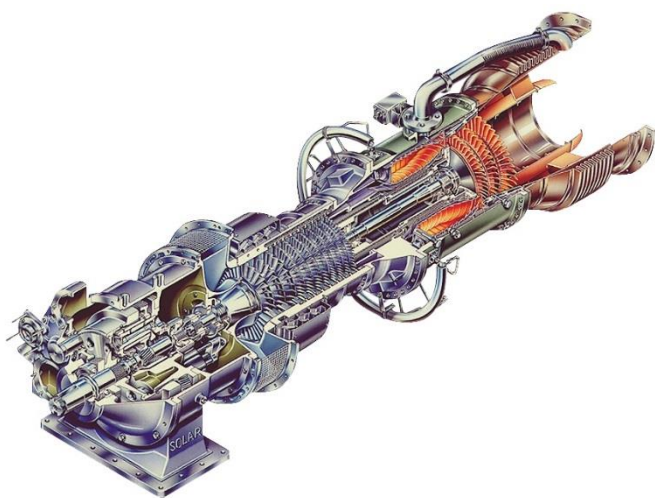


BORESCOPE INSPECTION REPORT



GAS TURBINE ENGINE
TAURUS 60
COLD END DRIVE

Engine Serial Number
OHA22-T3018

Engine Rating
5500KW

Engine Serviceable
Yes

Inspection Performed By
Muhammad Usman Ur Rab

Inspection Date
Monday, May 22, 2023

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B O R E S C O P E I N S P E C T I O N I N F O R M A T I O N

Country	Pakistan	Inspection Date	5/22/2023
Customer Name	Gatro Power	Inspection Performed By	Muhammad Usman Ur Rab
Site Name	Gatro Power Hub Choki	Reason For Inspection	Unplanned Inspection
District	MEED	Borescope Equipment Used (Brand/Model)	GE XL Plus
Work Order #	M1061731303	Borescope Inspection Procedure (WFM Task #)	128

P A C K A G E I N F O R M A T I O N

PD #	72851A	Package S/N	10695T1
Unit Customer Tag	TG1	Package Hours	141676
		Package Starts	266

E N G I N E I N F O R M A T I O N

Engine GP ¹ P/N	ET781C-C0D0RH00	Gas Fuel Hours	2748
Engine GP S/N	OHA22-T3018	Liquid Fuel Hours	17
Engine Rating	5500KW	Total Hours	2765
Combustion Type	Conventional	Total Starts	31
Fuel Type	Dual	Next Planned Overhaul	TBO
		Running Hours	

Inspection Last Date	Tuesday, August 30, 2022	Gas Fuel Hours since last inspection	0
		Liquid Fuel Hours since last inspection	0
		Starts since last inspection	0

N O T E S

Borescope completed after Offline Compressor Wash.

Borescope was performed without water wash , but previously water wash was done , since then turbine has 0 operating hours .

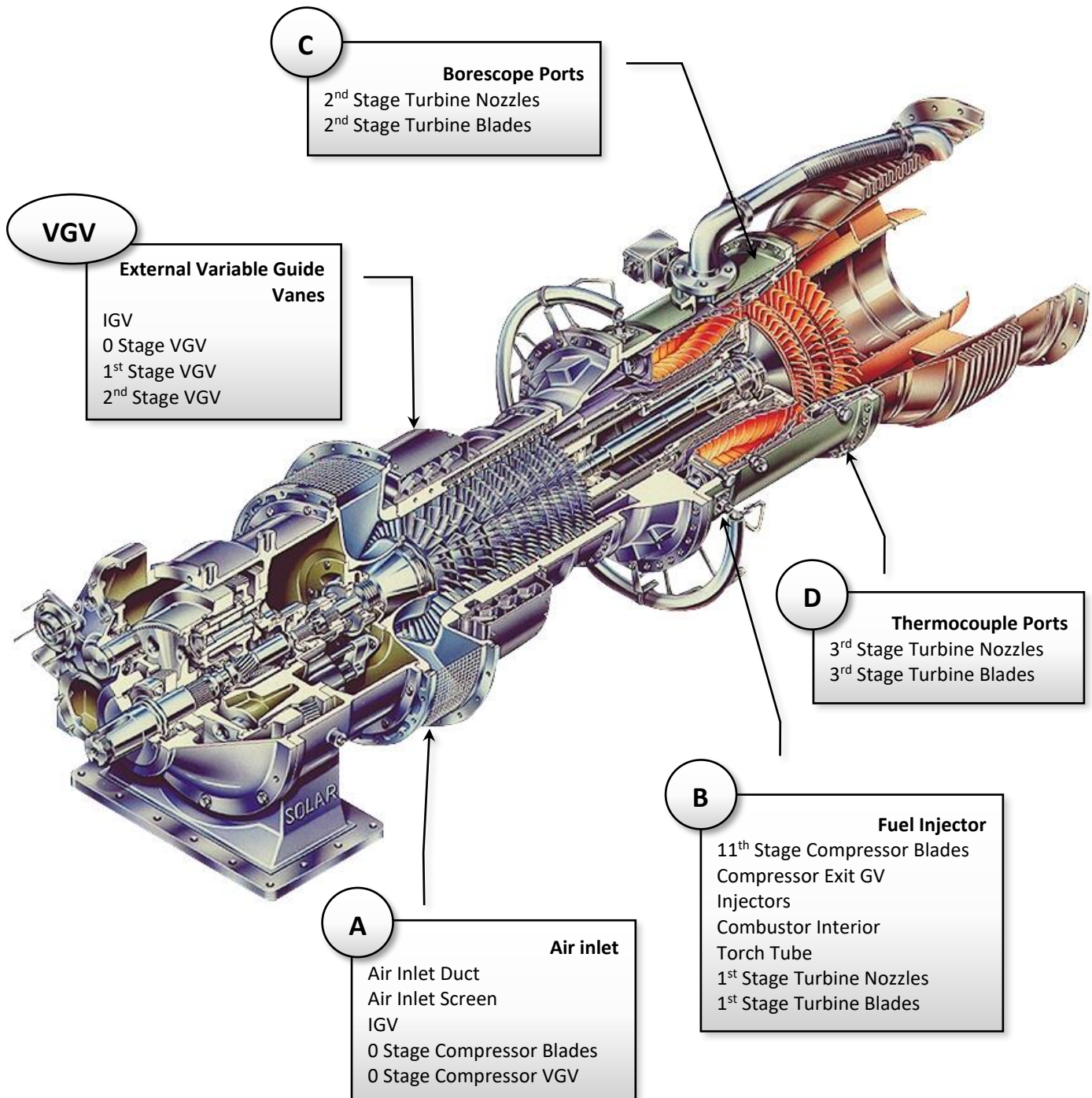
¹ GP stands for "Gas Producer".

BORESCOPE INSPECTION CHECK LIST

Step	Description ²	Performed			Initials & Date
		Yes	No	N/A	
1	Complete Task Risk Assessment.	✓			MU May 21, 2023
2	Complete Job Safety Analysis.	✓			MU May 21, 2023
3	Ensure the shutdown Gas Turbine engine is cool.	✓			MU May 21, 2023
4	Prepare the package for a Borescope Inspection.	✓			MU May 21, 2023
5	Perform Borescope Inspection (Record images, measurements and comments on the Borescope Inspection Report).	✓			MU May 21, 2023
6	Return Gas Turbine engine to service.	✓			MU May 30, 2023
7	Complete the Borescope Inspection Report (Borescope report sections populated correctly, FSR signature, Customer signature).	✓			MU May 31, 2023
8	Print/Scan the document as a PDF. Archive the document under the WFM associated Major Assembly / Field Attachments section.	✓			MU May 31, 2023

² For detailed step instructions, please refer to the Solar Turbines WFM (Work Force Management) internal procedure mentioned in the Equipment Information section.

BORESCOPE INSPECTION LOCATIONS



BORESCOPE INSPECTION SUMMARY

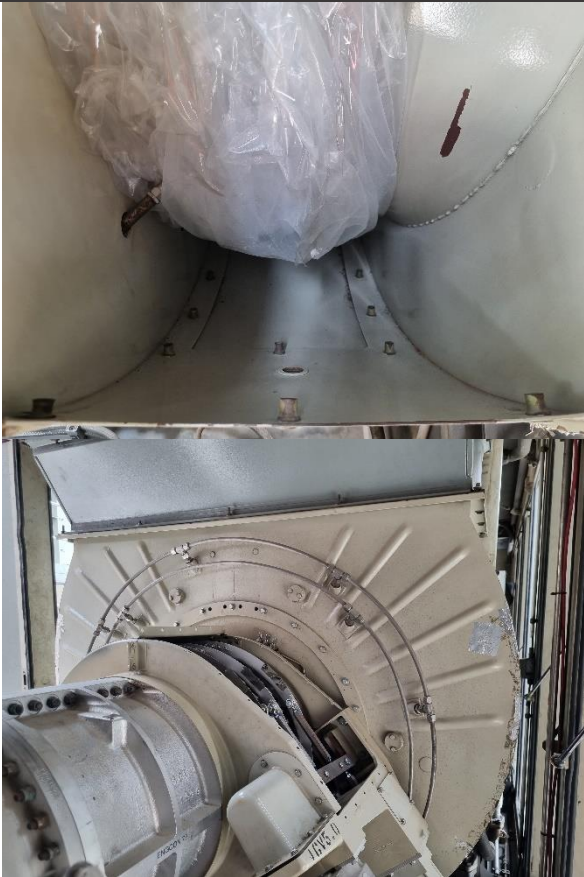
Access Port	Location	Inspection for	Normal Condition	Minor	Moderate	Severe	Comments
<u>A</u>	Air Inlet Duct	a)Potential FOD b)Corrosive Pitting c)Cracks d)Excessive fouling		✓			The Air inlet duct is contaminated with minute particles of dust
<u>A</u>	Air Inlet Screen	a)Potential FOD b)Cracks, damaged mesh		✓			Minor contamination was left after water washing and slight rusting has started on the edges
<u>A</u>	IGV	a)Nicks and dents. Quantity and size b)Excessive fouling c)Corrosive pitting. Affected area			✓		Contamination can be observed on the IGVs , this is heavy contamination considering the running hours
<u>A</u>	0 Stg Compressor Blades	a)Nicks and dents. Quantity and size b)Excessive fouling c)Corrosive pitting. d)Tip rub, gap width, curling			✓		Contamination can be observed on the blades , this is heavy contamination considering the running hours
<u>A</u>	0 Stg Compressor GV	a)Nicks and dents. Quantity and size b)Excessive fouling c)Corrosive pitting. Affected area				✓	Contamination can be observed on the GV's , this is heavy contamination considering the running hours

Access Port	Location	Inspection for	Normal Condition	Minor	Moderate	Severe	Comments
<u>B</u>	11th Stg Compressor Blades	a)Nicks and dents. Quantity and size b)Excessive fouling c)Corrosive pitting. d)Tip rub, gap width, curling		✓			Considering the running hours the contamination is higher than expected .
<u>B</u>	Compressor Exit GV	a)Nicks and dents. Quantity and size b)Excessive fouling c)Corrosive pitting. Affected area			✓		Considering the running hours the contamination is higher than expected
<u>B</u>	Injectors	a)Pilot center erosion b)Fuel hole contaminated, blocked c)Cracks d)Liquid: broken fuel spoke		✓			Considering the running hours the contamination is higher than expected
<u>B</u>	Combustor Interior	a)Crack, Qty and size b)Thermal erosion c)Hot spots d)Buckling or warpage		✓			Considering the running hour the marks inside the combustion chamber are unusual
<u>B</u>	Torch Tube	a)Thermal erosion	✓				
<u>B</u>	1st Stg Turbine Nozzles	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Affected area		✓			

Access Port	Location	Inspection for	Normal Condition	Minor	Moderate	Severe	Comments
<u>B</u>	1st Stg Turbine Blades	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Affected area d)Tip rub width	✓				
<u>C</u>	2nd Stg Turbine Nozzles	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth, Affected area	✓				
<u>C</u>	2nd Stg Turbine Blades	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Affected area d)Tip rub width	✓				
<u>D</u>	3rd Stg Turbine Nozzles	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth, Affected area		✓			Previously minor pitting was observed , however currently the image is not attached .
<u>D</u>	3rd Stg Turbine Blades	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Affected area d)Tip rub width	✓				
<u>VGV</u>	IGV	a)Cracks b)Lever arms bent c)Grommet out of position on unison ring d)Corrosion		✓			Rust can be observed on the turn buckles

Access Port	Location	Inspection for	Normal Condition	Minor	Moderate	Severe	Comments
<u>VG</u> V	0 Stg VGV	a)Cracks b)Lever arms bent c)Grommet out of position on unison ring d)Corrosion		✓			Rust can be observed on the 0stg VGV turn buckle
<u>VG</u> V	1st Stg VGV	a)Cracks b)Lever arms bent c)Grommet out of position on unison ring d)Corrosion		✓			Rust can be observed on the 1stg VGV turn buckles
<u>VG</u> V	2nd Stg VGV	a)Cracks b)Lever arms bent c)Grommet out of position on unison ring d)Corrosion		✓			Rust can be observed on the 3rdstg VGV turn buckles
<u>X</u>	Other1	TBD					
<u>X</u>	Other2	TBD					
<u>X</u>	Other3	TBD					

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	Minor Contamination The Air inlet duct is contaminated with minute particles of dust

Access location Description	Picture	Inspection for	Severity / Comments
A Air Inlet Screen		a) Potential FOD b) Cracks, damaged mesh	Minor Contamination Minor contamination was left after water washing and slight rusting has started on the edges

A

IGV



Moderate

a) Nicks and dents.
Quantity and size

b) Excessive fouling

c) Corrosive pitting.
Affected area

Contamination

Contamination can be observed on the IGVs, this is heavy contamination considering the running hours

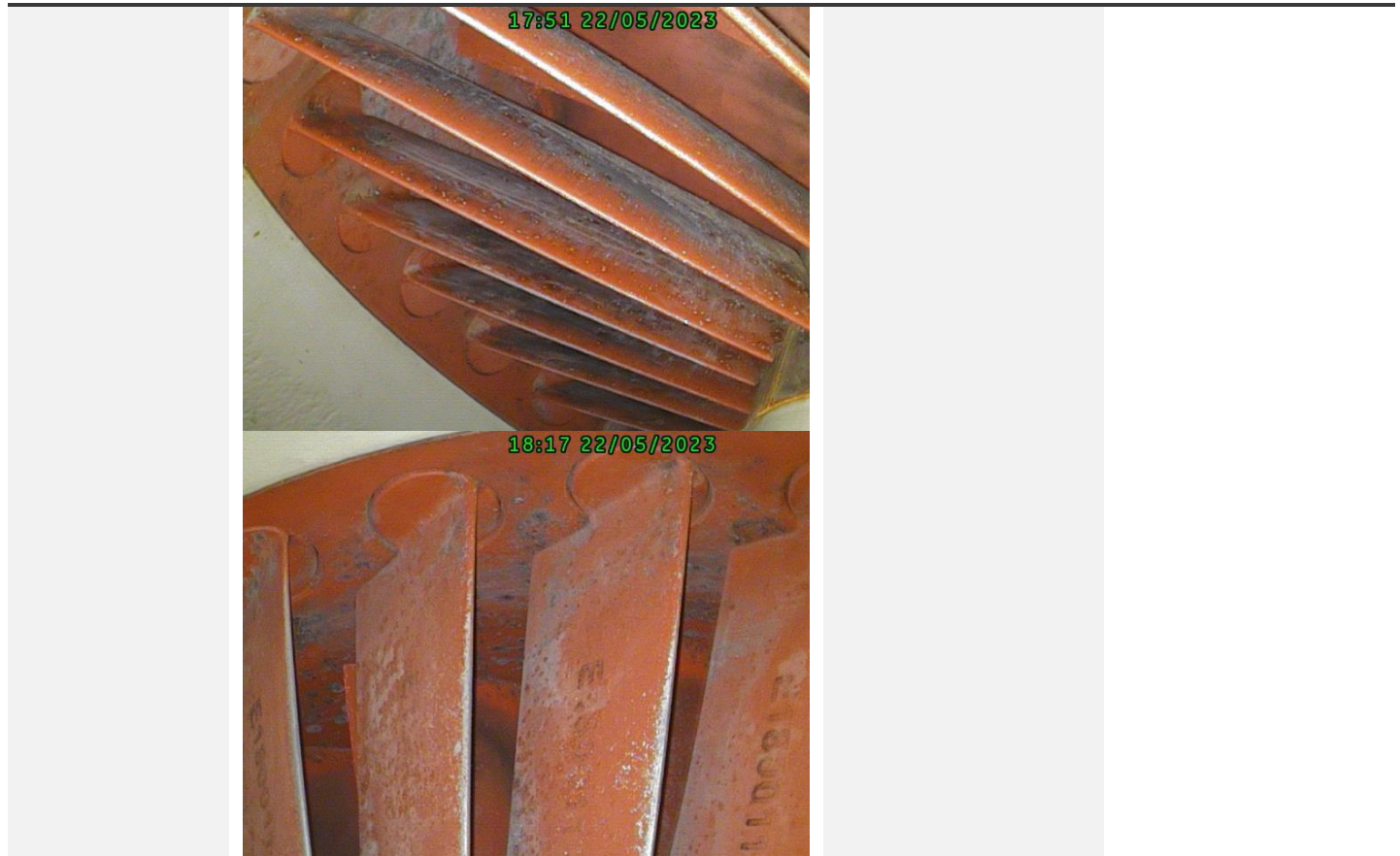


17:47 22/05/2023



17:50 22/05/2023





Access location Description	Picture	Inspection for	Severity / Comments
	18:17 22/05/2023  18:18 22/05/2023 		

A

0 Stg
Compressor
Blades



- a)Nicks and dents.
Quantity and size
- b)Excessive fouling
- c)Corrosive pitting.
- d)Tip rub, gap width,
curling

Moderate

Contamination

Contamination can be
observed on the
blades , this is heavy
contamination
considering the
running hours

Access location Description	Picture	Inspection for	Severity / Comments
			

A 0 Stg Compressor GV		a)Nicks and dents. Quantity and size b)Excessive fouling c)Corrosive pitting. Affected area	Severe Contamination Contamination can be observed on the GVs , this is heavy contamination considering the running hours
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Access location Description	Picture	Inspection for	Severity / Comments
	18:19 22/05/2023  18:20 22/05/2023  18:25 22/05/2023 		

B

11th Stg
Compressor
Blades

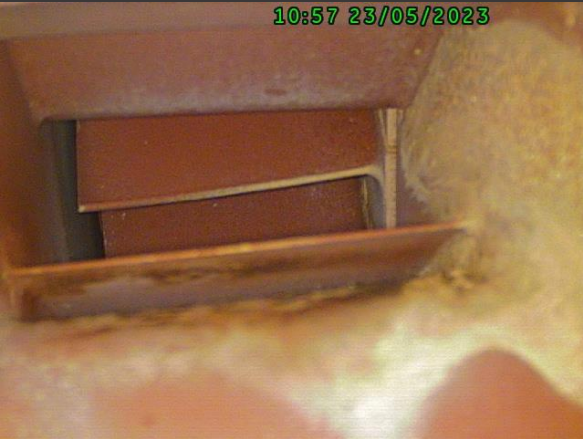
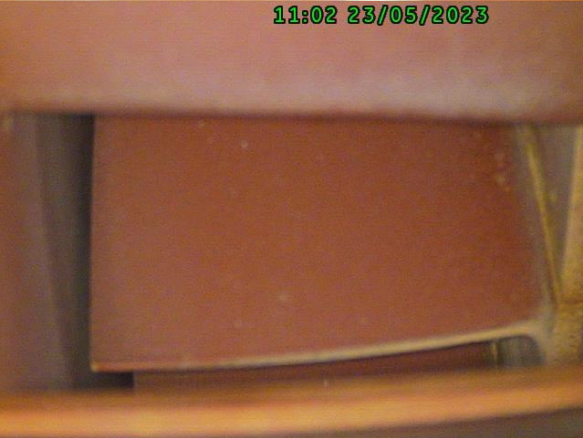


- a) Nicks and dents. Quantity and size
- b) Excessive fouling
- c) Corrosive pitting.
- d) Tip rub, gap width, curling

Minor

Contamination

Considering the running hours the contamination is higher than expected .

Access location Description	Picture	Inspection for	Severity / Comments
	10:57 23/05/2023  11:02 23/05/2023  11:03 23/05/2023 		

B

Compressor Exit
GV



- a)Nicks and dents.
Quantity and size
- b)Excessive fouling
- c)Corrosive pitting.
Affected area

Moderate

Contamination

Considering the
running hours the
contamination is
higher than expected



Access location Description	Picture	Inspection for	Severity / Comments
			

B

Injectors



- a)Pilot center erosion Minor
- b)Fuel hole contaminated, blocked Contamination
- c)Cracks Considering the running hours the contamination is higher than expected
- d)Liquid: broken fuel spoke



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

Considering the running hour the marks inside the combustion chamber are unususal

Access location Description	Picture	Inspection for	Severity / Comments
			

Access location Description	Picture	Inspection for	Severity / Comments
B Torch Tube		a) Thermal erosion	Normal Condition
			Not applicable

B

1st Stg Turbine
Nozzles



a)Cracks, Qty, length, orientation
b)Thermal erosion, Depth and area
c)FOD, Affected area

Minor
Erosion

Access location Description	Picture	Inspection for	Severity / Comments
	  		

B

1st Stg Turbine
Blades



- a)Cracks, Qty, length, orientation
- b)Thermal erosion, Depth and area
- c)FOD, Affected area
- d)Tip rub width

Normal Condition



Access location Description	Picture	Inspection for	Severity / Comments
	11:20 23/05/2023  11:22 23/05/2023 		

C 2nd Stg Turbine Nozzles	  	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth, Affected area	Normal Condition Not applicable
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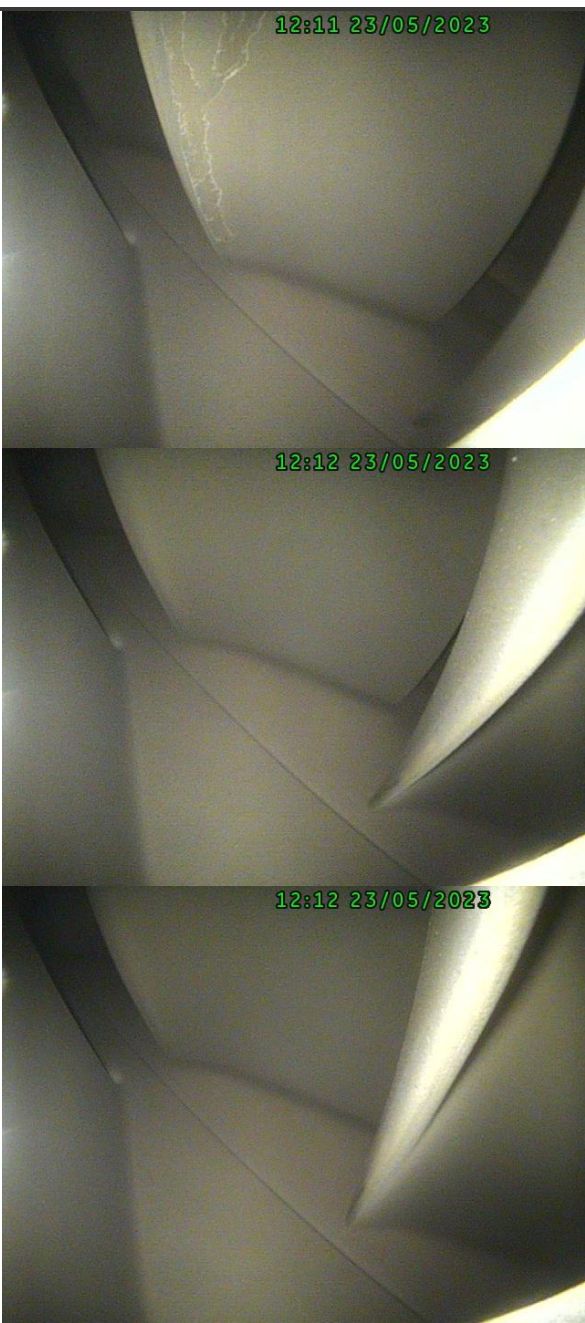
Access location Description	Picture	Inspection for	Severity / Comments
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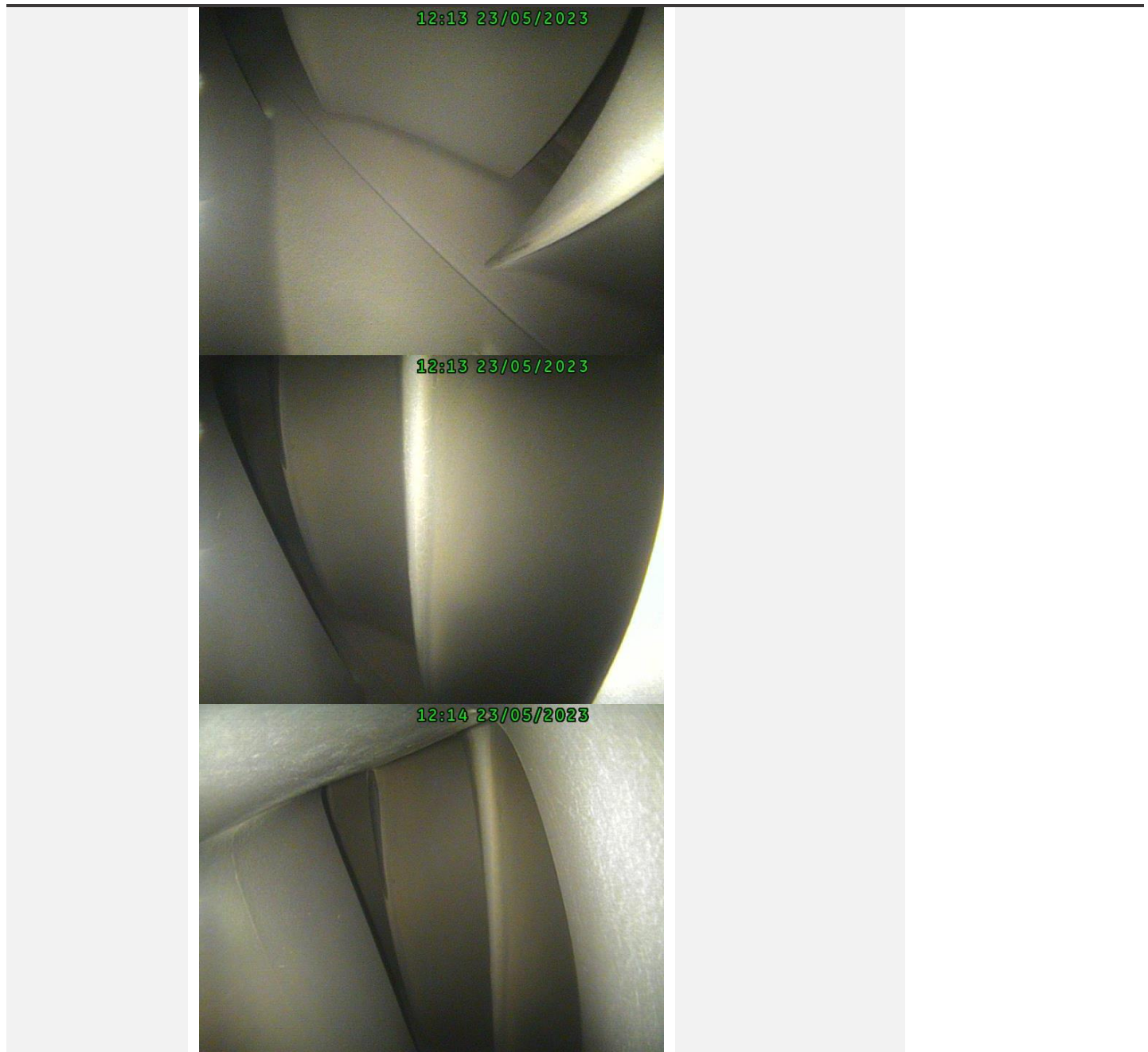
C 2nd Stg Turbine Blades	  	a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Affected area d)Tip rub width	Normal Condition Not applicable
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Access location Description	Picture	Inspection for	Severity / Comments
			
			
			

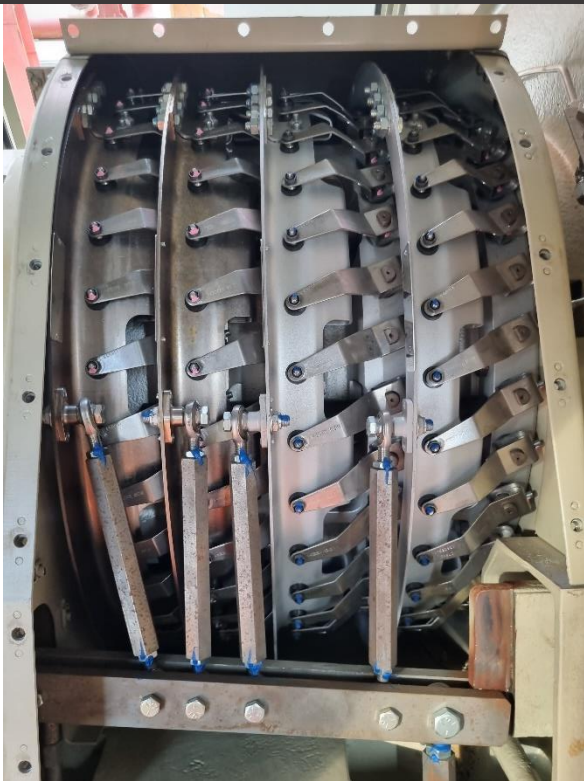
D 3rd Stg Turbine Nozzles			
		a)Cracks, Qty, length, orientation b)Thermal erosion, Depth, Affected area	Minor Pitting Previously minor pitting was observed , however currently the image is not attached .
			

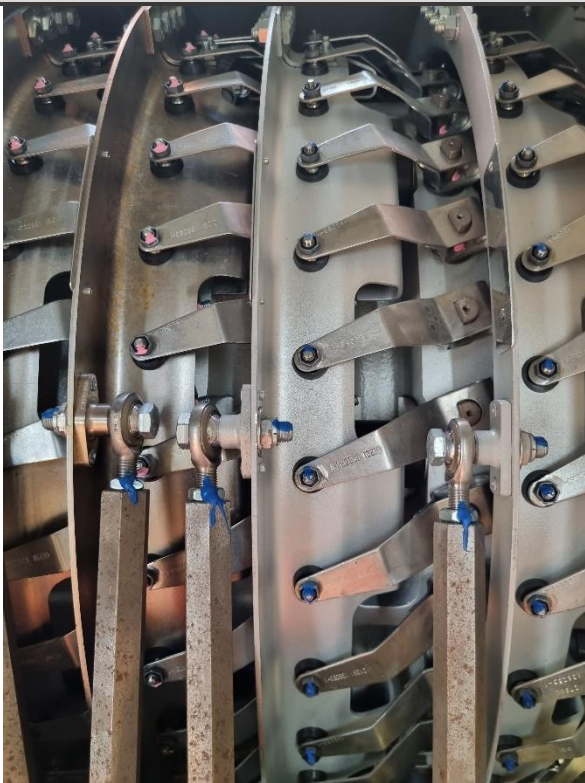
Access location Description	Picture	Inspection for	Severity / Comments
	12:05 23/05/2023 		
	12:06 23/05/2023 		
	12:06 23/05/2023 		

D 3rd Stg Turbine Blades		a)Cracks, Qty, length, orientation b)Thermal erosion, Depth and area c)FOD, Affected area d)Tip rub width	Normal Condition
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Access location Description	Picture	Inspection for	Severity / Comments
	12:14 23/05/2023 		
	12:18 23/05/2023 		

Access location Description	Picture	Inspection for	Severity / Comments
VGV IGV		a)Cracks b)Lever arms bent c)Grommet out of position on unison ring d)Corrosion	Minor Corrosion Rust can be observed on the turn buckles
VGV 0 Stg VGV		a)Cracks b)Lever arms bent c)Grommet out of position on unison ring d)Corrosion	Minor Corrosion Rust can be observed on the 0stg VGV turn buckle

Access location Description	Picture	Inspection for	Severity / Comments
VGV 1st Stg VGV		a)Cracks b)Lever arms bent c)Grommet out of position on unison ring d)Corrosion	Minor Corrosion Rust can be observed on the 1stg VGV turn buckles
VGV 2nd Stg VGV		a)Cracks b)Lever arms bent c)Grommet out of position on unison ring d)Corrosion	Minor Corrosion Rust can be observed on the 3rdstg VGV turn buckles

Access location Description	Picture	Inspection for	Severity / Comments
X Other1	No Picture Available	TBD	
X Other2	No Picture Available	TBD	
X Other3	No Picture Available	TBD	

C O N C L U S I O N

Considering the running hours the compressor section is not in good state , customer replaced filters .

R E C O M M E N D A T I O N

Customer is recommended to do frequent water washes and borescope inspection to trace the condition of the compressor and turbine section .

**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 performed following a Hierarchical Task Analysis procedure exposed in TL 21.7/100.

SOLAR TURBINES INSPECTOR SIGNATURE / DATE

Inspector Name: **Muhammad Usman Ur Rab**
Inspector Email Address: usman_urrab@solarturbines.com
Inspector Phone Number: +92-3008435879

Wednesday, May 31, 2023