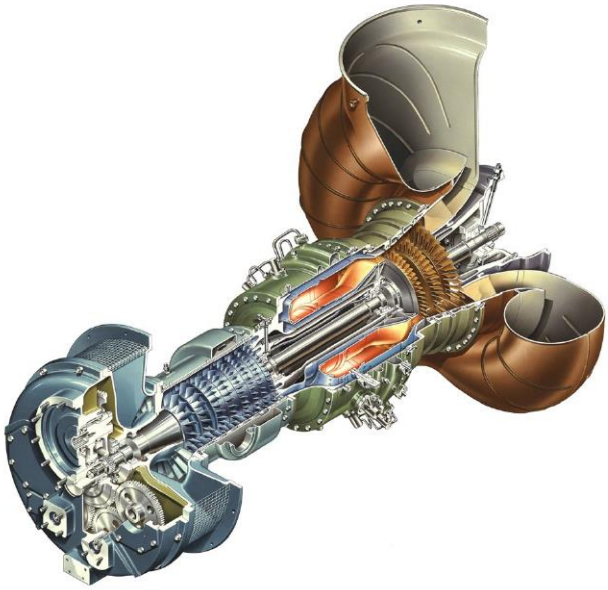
Solar Turbines
A Caterpillar Company

Solar Turbines Incorporated - Customer Service Center
9330 Sky Park Court
SAN DIEGO, CA, 92123-4304
U.S.A.

BORESCOPE INSPECTION REPORT



GAS TURBINE ENGINE
SATURN
HOT END DRIVE

Engine Serial Number
211263

Engine Rating
1401

Engine Serviceable
Yes

Inspection Performed By
Michael Werling

Inspection Date
Saturday, May 27, 2017

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BORESCOPE INSPECTION INFORMATION

Country	**USA**	Inspection Date	**5/27/2017**
Customer Name		Inspection Performed By	**Michael Werling**
Site Name		Reason For Inspection	**4000 Hrs Inspection**
District	**DSNO**	Borescope Equipment Used (Brand/Model)	
Work Order #		Borescope Inspection Procedure (WFM Task #)	**131**

PACKAGE INFORMATION

PD #	**63001**	Package S/N	**DSG0253**
Unit Customer Tag	**Unit #1**	Package Hours	**42393**
		Package Starts	**3475**

ENGINE INFORMATION

Engine GP[1] P/N		Gas Fuel Hours	
Engine GP S/N	**211263**	Liquid Fuel Hours	
Engine PT[2] P/N		Total Hours	**42393**
Engine PT S/N		Total Starts	**3475**
Engine Rating	**1401**	Next Planned Overhaul Running Hours	
Combustion Type	**Conventional**		
Fuel Type	**Dual**		
Inspection Last Date	**Saturday, December 10, 2016**	Gas Fuel Hours since last inspection	
		Liquid Fuel Hours since last inspection	
		Starts since last inspection	

NOTES

Borescope completed before Offline Compressor Wash.

[1] GP stands for “Gas Producer”.
[2] PT Stands for “Power Turbine”.

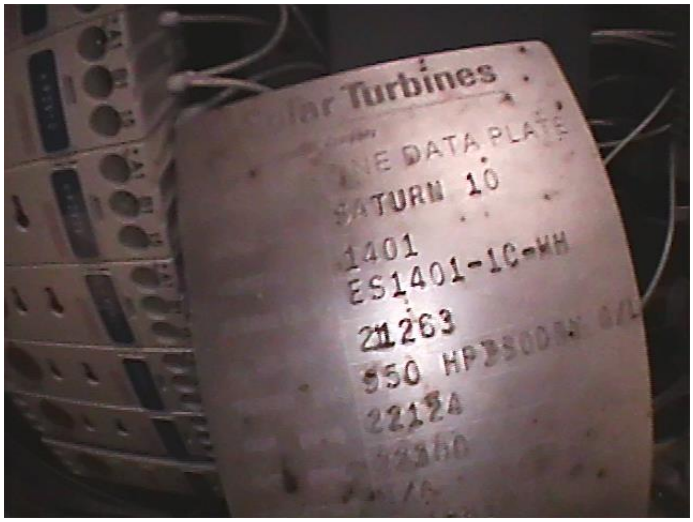
BORESCOPE INSPECTION CHECK LIST

Step	Description[3]	Performed			Initials & Date
		Yes	No	N/A	
1	Complete Task Risk Assessment.	✓			MW May 27, 2017
2	Complete Job Safety Analysis.	✓			MW May 27, 2017
3	Ensure the shutdown Gas Turbine engine is cool.	✓			MW May 27, 2017
4	Prepare the package for a Borescope Inspection.	✓			MW May 27, 2017
5	Perform Borescope Inspection (Record images, measurements and comments on the Borescope Inspection Report).	✓			MW May 27, 2017
6	Return Gas Turbine engine to service.	✓			MW May 27, 2017
7	Complete the Borescope Inspection Report (Borescope report sections populated correctly, FSR signature, Customer signature).	✓			MW May 27, 2017
8	Print/Scan the document as a PDF. Archive the document under the WFM associated Major Assembly / Field Attachments section.	✓			MW May 27, 2017

[3] For detailed step instructions, please refer to the Solar Turbines WFM (Work Force Management) internal procedure mentioned in the Equipment Information section.

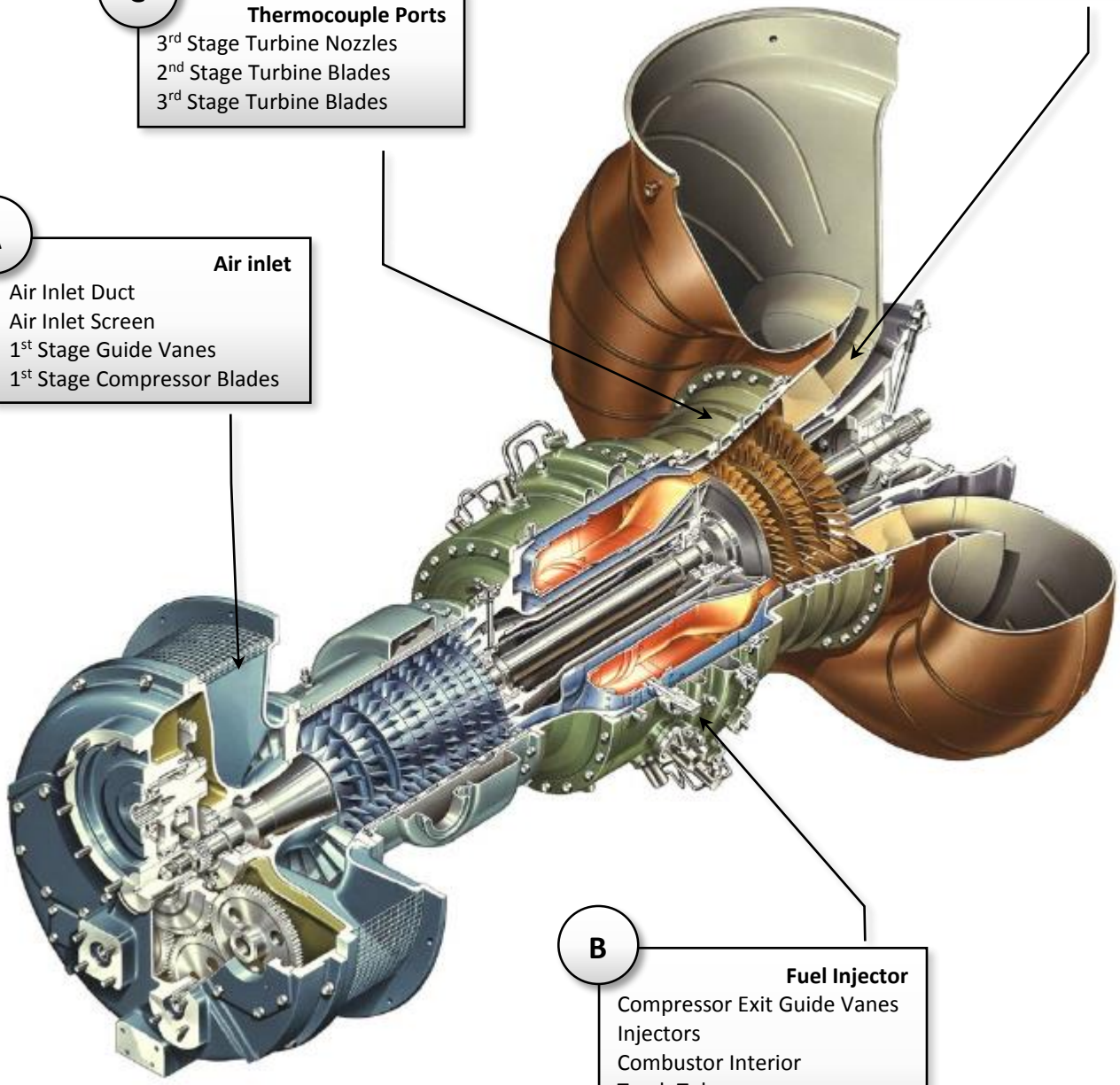
EQUIPMENT DATA PLATE

Gas Turbine



Power Turbine

BORESCOPE INSPECTION LOCATIONS



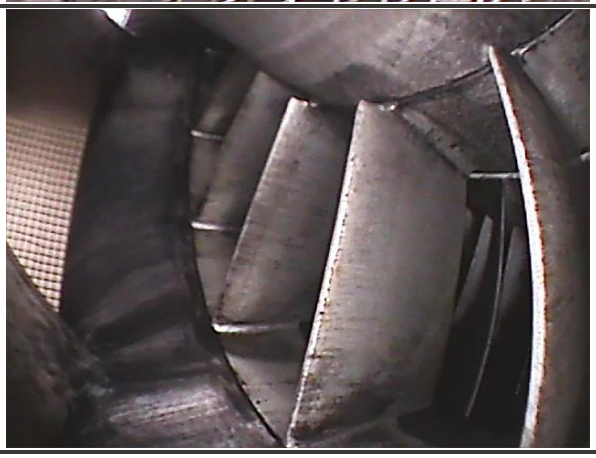
BORESCOPE INSPECTION SUMMARY

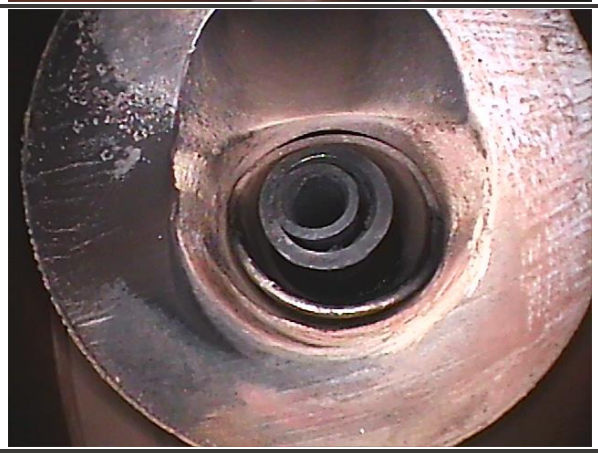
Access Port	Location	Inspection for	Normal Condition	Minor	Moderate	Severe	Comments
A	Air Inlet Duct	a)Potential FOD b)Corrosive Pitting c)Cracks d)Excessive fouling	✓				
A	Air Inlet Screen	a)Potential FOD b)Cracks, damaged mesh	✓				
A	1st Stg Guide Vanes	a)Nicks, dents, Qty and size b)Excess fouling c)Corrosive pitting. Affected Area	✓				
A	1st Stg Blades	a)Nicks and dents. Qty & size b)Excess fouling c)Corrosive pitting, Area d)Tip rub, Gap & curling	✓				
B	Compressor Exit Guide Vanes	a)Nicks and dents. Quantity and size b)Excess of fouling c)Corrosive pitting. Affected area	✓				
B	Injectors	a)Pilot center erosion b)Fuel hole contaminated, blocked c)Cracks d)Liquid: broken fuel spoke	✓				

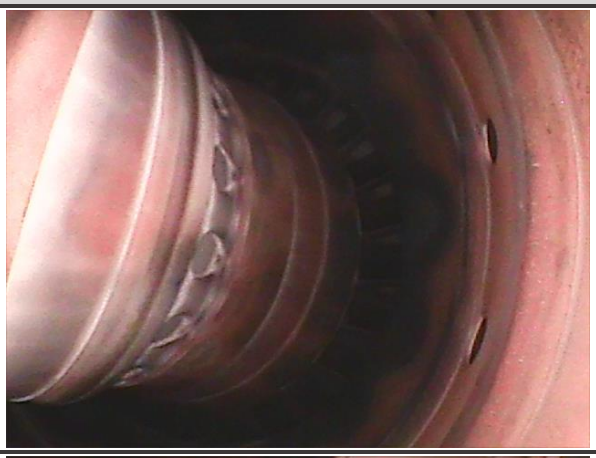
Access Port	Location	Inspection for	Normal Condition	Minor	Moderate	Severe	Comments
B	Combustor Interior	a)Crack, Qty and size b)Thermal erosion c)Hot spots d)Buckling or warpage		✓			Minor burn spots near 1st stage nozzles
B	Torch Tube	a)Thermal erosion	✓				
B	1st Stg Turbine Nozzles	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area		✓			Coating missing, burn spots, and pitting noticed
B	1st Stg Turbine Blades	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth & area c)FOD, Area d)Tip rub, gap width	✓				Some thermal wear noticed at base of blades
C	2nd Stg Turbine Nozzles	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area		✓			Burn spots
C	2nd Stg Turbine Blades	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area d)Tip rub, gap width	✓				

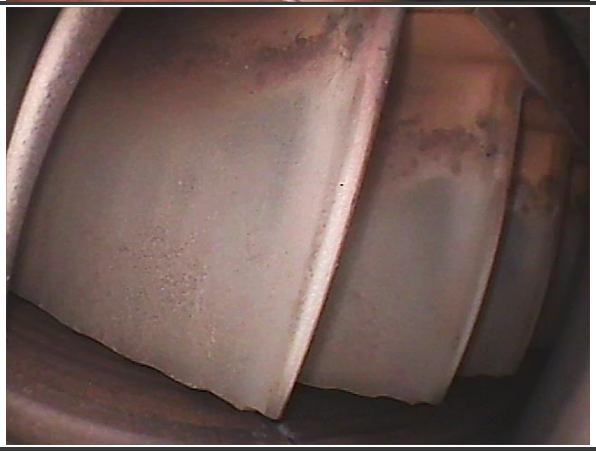
Access Port	Location	Inspection for	Normal Condition	Minor	Moderate	Severe	Comments
C	3rd Stg Turbine Blades	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area	✓				
D	3rd Stg Turbine Nozzles	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area d)Tip rub, gap width		✓			Burn spots

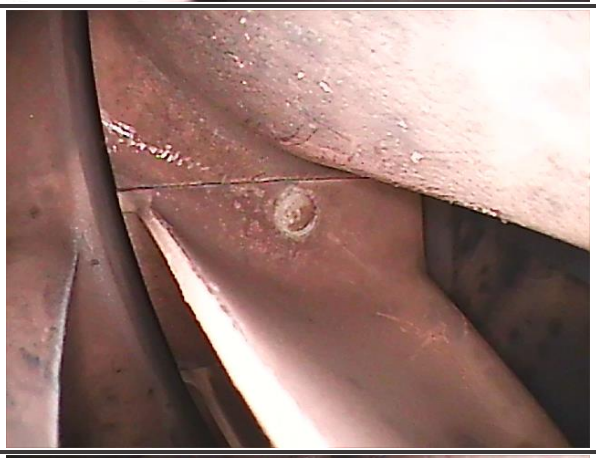
BORESCOPE INSPECTION PICTURES

Access location Description	Picture	Inspection for	Severity / Comments
A Air Inlet Duct		a)Potential FOD b)Corrosive Pitting c)Cracks d)Excessive fouling	Normal Condition
A Air Inlet Screen		a)Potential FOD b)Cracks, damaged mesh	Normal Condition
A 1st Stg Guide Vanes		a)Nicks, dents, Qty and size b)Excess fouling c)Corrosive pitting. Affected Area	Normal Condition Contamination, minor

Access location Description	Picture	Inspection for	Severity / Comments
A 1st Stg Blades		a)Nicks and dents. Qty & size b)Excess fouling c)Corrosive pitting, Area d)Tip rub, Gap & curling	Normal Condition Contamination, minor
B Compressor Exit Guide Vanes		a)Nicks and dents. Quantity and size b)Excess of fouling c)Corrosive pitting. Affected area	Normal Condition
B Injectors		a)Pilot center erosion b)Fuel hole contaminated, blocked c)Cracks d)Liquid: broken fuel spoke	Normal Condition Carbon build up

Access location Description	Picture	Inspection for	Severity / Comments
B Combustor Interior		a)Crack, Qty and size b)Thermal erosion c)Hot spots d)Buckling or warpage	Minor Burn spots Minor burn spots near 1st stage nozzles
B Torch Tube		a)Thermal erosion	Normal Condition

Access location Description	Picture	Inspection for	Severity / Comments
B 1st Stg Turbine Nozzles	 	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area	Minor Thermal erosion and pitting Coating missing, burn spots, and pitting noticed
B 1st Stg Turbine Blades		a)Cracks, Qty, length, orientation b)Thermal erosion, Depth & area c)FOD, Area d)Tip rub, gap width	Normal Condition Blade tip rub, gap width Some thermal wear noticed at base of blades

Access location Description	Picture	Inspection for	Severity / Comments
C 2nd Stg Turbine Nozzles		a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area	Minor Burn spots Burn spots
C 2nd Stg Turbine Blades		a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area d)Tip rub, gap width	Normal Condition
C 3rd Stg Turbine Blades		a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area	Normal Condition

Access location Description	Picture	Inspection for	Severity / Comments
D 3rd Stg Turbine Nozzles		a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Area d)Tip rub, gap width	Minor Burn spots Burn spots

CONCLUSION

Some contamination in compressor section; burn spots noticed near 1st stage nozzles, and on 2nd and 3rd stage nozzles; 1st stage nozzles show signs of wear from thermal exposure and minor pitting.

RECOMMENDATION

Continue to follow Solar's recommended maintenance practices; detergent wash regularly

BORESCOPE INSPECTION OF GAS TURBINE ENGINE GENERAL OBJECTIVES

The gas turbine borescope inspection is an internal inspection performed by a trained specialist who assesses the condition of the gas turbine components. This inspection is performed using an instrument specifically designed to examine the gas path, via the access ports positioned along the engine, from the air inlet to the exhaust.

These inspections are one of the primary diagnostic methods for maintaining turbo-machinery. Both rigid and flexible fiberscopes are used in conjunction with especially formed guide tubes to inspect the internal stationary and rotating components. Primary goals are to detect early signs of wear or impending failure. The major benefits of the inspection include equipment condition awareness and effective scheduling of any necessary maintenance interventions. In addition, greater reliability / longevity can be achieved through internal inspections, as well as reducing the potential of severe equipment damage.

The operating gas turbine engine components, by design, are exposed to high thermal and mechanical constraints. Internal inspections are thus necessary to determine if wear or thermal erosion has occurred. In addition, these inspections will quantify if any foreign object damage (FOD) or corrosion has occurred, as well as assessing internal components for thermal deterioration, cracking or distortion.

While every effort is made to examine all accessible parts of the engine, some areas are not accessible through a borescope inspection. Therefore, a borescope inspection should not be considered to be the ultimate method to assess an engine's health.

This borescope inspection has been perfomed following a Hierarchical Task Analysis procedure exposed in TL 21.7/100.

SOLAR TURBINES INSPECTOR SIGNATURE / DATE

Inspector Name: **Michael Werling**
Inspector Email Address:
Inspector Phone Number: