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# ETN SGT-A35 User Group Update

Siemens May 19th 2021



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# Introduction





- Steve Broomfield A35 Senior Key Expert •
- Nick Corbett Head of Research AGT •
- Angelo Gazzillo Head of Customer Demand ٠
- Dean Garrington Head Supply Chain Management •
- Mark Scudamore A35 Service Product Manager •
- Johann Wiseman A35 Service Engineering Manager •

ECCN: N

2

# **Safety Moment**

## SIEMENS COCIGY

### HOW SITTING ALL DAY AFFECTS THE BODY



Safety&Health magazine

## Studies show

people who sit more than 8 hours a day experience higher risk of

certain types of cancers heart disease diabetes

The global pandemic has allowed for more flexible ways of working, however has it also increased our reliance on screens and sitting at desks ?

Healthmatters.nyp.org

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## Agenda Siemens SGT-A35 Update

Index No.	Title	Presenter
	ETN Requested Topics	
122	Spare parts lead time excessively long + supply chain changes since business takeover from Rolls Royce	Dean Garrington / Angelo Gazillo
110.1, 110.2	Lack of alternatives for RT Power Turbines overhaul (RT61)	Mark Scudamore
123	HPT GT blade failure event (2018), and risk for the fleet + NGV redesign	Steve Broomfield
121	Hexavalent Chromium (PSW01-008)	Steve Broomfield
	IPC St 6 Vane failures	Steve Broomfield
	MROC Testbeds overview & certification process	Johann Wiseman
	Siemens topics	
	Decarbonisation update – efficiency improvements / sCO2 / PEMs	Nick Corbett
	Fleet Reliability & Improvements	Mark Scudamore

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# AGT – Operations On Time Delivery

# Angelo Gazzillo

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## **Journey So Far**



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### **OTD – Recovery Workstreams**





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# Lead-time Reduction (LTR)



#### Reduce lead-times at the RFQ stage to improve competitiveness and customer satisfaction



A data driven Lean Six Sigma approach aims to reduce our average LT from 90 days by 30% to 63 days

YYYY-MM-DD

Author | Department 9 Restricted © Siemens Energy, 2020



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## **Rolls Royce GT Supply Chain Exit**



- Programme aimed at Removing the remaining GT Parts still manufactured in RR factories (c. 300 Part nos.)
- **Good progress** is being made in many areas of the transfer.
- More Complex Drums and Turbine blades are in full production at the new suppliers.
- Rolls Royce continue to support Siemens with the manufacture on a small number of critical components.
- The programme includes a selection of Siemens internal manufacturing plants and external suppliers.
- Make Versus Buy strategies are being used to mitigate longer term risks or delays.
- **Intense focus** continues to be applied to all aspects of the Project Management and Manufacturing processes with Engineering key to the success of the plans.

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# **Power Turbines** Mark Scudamore

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# Power Turbine Operations strategy update

- Montreal will become the Power Turbine Center of Excellence for both Overhaul & New build from Fiscal 2022
- Internal Transfer programme is in progress to ensure seamless delivery to customers
- All vital support functions for Power turbines will continue to be provided as an integrated OEM support to each project.
- All work is performed to rigorous OEM standards using 100% OEM components and processes
- On a case-case basis, Siemens continues to evaluate several locations globally to install repair and overhaul capabilities on the Legacy RT and DR Power Turbine frames

Siemens Product Advisory Bulletin (PAB-01-0008-01)



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## A35 Gas Turbine Technical updates – various topics

**Steve Broomfield** 



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# **GT DLE HPT blade failures**

There have been 9 HPT blade failures on the GT
 All have been on engines with DLE combustors.

□ 3 failures have been through the root platform.

□ 6 have been through the aerofoil at approx. 50% height.

GT DLE Fleet = 95 engines / 2.18m hours

- Aerofoil failure rate 2.75/m hours
- Platform failure rate 1.37/m hours







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# **GT DLE HPT blade failures**

#### **Platform Failures**

- □ Analysis of two failures has been carried out. Parts for the third failure are not available.
- > No metallurgical or dimensional defects found
- Low temperature sulphidation has been found in the failure region.
- □ Analysis of deposits found in the platform containing sulphur, sodium and potassium were also found
- □ This area is primarily compressor cooling air therefore contaminants will have originated in the intake air
- Operators are advised to ensure airborne contamination is minimised which can be achieved by the use of HEPA filters ref PAB01-0008.
- □ HEPA filters also reduce contamination leading to performance loss which then reduces the downtime necessary for compressor washing.





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# **GT DLE HPT blade failures**

#### **Aerofoil Failures**

- □ Failure is due to High Cycle fatigue initiates at the leading edge. No metallurgical or dimensional defects found.
- Cyclic operation is contributory factor as it causes wear of the shroud interlocks. This allows the blade to vibrate in cantilever modes.
- Blockage of fuel injectors as a result of fuel quality was also a factor in one failure.
- □ The vibration mode likely to cause mid-height aerofoil failures is primarily generated by wakes from the 36 HPNGVs.
- □ To minimise risk Siemens recommends DLE overhaul life is limited to ~25K to maintain interlock condition.
- □ Siemens has initiated a programme to redesign the HPNGV aerofoils to reduce the aerofoil wake strength reducing the vibration forcing on the blade.
- □ The new HPNGV's will be available for retrofit onto the existing DLE combustor as well as with the new <15ppm DLE combustor.



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# GT DLE HPT blade failures – HP NGV Redesign



HP NGV redesign using an aerofoil scaled from the SGT-A65 with a '3D' shape to reduce the strength of the wake impacting the rotor blade.



# **Hexavalent Chrome**



- □ Siemens recommendations for identifying and dealing with Hexavalent Chrome (Cr6) are contained in PSW 01-0008 originally issued in March 2019
- □ Rev 02 was issued in Nov 2020 to add details of additional Cr6 test kits.
- □ Cr6 forms in external locations as a result of reaction with anti-seize compounds used on bolts.
- Data provided by Rocol for an alternative anti-seize that does not produce Cr(VI) is being evaluated and is expected to be approved for use by end July 21.
- □ Siemens is also due to conduct laboratory assessments of additional alternative anti-seize compounds that will not react with engine materials to form Cr6.
- □ Until the new anti-seize compounds are in use engines will still need HSE precautions to be taken until they are removed and returned to the MROC where all parts will be cleaned.

## **IP Compressor Stage 6 Stator Failures**

- The current standard of IPC stage 6 vane was introduced in 1992. The majority of the fleet (>700 engines) has this standard of vane.
- □ There have been 6 known IPC stage 6 stator vane failures since 2005 resulting in engine removal.
- □ They are a mix of G and GT engines with total lives of between 33K and 100K.
- □ Failure generally results from loss of damping rubber followed by increasing wear between the stator feet and the shroud ring.
- □ Eventually debris is released which impacts the HPC blades.
- The shroud ring and vane feet have wear resistant coatings.
  However these are very thin and accurately measuring worn / missing coatings at overhaul was difficult.
- In 2015 the inspection criteria was revised to improve detection of partially worn vanes and shrouds which can then be repaired.
- Siemens are initiating an R&D project in Fiscal 2022 to make the Gzero stage 5 & 6 vane part numbers the baseline for the G & GT variants. These vanes will be offered as an improvement to the current vane with the expected benefits of less vane feet wear and the potential to remove the need for vane foot re-rubbering at overhaul.





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# **Test Bed Certification** Johann Wiseman



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## **Test Bed Certification**



Historically test beds have been categorised based on their qualification

- Performance of the test beds is traceable
- Every 3 years (minimum) performance data is cross checked
  - From data trending, if the values start to drift then corrections made sooner
  - e.g. RWG Ansty test bed shares data for performance evaluation every 6 months

#### **Test bed Locations**

- Canada: Siemens Energy Test bed 5 Montreal cross calibration is done against this bed
  - A35 G & GT, DLE & Conventional (gas and liquid)
  - TCT, A35 DLE & Conventional (gas only)
- UK: RWG Ansty, A35 G & GT, DLE & Conventional (gas only)
  - RWG Tulles Aberdeen, A35 G Conventional (liquid only)
- China: Petrochina, A35 G Conventional (gas only)

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## **Test Bed Certification**

**Re-Certification:** 

- Cross check parameters over the last X months since last check •
- Recalibrate any sensors which have shown drift ٠

Lapsed Certification or New Test Bed

- Cross-calibration exercise has to be carried out against Montreal test bed 5 •
- Using same engine with similar ambient conditions to carry out cross check •







Gas Horsepower **Engine Efficiency** 

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Nick Corbett



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## AGT Solutions for Decarbonization

# Operational optimization

- Improved part-load efficiency measures
- Improved air filtration

#### Energy Efficiency

- Waste heat recovery
  - Steam
  - ORC
  - SCO<sub>2</sub>

#### Zero Carbon & Low NOx

Solutions requiring development

#### **Carbon Neutral Fuels**

Known solutions requiring test and demonstration

#### Efficiency

Immediately available solutions

#### Today

Customers seeking help to reduce the climate impact of their operations

2020-05-10

Technology Classification : AL: N

ECL: N

EC

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## **Product Efficiency Modifications**



HEPA Air Filterscompressor degradation is reduced between overhaulsRT62X Power TurbineRT62 blades and vanes are upgraded to a more efficient designBleed Valve Reschedulingcontrol system closes bleed valves during stable, partial-load operation



## **Combined Cycle / Cogeneration**

#### Utilizing GT Exhaust to produce additional power or process heating

- Plentiful energy exists in a GT exhaust •
  - High temperature
    - Steam •
    - Hot Oil
    - Hot Water
    - Hot air
- Combined Cycle Power Generation can • significantly reduce CO<sub>2</sub> footprint
  - Steam, ORC, SCO<sub>2</sub>
  - On a gas platform, heat recovery from GT compressor sets can generate enough power for the platform needs
  - **Challenge: Space** •



#### **Annual CO<sub>2</sub> Emissions**

2020-05-10

ECCN: N

US Content N

ECL: N

Nick Corbett | SE GP I SV AGT EN 28

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## Waste Heat Recovery



**Ultra Light Bottoming Unit** Compression & Oil separation modules



2020-05-10

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US Content N

Supercritical CO<sub>2</sub> Heat Recovery Engine

## **Predictive Emissions Monitoring**

- PEMS Digital Intelligence
- Quantify the emissions profile of an installation
- Quantify the benefits when implementing modifications and optimising operations





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2021-<u>05-19</u>

Technology Classification : AL: N

ECL: N E

ECCN: N

US Content N

## **Future events**

#### Talking Decarbonization with Siemens Energy Webinar Series



Contact to register....

decarbonisation.energy@siemens-energy.com

We are presenting at ASME's Turbo Expo. GT2021-60264, "Unlocking the Green Economy for Aeroderivative Gas Turbines"

# Learn more & register at <u>event.asme.org/Turbo-Expo</u>. #TurboExpo2021





# Reliability

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# **A35 Fleet MTBFO**

12 Month Rolling Fleet MTBFO Delta Change



Data represents approx. 30% of the total A35 fleet; those reporting into ORAP. Statistics consider all events which fall under Siemens Energy scope of responsibility.

## Overall trip count and service hours change in 12 months

- Forced Outages: 22% Reduction
- Service Hours: 12% reduction

#### **BOV Solutions**

- 25% reduction of forced outages in 12 months for BOV related events for the fleet combined.
- 52% reduction in 24 months

#### **FMV Solutions**

- 37% reduction of forced outages in 12 months for FMV related events for the fleet combined.
- 54% reduction in 24 months

#### VIGV Solutions

- No numerical reduction of forced outages in 12 months for VIGV related events for the fleet combined
- 40% reduction in 24 months

#### **Valve Solutions**

- 31% reduction of forced outages in 12 months for Valve related events (excluding BOVs) for the fleet combined.
- 41% increase in compared to 24 months

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October 08 2020

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ECL: N ECCN: N

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# **A35 Fleet Reliability and Availability**

12 Month Rolling Fleet Reliability Delta Change



Data represents approx. 30% of the total A35 fleet; those reporting into ORAP. Statistics consider all events which fall under Siemens Energy scope of responsibility.

October 08 2020 Technology Classification : AL: N ECL: N ECCN: N US Content N

## Overall Trip count and service hours change in 12 months

- Unscheduled : 40% Reduction
- Scheduled: 14% increase

#### **BOV Solutions**

- 82% outage time reduction in 12 months for BOV related events for the fleet combined.
- 74% reduction in 24 months

#### **FMV Solutions**

- 62% outage time reduction in 12 months for FMV related events for the fleet combined.
- 75% reduction in 24 months

#### **VIGV** Solutions

- 46% outage time reduction in 12 months for VIGV related events for the fleet combined.
- 28% reduction in 24 months

#### **Valve Solutions**

- 4% outage time reduction in 12 months for Valve related events (excluding BOVs) for the fleet combined.
- 44% reduction in 24 months, due to some high downtime events in 2018

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## **Reliability improvement – further information**

Below are examples of current modifications and upgrades we have available for these component groups. If you are experiencing issues with any of these component groups please contact your Regional Technical Support or the A35 Team, who will be able to assist you with a specific solution:

- FMV Solutions: PIB 01-0001, PAB 01-0026, PAB 01-0018, PAB 01-0001
- Valve Solutions: PAB 02-0013, PIB 02-0001, PIB 02-0004, PIB 02-0011
- BOV Solutions: PIB 02-0013, PIB 02-0004
- VIGV Solutions: PIB 02-0012



# Thank you for your attention

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## SGT-A35 Product Safety Warnings, Product Advisory Bulletins and Product Improvement Bulletins



### (Last 6 months)

#### **Product Safety Warnings** PSW 02-0005 SGT-A35 Life-Limited Parts Declaration Hexavalent Chromium Residue on Gas Turbine Components PSW 01-0008-02 **Product Advisory Bulletins** PAB 02-0007-04 SGT A35 gas generator Lubricating Oil Specification PAB 02-0017 Procedure for the Interchangeability of Accelerometer Standards PAB 02-0019 SGT-A35 T455 Spread Limits PAB 02-0020 A21 Hose Fitting Advise PAB 02-0018 **RVDT Replacement** PAB 01-0034 Precautions when Welding within or around Gas Turbine Enclosure PAB 01-0033 Power Turbine Check Balance Limits

#### **Product Improvement Bulletins**

PIB 02-00016	Quantitative Debris System (QDM) System Installation
PIB 01-0008	Introduction of Siemens Air Filters (SAF)

## **SGT-A35 Working Together Meetings (WTM)**



These meetings aim to proactively provide information to customers on both technical and service issues; help us (Siemens Energy) to understand and address customer issues; and promote open communication and ultimately build sustainable and integrated relationship with Customers.

At the meetings there is ample opportunity to speak with our subject matter experts on the agenda topics and after the meeting you will be sent a copy of the presentation pack and a copy of the questions and answers from the meeting (anonymised). You can also suggest agenda topics you would like included.

If you would like any further information, please contact <u>anne.gardner@siemens-energy.com</u>

#### SGT-A35 WTM 2021

- 10<sup>th</sup> March
- 9<sup>th</sup> June
- 8<sup>th</sup> December

ECL: N ECCN: N