. Inspected Ignitors, Pressure Probe and T48 Probes.
7. Inspected PCC Manifold FWD mount bolts.
8. Inspected D/E sump Drain Block
9. Inspected Filter House, Inlet and Exhaust.
10. Replaced VSV Sleeves.
11. Replaced Lever Arm stage 5 Bearing.
12. Replaced several VSV Bushing stage IGV, 1 and 2.

SAI Results and Sign outs

3.3 Borescope Inspection

Perform Borescope Inspection IAW GEK105059 WP4015 00		DONE	N/A
Borescope inspection performed and report Uploaded to SN case	CHECK	X	

For findings details please refer to Borescope inspection report

3.4 Inlet and Coupling Inspection

Perform Inlet and Coupling Inspection IAW GEK105059 WP4010 00		DONE	N/A
C. Using bright light, visually inspect gas turbine inlet per table 1. See figures 1 and 2.	6.C.	X	
E. Before exiting the enclosure, perform a thorough, final inspection for possible foreign objects.	6.E.	X	

Result: Found Inlet plenum in a bit dirty condition and also three VIGV found in dirty condition, LPC stage zero was found clean.





Dirty Inlet Plenum



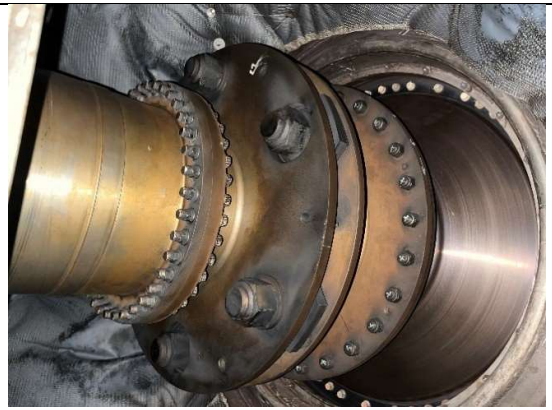
Dirty VIGV



Dirty VIGV



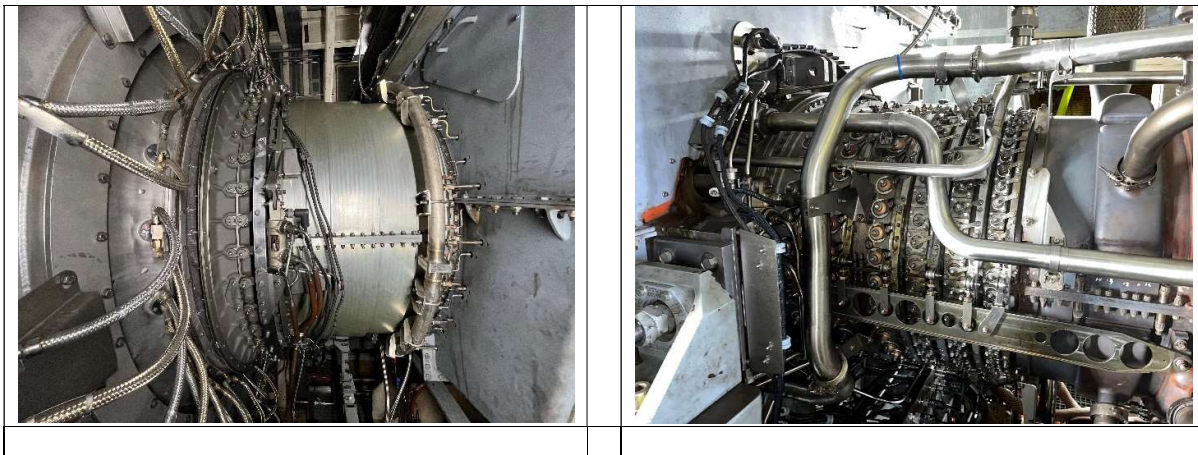
LPC stage 0 Blades clean

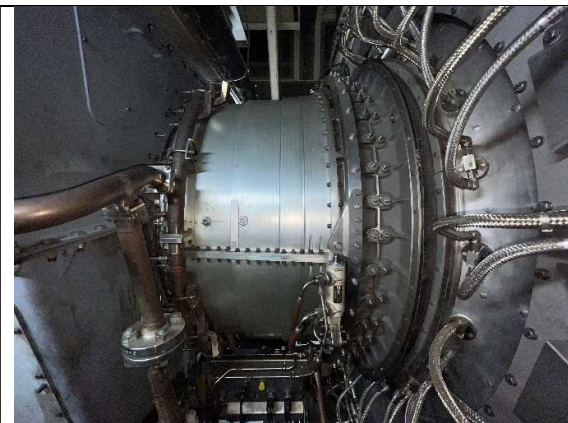
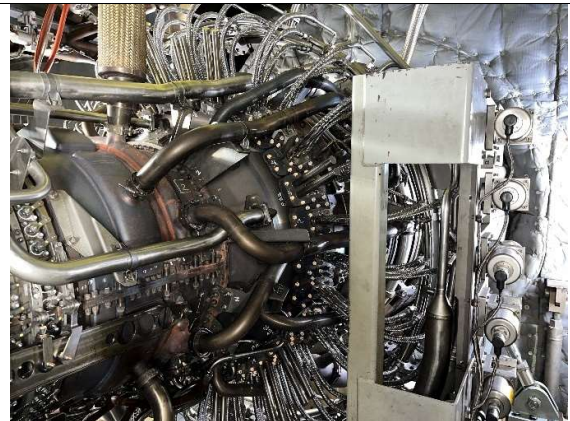


3.5 External Engine Inspection

Perform External GT Inspection IAW GEK105059 WP4012 00		DONE	N/A
A. Inspect tubing, hoses, and electrical harnesses per table 1.	6.A.	X	
B. Inspect variable inlet guide vane (VIGV) assembly per table 2 and figure 1.	6.B.	X	
C. Inspect low pressure compressor (LPC) per table 3 and figure 2.	6.C.	X	
D. Inspect air collector per table 4.	6.D.	X	
E. Inspect the front frame assembly per table 5 and figure 2.	6.E.	X	
F. Inspect transfer gearbox assembly (TGB) per table 6.	6.F.	X	
G. Inspect high pressure compressor (HPC) case per table 7 and figures 3 and 4.	6.G.	X	
H. Inspect variable stator vane (VSV) actuation components per table 8 and figure 5.	6.H.	X	
I. Inspect fuel manifold per table 9.	6.I.	X	
J. Inspect compressor rear frame (CRF) per table 10 and figure 6.	6.J.	X	
K. Inspect acoustic baffles per table 11.	6.K.	X	
L. Inspect high pressure turbine (HPT) per table 12 and figure 7.	6.L.	X	
M. Inspect low pressure turbine (LPT) per table 13 and figure 8.	6.M.	X	
N. Inspect turbine rear frame (TRF) per table 14 and figure 8.	6.N.	X	

Results: Found oil at RH side below L&S pump on RH Leg.







Oil found at RH side Leg, couldn't see were it is coming from.



3.6 Lube & Scavenge Pump Screen Check

Perform L&S pump Screen Check IAW GEK105059 WP4020 00		DONE	N/A
(1) Remove drain plugs or chip detectors from transfer gearbox (TGB), accessory gearbox (AGB), B-sump, C-sump, D-sump, and E-sump inlet screens. Remove and discard preformed packings.	6.B.(1)	X	
(4) Remove lube inlet screen and six lube scavenge inlet screens from lube and scavenge pump, and identify by location using tags or vibropen etch. Remove and discard preformed packings.	6.B.(4)	X	
1 Component replacement is required. See table 1 for possible corrective action details.	7.A.(2)(a)1		X
B. Lubricate new packings, P/N M83248/1-912, with lubricating oil, and install onto TGB, B-, and C-sump inlet screens. Install inlet screens into same ports from which they were removed and tighten to 57-67 lb in. (6.5-7.5 Nm) of torque. Safety-wire inlet screens.	8.B.	X	
C. Lubricate new packings, P/N M83248/1-908, with lubricating oil, and install onto AGB, D, and E-sump inlet screens. Install inlet screens into same ports from which they were removed and tighten to 57-67 lb in. (6.5-7.5 Nm) of torque. Safety-wire inlet screens.	8.C.	X	
D. Lubricate packing, P/N M83248/1-121, with lubricating oil, and install on lube inlet screen. Install lube inlet screen into same port from which it was removed and tighten to 57-67 lb in. (6.5-7.5 Nm) of torque. Safety-wire lube inlet screen.	8.D.	X	
E. Lubricate new packings, P/N M83248/1-905 or P/N J221P905, if chip detectors are used, with lubricating oil. Install packings onto drain plugs or chip detectors and install in AGB, TGB, B-, C-, D-, and E-sump inlet screens. Tighten drain plugs or chip detectors to 57-67 lb in. (6.5-7.5 Nm) of torque.	8.E.	X	

Results: No metal or any debris found.

GEK 105059 Volume # WP 4020 00 LM6000 PC GE Industrial Aero-Derivative Gas Turbines Figure 1: Lube and Scavenge Pump Screens Check	
VBV doors open	VBV doors closed with rigging pin aligned with hole.

3.7 Lube and Scavenge Pump Chip Detector Check

Perform L&S pump chip detector inspection IAW GEK105059 WP4017 00		DONE	N/A
(a) If material can be visually identified as bearing material, such as roller, ball, and/or race fragments: 1 Component replacement is required. See table 1 for possible corrective action details. Main engine bearings cannot be replaced on site. Main engine bearings must be replaced at depot level. 2 Review gas turbine log sheets for significant changes in gas turbine logged parameters because main gas turbine bearing distress normally increases lube scavenge temperatures and gas turbine vibration. (b) If suspect material is found on TGB chip detector or in TGB screen, source must be further identified. Remove lower drain plug and inspect TGB/A-sump area for any distress. (c) If suspect material is identified as bolt or rivet fragments, replace component as indicated by screen identity.	7.A.(2)(a)	X	

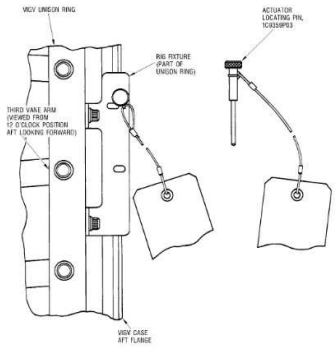
Result: No metal or any debris found.



3.8 VIGV system check

Perform VIGV system check IAW GEK105059 WP1113 00		DONE	N/A
(1) Install reducers from adapter set, 1C9393, onto hydraulic actuator unit, 1C3569 (figure 1). Tighten to 135-150 lb in. (15.3-16.9 Nm) of torque.	6.A.(1)	X	
(3) Disconnect head tube from HCU. Install head tube onto -4 to -10 reducer. Tighten coupling nut to 650-770 lb in. (73.5-87.0 Nm) of torque.	6.A.(3)	X	
(4) Disconnect rod tube from HCU. Install rod tube onto -4 to -8 reducer. Tighten coupling nut to 450-550 lb in. (50.9-62.1 Nm) of torque.	6.A.(4)	X	
(3) Apply 200-250 psi (1,379-1,724 kPa) system pressure to actuate VIGV system to full open Position. VIGV position indicator shall read 100 ± 1 percent (full open).	6.B.(3)	X	
(4) Insert actuator locating pin, 1C9359P03, through rig fixture -10 degree hole. Actuator locating pin, P03, shall slide freely. See figure 3. If difficulty is encountered, loosen both actuator-to-ring brackets at actuator rod ends as follows: (a) Release hydraulic pressure from system. (b) Loosen nuts that secure both VIGV actuator rod ends to actuation-to-ring brackets. See figure 4. (c) Insert pin so that actuator locating pin, figure 3, slides freely into rig fixture -10 degree hole.	6.B.(4)	X	
(8) Apply thread lubricant to threads of actuator rod-end bolts (detail A). Using bolts and nuts, secure actuator rod-ends onto actuator-to-ring brackets. Bolt heads are outboard. Tighten nuts to 350-410 lb in. (39.6-46.3 Nm) of torque.	6.B.(8)		x
(9) Tighten nuts that attach actuator-to-ring brackets onto actuation ring to 368-432 lb in. (41.6-48.8 Nm) of torque.	6.B.(9)		x
D. Connect head tube onto HCU. Tighten coupling nut to 55-65 lb ft (75-88 Nm) of torque (figure 2).	6.D.		x
E. Connect rod tube onto HCU. Tighten coupling nut to 460-540 lb in. (52.0-61.0 Nm) of torque.	6.E.		x
(3) Plot and review clearances at support blocks 180 degrees opposite each other. Example: 12:00 o'clock position equals 0.000 inch (0.00 mm) clearance, 6:00 o'clock position equals 0.040 inch (1.02 mm) clearance. Obtain shims L45101P01 through P08. Remove two bolts attaching support block to VIGV case at 12:00 o'clock position. Install shim to correct clearance at 6:00 O'clock position to 0.020 inch (0.51 mm). Install bolts and tighten to 33-37 lb in. (3.7-4.2 Nm) of torque.	6.F.(3)		x
	12:	x	
	6:	x	
(5) After shim corrections are complete, perform rig check per this WP.	6.F.(5)		x

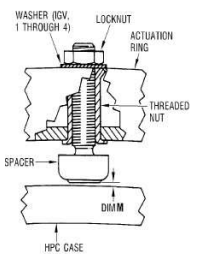
Result:

	
VBV doors open	VBV doors closed with rigging pin aligned with hole.

3.9 VSV Rigging check

Perform VSV rigging check IAW GEK105059 WP1411 00		DONE	N/A
B. Install reducers, from adapter set, 1C9393, onto hydraulic actuator unit. Tighten reducer to 133-157 lb in. (15.1-17.7 Nm) of torque.	6.B.	X	
C. Disconnect head tube from HCU. Install head tube onto -4 to -10 reducer. Tighten tube to 55-65 lb ft (75-88 Nm) of torque.	6.C.	X	
D. Disconnect rod tube from HCU. Install rod tube onto -4 to -8 reducer. Tighten tube to 460-540 lb in. (52.0-61.0 Nm) of torque.	6.D.	X	
C. Tighten locknuts to 60-70 lb in. (6.8-7.9 Nm) of torque.	7.C.	X	
D. Measure clearance between spacer and high-pressure compressor (HPC) case (dimension M). Clearance shall be within limits of figure 2.	7.D.		
	Dim M	X	
B. Apply 200-250 psi (1,379-1,724 kPa) system pressure to actuate VSV system to full closed position. VSV position indicator shall indicate 0 ± 1 percent.	10.B.	X	
C. Apply 200-250 psi (1,379-1,724 kPa) system pressure to actuate VSV system to fully open position. VSV position indicator shall indicate 100 ± 1 percent.	10.C.	X	
B. Connect head tube to HCU. Tighten coupling nut to 55-65 lb ft (75-88 Nm) of torque.	11.B.	X	
C. Connect rod tube to HCU. Tighten coupling nut to 460-540 lb in. (52.0-61.0 Nm) of torque.	11.C.	X	

Result: During VSV sleeves replacement we noticed several VSV bushing were gone or broken and it was metal to metal. We have replaced 11 of the Bushings, mentioned before in this report.



NOTE:
SPACER TO CASING CLEARANCES ARE TO BE MEASURED WITH THE VANE LEVER ARMS IN FULL OPEN POSITION

STAGE	DIMENSION M	
	MIN	MAX
IGV	0.002 IN (0.05 MM)	0.004 IN (0.10 MM)
1	0.002 IN (0.05 MM)	0.004 IN (0.10 MM)
2	0.002 IN (0.05 MM)	0.004 IN (0.10 MM)
3	0.002 IN (0.05 MM)	0.004 IN (0.10 MM)
4	0.005 IN (0.13 MM)	0.007 IN (0.18 MM)
5	0.017 IN (0.43 MM)	0.019 IN (0.48 MM)

1145665-00-012

Figure 2. VSV Actuation Ring Spacer Clearance



3.10 VBV System Check

Perform VBV System Check IAW GEK105059 WP1312 00	DONE	N/A
--	------	-----

C. Install seal gasket, P/N J219P04, onto VBV hose adapter from adapter set, 1C9393. Secure adapter to VBV head hose using washers and bolts. Tighten bolts to 32-38 lb in. (3.7-4.2 Nm) of torque.	6.C.	X	
E. Install seal gasket, P/N J219P03, onto VBV hose adapter from adapter set, 1C9393. Secure adapter to VBV rod hose using washers and bolts. Tighten bolts to 32-38 lb in. (3.7-4.2 Nm) of torque	6.E.	X	
F. Connect hydraulic actuator unit, 1C3569, to hose adapters. Tighten fittings to 133-157 lb in. (15.1-17.7 Nm) of torque.	6.F.	X	
H. Apply 200-250 psi (1,379-1,724 kPa) system pressure to actuate VBV system to the full closed position. Insert four rig pins, 1C9353. Rig pins shall insert freely through unison ring and thread into the four threaded bosses at the 12:30, 2:00, 6:30, and 8:00 o'clock positions. See figure 3. VBV position indicator shall indicate 0 ± 1 percent (full closed).	6.H.	X	
(7) Install six bolts and nuts that attach rod-end bearing/actuator clevis linkages to actuator rods. Tighten nuts to 125 lb in. (14.1 Nm) of torque.	6.I.(7)		x
(8) Ensure that a 0.055-inch (1.40 mm) diameter wire will not pass through witness hole in actuator devices. If necessary, turn rod-end bearing and clevis on actuator rod to position rodend bearing centered in actuator clevis.	6.I.(8)		x
(9) Tighten nuts on rod-end bearing/actuator clevis linkages to 80 lb in. (9.0 Nm) of torque. Safety cable or safety wire nuts to clevises as necessary.	6.I.(9)		x
K. Apply 200-250 psi (1,379-1,724 kPa) system pressure to actuate VBV system to the full open position. VBV position indicator shall indicate 100 ± 1 percent (full open).	6.K.	X	
O. Install new or serviceable seal gasket, P/N J219P03, onto HCU rod-end port. Secure VBV rod hose to HCU using washers and bolts. Tighten bolts to 32-38 lb in. (3.7-4.2 Nm) of torque.	6.O.	X	
P. Install new or serviceable seal gasket, P/N J219P04, onto HCU head-end port. Secure VBV head hose to HCU using washers and bolts. Tighten bolts to 32-38 lb in. (3.7-4.2 Nm) of torque	6.P.	X	
Q. Using washers, bolts, and nuts, install air collector access panels (figure 1). Tighten bolts and nuts to 57-67 lb in. (6.5-7.5 Nm) of torque.	6.Q.	X	

Result: Found worn VBV Door Bellcrank Bearing (mentioned last year also), Found VBV Actuating Ring Bellcrank Bearing worn and also found again cracked bushings, see reported above in this report.

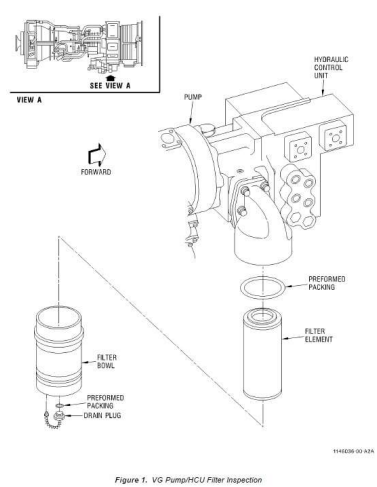
	
VBV doors open	VBV doors closed with rigging pin aligned with hole.

3.11 Variable Geometry Pump/HCU Filter Check

Perform HCU filter Check IAW GEK105059 WP4021 00		DONE	N/A
(1) Remove filter bowl drain plug. Drain fluid into a suitable container. Remove and discard preformed packing.	6.B.(1)	X	

(3) Remove and discard filter element.	6.B.(3)	X	
(5) Remove and discard preformed packing from filter bowl.	6.B.(5)	X	
(3) Install preformed packing, P/N M83248/1-243, into filter head.	6.C.(3)	X	
(4) Push filter element, P/N AC-B244F-2440Y1, into filter bowl.	6.C.(4)	X	
(5) Install filter bowl onto filter head and hand-tighten until filter bowl bottoms. Tighten filter bowl to maximum of 50 lb ft. (67.8 Nm) of torque.	6.C.(5)	X	
(6) Install preformed packing, P/N M83248/1-110, onto drain plug and install plug. Tighten plug to 49-57 lb in. (5.6-6.4 Nm) of torque.	6.C.(6)	X	

Result: Removed HCU Filter was clean, installed new HCU Filter.

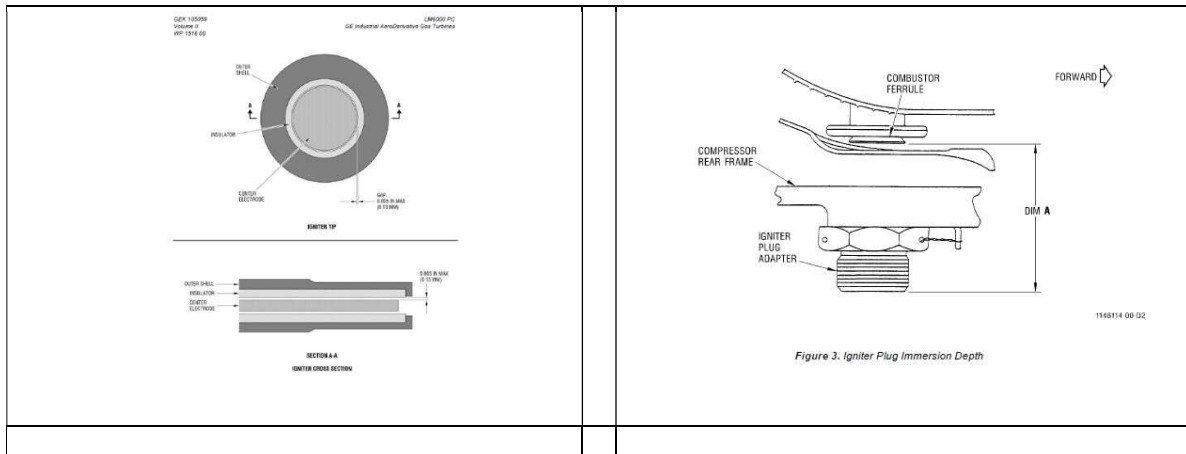
WP-4021 00  Figure 1. VG Pump/HCU Filter Inspection	 Old and new HCU filter
---	---

3.12 Igniter Plug Inspection

Perform Ignition Plug Inspection IAW GEK105059 WP1516 00		DONE	N/A
A. Inspect igniter plug per table 1 and figure 2.	7.A.	X	
A. Determine number of shims required as follows (figure 3): (1) Measure from outer surface of igniter plug adapter to outer surface of combustor ferrule using immersion depth gage, 2C6613. Record as dimension A.	8.A.(1)	X	
	Dim A (IGN1)LHS	60.22mm	

(2) Refer to table 2 to determine number of shims required.	Dim A (IGN2) RHS		59.94mm
	#Shims (IGN1)		3
	#Shims (IGN2)		4
D. Install ignition lead over igniter plug adapter. Tighten coupling nut to 23.0-27.0 lb ft (31.2-36.6 Nm) of torque.	8.D.	X	
E. If installing a single igniter unit in place of a double igniter unit, ensure correct plug and washer are installed. Apply thread lubricant to thread before installation. Tighten plug to 46-54 lb ft (63-73 Nm) of torque. Safety-wire blank off plug (figure 4).	8.E.	N/A	

Result: In good condition and amount of shims is correct.



3.13 T48 Inspection

Perform T48 Inspection IAW GEK105059 WP1711 00		DONE	N/A
D. Remove and discard gasket.	6.D.		X
A. Inspect thermocouples per table 1 and figure 3.	7.A.		X
A. Install new gasket, P/N 9379M93P01, onto LPT case.	8.A.		X

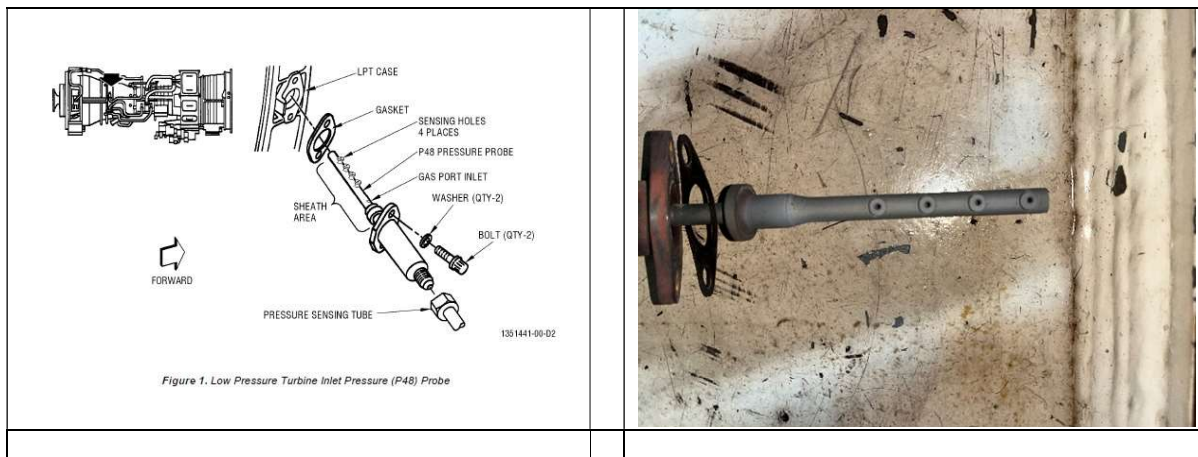
B. Install T48 thermocouple into LPT case with flat side of flange facing aft. Using thread lubricant, lubricate threads and friction surfaces of bolts and secure thermocouple with bolts. Tighten bolts to 90-100 lb in. (10.1-11.3 Nm) of torque and safety cable/wire.	8.B.	N/A
D. Tighten largest diameter nut to 29-33 lb in. (3.3-3.7 Nm) of torque. Tighten smallest diameter nut to 16-18 lb in. (1.8-2.0 Nm) of torque.	8.D.	N/A

Result: See BSI report, inspected the T48 Thermocouple in situation during borescope inspection, all in good condition.

3.14 P48 Inspection

Perform P48 Inspection IAW GEK105059 WP1712 00		DONE	N/A
C. Remove and discard gasket.	6.C.	X	
B. Inspect probe per table 1 and figure 1.	7.B.	X	
A. Install new gasket, P/N 1538M42P01, onto LPT case. See figure 1.	8.A.	X	
B. Install P48 pressure probe in LPT case so that holes in probe face forward. Secure probe with two washers and bolts. Tighten bolts to 55-70 lb in. (6.3-7.9 Nm) of torque. Safety-wire bolts	8.B.	X	

Result: No blocked holes or worn P48.



3.15 Gas Turbine Exhaust System Inspection

Perform GT Exhaust Inspection IAW GEK105059 WP4013 00		DONE	N/A
C. Using bright light, visually inspect turbine rear frame and inner and outer seal carriers for cracks, security, metal deposits, and damage. Contact General Electric Marine and Industrial Customer Service if discrepancies are found. See figure 1.	6.C.	X	

D. Using bright light, visually inspect exhaust duct, inner and outer diffuser walls, and housings for cracks, security, metal deposits, and damage. If discrepancies are found, refer to the packager's manual for limits and corrective action.	6.D.	X	
E. Using bright light, visually inspect inner and outer piston rings for wear and cracks (figure 1). If rings are worn or cracked, replace rings.	6.E.	X	

Result: Found cracks in the weldings, loose studs on the floor and found the LPT stage 5 TE dirty.

	
	Loose studs

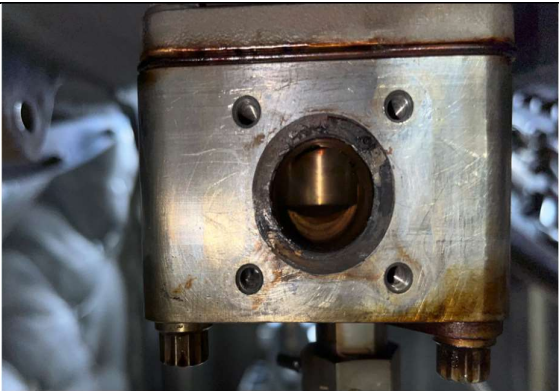
	
Cracks in welding	Crack in the welding

	
LPT stage 5 TE	LPT stage TE 5 dirty

3.16 D/E Sump Interface Cleaning

Perform D/E sump Interface Clean IAW GEK105059		DONE	N/A
disconnect package drain to clean engine and package drain	ANUALLY	X	

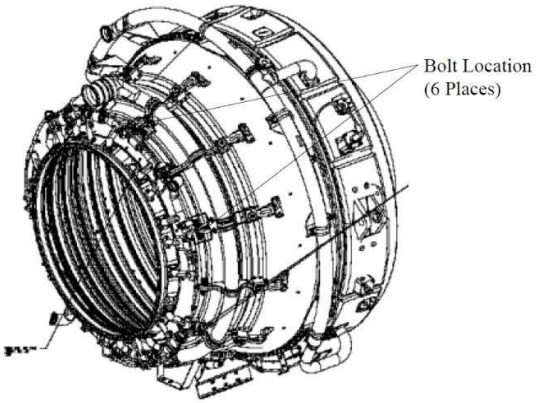
Result: Clean no cooked oil.


VBV doors open

3.17 PCC Forward Mount Bolt Wear Check

Check PCC Forward Mount Bolt Wear IAW SL 6000-01-03		DONE	N/A
Inspect these bolts for condition of wear (see photograph 1). The wear mode to inspect for is the reduction of bolt diameter where the bolt contacts the brackets. Replace bolts that are worn more than 0.005 – 0.010 inches in diameter.	CHECK	X	

Results: No seals coming out or worn Bolts.

 Bolt Location (6 Places)	
	No seals coming out and bolts ok


Bolts ok