



SIEMENS

Ingenuity for life



Operation & Maintenance

HRSG Performance Management and Service

Continuous Condition Assessment

[siemens.com/power-generation-services](https://www.siemens.com/power-generation-services)

Expertise over a wide range of HRSG designs

Customers worldwide have signed Operation and Maintenance (O&M) contracts with Siemens to help maximize their plants' operational performance, reliability and availability by handing over operational tasks and responsibilities to Siemens. Experience shows that Heat Recovery Steam Generators (HRSGs) supported by a service program can actually operate with a higher availability and performance, following the general trend of the electricity producer to maximize the reliability of the entire plant under an Asset Management Program.



Siemens recommends regular inspections of the HRSG during every minor and major outage.

Siemens' O&M organization has performed inspections, repairs and upgrades of HRSGs worldwide, winning extensive expertise over a wide range of HRSG designs by different OEMs.

Our know-how

Siemens' O&M inspectors have long term experience in performing:

- Visual inspections
- Ultrasonic thickness testing
- Liquid penetrant testing
- Hardness testing
- Borescope inspections
- Replications metallography
- Infrared analysis/thermography
- Root cause analysis
- Repairs
- Expertise for cleaning fouled heat transfer surfaces
- Water chemistry

Siemens O&M inspections and repair works are based upon relevant industry standards and applicable references from ASME (American Society of Mechanical Engineers) and PED (European Pressure Equipment Directive).

HRSO Performance Management – Continuous Condition Assessment

The Siemens' O&M organization performs Level I and Level II inspections of HRSOs in order to assess the HRSO's current condition. A systematic maintenance schedule can help reduce the risk of non-scheduled outages and decrease the costs for corrective measures.

This helps Siemens perform its O&M services cost effectively with optimized reliability. HRSO reliability can be even more important in power markets that require intermittent dispatch mode as opposed to base load operation, as frequent cycling can decrease the lifetime of HRSO components.

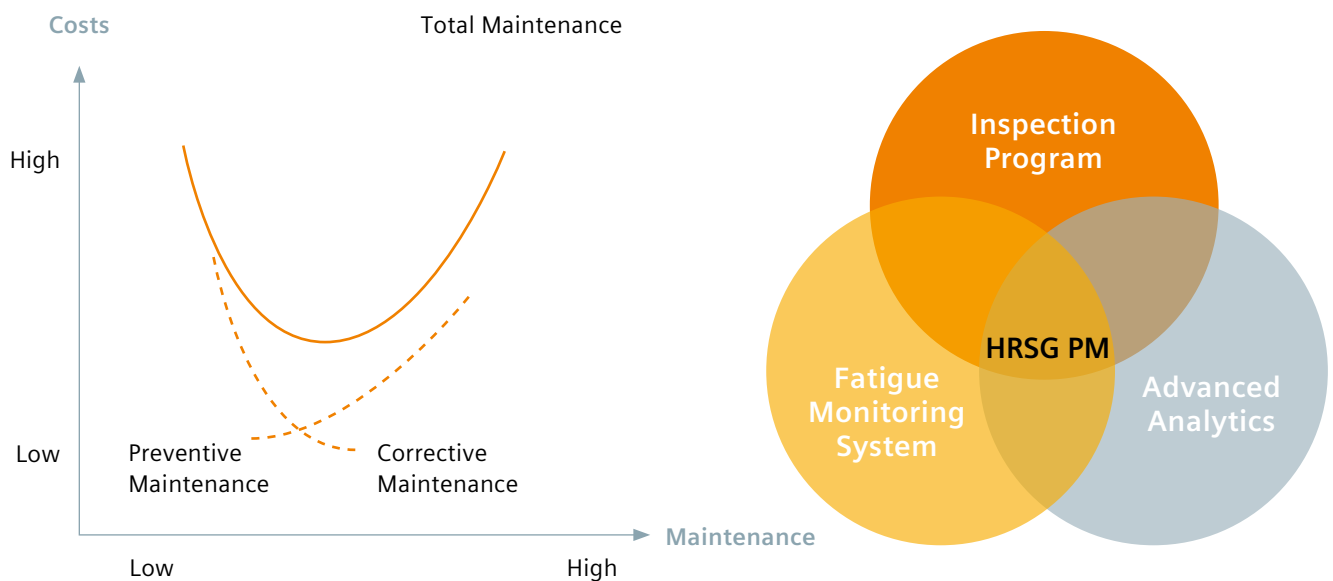
Our solution

Siemens developed HRSO Performance Management to fulfill customer requirements of obtaining the highest availability and reliability possible.

HRSO Performance Management is part of the overall Plant Asset Management Program. It provides regular documentation and analysis of the technical condition and operational performance of the HRSO. These results merge into operating and servicing recommendations according to the principle of reliability centered maintenance optimization.

HRSO Performance Management consists of three major components:

- Inspection Program
- Advanced Analytics
- Fatigue Monitoring System



HRSO Performance Management (PM) Reliability centered maintenance optimization
(Conceptual illustration only. Actual experience may vary)

Inspection Program



Your benefits can include

- Consistency in inspection procedure, structure and reporting
- Recommendations for maintenance and repair work
- Recommendations for an adequate inspection and maintenance plan
- Regular surveillance of HRSG and related component condition
- Identification of component issues
- Reduction of forced outage times due to early detection

The function

The basis of HRSG Performance Management is the periodic inspection program for the HRSG which can be tailored to the inspection plan and schedule of the power train. Thereby, it provides the advantage of a coordinated outage of the power train and the HRSG, with a single point of contact. The inspection program consists of regular Level I and Level II HRSG inspections.

The features

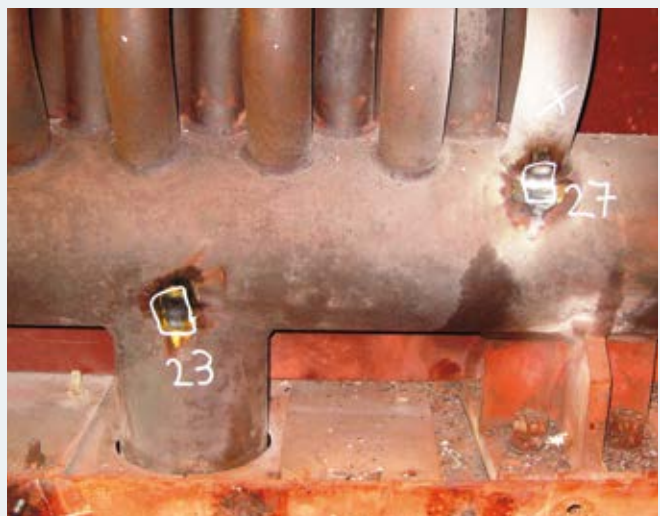
The purpose of the inspection program is to gather information on the condition of the components in order to derive recommendations for immediate action, as well as medium and long term repair of components. Furthermore, data gathered during each individual inspection is used to help identify reliability issues, focus future repair efforts and point out component issues. Additionally, results of past inspections can allow Siemens to prioritize those areas which require closer attention and non-destructive examination in subsequent inspections. Inspections are managed by experienced Siemens inspectors.

Level I Inspection (Minor Outage)

is a visual inspection to detect mechanical and corrosion issues, performed during a minor inspection of the gas turbine.

Level II Inspections (Major Outage)

comprise visual inspection, borescope inspection, metallography and other non-destructive testing according to Siemens O&M standards – and if necessary, local requirements, and the unit's operational history.



Metallography

Advanced Analytics

The function

Operation and performance monitoring as an integral part of the HRSG Performance Management allows identification of gradually deteriorating performance and to the components leading to such deterioration.

3D FEM (Finite Element Method) Analysis combined with Siemens FMS (Fatigue Monitoring System) allows prioritization and customizing of the inspection schedule for those areas which require closer attention and non-destructive examination in upcoming inspections. This supports long term planning for replacement of major components.

The features

A comprehensive set of data points, not limited to the HRSG boundaries, are used to record pressure, temperature, water/steam mass flows and heat rejection on the HRSG, HP, IP and LP circuits from the gas turbine exhaust manifold expansion joint up to and including the exhaust stack.

Daily monitoring of the site data is performed by the Siemens Power Diagnostic Center (PDC). A dedicated data acquisition team is assigned to verify that data is received and processed. Daily monitoring consists of a detailed review of the previous day's data for deviations from normal values. Deviations are detected using the proprietary advanced rule base tools developed by Power Diagnostics.

A comprehensive report shows the processed data in various graphs. Information derived from the evaluation of the long term trends can allow identification of component issues and recommendations of counter measures to help avoid unplanned outages.

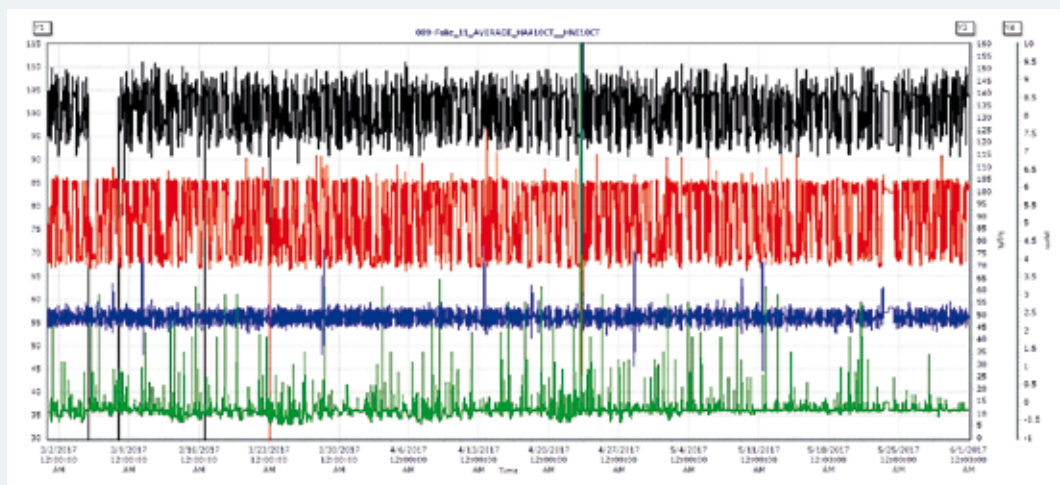
Operations monitoring and trending supports and refines the regular inspection work. Advanced Analytics provide online monitoring of HRSG components as well as plant performance data within the overall Siemens Digital Services for power plants.

Siemens Digital Services is running on MindSphere, our robust operating system that combines new developments in data analytics, connectivity and cyber security with proven capabilities for remote maintenance and optimization.

The MindSphere ecosystem integrates, manages, analyzes and visualizes data from disparate sources, such as machine data and weather data, to enable new insights in the cloud or on premise. These insights can enable our experts to predict and prevent failures and uncover opportunities for performance improvements, as well as energy and cost savings.

Your benefits can include

- Readily available dataset to supply add-on engineering and services
- Continuous HRSG monitoring and trending
- Identification of deviations from design conditions
- Surveillance and optimization of thermal performance



Monitoring and Trending: Exemplary identification of HRSG issues

Fatigue Monitoring System

The function

Siemens developed Fatigue Monitoring System (FMS) as a module of the Power Diagnostics® system.

FMS calculates the total theoretical material fatigue of highly stressed components in the water and steam piping systems as the sum of creep fatigue and low-cycle fatigue. Calculation is based on recorded operating conditions of HRSG components and on available manufacturer data. By computing the residual component lifetime it can provide an overview of the service life utilization of boiler components.

The features

FMS provides calculated values of:

- Creep fatigue
- Low-cycle fatigue
- Total fatigue

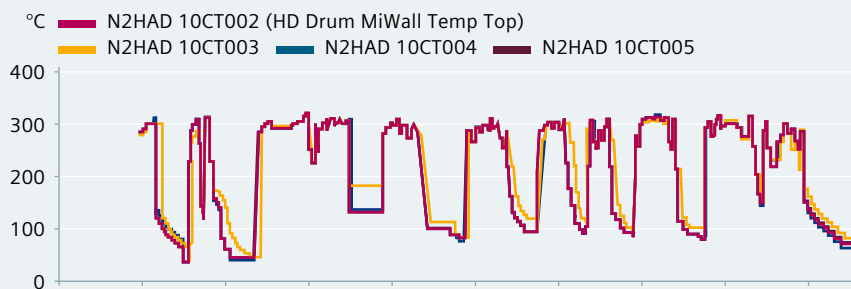
Creep fatigue is calculated from creep resistance (material property), operating temperature and membrane stress (or pressure).

Low-cycle fatigue is determined by counting the number of load cycles incurred by a component and comparing these with the number of cycles to crack initiation.

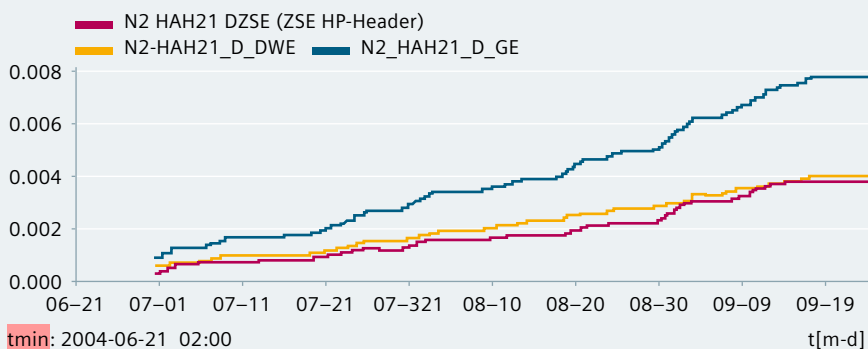
FMS is designed to meet the requirements of the water-tube boilers and auxiliary installations standard (DIN EN 12952) and has been certified by the technical inspectorate TÜV Süd.

Your benefits can include

- Monitoring of component condition
- Transparency in the impact of operating mode on calculated residual life
- Optimum selection of point in time for requisite overhaul and inspection
- Enhanced power plant reliability
- Detection and prevention of high wear operating modes



Temperature trends in HP drum at different positions



Trend of
• Creep Fatigue
• Low-Cycle Fatigue
• Total Fatigue

FMS: Exemplary course of monitored data and lifetime consumption

Overall benefits and O&M references for HRSG Performance Management

Our references

Siemens O&M inspectors have acquired expertise over a wide range of HRSG designs and OEMs. This experience comprises the regular inspection scope during scheduled outages as well as root cause analyses of component issues and associated repairs during unscheduled outages.

More than 30 Level II Inspections were performed worldwide since 2007 in:

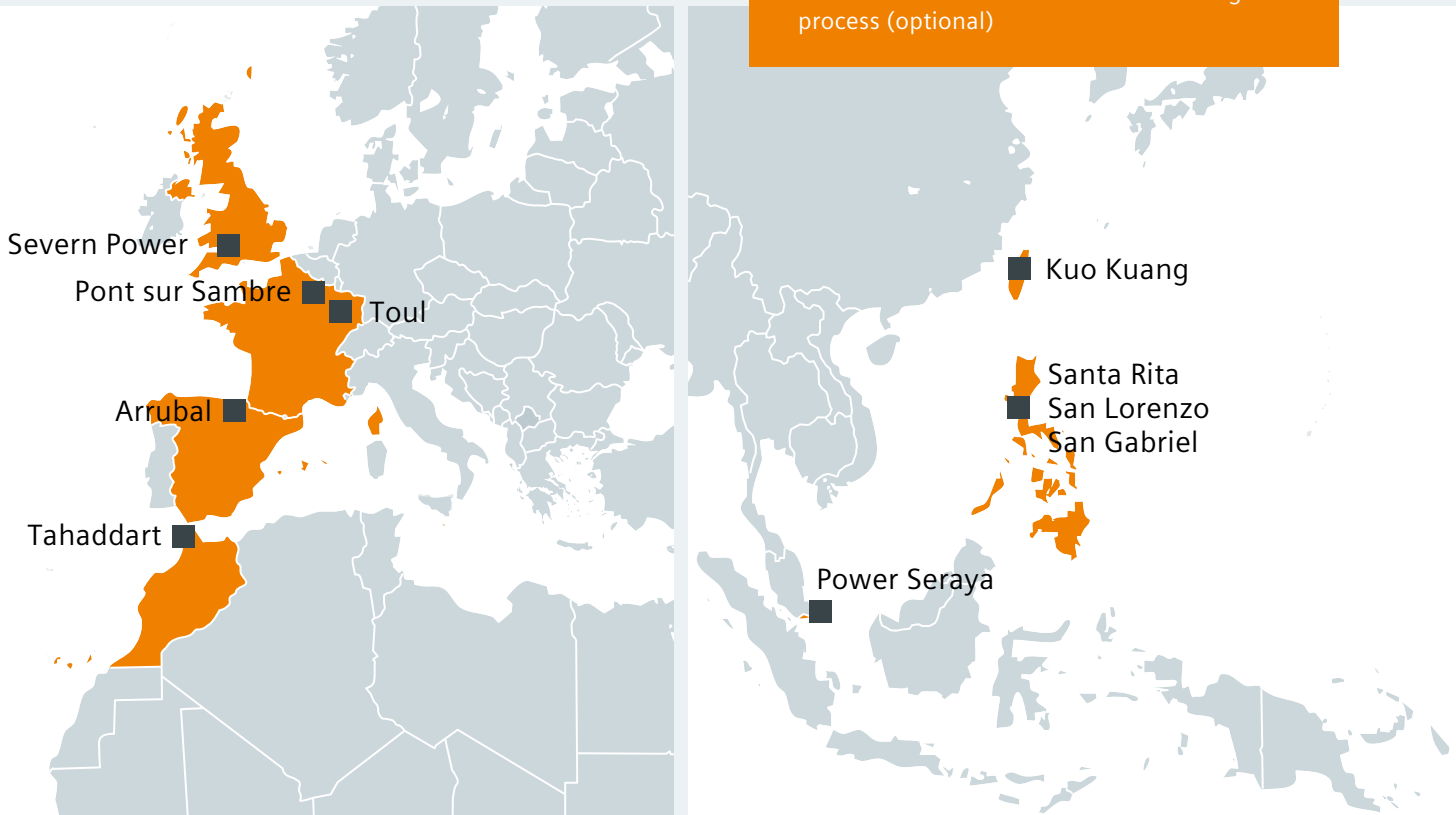
- UK
- France
- Spain
- Morocco
- Philippines
- Taiwan
- Singapore

Total 15 HRSG's in Service

Your benefits

The three combined parts of HRSG Performance Management can provide:

- Reduction of corrective HRSG service costs
- Reduction of preventive HRSG service costs via maintenance recommendations
- More stable HRSG inspection costs over the life of the program
- Optimization of operation, including avoidance of unfavorable operating conditions
- Optimization of life cycle of existing plant assets
- Unscheduled services and repairs at established rates and facilitated ordering process (optional)



Worldwide references encompass a wide range of HRSG OEMs, status: 2017

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First Gen Corporation: 1,000 MW Santa Rita Plant HRSG.
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