



SGT-A35 User Group Conference 6-8th October 2020







Meet Our Team

RWG Participants



Mick Conway

Business Development Manager All Regions All Supported Products



Chamaka Li

Rotating Equipment Engineer All Supported Products



Dave Ogden

Senior Project Engineer Large Engine Business



Kyle Harper

Regional Sales Manager Europe, Middle East & Africa All Support Products



Darren Craigmile

Project Engineer Large Engine Business







Introduction to RWG

Company Profile and Capabilities







Introduction to RWG - Overview

Overview

RWG is a Siemens and Wood Company and is the market leader in aero-derivative industrial gas generator maintenance services.

As a provider to worldwide Oil & Gas, Energy and Marine Propulsion Industries for over 30 years, RWG holds OEM approval for all required aftermarket maintenance services.

Over 500 Specialist Personnel and three global locations provides unrivalled support for Gas Generator Operators worldwide.

Our reputation for the highest quality standards in the industry is maintained through continuous investment in training and certification, competence and quality assurance.

SIEMENS + wood. = RWG





RWG **REPAIR & OVERHAUL EXPERTISE**

Maintenance Support for Siemens Aero-derivative Gas Turbines

Introduction to RWG – Our Evolution



hour overhaul on the SGT-A35 GT variant.

Paving the way for the major maintenance

requirements of the global fleet.

accreditation for specialist processes

including fusion welding and

heat treating.

Avon 200 Upgrade The 130th Avon 200 Upgrade is completed at RWG's Aberdeen facility, marking a significant milestone in the history of the Avon Engine.







Introduction to RWG

Supported Siemens Equipment

Equipment	RWG Supports		
SGT-A35 (Industrial RB211)	All variants including DLE, GT, GT30 and Gzero		
SGT-A20 (Industrial Avon)	All variants		
SGT-A05 (Industrial 501)	All variants including DLE		
Industrial Olympus	All variants, limited supportability on 2024 'C' rated machines		
Marine	Olympus, Tyne, Spey, WR21		

Global Locations



RWG Ltd, Aberdeen, UK



RWG Inc, Houston, USA



RWG OTEC, KL, Malaysia





Introduction to RWG

Our Capability Profile







Customer Experience

Adapting our business to promote uninterrupted support







Customer Experience

Business Continuity

- RWG's facilities have remained fully operational during the COVID pandemic.
- We have adapted our business to operate in the new environment.
 - Remote working locations
 - Promoting social distancing where possible
 - Minimising contact between employees
 - Continually reviewing working conditions and challenges
 - Following and adhering to the guidance as it changes
- On-going challenges exist around field service mobilisation
- RWG has infrastructure to allow customers to remain close to our business during these times

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RWG Ref No:								U53				
Location:								All RWG Sites				
Work Activity:								Reducing exposure to COVID-19				
Assessor's Name(s) / Responsible Person(s): Jennifer Dean							le Person(s):	Signature(s): jdean@rw				
John Edwards								group.com				
Assessment Date: 23/09/20								Review Date: As Government updates are issued				
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Customer Experience

Promoting Customer Interaction

- Utilising existing and investing in new technology, RWG is focused on maintaining external communication during these challenging times
- Customer engagement during repair, overhaul and field service activities is essential
- Remote test witness allows the customer to experience the test from any location
- Remote video reporting and document sharing avoids travel costs and risks whilst providing vital information transfer to customers.
- Huddle is a Document Collaboration & Client Engagement Portal allowing workflows to be created and documents to be shared.







SGT-A35 – Industrial RB211

Over 30 Years of Supporting the Global User Network







SGT-A35 – Industrial RB211

RWG is the global leader for SGT-A35 aftermarket maintenance

- 70+ engines per year
- Over 100 employees dedicated to the maintenance programme
- 1370 major workscopes have been completed to date
- Strict turn times reduce operational downtime
- Core modules and engines available for exchange or lease
- Full liquid and gas testing capabilities
- Vast inventory of new and serviceable parts available off the shelf
- Fleet leading machines now over 200k TSN, whilst early -24GT's are now over 100k TSN
- · Unique repair processes to promote in-service integrity



Technologies Supported

-22
-24 A,B,C
-24 G
-24 GT
GT30/+
Dry Low Emissions (DLE)
GZero



RWG

SGT-A35 – Industrial RB211 Advanced Remanufacturing



Advances in gas generator design, materials technology and enhanced protective coating systems has greatly improved equipment service life.

- Despite such achievements performance of critical components deteriorate over time
- Harsh operating environments degrade coatings, component metallurgy and dimensional tolerance
- Without intervention operators face significant costs for replacement of unserviceable material

Continued investment by RWG in SGT-A35 component repair development has delivered:

- 600 Remanufacture Routes including 287 source method controlled and 170 RWG proprietary repairs (TIs)
- Annual Repair Volume in a given year in excess of 110,000 individual SGT-A35 components pass through RWG's dedicated Advanced Remanufacture Business
- Life Extension Many SGT-A35 parts achieve significant service lives, undergoing RWG's remanufacturing process between four and five times, exceeding 100,000 service hours

Customer Benefits

- Dedicated engineering resource accelerating OEM repair approval process
- High quality OEM approved repairs ensuring equipment integrity
- Improved maintenance cost management





User Issues

SGT-A35 Reported Issues







Index 116 - Metco Abradable Seal Degradation







Lightweight aero derivative gas turbines can be susceptible to corrosion, particularly to the compressor sections (Metco abradable linings)

This can be due to reasons such as:-

- □ Hostile operating environments
- Prolonged periods of shut down
- □ Inadequate intake filtration
- □ Insufficient compressor washing/drying
- □ Inadequate preservation per PAB 02-0003-02

Effect on Operation

- Premature engine removals due to performance loss or component failure
- Higher rate of component repair/rejection during overhaul
- Increases maintenance and overhaul costs





Index 101.2 (DLE Operational Flexibility)



DLE machines are sensitive to changes in environment, ambient conditions and wear and tear through operation.

This may lead to side effects such as:-

- Diminished operational window
- Hardware damage due to excessive combustion noise
- High emissions
- Pullback and shutdown of Engine











Index 101.2 (DLE Operational Flexibility)





RWG Solution

Definition and setting of critical dimensions, specific to operational profile:

- Operator requirement Review of site requirements and operating profile
- Calculation Engineering assessment of critical flows and historic tolerances to determine optimum build settings
- Machining Machining and matching of Discharge Nozzle bleed control rail
- □ Fine tuning Adjustment during engine test (if required)

Customer Benefits

- Operational flexibility and compliance for full life cycle between overhauls
- Lower maintenance costs due to reduced parts requirement
- Increased online time





Index 101.2 (DLE Combustor Cracking)

Secondary fuel gas feeder ring



Transply section

DLE Combustion Swirlers can be susceptible to cracking around the secondary fuel gas feeder ring (GFR) which can necessitate costly replacement

- VSS engines particularly susceptible due to large temperature variations
- □ Cracking in feeder ring can be repaired using conventional weld repair methods
- Cracking extending into transply material could not be repaired due to complexity of brazed 'sandwich' material
- Combustors which had been repaired >2 times became more susceptible to cracking







Index 101.2 (DLE Combustor Cracking)



RWG collaborated with combustor OEM to develop solution to reduce cost for operators

- Repair developed in conjunction with Combustor
 OEM to repair GFR and Transply cracking
- GFR and transply replaced with complete new combustor section
- Reviewed and approved by Siemens
- □ Repair cost ~30% of new part price
- **Can be completed in normal overhaul time frame**
- Renews life of combustor for a further 2 overhaul cycles







RWG

Index 109 (Burning of Heatshields)

Combustor Recovery (Phase 1 & 2 FCL)





Fuel quality has an effect on the degradation rate of Combustion Components which leads to defects such as:-

- Accelerated burning of Heatshields
- Mini Flare material loss and erosion
- □ Thinning of wall sections
- Excessive costs for replacement of defective components

RWG Solution

In-depth repair processes are available to address and mitigate recurring issues:

- Enhanced Coating RWG has introduced revised coatings to slow the rate of degradation
- Part replacement Complete replacement of individual parts and sections, using serviceable donors if required

and

In Service Inspection – review at scheduled intervals to monitor condition

Customer Benefits

- Significant reduction in maintenance costs
- Maintained Combustor performance for duration of life cycle



RVG

Maintenance Support for Siemens Aero-derivative Gas Turbines

Index 23.1 – 23.3 (HP Thrust Bearing)

RWG HP Thrust Bearing Failure Experience

Year	Operator	Root Cause			
		Oil Quality	LOC Malfunction		
2018	Offshore West Africa		x		
2015	Onshore UK	X			
2015	Offshore West Africa	X			
2015	Onshore North America	X			
2010	Onshore South America	x			
2008	Offshore UK		x		



To reduce incidence of this failure Siemens has issued a revised Product Advisory Bulletin

PAB 02-0007-03 (July 2020)

Product Advisory Bulletin SGT-A35	EU EXPORT CONTROL Terrinings Classification & CCM The despendence of a classification of regulations. The despendence mode of the terrining of the classification of the Completion of the classification of the classification of the classification of the Completion of the classification of the classification of the classification of the Completion of the classification of the classification of the classification of the Completion of the classification of the classification of the classification of the Completion of the classification of t
Power Generation Services for Aero Derivative Gas Turbines	IP Cestil-
Date: July 2020	PAB 02-0007-
GAS GENERATOR LUBRICATING	OIL
APPLICABILITY This Product Advisory Bulletin (PAB) applies to all SGT-A35 gas g	enerators.
This PAB supersedes Service Bulletin PAB 02-0007-02.	
REASON This bulletin provides the following information: • Approved lubricating oils for the SGT-A35	
 Guidance on monitoring lubricating oil condition Guidance on sampling and analysing lubricating oil. 	
The following oil has recently been approved for use in the SGT-	A35:
 Castrol AGT-STD. 	
The oils listed below are no longer available and have therefore t list; any remaining stock, however, may be used:	been removed from the approved
Castrol Perfecto GT 5 Chevron Synthetic Turbine Oil SGT Metrex Turbo Oil 10.	
YOUR BENEFIT	
Maintaining the gas generator lubricating oil within the limits sp maintain the performance and reliability of your gas generator.	ecified in this document will help
This PAB affects the safe operation of the equipment. It is impor-	tant that you follow its instruction







RWG

Index 103 – IP Turbine Blade Failure and Fleet Risk

View of failed IP Turbine Blade





With 800 units sold worldwide and over 38 million* hours of service, the SGT-A35 has evolved to be an inherently reliable gas generator. Failure of critical component is thankfully a very rare event. When an event of this nature occurs each incident is thoroughly investigated to establish root cause, with subsequent actions recommended to mitigate future risk.

IP Turbine Blade Failure

RWG is aware of two IP turbine blade failures in recent history. Both failures occurred in 2019, relating to gas generators used in base load power generation. RWG performed a Root Cause Failure Analysis (RCFA) for one of the gas generators following loss of an IP Turbine Blade:

Model:	SGT-A35 GT (non DLE)
Serial No:	1880-XXXX
TSN:	88,702
TSO:	16,683 (RWG 2017)
Cvcles:	≥ 602





Index 103 – IP Turbine Blade Failure and Fleet Risk

Images from RCFA











IP Turbine Blade Investigation

Following strip of Module 05, extensive analysis was performed on a selection of IP Turbine Blades exhibiting damage and/or loss of the aerofoil including:

- **Creep Life Analysis** Dimensional inspection to identify any change in blade length, lean, shroud curl, interlock erosion and blade untwist
- **Component History** Review of operating hours, repair history (RWG 2017) and comparison with other fleet leading gas generators
- **Metallurgical Assessment** In-depth analysis of affected components to determine mode of failure

This assessment concluded that IP Turbine Blade failure was due to **high cycle fatigue (HCF)** associated with blade excitation resulting from worn blade outer shrouds.

Conclusion

It was noted at detailed inspection that IP Turbine Blade interlocks exhibited significant thermal erosion, much more than usual for the TSO. Detailed investigation of Module 04 and Module 05 also identified evidence of thermal erosion and hot streaking in the combustion chamber, HP and IP Nozzle Guide Vanes. Analysis of gas fuel nozzles and fuel manifold identified the presence of contamination, including sulphur and liquid condensates. Fuel quality was identified as the probable root cause of localised overheating and accelerated thermal erosion within the combustor and turbine section.





Index 122 (Critical Spares Availability)



Maintaining a supply of critical spares for gas generator overhaul is always a challenge for MRO shops. Recently this has been exacerbated by:

- Problems experienced by the OEM in managing the transition from Rolls-Royce to Siemens supply chain
- Maturing fleet and the impact of SB191 on 'GT' LLP lives

It's RWG's job to shield our customers from potential delays, which can be achieved in several ways

Mitigating Supply Chain Challenges

- Extensive Stock 18 month forward order on critical spares with over £22MM of current inventory
- RTP Programmes Purchase of surplus assets to create a rotable pool of serviceable and overhauled inventory
- Component Repair Deploying inhouse component repair capability to mitigate requirements for new replacement parts
- Common Parts Securing TLRF acceptance for substitution of common 24 G and GT LLPs
- LLP Life Extension Securing TLRF acceptance on a case-by-case basis for life extension of 'GT' LLPs
- RWG Quality Acceptance Standard Establishing a precedent with the OEM for revision to defect acceptance criteria



RWG

Index 121 (Hexavalent Chromium)

Hexavelent Chromium has been identified at RWG during SGT-A35 overhauls

- Yellow residue identified on 04 Module
- Particles disturbed during bolt removal
- Action plan initiated to mitigate health and safety risks
- Siemens PSW-0008-01 released March 2019 introducing screening method for identification of Cr(VI).

Processes introduced to reduce safety risk

- Controlled environment in facility, low risk
- □ Further work to develop new coatings with no chrome content
- Quarantine suspect assemblies and components
- Take samples for lab analysis
- Spray Ardrox on any dust particles to prevent airborne contamination
- □ Wash affected parts using approved method









Group Discussion

