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Case Study

How SSE used site engineers, continuous online vibration and condition monitoring systems with specialist remote diagnostic engineers support

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AT A GLANCE

Challenges

- Detection and diagnosis
- Integration of systems
- Maintenance and repair

Benefits

- Proactive maintenance
- Enhanced monitoring
- Operational efficiency

EXECUTIVE SUMMARY

This paper emphasises the critical role of site walk-downs performed by engineers, who utilise their senses—listening, looking, hearing, and smelling—to detect minor changes in machinery that could indicate potential issues before they escalate into major problems. By promptly reporting and addressing these observations, engineers can prevent significant deterioration.

Furthermore, the integration of additional instrumentation into continuous monitoring systems enhances this process by enabling round-the-clock surveillance of minor machinery changes by specialist engineers, including those working remotely. This dual approach ensures a comprehensive and proactive maintenance strategy, enhancing the reliability and safety of the machinery.

> By leveraging the combined expertise of site engineers and remote diagnostics, alongside advanced monitoring systems, SSE has significantly enhanced its ability to detect and address potential machinery issues early.
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> This proactive approach not only ensures operational reliability but also optimises maintenance costs and extends the lifespan of critical assets.
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> **Dr John Twiddle**
> **Equipment Performance Centre Manager, SSE Thermal**

INTRODUCTION

SSE Plc operates a versatile portfolio of power generation assets including thermal, wind and hydro turbines. SSE Thermal is the business unit responsible for a fleet of combined cycle gas turbines located in GB and Ireland. This includes advanced machines from manufacturers such as Mitsubishi, GE, Alstom and Siemens Energy. These thermal assets play a crucial role in providing flexible generation to meet varying grid conditions and demand requirements.

Traditionally, SSE Thermal's fleet ensured reliable, continuous, long-term base load generation. However, in response to the UK's commitment to decarbonisation, SSE has diversified its generation portfolio to incorporate solar and wind power. This transition necessitates greater operational flexibility from large gas-fired units, which now must handle base load operations, peak load, cyclic two-shifting, or extended periods of inactivity until demand dictates their activation.

SSE's Thermal Generation units are equipped with continuous online vibration monitoring systems provided by Beran PlantProtech™ Analysers and software. These systems digitise mechanical vibration signals from sensors and decode them into critical spectral frequency components, allowing specialist engineers to assess machinery health. By integrating vibration data with process parameters—sourced either through hard-wired connections or data historians—engineers gain comprehensive insights into machinery conditions, even from remote locations like SSE's Equipment Performance Centre (EPC).

To ensure early detection of minor machinery changes, engineers can set alerts or alarms based on overall levels or order-locked magnitude and phase vectors during normal operations, applying a tolerance boundary that these vectors should not exceed.

HISTORY OF THE ISSUE

At one of SSE's thermal generation sites, plant engineers were performing their regular walk-down routine, looking and listening for changes from the norm. During one of these inspections, they found that the generator was making a strange noise. Considering that a machine weighing over 150 tonnes and spinning at 3,000 rpm requires acoustic housing to minimise emitted noise, the noise must have been significantly loud. The noise was reported as an intermittent "hum" from around the generator area.

Site engineers contacted SSE Thermal specialist engineers, who are based remotely, for advice and guidance on whether the machine was safe to continue operating.

Remote machine diagnostics were possible as the site had an installed Beran PlantProtech™ Analyser monitoring bearing casing sensors and also shaft vibration sensors.

Several process parameters were analysed, including MegaWatts, MegaVars, Generator Pressure, Temperature and Flows relating to the generator. However, these did not correlate with any machinery changes when the reported noise was occurring.

The remote specialist engineers at SSE EPC requested site engineers to install additional vibration sensors to monitor generator casing vibrations (see Figure 1), and connect them to the installed Beran PlantProtech™ Analyser.

The station was fortunate to have enough spare sensors and cables in the stores department to enable a quick installation.

Figure 1: Temporary vibration sensors attached to the generator casing.

REMOTE DIAGNOSTICS

With additional sensors installed and connected to the PlantProtech™ Analyser, SSE's EPC remote specialist engineers were able to provide real-time machinery health assessments and advise the station on the next steps.

Figure 2 is a screenshot from the Beran PlantProtech software and shows the overall vibration levels measured by the temporarily installed vibration sensors correlating to the period machinery noise identified by station personnel.

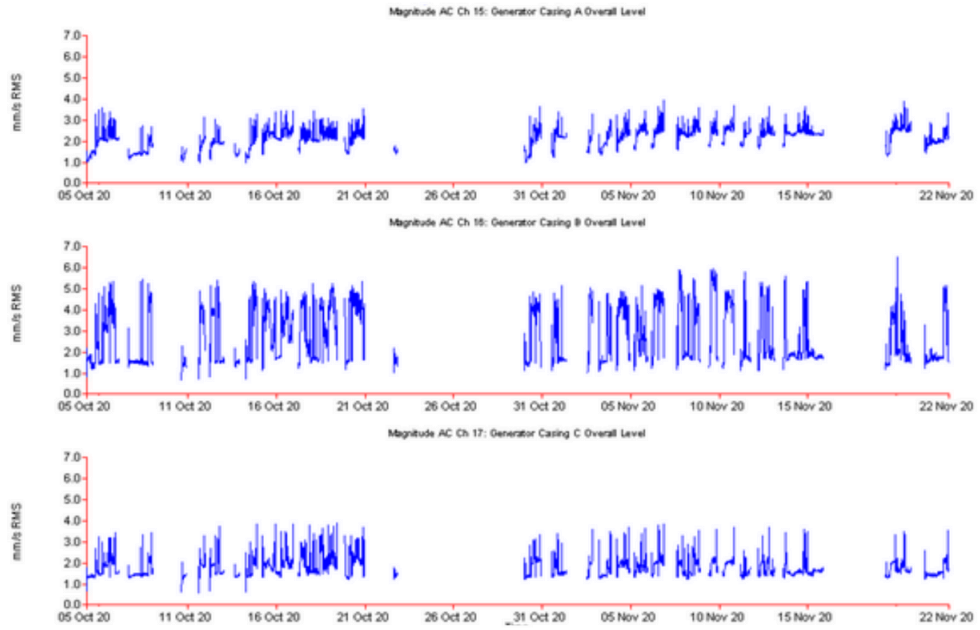

Figure 2: Overall vibration levels seen by the temporarily installed generator sensors.

To ensure SSE's number one priority of safely operating turbine generator units, SSE's specialist engineers configured several tight boundary condition monitoring alarms in the PlantProtech™ Analyser to provide advanced warnings of small changes in machinery behaviour. These detected alerts and alarms differ from ISO machine zone alarms, typically configured at a higher level for broadband vibration in the vibration protection system. PlantProtech™ alarms can be configured based on the normal operation, combined with vibration vector magnitude and phase, with any deviations outside of the boundary alerted to engineers.

SSE specialist engineers created machine dashboards shared with station engineers to ensure efficient sharing of continuous machinery health monitoring. Dashboards included the alert, alarm status, and long-term vibration levels plotted over time, allowing station engineers to quickly see any changes that may have occurred.

WHAT WAS IDENTIFIED?

SSE EPC remote vibration monitoring engineers identified an increase in the generator casing vibrations corresponding to the change in generator noise change as identified by the station staff.

By reviewing the data on the installed Beran PlantProtech™ Analyser, engineers quickly saw that the predominant frequency component of the casing vibration was 100Hz and its harmonics, even though the noise was intermittent. The generator at this site is a 2-pole design, so twice the line frequency is observed.

Figure 3 shows the vibration components plotted against time from one of the temporarily installed generator casing sensors. The reader can see that the change in the overall level (top graph) correlates to the change in Order 2 (2x running speed), Order 1 (1x running speed), order 3 (3x running speed) and order 4 (4x running speed) levels, with negligible change.

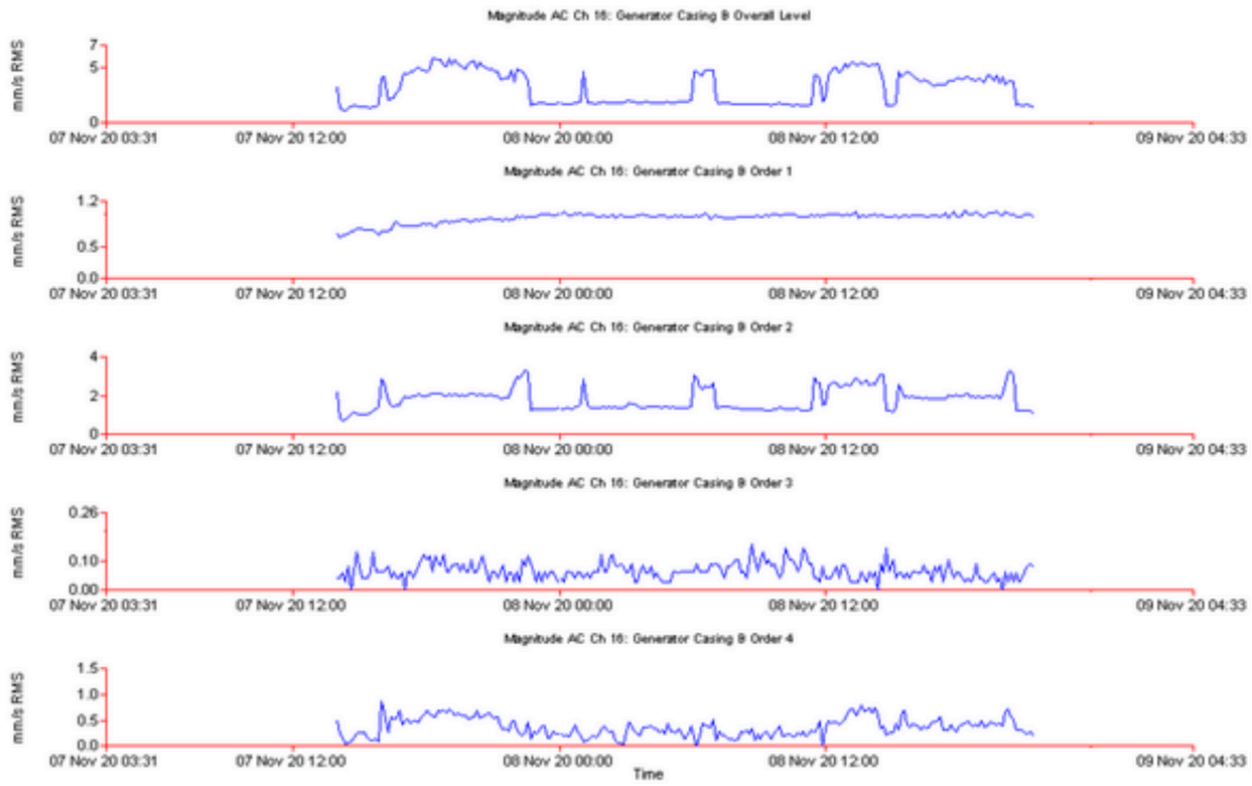

Figure 3: Shows overall order 1, 2, 3 and 4 vibration levels plotted against time.

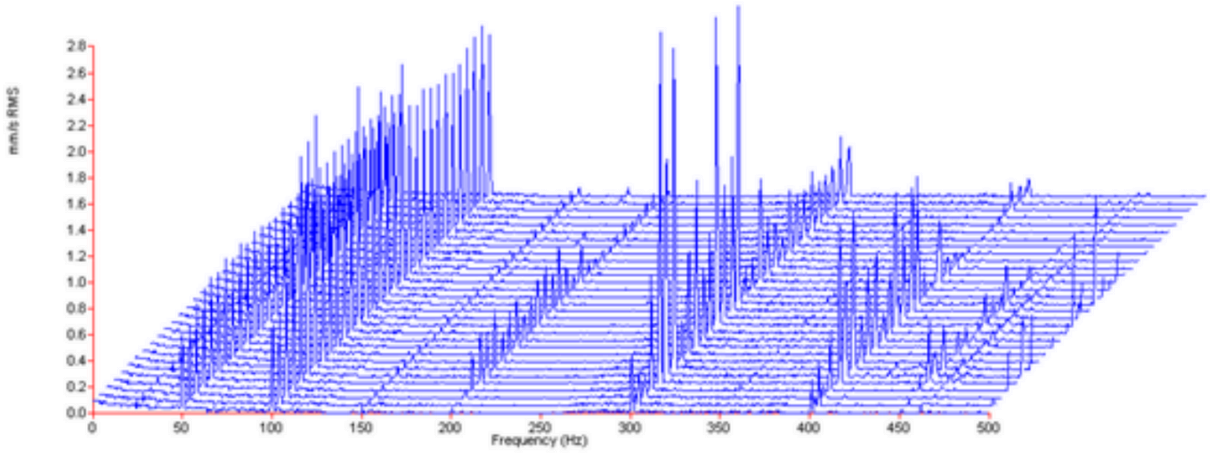

Figure 4: Shows frequency spectrum from generator casing sensor.

Figure 4 shows the frequency spectrum from one of the installed casing sensors. This machine generates electricity at 50Hz, and we can see the order 1 (1x) component in the frequency spectrum. Additionally, we can see a larger vibration component at 100Hz, order 2 (2x running speed) and harmonics at 200Hz, 300Hz, and 400Hz.

At the same time, there were no changes in vibration on the bearing absolute or shaft relative levels during the generator casing vibration increases.

Figure 5: Shows overall vibration trend for 20 hours showing intermittent nature of issue.

As stated earlier, the experienced fault was intermittent, as seen in the overall vibration level shown in Figure 5 for less than a 24 hour period.

WHAT WAS REQUIRED TO REPAIR?

To continue to operate machines safely and reliably, utilities must perform risk assessments to ensure machinery is suitable to operate. During the risk assessment review process, SSE EPC engineers increased the frequency of machine reviews and added more alarms within the Beran PlantProtech™ system to identify any changes immediately using tools such as Beran's PlantProtech™ Alarms Manager.

SSE's concern was the cause of the change in machine vibration characteristics, which was unusual and required investigation at the next opportunity. The vibration symptoms suggested either some looseness or impacting within the generator.

EPC engineers advised investigating the generator stator and frame mounting area. Engineers found some looseness within the stator to core mounting, requiring an adjustment to the generator "belly band".

Following the adjustment, the return to service was closely monitored by both station engineers and remote specialist engineers at the EPC, reviewing the temporarily installed generator casing vibration sensors in real-time using the installed Beran PlantProtech™ system. The sensors showed low, steady, stable levels of vibration. The temporarily installed sensors have been left on the generator casing for long-term condition monitoring of the generator stator frame.

Our collaboration with SSE Thermal demonstrates the remarkable capabilities of Beran's PlantProtech™ system.

By leveraging our advanced online vibration and condition monitoring technology, we identified potential issues with SSE's equipment before they escalated into serious problems. This proactive approach not only saved time and money but also significantly enhanced operational efficiency. Moreover, the ability to provide remote diagnostics meant that specialist engineers did not need to visit the site, ensuring continuous support and minimising downtime.

The successful implementation of our system at SSE underscores the value of integrating cutting-edge technology in maintaining the reliability and safety of critical infrastructure.

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CONCLUSION

In conclusion, effective machinery health monitoring hinges on a synergistic partnership between site engineers, specialist diagnostic engineers, and instrumentation suppliers. This collaborative effort ensures that potential issues are identified early and addressed promptly, thereby preventing significant breakdowns.

By continuously monitoring machinery health and swiftly responding to anomalies, engineers can maintain safe and reliable operations even as equipment ages. Rigorous risk assessments and proactive mitigation strategies are essential in this process, enabling the identification of faults and efficient planning for necessary repairs. This approach not only ensures the longevity and reliability of machinery but also optimises maintenance costs and operational efficiency.

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ABOUT SSE

SSE has seven business units that make up the SSE group. Our collective strategy is to create value for shareholders and society sustainably by developing, building, operating and investing in the electricity infrastructure and businesses needed in the transition to net zero, whilst ensuring a fair and just transition for our people.

Our businesses are engaged in onshore and offshore wind, hydropower, flexible thermal generation, solar and battery technologies, electricity transmission and distribution, and localised energy systems. We also provide energy products and services to businesses and other customers.

SSE Thermal operates Combined Cycle Gas Turbine power generation units in both England, Scotland and Southern Ireland which are called upon to support diverse electricity generation.

www.sse.com

ABOUT BERAN

For over 40 years Beran has been supplying high-speed digitisation of machinery signals for online vibration and condition monitoring of critical assets used within electricity generation. Data can be shared with engineers onsite or with off-site remote specialist engineers within Engineering Centres.

Beran is part of Condition Monitoring Technology Group Ltd (CMTG). The group provides customer care, innovative with both health and safety and quality running through the core of the company's activities. CMTG are leaders in condition monitoring of rotating machinery used within industrial power generation, rotor track and balancing within helicopters, high precision quality vibration sensors, and high-speed data acquisition systems.

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