SGT-A05 (Industrial 501) Service Solutions

Engineered Solutions to enhance engine operability
The long-term reliability inherent in Siemens equipment means we have gained unrivalled experience and knowledge when it comes to developing the engineered modernizations and upgrades. It allows Siemens to meet customer’s needs so they can sharpen their vital competitive edge by enhancing the efficiency, environmental performance and profit generating potential of their equipment. These engineered solutions from Siemens enhance your total package, from the gas turbine and its control and ancillary systems through to the final driven equipment.

Siemens, as the OEM for the SGT-A05, is uniquely positioned to support the upgrade requirements to improve the units’ operation in the facet(s) that need to be addressed.

The options available to your operation can be customized to meet your situation.

With Siemens at your side you gain the benefit of a world-class, global, customer-focused organization.

Please contact your Siemens representative to discover the art of the possible.
Improving the operation of an asset is a key goal for our customers. Through our Unit Health Assessments (UHA), Siemens can provide you with information that can help improve the long-term operation of your fleet.

By undertaking a detailed assessment of your current equipment, Siemens can provide a health assessment and make recommendations around:

- Safety
- Reliability
- Operations Optimization
- Modifications and Upgrades
- Spare Parts

This information, coupled with a better understanding of your operational needs, will be vital in helping shape what improvement opportunities are available to you.

**Benefits**

Using Siemens Original Equipment Manufacturer expertise, the UHA provides an assessment of equipment condition in order to identify risks and opportunities for operation. At the end of the UHA you will receive a report detailing:

- Identification of risks to enable safe operation.
- Opportunities for optimizing your operation.
- Opportunities for improved reliability and availability to reduce downtime and operating cost.
- Identification of old and obsolete equipment and associated risk.
- A complete Spare parts list and stocking level recommendations.
- Available product modifications and upgrades to benefit performance with short and long term recommendations.
- Assistance with maintenance and outage planning.
- Operational practice recommendations.
- Key information to facilitate production planning and asset sustainability.

**Applicability**

Unit Health Assessments are available with all Siemens Aeroderivative Gas Turbines including:

- SGT-A65 (Industrial Trent)
- SGT-A35 (Industrial RB211)
- SGT-A20 (Industrial Avon)
- SGT-A05 (Industrial 501-K)

**Description**

The Siemens Unit Health Assessment team will undertake the assessment which will cover every individual engine or package on your fleet and provide observations on safety, reliability and integrity within an existing site.

In order to do this effectively we will need access to the area for up to four days. This can be done during a planned shutdown. This will allow for us to effectively log the correct data and conduct a complete assessment of the product and auxiliaries. The information gathered will include (but not limited to)

- Summary of Site Tailgate Notes and Safety Observations
- Site Information
- Data Log information
- Site General Arrangement
- Maintenance History
- Detailed Equipment List specific for each sub system
- Service Bulletins
- Modernizations and Upgrades

**Experience**

Siemens has experience of conducting UHAs across its global fleet with recommendations made in O&G and PG applications.

**Further information**

To find out more about Unit Health Assessments or to request one, please contact your local Siemens Client Manager.
Engineered Solution Purpose

Meeting emission requirements without the need for water injection.

Benefits

- SGT-A05 engine variants KB5S, KB7HE and KB7S can expect emission levels of 25 vppm NOx and 50 vppm CO.
- The emission reduction is achievable at 15% O, and sustainable from 50% to 100% power with a 14th stage bleed upgrade.
- SGT-A05 KC5 applications can expect similar emission levels, but from 60% to 100% power with 14th stage bleed.
- DLE conversion reduces customer’s operating costs associated with water treatment.

Technical Description

This engineered solution reduces emissions through advanced lean burn combustion technology.

To achieve low emissions the DLE liners have two fuel circuits: Main and Pilot. The pilot circuit is only utilized during start. Our combustion liners achieve low emissions through the use of the main fuel circuit at full power. Part power emissions compliance is achieved through the use of the main fuel circuit and bleed valves.

DLE is only available for gas fuelled applications.

Experience

- More than 120 engines are already successfully utilizing DLE technology to reduce NOx and CO emissions.
- 3.9 Million Operational Hours Accumulated (Feb 2018). We now have 226,000 operating hours per year on our LE5 liners.
- High time DLE engines have over 130,000 hours of operation.

Accomplished

At overhaul

Bundle Opportunities

Controls Upgrade

Scope of Work

- Replace combustion liners
- Replace outer combustion casing
- Replace compressor diffuser assembly
- Fuel inlet assembly
- Liner supports
- Replace fuel manifolds
- Install 14th stage bleed system
- Modify control system (digital controls required)
- Install additional fuel metering valve
SGT-A05 KB7S to KB7HE Upgrade

Engineered solution purpose – increase in power and fuel efficiency

**Benefits**
- Higher Power – 8% power increase (8000 SHP) at ISO condition
- Lower Fuel Burn – 34% Fuel Efficiency (Uninstalled)
- Heat rate – 2.6% improvement
- Fuel Flexibility – Same fuel options as current SGT-A05 KB7S Model Specification
- Proven dual fuel configuration and combustion system
- Payback period for the upgrade of the engine – customer can expect return on investment in 1-3 years*  

Based on proven aeroderivative, the SGT-A05 KB7HE is an outstanding solution for power generation.

Siemens can supply Long-Term Programs (LTPs) and aftermarket services upon request.

A service upgrade kit is available for easily converting KB7S to KB7HE.

**Applicability**
SGT-A05 KB7S**

**Technical Description**
This upgrade improves efficiency and increases power through superior interstage sealing in the compressor and increases power by operating at a higher control temperature.

**Scope of work**
- Remove and replace compressor wheel Stages 1st-13th
- Remove and replace compressor vanes 1st-13th remove and replace ancillary hardware
- Balance rotor and grind blade tips
- Update control program

**Experience**
Performance enhancement was confirmed through testing. A service evaluation engine has been running for 1.5 years.

**Work Performed**
At overhaul facility and at site

**Bundle opportunities**
Controls Upgrade

Existing SGT-A05 KB7S easily retrofits to SGT-A05 KB7HE at a cost competitive investment.

*Depends on location specific price of natural gas and electricity
**UHA may be required to verify the suitability of the upgrade for the package.
Engineered Solution Purpose

By upgrading from either LE3 or LE3.1 combustion liner to either the LE3.2, which is recommended for dry engines or the LE3.4, which is recommended for water or nozzle steam injected engines, the peak metal temperatures in the turbine can be reduced.

Improved effusion cooling of the liner walls has reduced liner wall temperatures which can extend the working life of the liner and reduce overall engine maintenance costs and unit down time.

Benefits

- Through the application of improved effusion cooling technology the service life of the combustion liners may be extended as much as 50%.
- An improved pattern factor increases turbine vane life due to the reduction in the turbine when compared to LE2, LE3 and LE3.1 liner configurations.
- The LE3.4 liner builds from the experience with the LE3.2 liner and improves liner life for operators utilising water or steam injection applications.
- Reduction of water consumption for emissions control by converting from LE2 to LE3.4 combustion liners. Water consumption can be even further reduced when this upgrade is combined with the use of the Pilotless Dual Fuel Nozzle upgrade.

Applicability

This engineered solution applies to all SGT-A05 engine variants not employing Dry Low Emissions combustion.

Technical Description

LE3.2 and LE3.4

The LE3.2 and LE3.4 combustion liners utilize effusion cooling technology rather than the convection cooling arrangement of the LE2 liner and has lower liner wall temperatures than the LE3 and LE3.1 liners.

The LE3.2 is recommended for dry engine applications.

The LE3.4 is recommended for applications utilizing water or nozzle steam injection.

Experience

LE3.2

- The LE3.2 barrel has achieved over 30,000 hours before requiring repair.

LE3.4

- The LE3.4 is the OEM build standard for all engines currently manufactured utilizing water or steam injection for emissions control.

Work Performed

At site

Bundle Opportunities

- SGT-A05 pilotless fuel nozzle conversion
- SGT-A05 fuel manifold upgrade
Engineered Solution Purpose

This engineered solution reduces carbon build-up in nozzles by eliminating the pilot fuel circuit, thereby improving hot section reliability and reducing maintenance costs.

Benefits

- The increased orifice size helps reduce carbon coking on the fuel nozzle. This reduction in coking subsequently reduces combustion liner distress due to flame pattern distortion.
- Eliminating carbon build-up on the nozzle also reduces carbon shedding which improves first and second stage turbine life.
- The installation of the fuel nozzle also simplifies maintenance cleaning by eliminating flow check requirements.
- For customers utilizing water injection as a method to control NOx, water consumption may be reduced through the use of Pilotless Fuel Nozzles.
  - Customers may further reduce their water consumption by upgrading to LE3.4 combustion liners.

Applicability

All SGT-A05 engine variants not employing DLE combustion technology.

Technical Description

The pilotless fuel nozzle eliminates the pilot fuel circuit. The resultant reduction in carbon build-up alleviates first and second stage turbine erosion caused by carbon shedding.

Scope of work

- Install air manifold
- Replace gas fuel manifold
- Connection to 125 PSI, 90 SCFM air source is required for a 15 second period during start only
- Install manifold for air assist start

Experience

This solution is the current build standard on all new production units.

Work Performed

At site

Bundle opportunities

- SGT-A05 Combustion Liner Upgrade
- SGT-A05 Fuel Manifold Upgrade
- Controls Upgrade
SGT-A05 First Stage Turbine Enhancement

Proven solution can increase service life by up to 30%

Engineered Solution Purpose

This engineered solution increases the part time and therefore also the mean time between overhaul.

Benefits

- By improving the first stage turbine hardware the life utilization is significantly improved for all hot section parts.
- The increased life of the turbine reduces the teardown frequency thus the operational costs for commonly replaced parts are reduced.
- The life improvements are further enhanced by bundling combustion liner upgrades as well as embodying fuel nozzle improvements.

Applicability

All SGT-A05 engine variants.

Technical Description

The enhancement replaces the first stage blades with Directionally Solidified (DS) blades, the first stage vanes with Advanced Thermal Barrier Coating (TBC) and an improved trailing edge cooling scheme.

To realize the full potential for power improvement, engines using Turbine Inlet Temperature (TIT) control must be converted to Turbine Outlet Temperature (TOT).

Scope of work

- Replace first stage turbine blades and vanes

Experience

This proven enhancement has accumulated millions of operational hours and is the current production standard on all new units.

Work Performed

Portion of this engineered solution may be accomplished at the operator’s site (Vane Replacement). Alternatively the engineered solution may be fully implemented at Overhaul where full benefit can be realised.

Bundle Opportunities

- SGT-A05 KB/KH TOT Thermocouple Conversion
- Controls Upgrade
- SGT-A05 Combustion Liner Upgrade
- SGT-A05 Pilotless Nozzle Conversion
- SGT-A05 Second Stage Turbine Enhancement

<table>
<thead>
<tr>
<th>Enhanced T1 Vane</th>
<th>Original T1 Vane</th>
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<tbody>
<tr>
<td>Improved trailing edge cooling</td>
<td>Original trailing edge cooling</td>
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Availability

Efficiency

Power

Reliability

Environment

Flexibility
Engineered Solution Purpose

This solution allows an increase in power due to an increase in firing temperature. This solution also allows an increase in mean time between overhaul.

Benefits

It is recommended that this solution be embodied at the same time as the first stage turbine enhancement.

Applicability

All SGT-A05 non-boosted engine variants.

Technical Description

To realize the full potential for power improvement, engines using Turbine Inlet Temperature (TIT) control must be converted to Turbine Outlet Temperature (TOT).

The second stage blades are replaced with new Platinum Aluminide (Pt-Al) coated, MAR-M247 material blades. The second stage vanes are coated with Pt-Al and have honeycomb interstage seals which requires a new 1-2 spacer with hardened knife edge seals.

In addition a control upgrade is required for increased firing temperature and power level.

Scope of work

- Replace second stage turbine blades and vanes
- Replace 1-2 spacer (if upgrading to honeycomb seal vanes)

Experience

All new engines are delivered with this standard blade, vane and spacer. This proven enhancement has accumulated millions of operational hours. The majority of the fleet has converted to the improved standard vane and seal assembly.

Work Performed

At overhaul

Bundle Opportunities

- SGT-A05 KB/KH TOT Thermocouple Conversion
- SGT-A05 MGT Thermocouple Conversion
- Controls Upgrade
- SGT-A05 Combustion Liner Upgrade
- SGT-A05 Pilotless Nozzle Conversion
- SGT-A05 First Stage Turbine Enhancement

Note

Industrial KB and KH Performance Improvements:

- Power – 11% expected improvement
- Heat rate – 2% expected improvement
- Durability – Up to a 30% increase in service life

Industrial KC Performance Improvements

- Power – 14% expected improvement
- Heat rate – 2.7% expected improvement

The increased life further decreases the overall operational cost by reducing the number of commonly replaced parts and downtime requirements. The honeycomb interstage seals provide for an improved fit and increased rub tolerance.
Engineered Solution Purpose

This engineered solution increases thermocouple life and reduces overall engine operating costs by adopting the Measured Gas Temperature (MGT) position for the thermocouple.

Benefits

The in-service life of the thermocouple is increased by an order of magnitude. The reduction in maintenance costs generates payback in less than two years.

Applicability

SGT-A05 KC engine variants.

Technical Description

This conversion relocates temperature measurement from the Turbine Inlet Temperature position to the cooler environment to be found aft of the 2nd stage blades.

Scope of work

- Replace vane case (if required)
- Install MGT thermocouples
- Install MGT harness, inner & outer
- Install new MGT ring
- Install modified diaphragm
- Control system modification (digital control required)

Experience

The MGT thermocouple is utilized on over 180 engines.

Work Performed

At site

Bundle opportunities

- Controls Upgrade
- SGT-A05 Fuel Manifold Upgrade
Engineered Solution Purpose

This engineered solution may increase mean time between overhauls and improves operational temperature monitoring. This is achieved by changing the locations of the thermocouples from the turbine inlet to turbine outlet.

Benefits

By extending the life of the thermocouples, payback on this conversion can be realized in less than two years. Thermocouples located at the turbine outlet provide a greater accuracy in temperature monitoring.

Applicability

SGT-A05 KB, KBS and KH engines

Technical Description

Turbine Inlet Temperature (TIT) thermocouples are relocated from the inlet of the turbine to the exhaust which improves the life of the thermocouple.

Scope of work

- Remove and replace the TIT thermocouples and harness with TOT thermocouples and harness
- Modify and/or replace controls (digital controls required)
- Replace Rear Turbine Bearing Support (if required)

Experience

TOT control is the production standard on all new units and has accrued millions of hours of operational experience.

Work Performed

At site

Bundle Opportunities

- SGT-A05 First Stage Turbine Enhancement
- SGT-A05 Second Stage Turbine Enhancement
- SGT-A05 Combustion Liner Upgrade
- SGT-A05 Controls Upgrade under the Bundle opportunities

TOT Thermocouple  TIT Thermocouple
SGT-A05 Dual Fuel Conversion
Reduce overall operating costs by incorporating greater fuel flexibility

Engineered Solution Purpose
Improves operational flexibility by increasing the number of fuel options with a pilotless dual fuel nozzle.

Benefits
- Continuous operation of the unit can be achieved even in periods of natural gas supply curtailment or supply disruptions due to the ability to run on an additional diesel or kerosene fuel.
- Operating costs may be reduced by allowing the inclusion of an interruptible clause in natural gas supply contracts by converting to a dual fuel system.

Applicability
All SGT-A05 engine variants not employing DLE (Dry Low Emissions) combustion technology.

Technical Description
Operation on natural gas can be changed to operation on liquid fuel (or vice versa) by switching during steady state operation by the addition of a liquid fuel system. There are multiple different fuel system options that can be used to meet customer’s operational requirements.

This option can be used with both dry and water injection applications.

Scope of work
Dependent on your operation and engine configuration. Additional changes may be required.
- Replace combustion liners (if required)
- Replace fuel nozzles
- Install additional fuel manifold(s)
- Install additional fuel control valve
- Install liquid fuel pump
- Misc. piping, check valves, shutoff valves, drain valves, and gauges
- Control system modification or replacement

Work Performed
At site

Bundle opportunities
- Controls Upgrade

Pilotless Dual Fuel Nozzle
SGT-A05 Service Solutions
Engineered solutions to enhance engine operability

**Digital Services**
- Additive manufacturing
- Performance optimization
- Maintenance optimization
- Flex programs

**Performance Enhancement**
- Lifetime extension
- Modernization and upgrades

**Service Programs**
- Long Term Program (LTP)
- Operation and maintenance
- Leasing program
- Condition-based maintenance
- Unit Health Assessment (UHA)

**Maintenance Solutions**
- Field service
- Overhaul and repair
- Remote operational service
- Spares and spares inventory review

**Training and Consulting**
- Training for customers and partners on equipment operation and maintenance
A Global Network

SGT-A05 packagers and Siemens maintenance, repair and overhaul centers

Our customers may be located in diverse regions around the world, but they all have one thing in common. They all require timely and accurate support to purchase, install and maintain their SGT-A05 gas turbines and equipment. That’s why we continually invest in our global infrastructure from distributors to repair and overhaul facilities.

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