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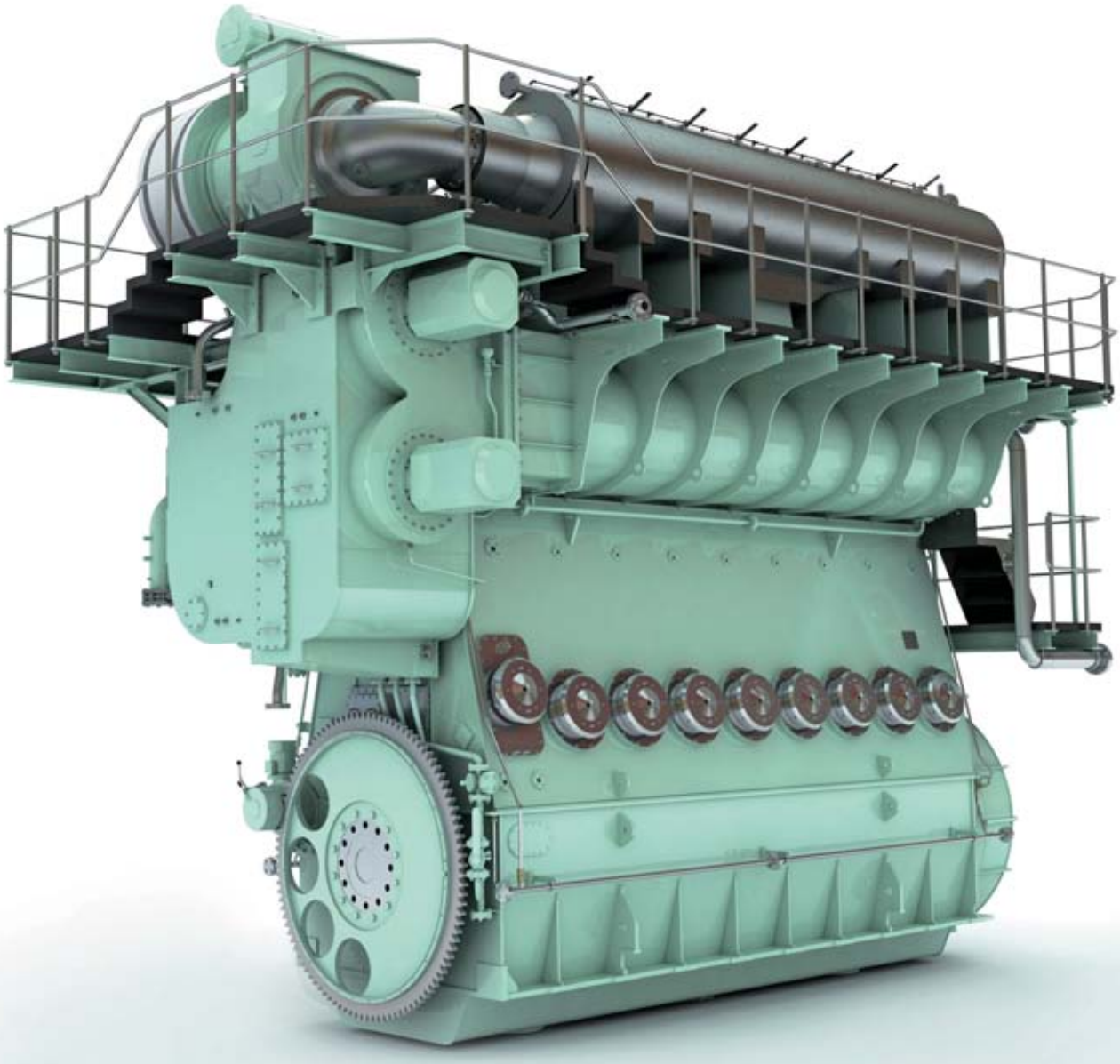


Container ships **Propulsion packages** Seals & bearings **Condition monitoring**

Costa Crociere expects to extend advanced condition monitoring of key machinery throughout its cruise ship fleet

Costa trials SPM-based CBM system

Growing interest by ship operators in condition-based maintenance (CBM) for machinery is stimulated by the potential for reduced costs in sustaining safety, reliability and performance. Traditional practices – preventive maintenance or allowing machinery to run until breakdown – are increasingly considered inefficient.

Many overhaul and maintenance tasks involve complex disassembly which often reveals they could have been postponed without affecting ship performance, while a run-to-failure policy impacts on ship functional availability. In both cases, machine failure is unpredictable. A CBM policy driven by the actual condition of the machinery is increasingly acknowledged as the optimum approach to maintenance, suggests Costa Crociere.

The technical management of the Italian cruise ship operator, a leader in the Mediterranean market, decided to test SPM Instrument's online Intellinova system on key machinery of its newest vessel, the 114,288gt *Costa Pacifica*. The system is capable of acquiring vibration measurements and automatically interfacing with process parameters to give a detailed overview of the operating condition of each monitored machine.

A full-scale system incorporating all the important rotating machinery (requiring considerable cabling and carpentry) was not viable for *Costa Pacifica* because of the newbuilding's advanced fitting-out status. Costa Crociere nevertheless wanted to develop, test and demonstrate a fixed SPM system for monitoring the health of various machinery elements, with the aims of improving reliability, avoiding critical faults and performing maintenance only when needed.

A subset of machinery was thus selected for coverage in a pilot CBM programme, including exhaust fans, cooling pumps, air compressors, propulsion motor bearings and thrusters. Among the key targets of the monitoring system are:

- vibrations from ad hoc-installed accelerometers
- vibrations from already installed velocimeters
- process parameters required by the classification society (RINA) for better machinery diagnosis, such as pressure at suction, pressure at delivery, temperature, electric motor current, mechanical power and torque.

In the weeks before installation of the monitoring system, Costa Crociere technical staff provided engineering data on the machines to be covered. SPM Instrument was then able to configure the software database and set the search parameters for different fault symptoms. The system was fed with the basic monitoring configuration and with polling times for different types of measurements.

During the creation of the database, the alert and alarm thresholds were set for the overall vibration value RMS according to international standards (ISO 2372 and ISO 10816). In the first two months of sailing, vibration measurements were recorded every three hours on all machines to collect a representative sample of readings.

These measures, derived in different sea conditions and under different machine loadings, enabled statistics analysis to set the alert and alarm thresholds on the basis of actual measures recorded on the machines rather than on those suggested by the ISO standards. All individual results were evaluated for statistical analysis.

The average value was calculated after deleting from the count the values registered in abnormal conditions; the alert threshold was set at 1.5 x

the average value and the alarm threshold set at 2 x the average value. Alert and alarm thresholds were set for the overall vibration value RMS and for the most relevant fault symptoms.

An alarm export function was also implemented to automatically generate emails, with precise indications on the symptom of failure, for sending to Italian consultancy and maritime service provider Cetena, SPM Instrument, the ship's chief engineer and superintendent.

After commissioning the system, Cetena and SPM gave training to the ship's inspector and senior engineer officers. A monthly visit to the vessel is included in the service contract, when crew training is also carried out (in view of routine staff turnover).

Costa Crociere's technical department is reportedly satisfied with the CBM system support, which provides up-to-date machinery condition information on a daily basis. Problems are immediately signalled, enabling a solution to be found as early as possible.

The shipowner plans to increase the number of machines monitored on *Costa Pacifica* and to install CBM integrating the SPM systems on two sisterships due for delivery in 2011 and 2012.

• SPM Instrument Srl is an Italian daughter company of Sweden based SPM Instrument AB, which offers technical service, support and training for condition based maintenance on ships.

A continually developing product range includes software, portable instruments, online systems and accessories designed for shock pulse and vibration monitoring of key rotating machines, such as electric motors, pumps, fans, compressors, turbochargers and thrusters. Impeller, gearing and balancing problems can be detected as well as imminent bearing failure and misalignments.

SmartSense Pulse smoothes pump monitoring

An extension of its SmartSense intelligent pump monitoring range by US-based fluid handling specialist Colfax Corporation offers the SmartSense Pulse. The compact device (2.4 inches long x 1.6 inches wide x 1.3 inches deep) fits near the bearing on a pump to monitor temperature and vibration. LEDs on the unit indicate pump performance and provide preventive maintenance alerts when necessary.

"SmartSense Pulse is designed to enable a level of monitoring that would otherwise require more staff and diagnostic equipment, which would be expensive and impractical," says Dr Dan Yin, a Colfax electronics engineer.

"Temperature and vibration are key indicators of a pump's operating performance. Excessive levels of either indicate a need for adjustments. A simple, easy-to-use automated system to constantly monitor pump conditions should enhance operation, reduce downtime and increase energy efficiency."

Colfax's original SmartSense system with a larger control unit and additional sensors monitors pressure, wear, cavitation and the integrity of the pump's mechanical seal as well as temperature and vibration. Its control modules can be accessed through the operator's own data network, the Internet, cell phones or wireless devices, and can operate independently using a customisable algorithm or connected to a group of pumps managed from a central office.

Software for the larger SmartSense system also has the ability to alert operators to the need for spare parts, with accompanying ordering documentation, for regular scheduled maintenance or for addressing replacement requirements as they arise.

Both original SmartSense and Pulse systems can be installed on new pumps during manufacture or retrofitted to existing pumps produced by any company.

LR taps acoustic emissions technology

The trend towards higher power ratings and increased complexity of machinery systems calls for improved detection of incipient damage mechanisms to avoid the consequences of in-service failure. Lloyd's Register has applied acoustic emission technology for measuring and

assessing fatigue damage in diverse machinery and structures for a number of years.

Acoustic emission monitoring of rotating machinery extends the frequency range of vibration analysis from a few tens of kHz to MHz. Vibration at these frequencies comprises wave packets of sound which propagate through the structure as stress waves, enabling location of the emission source using an array of sensors, LR explains.

Fluid turbulence and sliding friction are also particularly intense sources of acoustic emission, providing opportunities for detecting and locating such concerns as abrasion and fatigue damage in bearings and gears, cavitation erosion in pumps and small leaks in pressurised systems.

The methodology has been further developed to detect microcracks in the large, heavily loaded rolling element bearings of podded propulsors. In this case, detection of damage is complicated by the varying speed of azimuthing and the background hydrodynamic noise, particularly during low speed ship manoeuvres.

In addition, small oscillatory movements between contact faces within the bearing assembly, involving slip amplitudes of around 1 micron, contribute to complexity by producing fretting wear and corresponding intense acoustic emission which may interfere with sound from the rolling faces of the bearing.

Combining acoustic emission source location and spectral analysis of the associated time-domain signature, LR reports, has provided a powerful tool for detecting micro-damage in the various working faces of such bearings under variable speed and loading conditions before metal loss is evident in the bearing lubricant.

Other sources of acoustic emission in the body of the bearing housing, such as fretting at contact faces with securing dowels and pins and fluid turbulence, can be located and resolved so as not to interfere with diagnosing the bearing condition.

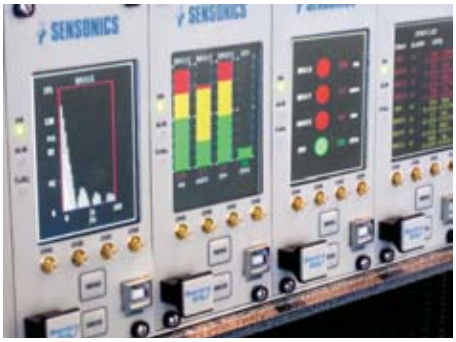
In one project involving the thrust bearing of a podded propulsor, LR positioned six sensors symmetrically around the perimeter of the bearing in the inside space of the pod as close to the outer ring as possible. Two further 'control' sensors were positioned diametrically opposite each other at the connection to the pod casing.

Monitoring vibration, position and speed

UK-based condition monitoring specialist Sensonics has strengthened its Sentry G3 portfolio with a system embracing vibration, position and speed measurements, whose hardware fault tolerance has been independently verified. Turbine algorithms covering shaft eccentricity and large differential expansion measurements are also included.

The established Sentry G3 machinery protection monitor is described as a high performance signal conditioning unit with a universal sensor interface. Channel hardware independence is important for machinery protection applications where a failure of any assembly should have minimal effect on the overall system measurement integrity, explains Sensonics. In this respect, it claims, the Sentry G3 is best in class.

The four-channel G3 module is designed with an independent digital signal processor (DSP) for each channel of measurement. The DSP can be loaded with the specific measurement algorithm which not only controls the sensor selection but also the protection relay status and analogue output levels. Complete hardware autonomy is thus provided from sensor through to the protection relay combined with high channel density (24 channels in a 3U format). ***MP***



Sensonics' G3 machinery protection system displays