



Aero Energy

## Borescope Inspection Report

28/09, 2019

For



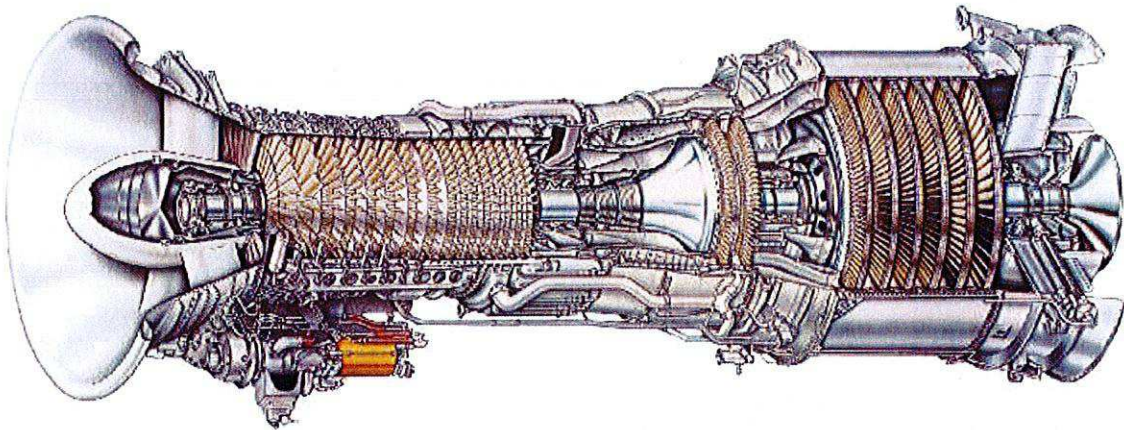
Unit A  
ESN 481-012

Under

GE project 1999123 / 2897805

Customer Representative:

GE Field Service Representative:



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.

Report completed by –



## **CONCLUSIONS & RECOMMENDATIONS**

The purpose of this visit was to perform a Periodic Borescope Inspection.

Engine wasn't wash before the BSI and will be done before start.

Found engine dirty

This Periodic Borescope inspection was completed in accordance with WP 406 00.

With the Filter house inspection found the filter dirty, a change of the filter needs to be done soon.

Found some oil in the air inlet, inlet will be cleaned after the water wash by the costumer reps.

The unit is available for continued operation.

### Engine Data:

ESN	481-012	Engine Fired Hours		Package Hours	84429
Model	LM 2500 Sac	Engine Fired starts		Package Fired Starts	1345

### Maintenance Data:

WP, SB, SL, PB, PL Performed	Revision/manual reference	Date completed	Comments
WP 406 00	Borescope Inspection	28.02.2019	Serviceable



## **DETAILS AND DATA**

### **Purpose of visit:**

The purpose of this visit was to perform a Periodic Borescope Inspection IAW WP 406 00.

### **Work performed:**

A borescope of the engine was performed using a Mentor flex scope and a electrical turning tool.

The engine was not water washed before the borescope, this is done after the inspection, before starting up.

VSV system check, opened by 13 Bar and closed by 15 Bar. Need more pressure for open and close the IGV/VSV system.

Filter house inspection (dirty filters)

Inlet inspection. (some corrosion on the inlet wall)

External engine inspection.

Screens and chip detectors checked, no findings.

HP recoup calc, calc shows no orifice change needed.

7 Fuel nozzle check and found all in limit

### **Daily activities**

27-02-2019 Travel to [REDACTED]

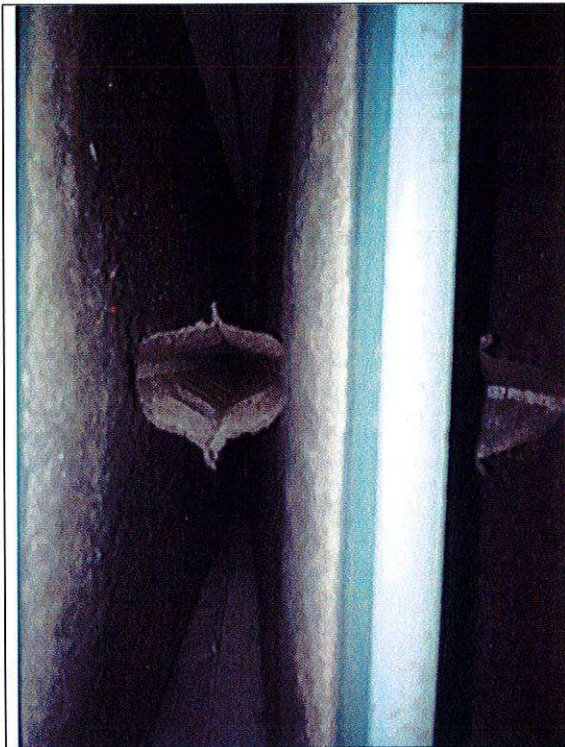
28-02-2019 Borescope and external engine inspection 481-012 and checked 7 fuel nozzles

29-02-2019 Travel onshore

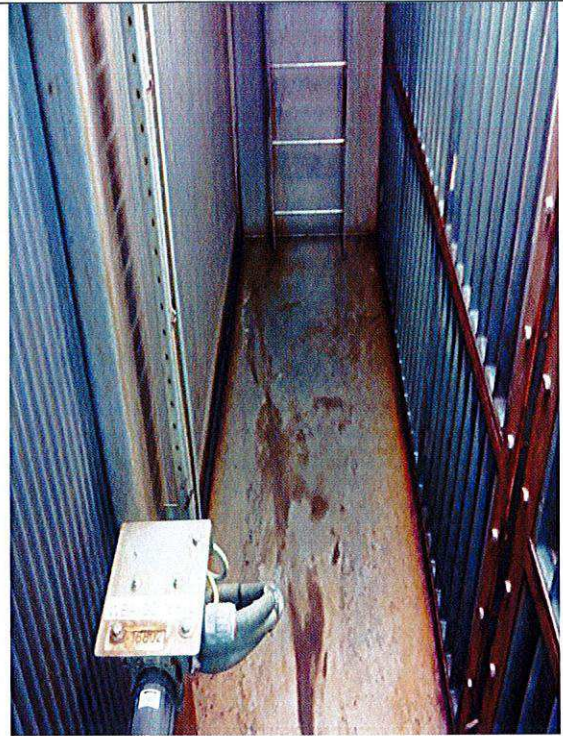




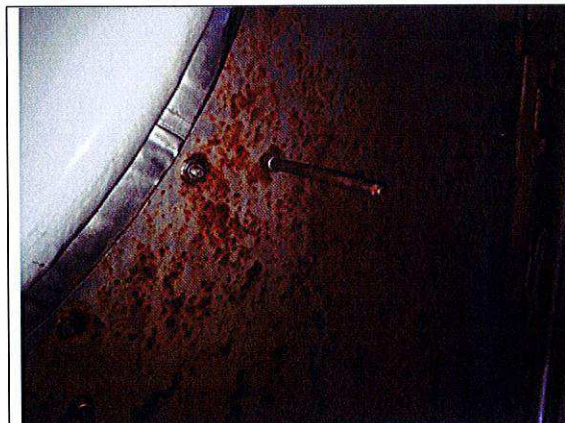
**Results:**



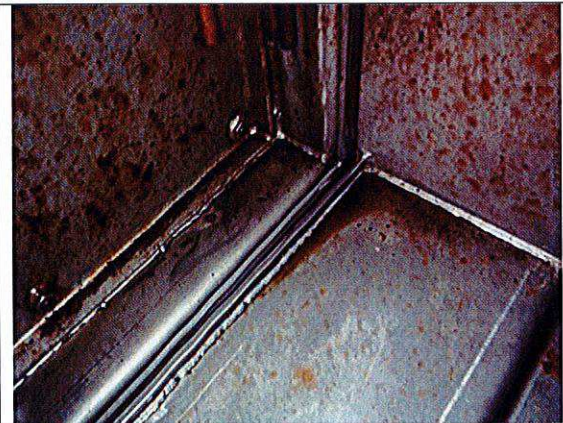
Found Filters dirty



Found dust on Filter house floor before filters

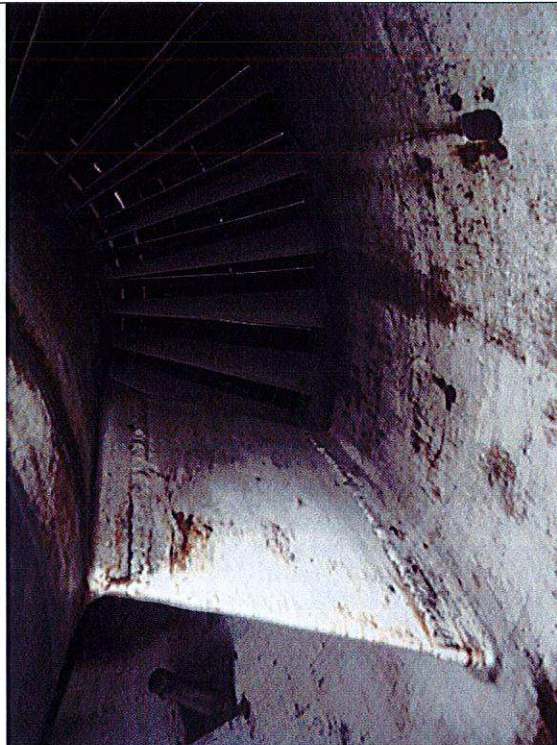


Corrosion on inlet wall

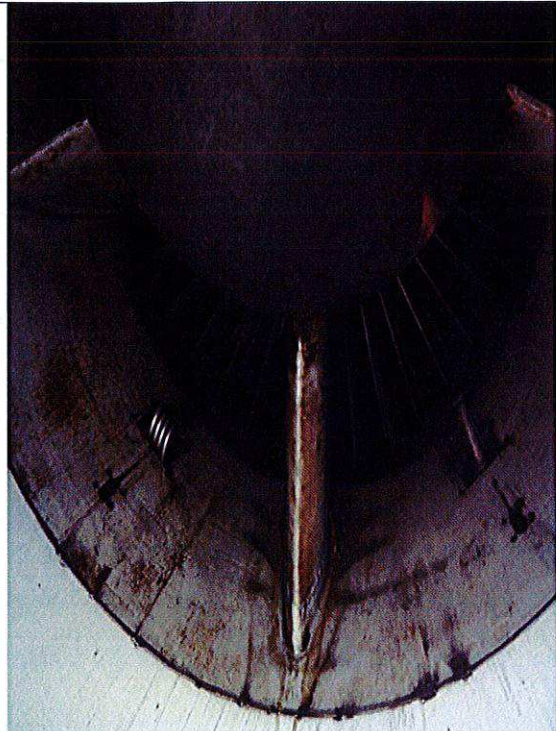


Found oil in Air inlet

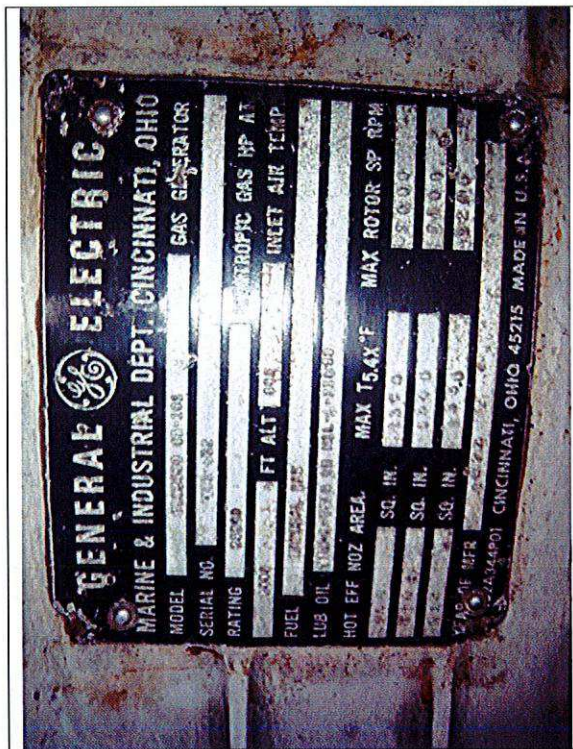




Engine inlet looks dirty



Stage 1 Mid Span



Engine S/N : 481-012





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# LM2500SAC Report

## High Pressure Compressor Photos

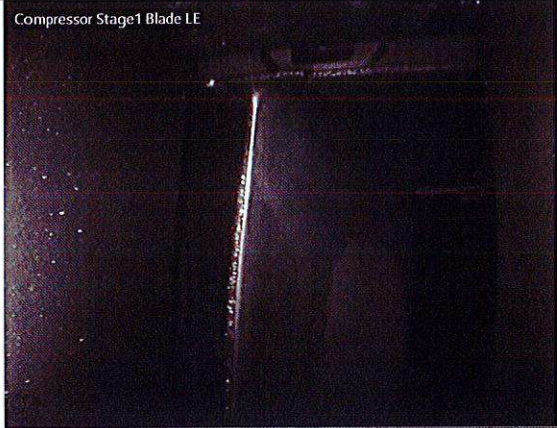


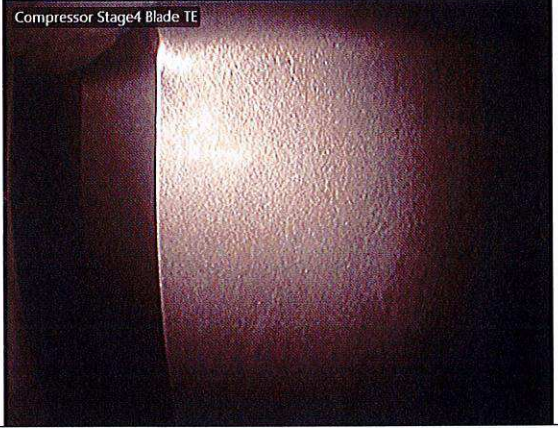


IGV	IGV casing found dirty
Stage 0 blades ok but dirty	Stage 0 Mid Span found dirty





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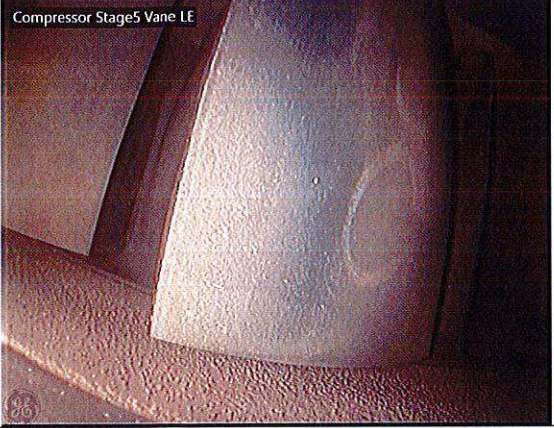
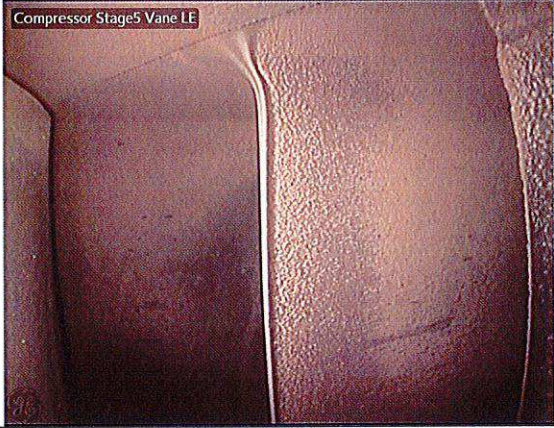
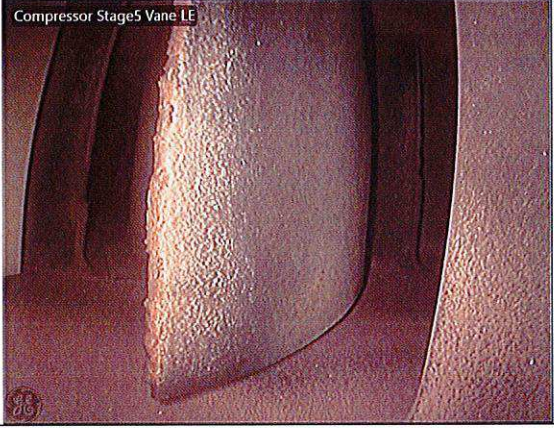
<p>Compressor Stage1 Blade LE</p>  <p>Stage 1 LE</p>	<p>Compressor Stage2 Blade LE</p>  <p>Stage 2 LE</p>
<p>Compressor Stage3 Blade LE</p>  <p>Stage 3 LE dirt build up</p>	<p>Compressor Stage4 Blade TE</p>  <p>Stage 4 TE</p>
<p>Compressor Stage5 Blade LE</p>  <p>Stage 5</p>	<p>Compressor Stage5 Vane LE</p>  <p>Stage 6 LE</p>





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 <p>Compressor Stage 5 Vane LE</p> <p>Stage 12 TE</p>	 <p>Compressor Stage 5 Vane LE</p> <p>Stage 13 LE</p>
 <p>Compressor Stage 5 Vane LE</p> <p>Stage 14 TE</p>	 <p>Compressor Stage 5 Vane LE</p> <p>Stage 15 LE Dirt build up</p>

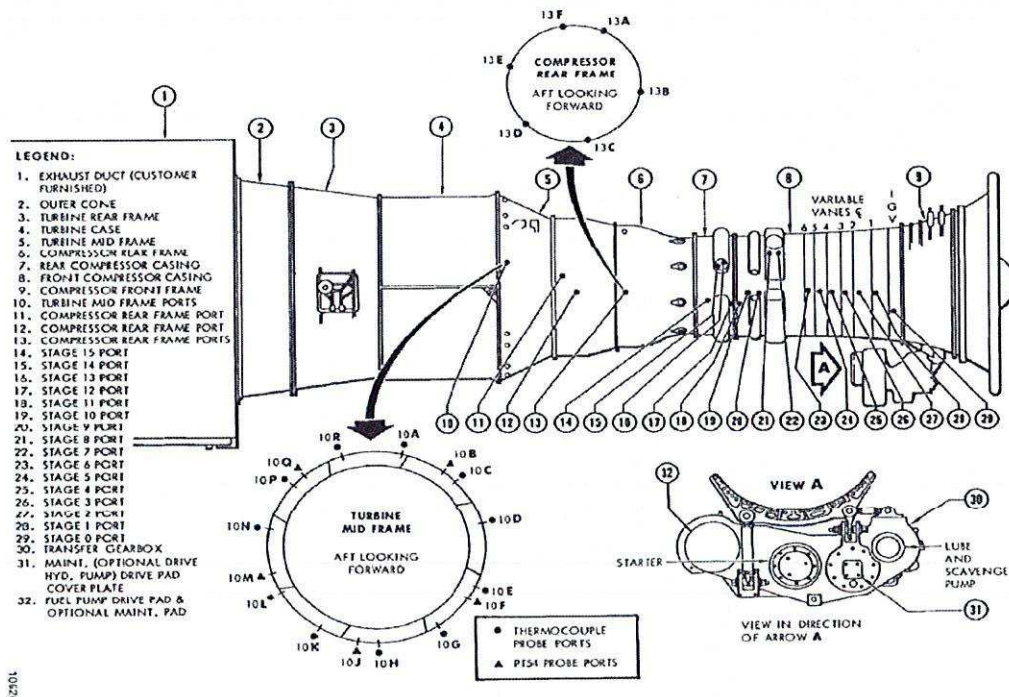




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## LM2500SAC Report

High Pressure Compressor	
Inspection Area	Comments
<input checked="" type="checkbox"/> Inspect stages 1 through 16 blades for cracks, nicks, tears, burrs, dents, missing material, evidence of tip clang, curl or deformation.	
<input checked="" type="checkbox"/> IGV	Serviceable
<input checked="" type="checkbox"/> Stage 1 Blades (Qty 26) & Vanes	Serviceable
<input checked="" type="checkbox"/> Stage 2 Blades (Qty 26) & Vanes	Serviceable
<input checked="" type="checkbox"/> Stage 3 Blades (Qty 42) & Vanes	Serviceable
<input checked="" type="checkbox"/> Stage 4 Blades (Qty 45) & Vanes	Serviceable
<input checked="" type="checkbox"/> Stage 5 Blades (Qty 48) & Vanes	Serviceable
<input checked="" type="checkbox"/> Stage 6 Blades (Qty 54) & Vanes	Serviceable
<input checked="" type="checkbox"/> Stage 7 Blades (Qty 56) & Vanes	Not insp.
<input type="checkbox"/> Stage 8 Blades (Qty 64) & Vanes	Not insp.
<input type="checkbox"/> Stage 9 Blades (Qty 66) & Vanes	Not insp.
<input type="checkbox"/> Stage 10 Blades (Qty 66) & Vanes	Not insp.
<input type="checkbox"/> Stage 11 Blades (Qty 76) & Vanes	Not insp.
<input checked="" type="checkbox"/> Stage 12 Blades (Qty 76) & Vanes	Serviceable
<input checked="" type="checkbox"/> Stage 13 Blades (Qty 76) & Vanes	Serviceable
<input checked="" type="checkbox"/> Stage 14 Blades (Qty 76) & Vanes	Not insp.
<input checked="" type="checkbox"/> Stage 15 Blades (Qty 76) & Vanes	Serviceable
<input checked="" type="checkbox"/> Inspect for erosion, corrosion or deposits.	
<input checked="" type="checkbox"/> Inspect for platform shingling, bowing, distortion or cracks	

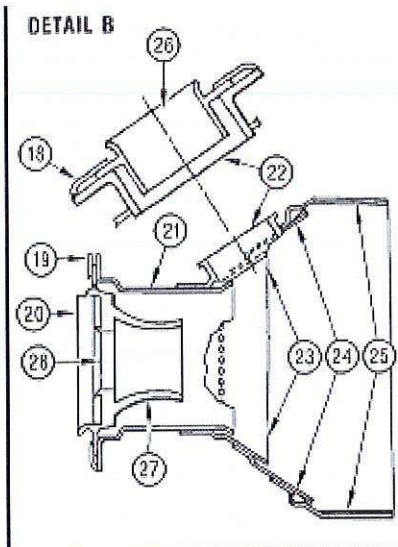
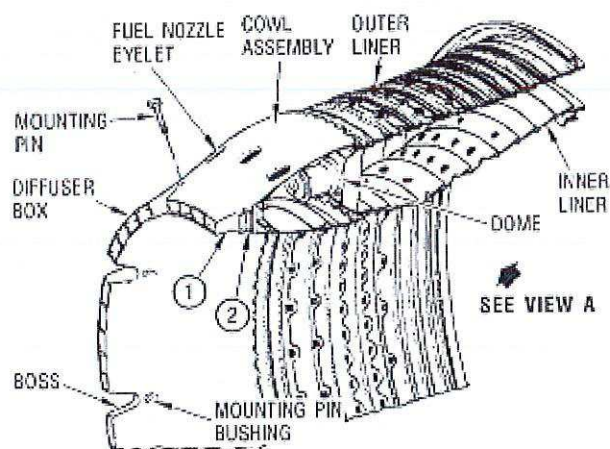






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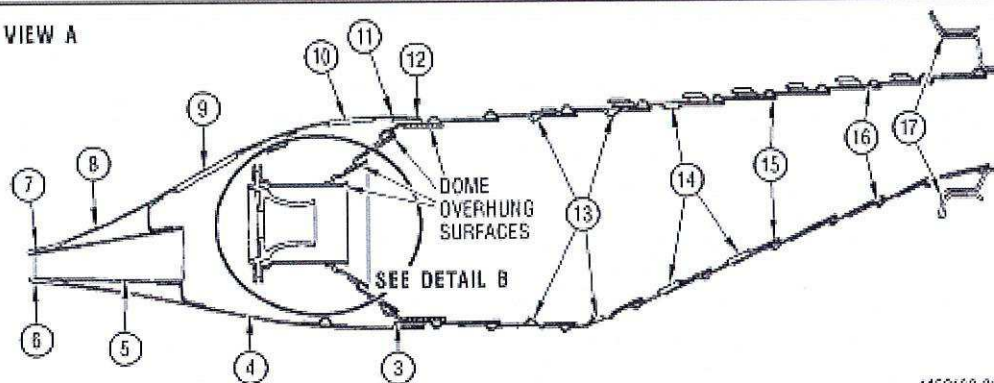
LM2500SAC Report



**LEGEND:**

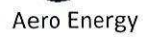
- |                          |                              |                                    |
|--------------------------|------------------------------|------------------------------------|
| 1. BOSS                  | 11. WIGGLE STRIP RING        | 20. SWIRLER/VENTURI                |
| 2. BUSHING, MOUNTING PIN | 12. RIVET JOINT              | 21. DOME CUP/SWIRL CUP             |
| 3. WIGGLE RING           | 13. SCOOP LOUVERS            | 22. SPARK IGNITER TUBE (2 PLACES)  |
| 4. INNER COWL            | 14. SCOOP LOUVERS            | 23. TRUMPET PLATE                  |
| 5. DIFFUSER BOX          | 15. BAND (TYPICAL)           | 24. DOME PLATE                     |
| 6. INNER RING            | 16. BAND COOLING HOLES       | 25. DOME RING/EMBOSSMENT/DOME BAND |
| 7. OUTER RING            | 17. SEAL                     | 26. IGNITER SLEEVE (2 PLACES)      |
| 8. OUTER COWL            | 18. IGNITER SLEEVE RETAINER  | 27. VENTURI                        |
| 9. FUEL NOZZLE EYELET    | 19. SWIRLER/VENTURI RETAINER | 28. WEAR SLEEVE                    |
| 10. IGNITER EYELET       |                              |                                    |

**VIEW A**

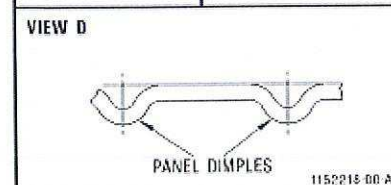
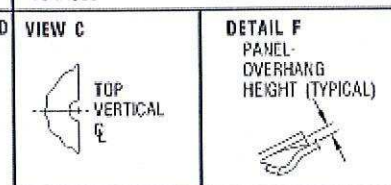
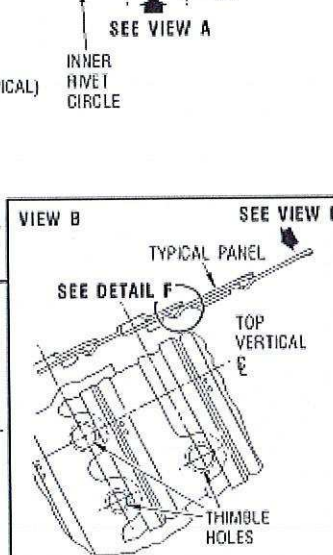
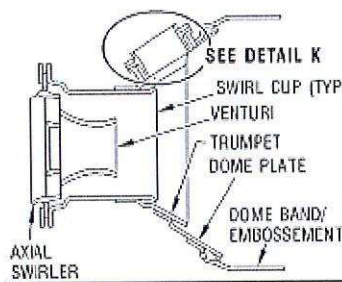
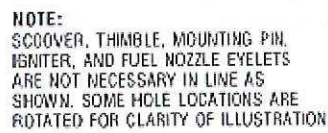


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**NOTE:**  
VIEW IS SAME AS THAT SEEN THROUGH  
BORESCOPE (MIRROR IMAGE)



1152215-00-A2T





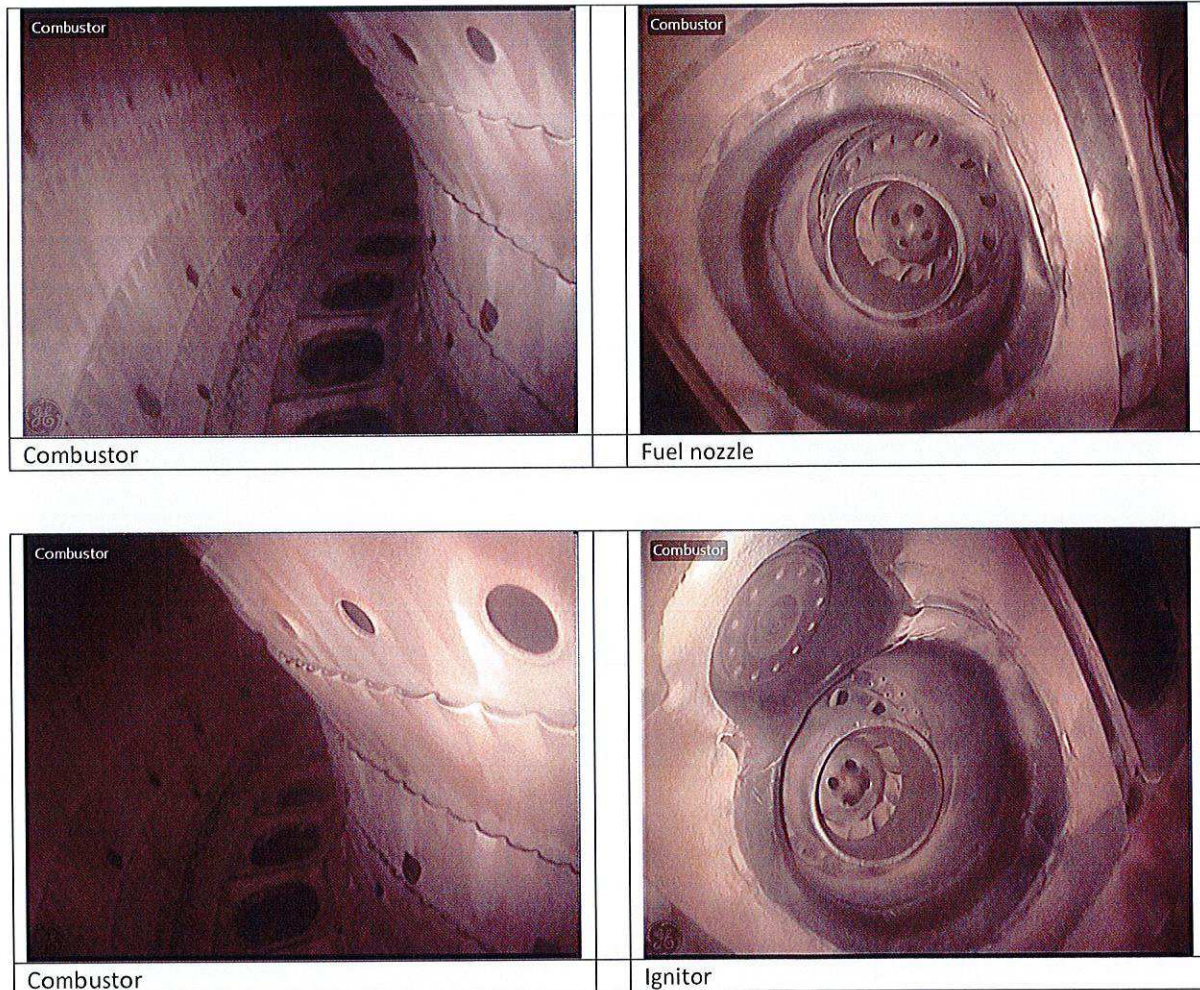
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LM2500SAC Report

Combustor	
Inspection Area	Comments
<input checked="" type="checkbox"/> Inspect combustor and 1 <sup>st</sup> stage HPTN Leading Edge with flex scope for burning, cracks, erosion, discoloration, wear and missing metal.	Serviceable
<input checked="" type="checkbox"/> Dome Plate	Serviceable
<input checked="" type="checkbox"/> Heat Shield Face and Wing areas	Serviceable
<input checked="" type="checkbox"/> Inner/Outer Liners	Serviceable
<input checked="" type="checkbox"/> Igniter Tube Area	Serviceable
<input checked="" type="checkbox"/> Fuel Nozzle Shrouds	Serviceable
<input checked="" type="checkbox"/> Fuel Nozzle Axial Swirler/Venturi	Serviceable
<input checked="" type="checkbox"/> 1 <sup>st</sup> Stage Nozzle	Serviceable
<input checked="" type="checkbox"/> Igniter Tube Area	Serviceable
<input checked="" type="checkbox"/> Inspect all visible fuel nozzle tips for contamination or damage.	Serviceable



Combustor Photos



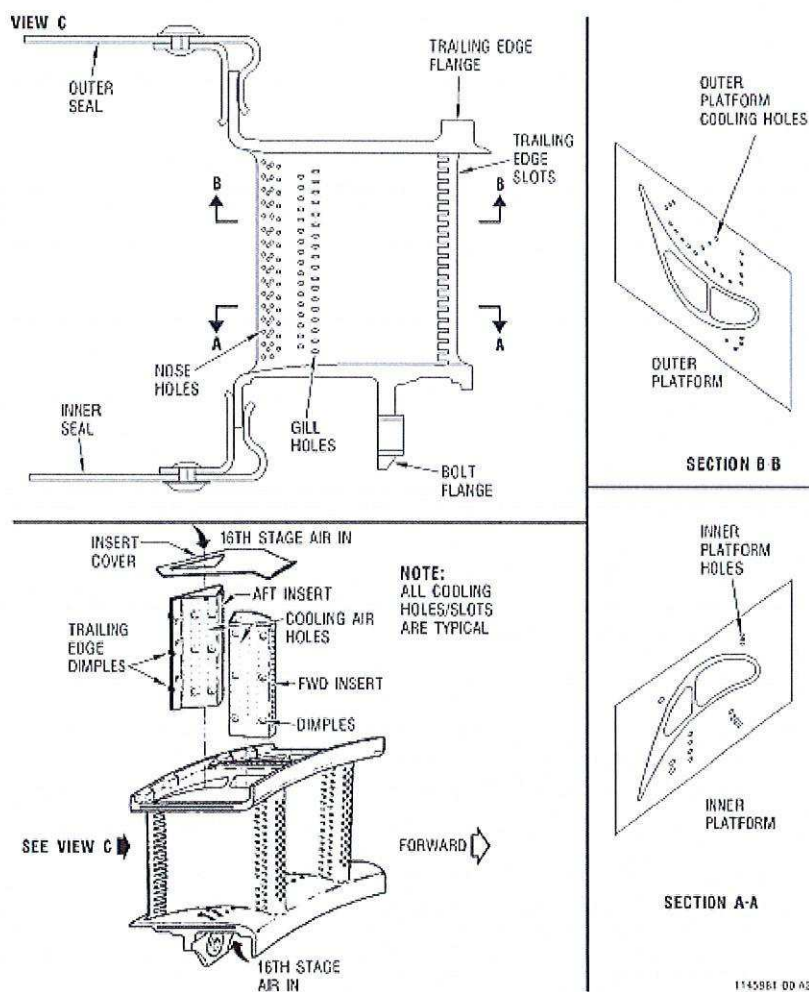




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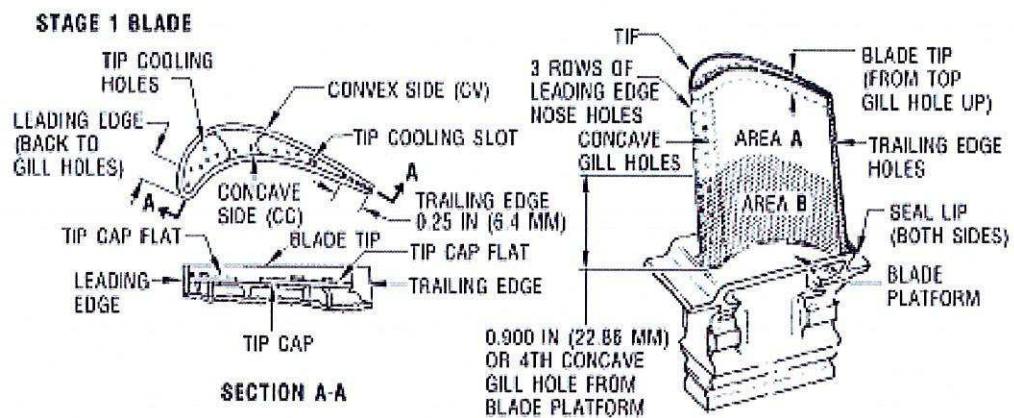
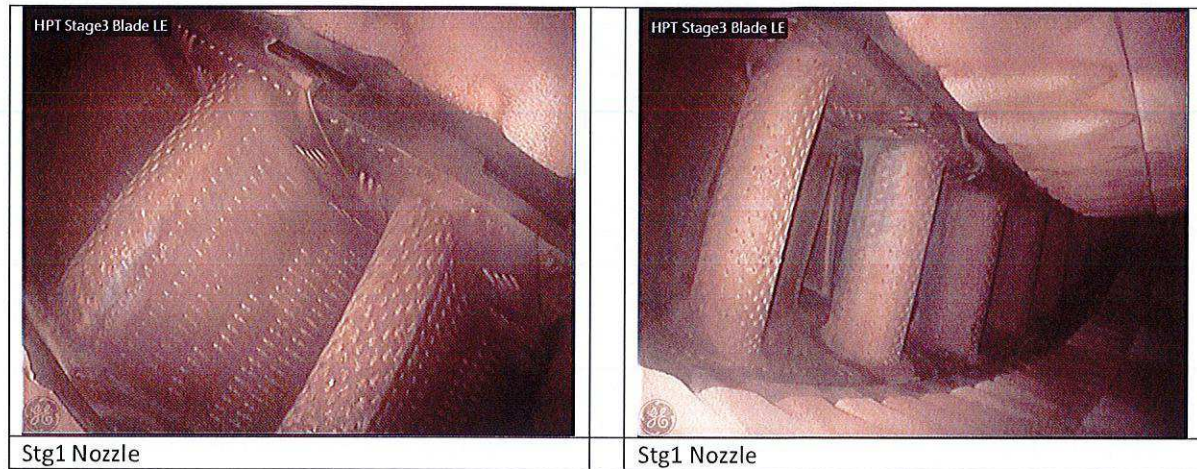
HPT	
Inspection Area	Comments
<input checked="" type="checkbox"/> Inspect 1 <sup>st</sup> stage HPTN Leading Edge through combustor with flex scope for burning, cracks, erosion, discoloration, wear and missing metal.	Serviceable
<input checked="" type="checkbox"/> HPT Stage 1 Rotor Blades (Qty 88)	Serviceable
<input checked="" type="checkbox"/> HPT Stage 2 Nozzle	Serviceable
<input checked="" type="checkbox"/> HPT Stage 2 Rotor Blades (Qty 90)	Serviceable



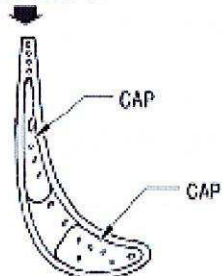


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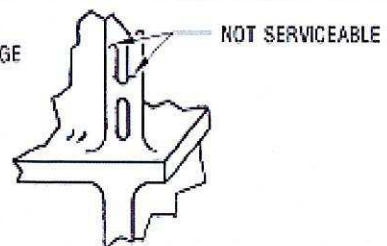


SEE VIEW A



VIEW A

TRAILING EDGE HOLES

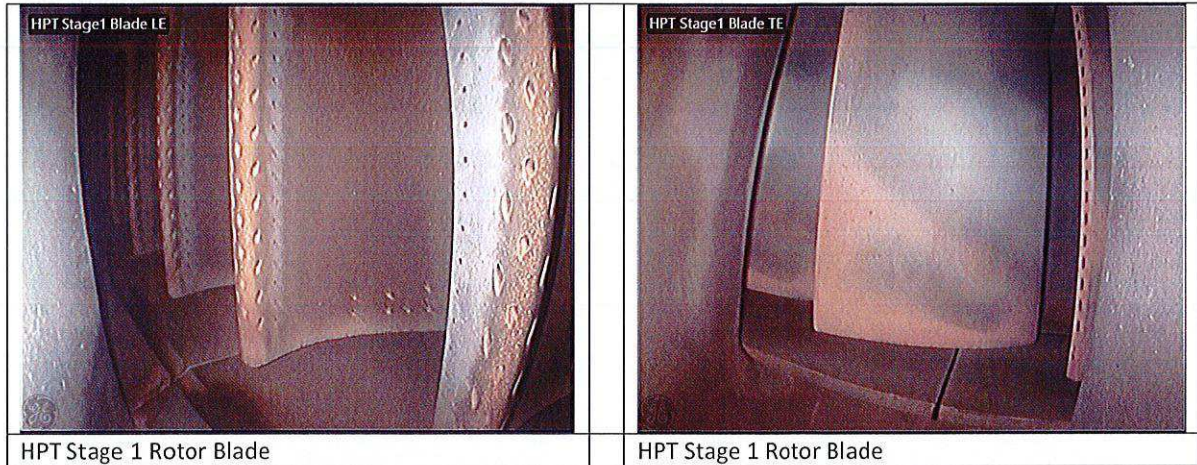


**TRAILING EDGE SURFACE  
AND INTERNAL HOLE CRACKS**

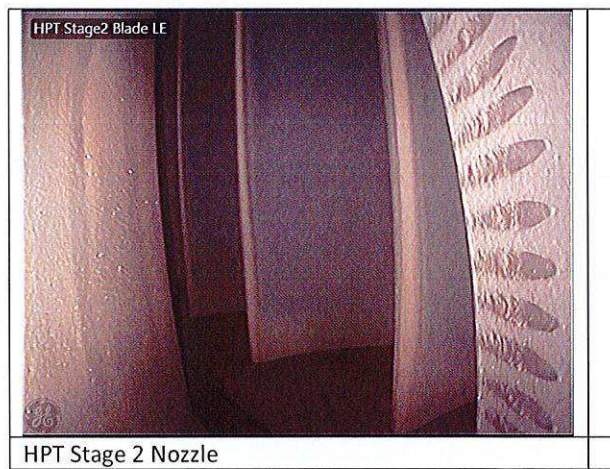


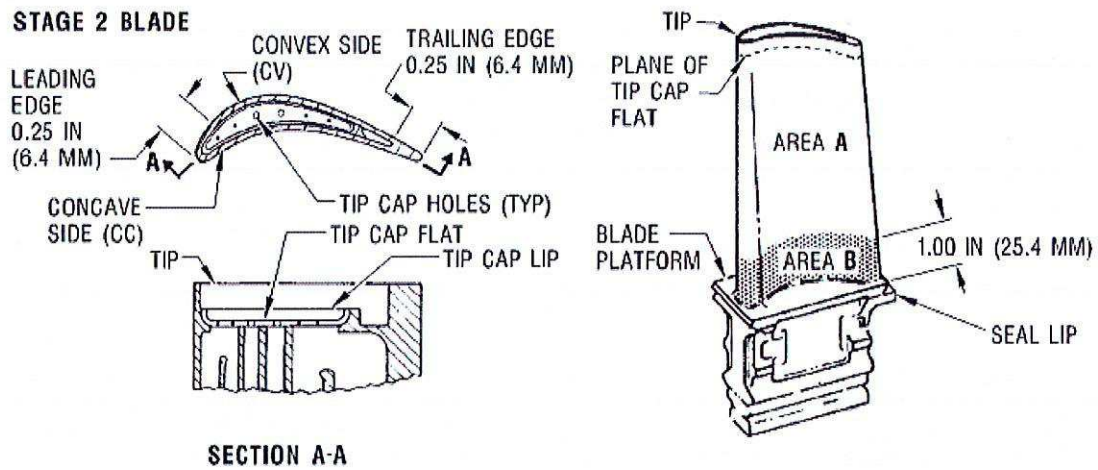


HPT Stage 1 Rotor Blade

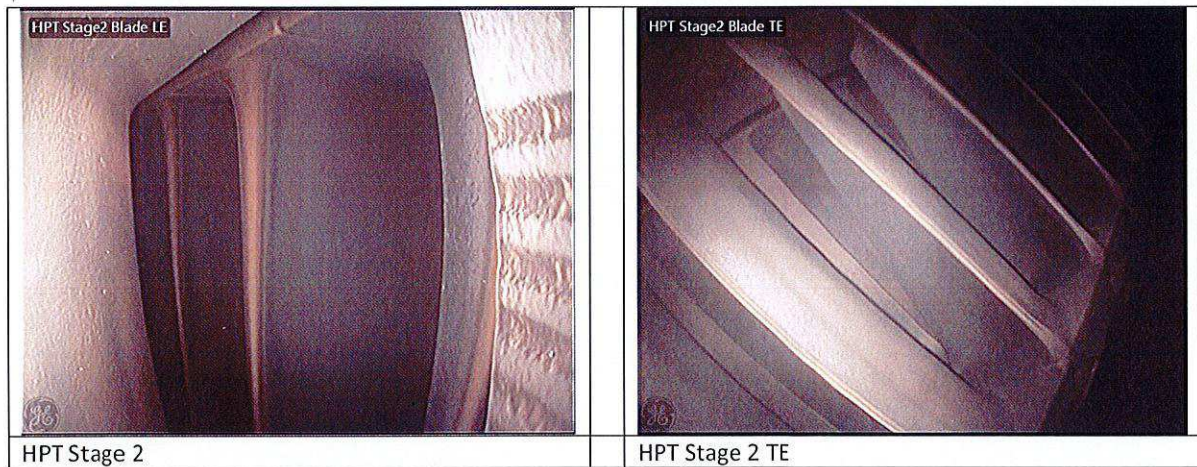


HPT Stage 2 Nozzle





HPT Stage 2 Rotor Blades







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## LM2500SAC Report

### Additional Photos

HPT Stage2 Blade TE



Termocouple (T 5,4)

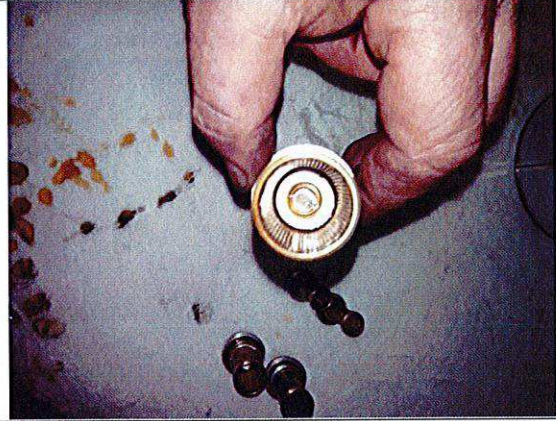
HPT Stage2 Blade TE



Stg 1 LPT Nozzle



Screen



Screen/chip





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LM2500SAC Report

## HP RECOUP ORIFICE SELECTION WORKSHEET

### LM2500 PE, PL, GE, GJ, PJ, GN, GS, PN, PS, PI, and PF MODELS ONLY

SITE Tyra west

DATE: 28-2-2019

RESET  
FORMLOG  
DATA

ESN: 481 O12

MODEL: PE/PL

Remove steam injection for a data point.

Fill in the below information for a data point: TARGET DATA POINT BETWEEN 9000 AND 9400 RPM AND ABOVE 40 PSIA P5.4

CURRENT ORIFICE DIA		4.000	Inches	{A}
INLET TEMPERATURE	(T2)	46.8	Deg F	{1}
INLET PRESSURE	(P2)	14.6	Psia	{2}
HP RECOUP PRESSURE	(HPRCP)	71.0	Psia	{3}
CDP	(PS3)	178.4	Psia	{4}
GG SPEED	(NGG)	8483	RPM	{5}
LPT INLET PRESSURE	(P5.4)	42.0	Psia	{6}

**Corrected Measurements:**

Corrected HPRC Pressure ((HPRCP/Delta) X 14.696)	14.696 * (	71.00	/	14.60	) =	71.47
14.696 x ( {3} / {2} ) = {7}		{3}		{2}		{7}
Corrected CDP Pressure ((PS3/Delta) X 14.696)	14.696 * (	178.40	/	14.60	) =	179.57
14.696 x ( {4} / {2} ) = {8}		{4}		{2}		{8}
Temperature Ratio (SQ RT of Theta)	SqRt of [ (	46.80	+ 459.67 ) /	518.67 ]	=	0.988
SqRt of [ ( {1} + 459.67 ) / 518.67 ] = {9}		{1}				{9}
Corrected Gas Generator Speed (NGGR)		8483.00	/	0.99	=	8585
{5} / {9} = {10}		{5}		{9}		{10}
HPT Pressure Ratio (PS3 / P5.4)		178.40	/	42.00	=	4.248
{4} / {6} = {11}		{4}		{6}		{11}

**4B Bearing Optimization Calculations:**

	Calculation Constant =	582.86	{12}
{7} x 1.3041 = {13}	{7} 71.47 x 1.3041 =	93.20	{13}
{8} x 0.55675 = {14}	{8} 179.57 x 0.55675 =	99.98	{14}
{10} x -0.074472 = {15}	{10} 8585 x -0.074472 =	-639.31	{15}
{11} x -27.856 = {16}	{11} 4.25 x -27.856 =	-118.32	{16}
Sum Total {12}+{13}+{14}+{15}+{16} = {17}		18.41	{17}
If {17} is > 30.58 then {18} = {17} - 30.58	=	0.00	{18}
If {17} is < 16.92 then {19} = {17} - 16.92	=	0.00	{19}
Predicted ADJUSTMENT needed to Current Orifice Diameter (inches)		0.000	{20}
{18} / 78 = {20} OR {19} / 78 = {20}			

**NEW ORIFICE DIAMETER (inches) = 4.000**

Calculated Recoupe Orifice with the available data. No change needed.





**Fuel Nozzle inspection:**

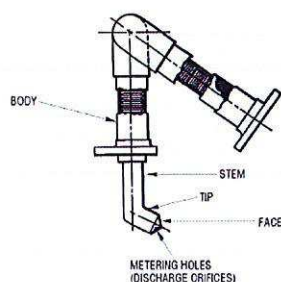


Figure 5-18. Fuel Nozzle (Natural Gas Fuel)

**FUEL NOZZLE** (See figure 5-17 [Liquid Fuel], 5-18 [Natural Gas Fuel], or 5-19 [Dual Fuel])

1. Fuel Nozzles for:

a. Cracks	Not serviceable		Replace fuel nozzle*
b. Chafing	Not serviceable		Replace part*
c. Wear on non-shrouded nozzle stem (Does not apply to shrouded nozzle stems)	Not serviceable	Any amount, up to 0.008 in. (0.20 mm) after blending	Blend max depth of 0.012 in. (0.30 mm) with min radius of 0.125 in. (3.18 mm). FPI inspection. Contour shall be smooth and polished

GEK 97310  
VOLUME I

Table 5-5. COMBUSTION LINER ASSEMBLY AND FUEL NOZZLES - Continued

Inspect	On-Site Max Serviceable Limits	On-Site Max Repairable Limits	On-Site Corrective Action
2. Dual Fuel Nozzles for:			
a. Nicks, scratches, dents, or wear on shroud OD	Not serviceable	0.015 in. (0.38 mm) maximum depth in cylindrical surface	Stone raised metal. Replace metering set if limits are exceeded
3. Fuel Nozzle Spray Orifices for:			
a. Carbon Deposit	Not serviceable	Any amount	Remove carbon deposit, inspect for carbon cause
4. Face for:			
a. Spalling	Not serviceable		Replace part *
5. Tip for:			
a. Wear	Maximum of 0.040 in. (1.00 mm) deep		Replace part *



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Fuel nozzle position	Work perform by JKP	Fuel nozzle Tip = 19,1 mm	Measured probe 28-2-2019
	Measure or change 9-9-2018	Not measured probe 9-9-2018	
4	New		18.9 mm
10	New		19.1 mm
14		X	18.8 mm
16	New		19.0 mm
22	18.9 mm		18.9 mm
27		X	18.8 mm
29	18.8 mm		18.8 mm

All measured Fuel nozzle tips are with in limit