The official journal of the Vibrations Association of New Zealand

Spectrum

Winter 2025 | Issue 116

Understanding your oil analysis

PART I THE FUNDAMENTALS

Steam turbine blade breakage – maintenance + monitoring challenge

Pressurised gas hazard in internal cavities

+ In focus

Full photo montage from Conference'25

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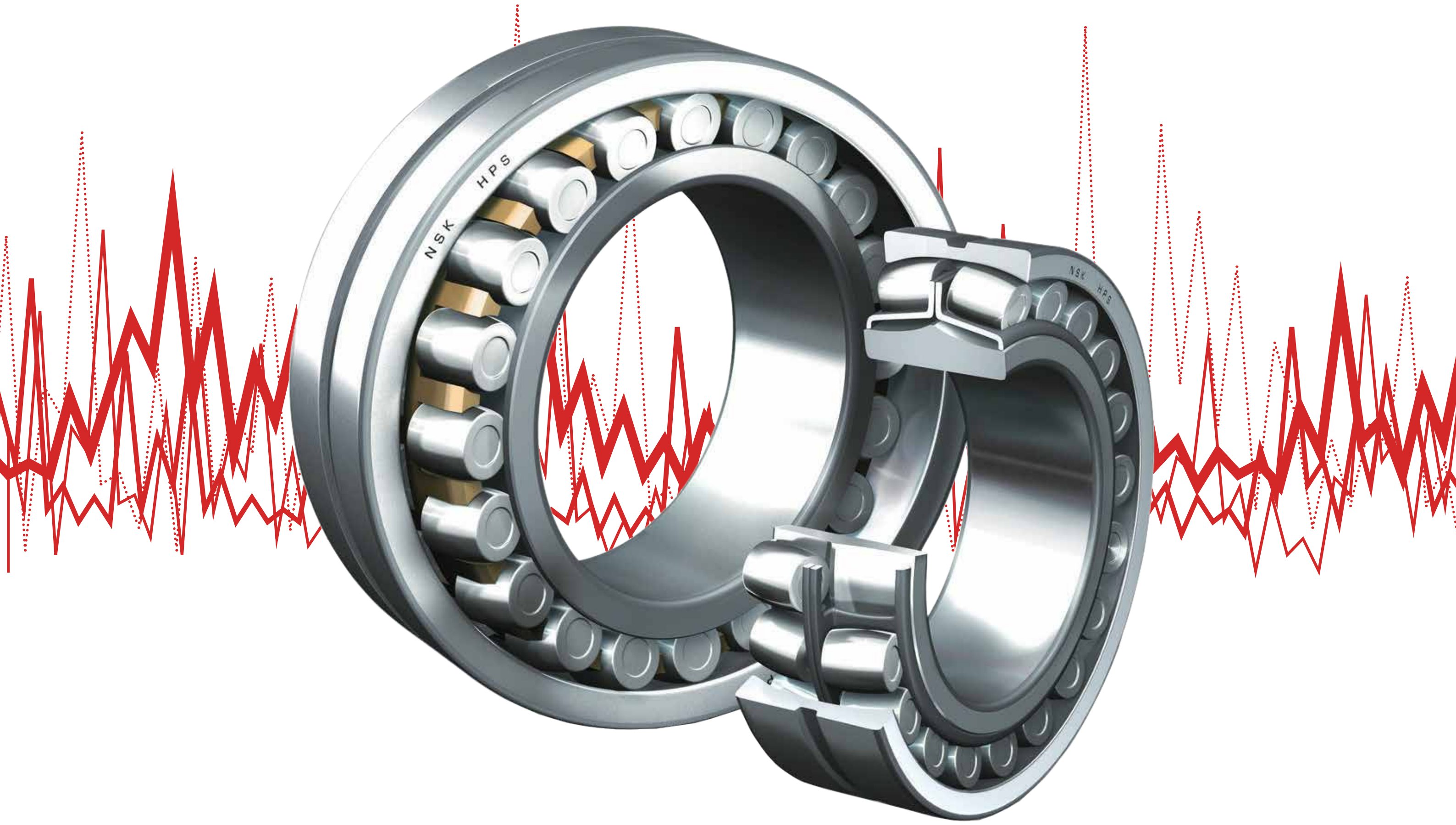

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Spectrum

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Spectrum is published by the Vibrations Association of New Zealand (VANZ). The magazine is produced in a quarterly cycle annually in both digital and printed mediums.

The magazine is designed to cover all aspects of the Vibration, Condition Monitoring, Reliability and the wider Predictive Asset Management field and distributed to all VANZ members, including corporate members.

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PRESIDENTS' REPORT

By Tim Murdoch | VANZ President

The dust is settling on yet another outstanding VANZ Conference, I'd like to take this opportunity to reflect on what was a truly remarkable event held in New Plymouth, New Zealand. This year's gathering once again demonstrated the variety, strength, innovation, and camaraderie that defines our industry and the VANZ community.

I would like to extend my deepest gratitude to ABD Group, our Platinum Sponsor for 2025. Your generous support made this year's conference not only possible but exceptional. Your commitment to the advancement of our industry in New Zealand and beyond is both valued and appreciated.

We were privileged to welcome Rob Simmonds as our keynote speaker this year from Australia. Being able to look behind the scenes from a lab point of view for oil analysis was both inspiring and thought-provoking.

Thank you to our presenters for your time in creating your presentations, your expertise, your professionalism, and your willingness to share your knowledge with your peers. Your contributions are the backbone of this conference and a testament to the spirit of collaboration that VANZ proudly fosters.

We had a very special guest, sponsored by Allied Petroleum for our Wednesday evening dinner event, Greg Murphy. It was a pleasure having you with us for the evening Greg, thank you.

VANZ has a new life member! Carl Townsend, thank you for your dedication, contribution and active service to VANZ, right from the beginning. If you have read these Spectrum magazines you would have come across the Quiz in each issue, these are provided by Carl. How many can you get correct?

Congratulations to Steve Hall on winning the Peter Burgess Award for Most Popular Conference Paper, his presentation was titled "My Condition Monitoring Journey with the Waikato Regional Council - Warts and All."

To our exhibitors, you brought innovation to life. Your displays, demonstrations, and conversations helped connect theory with practice and created tangible value for the attendees.

To all who joined us this year, your enthusiasm, curiosity, and commitment to professional growth are what make this conference such a success. Thank you for being part of VANZ 2025 – whether this was your first conference or one of many, we hope you left inspired, informed, and more deeply connected within our industry.

"Your contributions are the backbone of this conference and a testament to the spirit of collaboration that VANZ proudly fosters."

Our conference committee are thrilled to announce that the **VANZ Conference 2026** will take place from **May 19–21** at **Rydges Rotorua**. Mark your calendars for what promises to be another exceptional event in one of New Zealand's most iconic locations. Planning is already underway!

In line with the recent legislative updates to the Incorporated Societies Act, VANZ will be holding an Extraordinary General Meeting (EGM) later this year. The purpose of this meeting will be to present and adopt the necessary changes to our VANZ Constitution to ensure compliance with the new legal requirements. Further details regarding the EGM will be communicated to members in the coming months.

We encourage all members of our community to stay connected with us throughout the year via our social media platforms. Follow us on LinkedIn and Facebook for updates and upcoming event announcements. Help us grow our community by sharing your experiences, tagging us, and engaging online.

Thank you once again to all who made the VANZ 2025 Conference such a success. Your passion and professionalism continue to define who we are. We look forward to welcoming you to Rotorua in 2026, and to another exciting year ahead for VANZ.

VANZ

PRESENTS

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EDITORS' CORNER

By Angie Delfino | Spectrum Editor

As we recover from the hustle and bustle of the conference, we take stock of how everything has come together this year, the new ideas that worked well, the things we can improve on and the good old standard ideas that come through each year.

We'd like to thank our major sponsors ABD Group for the continued support, it is much appreciated and we hope all the attendees enjoyed their time with VANZ over the conference week. It was so good to see some new faces and also catch up with our regular supporters. Many thanks go to the organising team that helped push everything into place and to the various sponsors, many of which had a trade stand at the conference and have also placed an ad with us for this issue.

> **"Over the conference week, it was good to see some new faces and also catch up with our regular supporters."**

Be sure to check out our Presidents' report, squeeze a bit of the old grey matter with Carl's quiz and see what sort of deals our post-conference advertisers have to offer.

Whilst on the topic of quizzes; VANZ would like to extend 'congratulations' to Carl Townsend at Calton Technologies. Carl was handed the lifetime membership award at our recent conference in New Plymouth. Well done and thank you Carl for your continued hard work, committment and dedication to the association over the years, it is very much appreciated by all. He was very humble in receiving his award.

We also have an article on the Unit 2 situation at Huntly Power Station from Simon Hurricks and Mike Hastings and a paper from one of our conference speakers; Rico Van Niekerk on Oil Analysis.

As we continue on with the year our elected committee members are already ploughing into organising the conference for next year so we can continue to make it better and better for all involved. Stay tuned!

Stay warm during the winter months and happy reading!

Pressurised gas hazard in internal cavities

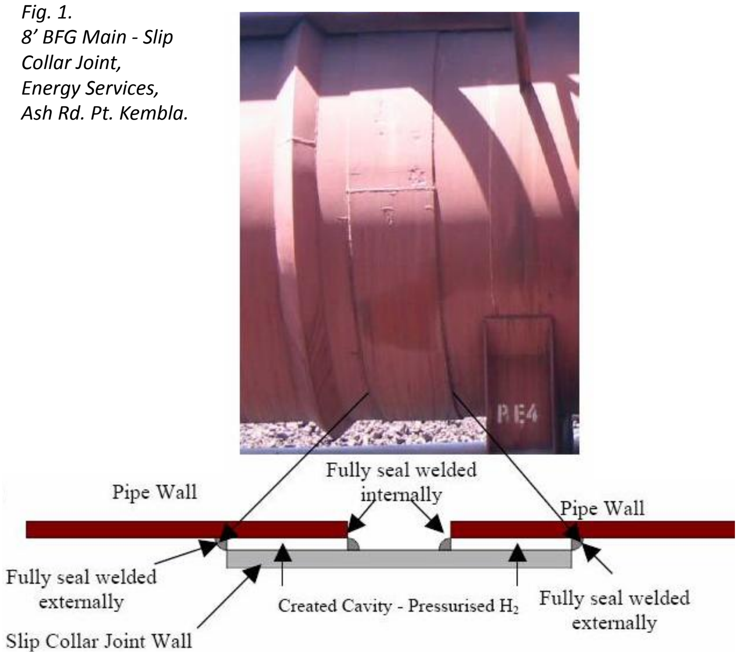
Prior to heating, cutting or welding on any structure or vessel, the likelihood of internal cavities in the design or as a result of subsequent repairs should be considered. In any enclosed “cell” there exists the possibility of pressurised flammable gas - even on non-gas applications. There is recent evidence to suggest that hydrogen (H2) is generated through a corrosion reaction over an extended period of time; typically years.

Where these internal cavities, or “cells” are identified, appropriate actions need to be followed to ensure people are protected from the hazard of a sudden release of flammable gas.

This hazard may occur in (but is not limited to): sleeves, double skinned structures, internal linings such as bricks, staves, gunning, over plated sections, slip collar joints, ‘box’ repairs over leaks, and stiffener rings.

Figure 1 shows an example of three “cells”, created by the stiffener ring on the left, and the two cavities created by a slip collar joint on a BFG main at Pt Kembla Steelworks.

Fig. 1.
8’ BFG Main - Slip Collar Joint,
Energy Services,
Ash Rd. Pt. Kembla.



Examples of this hazard have also been seen in salt water pipe work, however it should be remembered that it can occur in any enclosed cell, and is not limited to pipe work.

The following is a list of steps that must be considered to eliminate the hazard.

- Review drawing to understand internal construction and how many “cells” are likely to exist.
- Ensure gas procedures clearly define the scope of hot work for checking officers to review.
- Avoid cutting through cavities unless necessary.
- Drill holes in appropriate areas to check and relieve pressure.

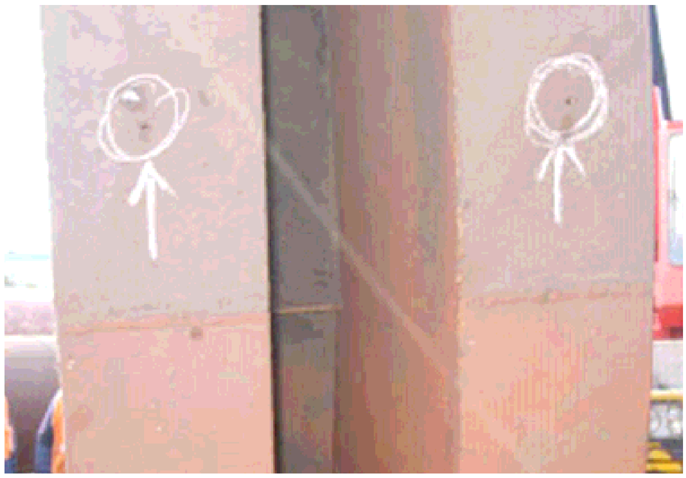


Fig. 2. Cavity test holes in 8’ BFG Main - Expansion joint.

See Fig. 2. Appropriate PPE must be worn, including a full face shield and leather gauntlets. Ensure to use a sharp drill, lubricated with CP40. If enough heat is produced such that the lubricant starts to smoke, STOP drilling and try another sharp drill bit.

- If deemed necessary, nitrogen purge the cavity to verify.
- If confidence cannot be obtained by the above, the use of other appropriate cold metal cutting methods may be applied such as a HP Water cutter.

Article prepared by Rod Bennett.

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EVENT GALLERY

VANZ would like to take this opportunity to thank our platinum sponsor ADB Group, as well as all advertisers, exhibitors, speakers and attendees at this year's conference contributing to the overall success that it was. In no particular order, photos from the three-day conference event and are showcased over the next few pages...

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ROTORUA 2026

The VANZ Conference is a place for learning and sharing!

- **Have you ever had an experience that you think others would benefit from?**
- **A case study that went right or wrong?**

We can all learn from our own experience, but we can avoid a lot of problems if we learn from other people as well!
That is what VANZ is all about.

You could talk for just 15 minutes (or longer if you like), we would love to hear from you.

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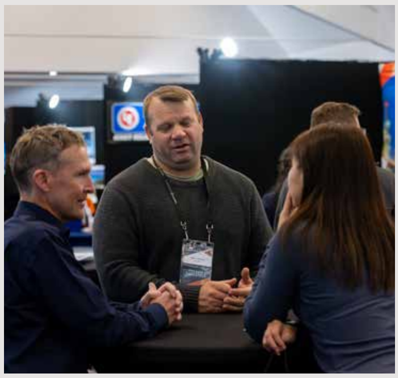

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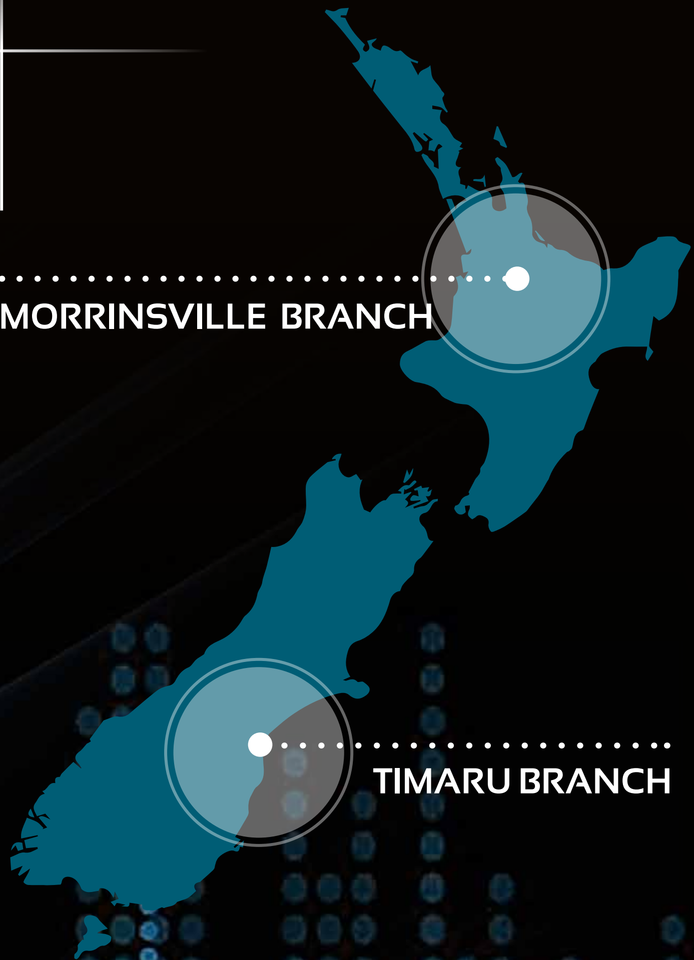

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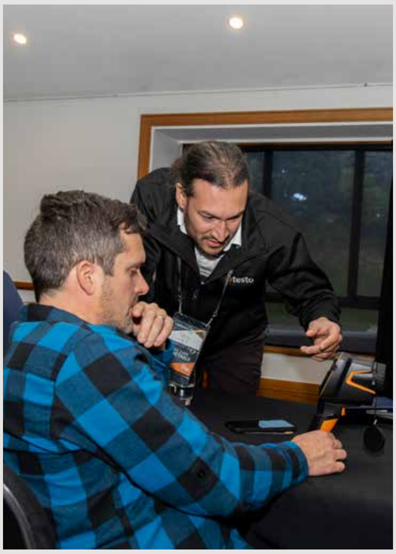
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FEATURE

PART. I

THE FUNDAMENTALS

Understanding your Oil Analysis

Having good clean oil to lubricate and protect our machines is one of the fundamentals of reliable operation.

When the oil condition deteriorates it can lead to lubrication breakdown and ultimately machine breakdown. Often we decide to test the oil condition if we suspect machine wear or poor condition, but the lab results can be difficult to understand. We'll aim to understand what is being tested, why and what we can do about it to improve our oil quality and, in turn, equipment life.

“It's important to remember that the oil is a sacrificial component of the machine and should be treated as such.”

Why do we lubricate?

Machine lubrication has a primary function of ensuring a lubricating film is maintained between parts to avoid metal-to-metal contact. This contact is detrimental to the machine as wear is starting to occur and as this progresses the signs become clearer. We can start to detect this using vibration analysis, we will be able to detect wear particles in oil analysis and ultimately we can hear and see the effects. The earlier we intervene in this cycle the more we prolong the equipment life.

Why do we test the lubricant?

It's important to remember that the oil is a sacrificial component of the machine and should be treated as such. When we have undesirable conditions such as wear particles starting to form, water or dirt ingress, seals leaking or lubricant breakdown, the system is designed for the oil to remove this debris away from the equipment parts protecting the machine health.

As such, the oil becomes contaminated and poses a risk to the equipment if the oil is not changed for clean new oil.

Continued over page >

Article prepared by Rico Van Niekerk.

The next step in your digital transformation just got easier!

Emerson's AMS Wireless Vibration Monitor is based on decades-proven technology that communicates using modern, cybersecure protocols. This is the wireless device that will extend your reliability program to an unprecedented number of plant assets – including those in hazardous or hard to reach areas – and deliver maximum visibility to asset health.

The unit features complete data acquisition – triax vibration with temperature and PeakVue measurements – to provide a sophisticated look at asset health on par with other online and portable monitoring options.

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- Simple installation in about 5 minutes.
- Fleet management tools for fast configuration in the shop or in the field.
- Prescriptive analytics using patented PeakVue Plus to accelerate your diagnosis.
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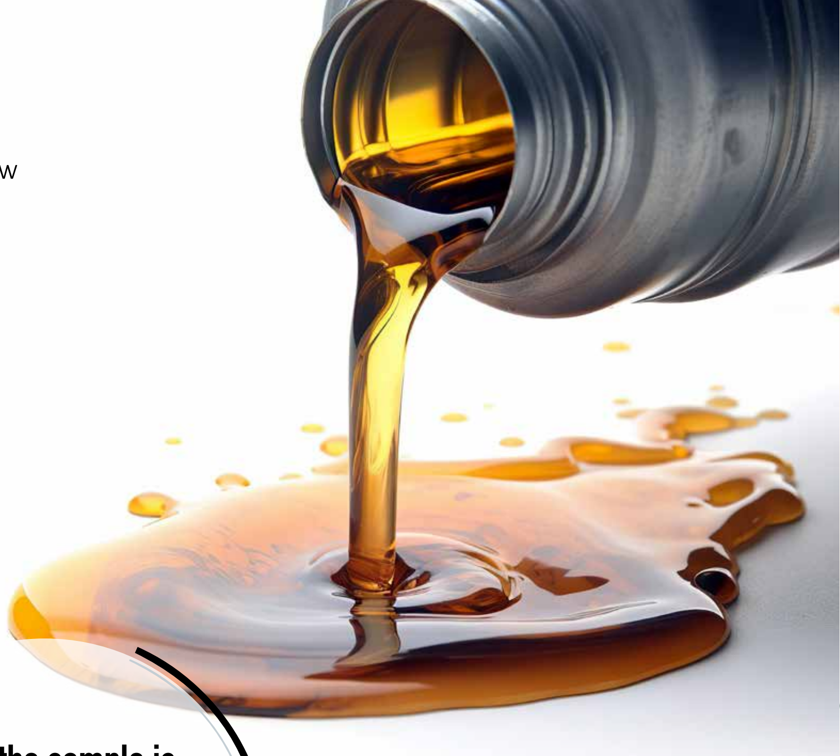

Testing the oil on a regular basis allows us to understand the current condition of the oil, which in turn, lets us know about the condition of the equipment. If in doubt, test it out!

The importance of new oil sampling

A useful tip is to sample each new oil type used on your site. This will serve as a baseline for all tests against this oil type. Trending the results over time will show how the values can deviate from this baseline result and clearly identify developing issues.

If large quantities of oil are used on site it is also recommended to test each batch, as they will naturally vary over time (even from the same supplier) and your baseline will need to be updated accordingly. Slight differences in the additive package, cleanliness even viscosity is not uncommon.

"When the sample is taken, ensure the tube to the machine is clean and only use the laboratory supplied bottles."

This will also serve as a method to ensure the oil received is as expected. Ensure the oil you receive is in line with the specification and also determine if the oil cleanliness is within your site's acceptable limits. Unfortunately it is not uncommon to receive 'dirty' oil and you might need to filter this offline before use on site.

Ensure the oil sampling is done correctly

The sampling point and method is just as important to the result as the oil condition itself. This is an easy point of ingress, that if not done correctly, can distort your analysis results. The point at which oil is collected from is important and should be representative of the oil in the machine. The most representative and reliable location would be a dedicated sampling port that is likely located midstream on the machine.

When the sample is taken, ensure the tube to the machine is clean and only use the laboratory supplied bottles. Use gloves during this process and take care where and how you put the lids and caps.

The most important part of the sampling process is consistency. If a sample is taken the same way every time it will result in reliable data that can be analysed effectively.

Track and communicate your results

Track your test results in your CMMS, document management system or a Platform. While one result can be indicative of the current state of the oil or machine, trending the results can be one of the most valuable tools to determine the long term trend of the machine. Both the lubricant and equipment will show signs of deterioration allowing you to plan for an oil change or machine maintenance.

When a bad oil sample is received and the recommended action is to change the oil, the machine might have already been damaged and the evidence lost. If there are already signs of wear you need to keep an eye on the machine and other condition indicators such as vibration and temperature to help prevent machine failure. It is therefore important to note and communicate poor or failed test results.

Ensure the correct oil is used

Colour code oil types! A common but unnecessary mistake is to add or change to incorrect oil which can cause severe damage to the equipment. A simple, yet effective, way to prevent this is to colour code the oils used. Whether this is mineral or synthetic, gear or hydraulic or different viscosity grades. From the time it arrives on site, storage, transport to the equipment via pail, and even the equipment lid itself, if one colour is used to colour the drum, the pail, the pump and machine lid, it is less likely to accidentally mix oils. Avoid stickers and labels even though this is a common labelling technique. Oily environments are not conducive to effective attachment and even with age or sun exposure, they are likely to peel or fade.

Summary

Oil as a method for lubrication is very effective, but it can be difficult to follow and manage good oil practices. By understanding how lubrication works, why and how to test, having clear and effective communication and good habits we can ensure the life of the oil, as well as the life of the machine it's protecting, is prolonged.

FEATURE

Steam turbine blade breakage –

Maintenance and Monitoring Challenge

One of the worst-case maintenance scenarios for an aged steam turbine is to lose blades during peak power demand. This is what exactly happened to one of the units at the Huntly Power Station. From a monitoring perspective, the event occurs so rapidly that there is no lead time to plan service. All that can be done was using after-event monitoring system diagnostics to isolate and identify the problem. From a maintenance perspective, there are limited options to repair the unit and only within a very narrow outage window.

> "From a maintenance perspective, there are limited options to repair the unit and only within a very narrow outage window."

The case story describes how this incredible challenge was resolved.

Power plant

Genesis Energy's Huntly Power Station is located on the banks of the Waikato River between Hamilton and Auckland in the North Island of New Zealand.

The station was commissioned from 1982 to 1985 and consists of four 250 MW, single reheat turbo-alternators made by Parsons in UK (see photo in Figure 1), where Unit 3 has been decommissioned in 2013 and is currently used as spare parts for the other units.

The Huntly turbo-generating units are unique in that they each are installed on an isolated steel support structure designed for earthquake protection. The low-tuned support structure consequently has a vertical resonant frequency that is below the turbine running speed. This has presented some monitoring challenges as later described in this article. AVEVA PI system is used as a company wide data historian. Process and vibration data is stored on a local Huntly server and mirrored to a corporate PI server. Genesis uses both PI Process Book and PI Vision. Data analytics are used to determine abnormal excursions, which are then further investigated.

At Huntly, some vibration data is exported from the monitoring systems into the distributed control system (DCS), which in turn also stores it in the PI system. (The exception to this is the SETPOINT VC-8000 system for Unit 1, which automatically stores vibration data in the PI system, as described further on.)

Article prepared by Simon Hurricks, Genesis Energy Ltd, and Mike Hastings, Sr. Application Engineer Brüel & Kjær Vibro A/S.

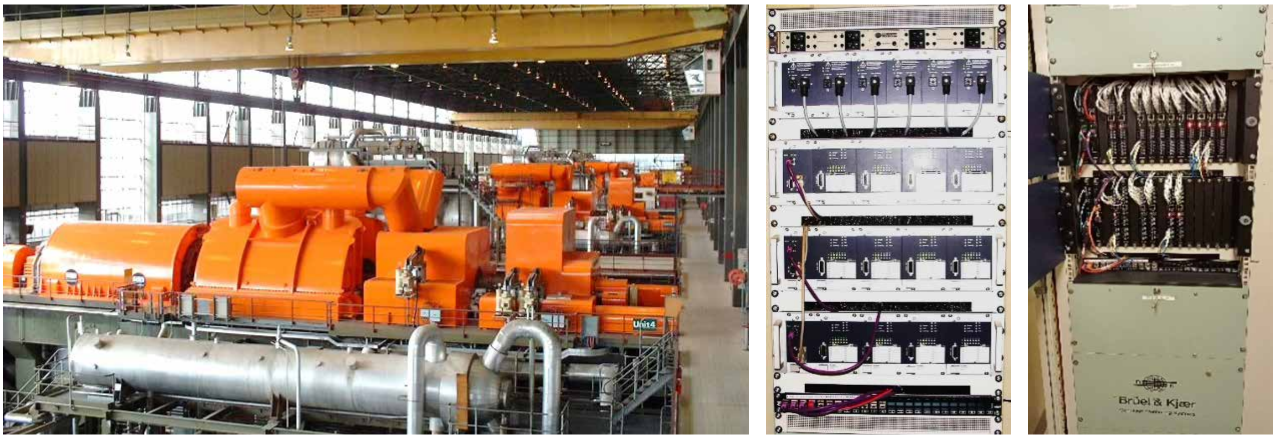

Figure 1. All four 250 MW turbo-generating units are seen in this machine hall photo (left). The Compass 6000 VC-6000 rack-mounted monitoring modules in a cabinet (middle) were originally installed for monitoring Unit 2 and Unit 4 (but are now replaced by SETPOINT on Unit 2 (right). SETPOINT is already installed on Unit 1 and will soon be installed on Unit 4.

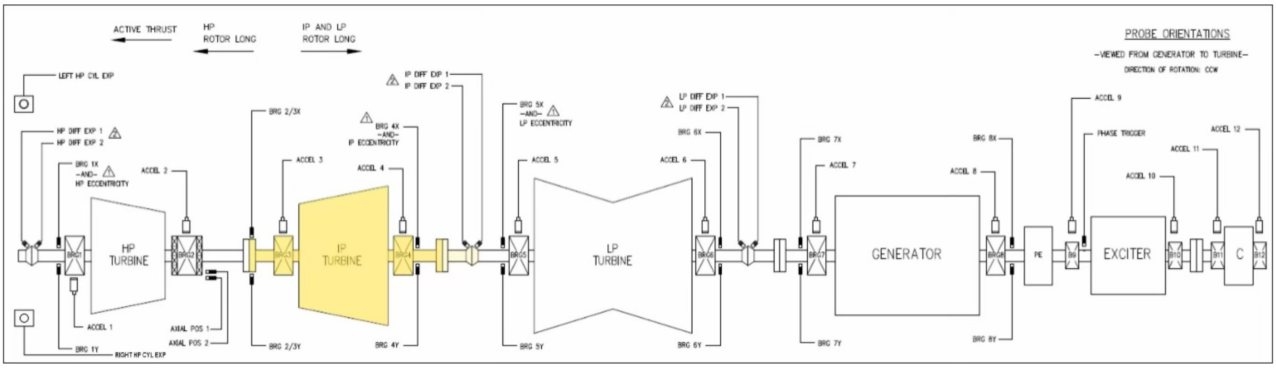

Figure 2. Schematic showing displacement sensor and accelerometer installation on the turbo-generator units. The IP turbine section, shown in yellow, is the subject of this case story.

Unit 2

This case story focuses on Unit 2, but each of the four turbo-generating units at the power station are identical, consisting of a high, intermediate and a low-pressure steam turbine section (HP, IP and LP), as shown in Figure 2. The turbine rotors are rigid, meaning they operate below the first critical speed (rotor resonance).

The units have been operating without too many problems over the years, although there have been issues with the natural frequency of the flexible steel foundations close to the generator turbine shaft running speed.

Monitoring Strategy

The sensor installation points and measurements on the turbo-generator units are summarized in Figure 2 (overspeed measurements are not shown). Tables 1 and 2 show some of the vibration measurements that are monitored but shown just for the steam turbine and generator portion of the entire turbo-generator unit.

As the bearing pedestals are relatively flexible due to the steel support structure foundation, special considerations are made for protection and condition monitoring of the turbo-generating units. During runup (29 to 2850 RPM) the BP vibration alarms are set to 50 mm/s and the 1X and 2X velocity vibration alarms are profiled around the normal runup values to avoid unnecessary alarms during runup due to the natural frequency resonances present. During the same runup a 1X or 2X velocity vibration alert alarm will hold the speed or run back (if in a critical speed range). A danger alarm will trip the unit. Above 2850 RPM, protection from the bearing pedestal accelerometers is only set up for BP vibration.

Monitoring system

In 2011 the Compass Classic monitoring systems on Units 2 and 4 were upgraded to the Compass 6000/VC-6000 system (see Figure 1), and in 2021 Unit 1 was upgraded to SETPOINT, which can automatically store data directly in the PI system, including vibration time waveform data. (This system is described further on.)

All the monitoring systems provide both protection and condition monitoring capability for not only the steam turbine, generator and exciter, but also for monitoring bearing vibration and thrust position of the main boiler feed pumps, driven by a steam turbine on each unit.

Continued over page >

Displacement Sensors				
Meas., CM/MPS, access			**Location**	**Figure 2 sensor symbol**
Casing expansion (mm) - 50 mm range sensor	CM	DCS, CMS	HP casing bearing #1	`LEFT HP CYL EXP` `RIGHT HP CYL EXP`

Differential expansion (mm)	CM, MPS	DCS, CMS	HP, IP, LP shafts (2x sensors each)	`HP DIFF EXP 1, HP DIFF EXP 2`
				`IP DIFF EXP 1, IP DIFF EXP 2`
				`LP DIFF EXP 1, LP DIFF EXP 2`

X-Y radial bearing vibration – 1X, 2X vector displacement magnitude (μm) and phase	CM	CMS only	Bearing #1-XY, #2/3-XY (HP-IP shaft coupling), #4-XY, #5-XY, #6-XY, #7-XY, #8-XY	`BRG 1X-AND-HP ECCENTRICITY, BRG 1Y`
				`BRG 2/3X, BRG 2/3Y`
				`BRG 4X-AND-IP ECCENTRICITY, BRG 4Y`
				`BRG 5X-AND-LP ECCENTRICITY, BRG 5Y`
				`BRG 6X, BRG 6Y`
				`BRG 7X, BRG 7Y`
				`BRG 8X, BRG 8Y`

Eccentricity (μm, Peak-peak)	CM, MPS	DCS, CMS	Bearing #1-X, #4-X, #5-X for HP, IP, LP shafts	`BRG 1X-AND-HP ECCENTRICITY`
				`BRG 4X-AND-IP ECCENTRICITY`
				`BRG 5X-AND-LP ECCENTRICITY`

2x Axial position (mm)	CM, MPS	DCS, CMS	Thrust bearing (bearing #2)	`AXIAL POS 1, AXIAL POS 2`
NOTE	CM	Condition monitoring	DCS	Bandpass vibration measurement
	CMS	Condition monitoring system	BP	Bandpass vibration measurement
	MPS	Machine protection system		

Table 1. Displacement sensor vibration measurements on steam turbine and generator (there are other measurements not shown, for brevity).

Accelerometers				
Meas., CM/MPS, access			**Location**	**Figure 2 sensor symbol**

BP (10-1kHz) vibration RMS, mm/s	CM, MPS	DCS, CMS	Bearing pedestal #1, #2, #3, #4, #5, #6, #7, #8	`ACCEL 1, ACCEL 2,`
				`ACCEL 3 ACCEL 4,`
				`ACCEL 5, ACCEL 6,`
				`ACCEL 7, ACCEL 8`

1X, 2X vector vibration magnitude (mm/s) and phase (degrees)	CM, MPS	CMS only		
NOTE	Same as for Table 1.			

Table 2. Accelerometer measurements on steam turbine and generator (there are other measurements not shown, for brevity).

As seen in Tables 1 and 2, a limited amount of vibration data is exported to the DCS from the Compass system for display and trending: BP vibration, eccentricity, differential expansion, casing expansion and the axial position.

The unit will trip if differential expansion or axial position danger alarm limits are breached at any time. During runup, a 1X and 2X velocity vibration danger alarm will trip the unit. Above 2850 RPM, a BP vibration danger alarm plus one other bearing BP vibration in alert will trip the unit (voting logic in DSC). An eccentricity danger alarm will also trip the unit, but only below 600 RPM as described further on.

All the other vibration measurements can only be remotely accessed from the Compass system for condition monitoring and diagnostics, as well as for viewing the following plots:

- Velocity vibration and displacement time waveform
- Spectra and waterfall/cascade
- Orbit
- Bode/polar
- Average shaft centreline and Amplitude & phase changes as a function of time plots.

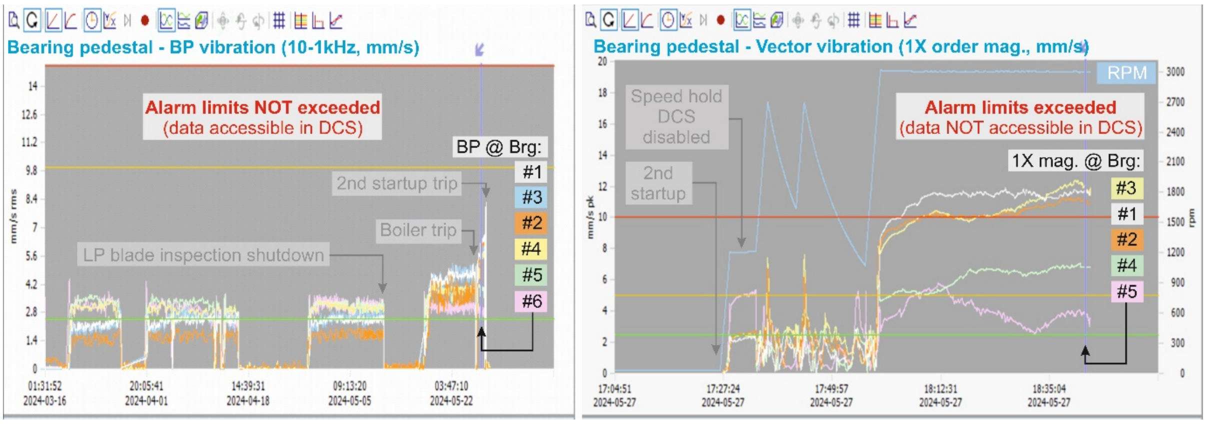

Figure 3. Compass trend plots showing data from the second startup. BP vibration is shown on the left (which is also visible in the DCS as seen in Figure 4, right), indicating high vibrations for the HP and IP turbine sections. 1x velocity vibration magnitude from the HP, IP and LP turbine bearing pedestal accelerometers (which is not accessible from the DCS) is shown on the right. This data was actually in an alarm state.

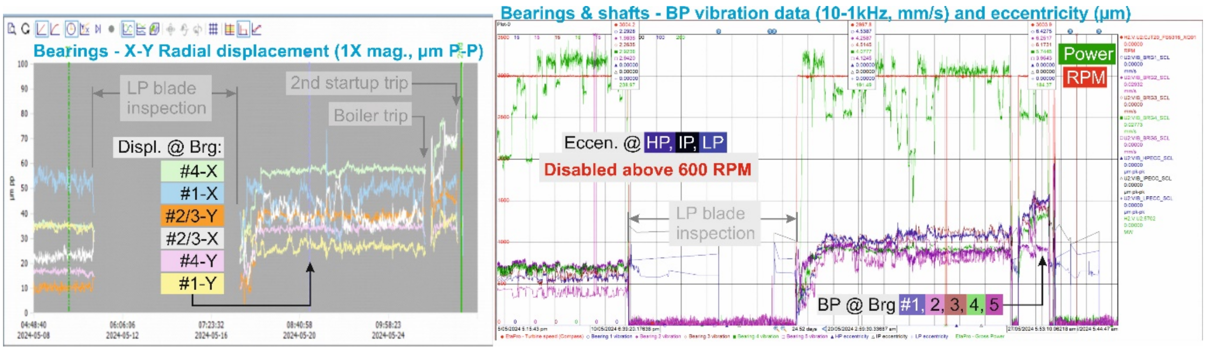

Figure 4. Compass trend plot on the left showing 1X radial displacement magnitude of the turbine bearings from the first and second startup. The DCS plot (right) shows the bearing pedestal BP vibration and turbine shaft eccentricity during the same startups.

Observation of an event

On 16 May, Unit 2 was returned to service after an LP turbine blade inspection. (The last row of LP blades is inspected every 500 running hours due to cracking having previously been found.) Shortly after startup, increased BP vibrations were observed at the bearing pedestals but were still below alarm limits (Figure 4). On 27 May, the unit tripped anyway, but it was due to a boiler fault, not high vibrations. The boiler issue was resolved quickly, and the unit was started up again.

During the second startup, however, there were two runup holds, which were bypassed in the DCS as there were no alarm limits that were exceeded. The unit eventually synchronised and was loaded to 130 MW.

The BP vibration was still high (Figure 3, 4) as it was during the first startup, so the operator contacted the Predictive Maintenance Engineer who remotely accessed the Compass system to look at the 1X velocity vibration (Figure 3).

Both the BP and 1X velocity vibration levels for the HP and IP turbine sections (bearings #1 to #4) had increased significantly and the 1X velocity vibration was actually in an alarm state (not seen in the DCS), so the Senior Operator, together with the Predictive Maintenance Engineer, decided to shut down the unit.

Given the state of the electricity market at the time of the incident, there was pressure to get the unit online again quickly.

Diagnostics

Immediately after shutdown the unit was inspected during the period from 27 May to 2 June. Without knowing the cause for the high vibrations at pedestal bearings of the HP and IP turbine sections, the unit was looked at to find any indications of a possible rub in the outer gland housings, and to check the axial keys to see if there was any wear. Nothing of significance was found.

In the meantime, the Predictive Maintenance Engineer remotely accessed the Compass system to look more closely at this data, such as eccentricity (disabled by DCS above 600 RPM, but still monitored by Compass), bearing vector displacement (Figure 4) and bearing pedestal vector velocity vibration.

The BP vibration for bearing pedestals #1 to #5 shown in Figure 3 is seen as increasing significantly just before shutdown, but as the DCS Operators mentioned, these values were still below the alarm limits. The 1X displacement magnitude shown in Figure 4 was also

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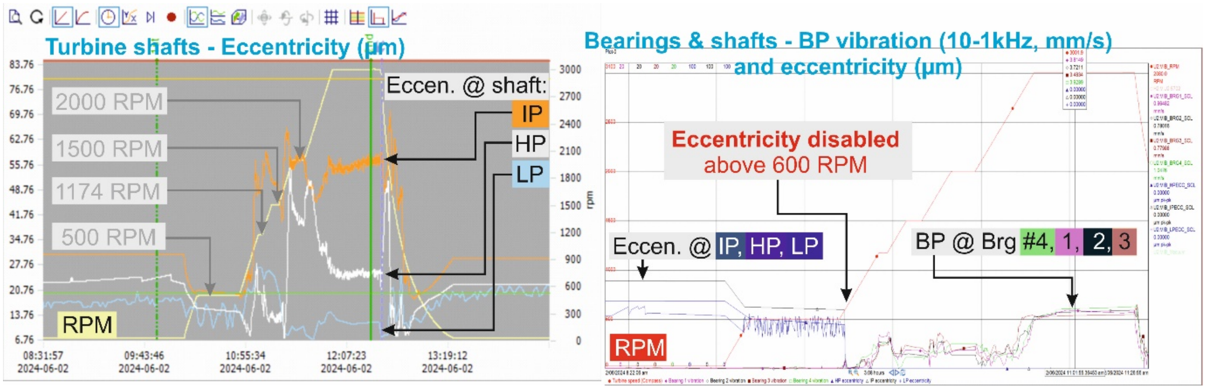

Figure 5. Compass runup plot (left) showing eccentricity from the third startup, and the same runup shown on the DCS plot (right). The IP shaft eccentricity (56.60 µm) is much greater than the HP shaft (31.71 µm) and LP shaft (12.17 µm).

Figure 6. IP casing bottom section (left), top stationary blades (middle), IP shaft (right).

high for the same HP and IP bearing pedestals and had exceeded alarm limits. This data cannot be seen in the DCS, similar to the eccentricity above 600 RPM.

Based on this information, it was decided that the problem was either on the HP turbine which consequently affected the IP turbine, or vice versa, or in both turbines.

"It was decided that the problem was either on the HP turbine which consequently affected the IP turbine, or vice versa, or in both turbines."

Root cause analysis

What could the problem be? This could have been caused by a bent rotor, permanent or only temporary during operation, which could have been caused by:

- Partial rub (i.e. uneven heat gain of the rotor on its circumference)
- No barring while the rotor was still hot after shutdown
- It could also be caused by other factors, such as:
- Imbalance due to erosion, corrosion, deposit buildup/ detachment, blade loss
- Bearing wear or damage
- Axial keyway wear or damage.

Or a combination of several of these factors.

Wear on the axial keys was ruled out during the initial inspection, and a permanent bent shaft was also ruled out since shaft eccentricity returned to normal on barring.

Some of the other causes mentioned normally develop gradually over time, which was not the case here, so this simplified the root cause analysis further.

Needless to say, more diagnostic work had to be done to identify the specific problem and get Unit 2 back online as quickly as possible.

Third startup

It was decided to do a controlled startup of Unit 2 to more closely evaluate the problem. This time a portable diagnostic analyser was connected to the buffered outputs of the Compass system to get higher resolution data for more detailed analysis.

The unit was run up with manual speed holds at 500, 1174, 1500, 2000 and 3000 RPM, to observe the vibration response. These particular speeds were chosen to avoid all of the generator critical speeds and the associated turbine run backs. The intention was to discontinue the startup if there were high vibrations at the speed hold, but this was not the case, so the turbine was run up to full speed.

The results of this startup test are shown in Figure 5.

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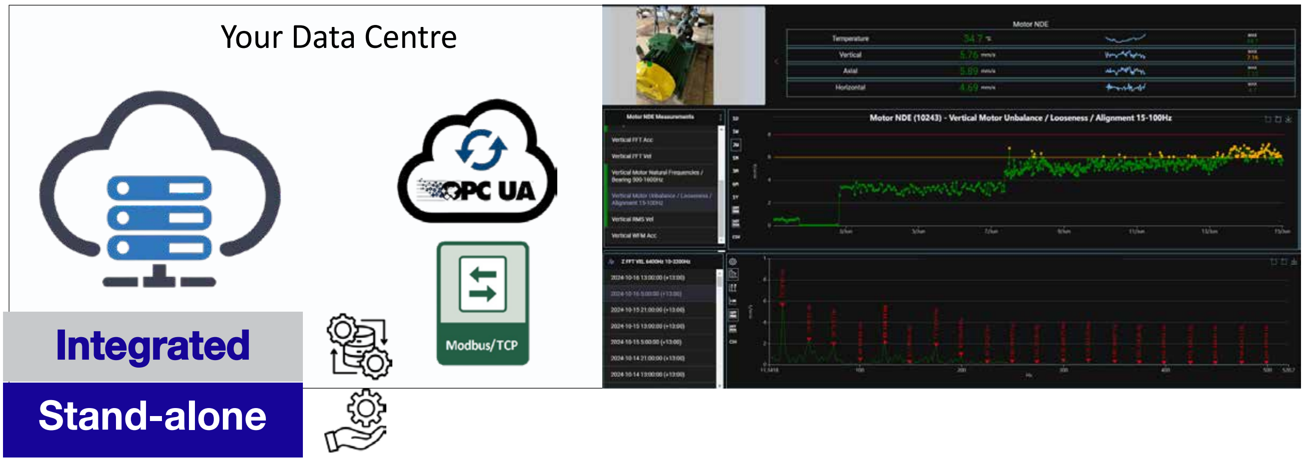

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Looking at the Compass transient and steady-state data shown in Figure 5, it was seen that primarily the IP turbine shaft eccentricity remained high during the entire runup to full speed. From this it was determined that it was the IP turbine section that had the problem, not the HP section.

Why was this eccentricity issue was not observed in the DCS trend when the original problem was first noticed? It's because eccentricity, which is the deviation of the rotor geometric centreline to its axis of rotation, is typically used only to assess turbine shaft straightness prior to runup. For this reason, it is used only during barring speeds and therefore disabled above 600 RPM in the DCS. If used above 600 RPM, this measurement would not only include the "static" eccentricity signal of the rotor, but it would also include any dynamic effects that occur at the higher rotational speeds, due to imbalance, misalignment, etc.

This is what is normally monitored by the 1X displacement measurement. In this case, above 600 RPM, eccentricity would serve as a type of backup to the 1X displacement measurement. As we will see later, it can be used this way.

Disassembly inspection

After finalizing that the IP turbine section was the source of the problem, the outer and inner casing were removed to inspect the turbine. An extensive amount of damage was discovered, as shown in Figure 6:

- Row one stationary blades in the top diaphragm had a blade package missing
- The turbine rotor had three separate blade packages missing and extensive rubbing wear on numerous other stages
- The second-row top stationary blades had a 90° arc of missing blades
- There was a lot of metal debris and damage to the stationary blade in the casing bottom half, where there were blade pieces no larger than 5 mm found. ■

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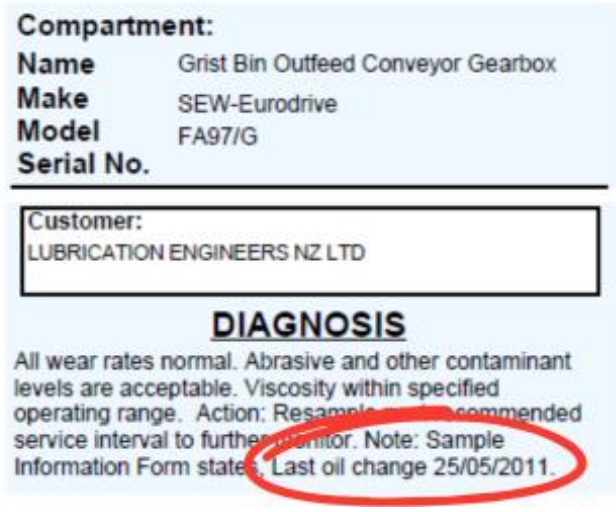
Compartment:

Name	Grist Bin Outfeed Conveyor Gearbox
Make	SEW-Eurodrive
Model	FA97/G
Serial No.	

Customer:
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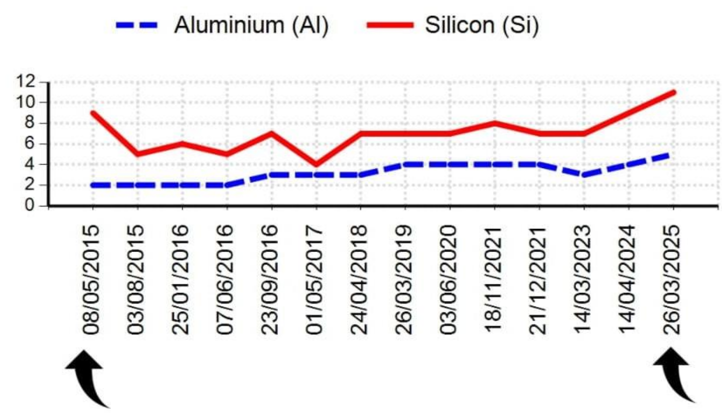
DIAGNOSIS

All wear rates normal. Abrasive and other contaminant levels are acceptable. Viscosity within specified operating range. Action: Resample at recommended service interval to further monitor. Note: Sample Information Form states, Last oil change 25/05/2011.

Above snapshot from a Gearbox Oil Analysis Report. Lubricant last changed in 2011 and still in operation.

How often are you changing your oil?



Oil Analysis snapshot of Duolec Industrial gear oil LE1605 (60 Litre) in service for 10 years, filtered once using LENZ's offline filtration trolley at 3 micron filter.

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PUZZLE CORNER

Solutions on page 40

WORD BUILDER

How many words of **three or more** letters can you make using the six letters below? You can only use each letter once. Plurals are allowed, but no foreign words or words beginning with a capital.

Word scores expected...

16 - Good | 22 - Very Good | 28+ - Excellent

P	I	T	N	O	O

There's 33 possible three or more letter words to find.

WORD LADDER

A Word Ladder has two words in the ladder, one at the top and one at the bottom. You must form a sequence of words going down. On every step of the ladder (1-6), you must unscramble and create a new word that only differs by one letter from the word above it until you reach the destination word on line 6.

TEA to CUP

1	TEA
2	
3	
4	
5	
6	CUP

SUDOKU

To solve, each number from 1 to 9 must appear once in:

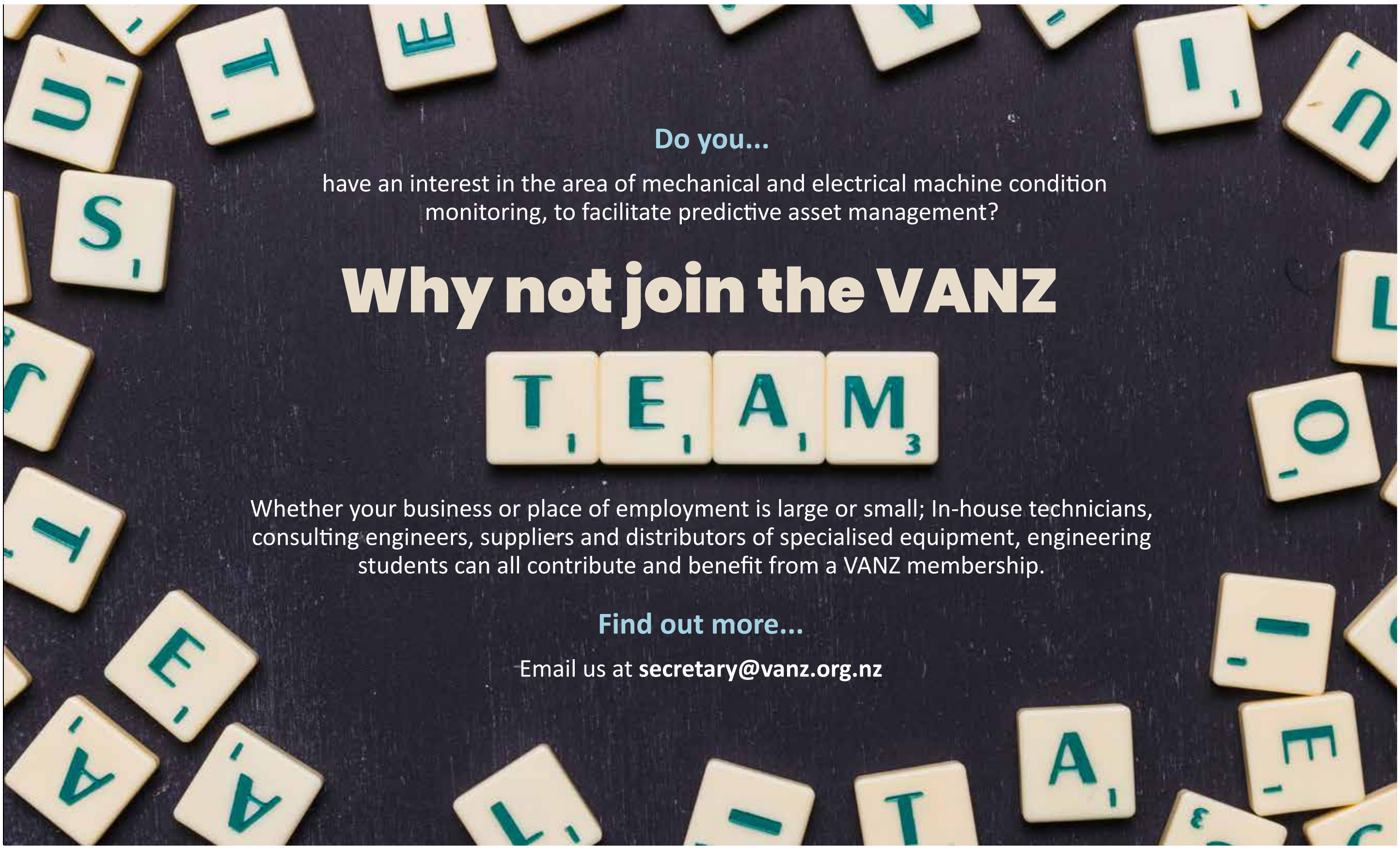
- **Each of the nine vertical columns**
- **Each of the nine horizontal rows**
- **Each of the nine 3 x 3 boxes**

No number can be repeated twice in a box, row or column.

Puzzle difficulty: **Real Hard**

41.6% of puzzlers can solve this. Can you?

	7							
		1	4		3	9		
		9					6	
		4	1			6		
		7	9		6		3	
	1					5		
7	4		8	1			9	6
		2		9		1	5	
	9	6			7	2		



Carlton Technology Ltd
Ph: 64 6 759 1134
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TEST YOUR KNOWLEDGE - PART 80 OF A SERIES

1. When carrying out vibration analysis on variable-speed machinery, why is it important that the analyst correctly identifies the speed of the machine at the time of data-collection?
A. Fault frequency calculations will be erroneous if an incorrect speed is entered
B. Orders-based band data will be erroneous if an incorrect speed is entered
C. Trends of overall vibration levels versus speed will be erroneous if an incorrect speed is entered
D. All of the above.

2. The 2025 VANZ conference was held in New Plymouth. What anniversary (in terms of annual conferences) did this mark?
A. 25th
B. 30th
C. 35th
D. 40th.

3. You have just carried out vibration analysis on two identical fans which run at the same speed and load and both have the same bearings and housings fitted. The non-drive end bearings of both fans have outer-race defects. On fan "A" there is a "hump" of energy generated by the fault in the spectrum in the 3 kHz region. On fan "B", the "hump" is closer to 5 kHz. In the absence of any other information, which of the fans do you think is likely to have the more severe defect?
A. Fan A most-likely has the worst defect.
B. Fan B most-likely has the worst defect.
C. Both defects are likely to be of the same severity
D. No conclusions can be drawn from the info provided.

4. A 4-pole motor runs under variable-speed control. The motor is so well balanced that there is no easily-measured 1 x signal in the vibration data. A 0-10 kHz acceleration spectrum does however show a grouping of electrically-sourced side-bands around the switching frequency of the VSD. The spacing of the side-bands is 80 Hz. From this, which of the following is a likely rpm of the motor during the testing?
A. 1200 rpm
B. 1300 rpm
C. 1500 rpm
D. 2400 rpm.

TurninSee question 8.

5. "Spiking" is sometimes done to change the mounting and improve vibration response of which of the following?
A. Large industrial fans
B. Motor vehicles
C. Vibrating conveyors
D. Floor-standing speakers.

6. A steel disk of 800 mm diameter and 10 mm thick has a weight of 39.46 Kg. A 40 mm hole was bored in its centre so that the disk could be mounted on a shaft. There was an error when this boring was done, and the hole was 0.1 mm off-centre. How much weight would need to be applied (or removed) at the outer diameter of the disk to bring it into balance? (Assume single-plane balancing).
A. 0.9865 grams
B. 9.865 grams
C. 98.65 grams
D. 986.5 grams.

7. The manufacturer of isolation mounts included in their brochure a chart showing isolation efficiency ranges for three groups of applications – critical, general, and non-critical. What isolation efficiency range do you think they gave for the general category?
A. 35-50%
B. 50-65%
C. 65-80%
D. 80-95%.

TEST YOUR KNOWLEDGE

Further enquiries can be directed to: Carl Townsend at Carlton Technology Ltd.
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8. You are standing next to a person with a sound-level meter measuring sound levels from a stereo system. The person increases the volume from the stereo until he/she perceives that the sound is twice as loud as before. What increase in decibel level do you think you might see on your sound level meter when the volume is increased as described?
A. 2 dB
B. 3 dB
C. 5 dB
D. 10 dB.

9. You swing a heavy wooden mall and impact the structure of an industrial fan so that you can measure its response and determine natural frequencies etc. At your first attempt the 0.5 g trigger level that you set for the bump test is not reached, so you conclude that you either have to lower the trigger level or swing the mall with more momentum. What factors are used in calculating momentum?
a. Mass and acceleration
B. Mass, density and acceleration
C. Mass, acceleration and atmospheric pressure
D. Mass and velocity.

10. The 2026 VANZ conference will be held in which of the following cities?
A. New Plymouth
B. Hamilton
C. Rotorua
D. Auckland.

How many did you get ***correct?*** *Check your answers on page 40.*

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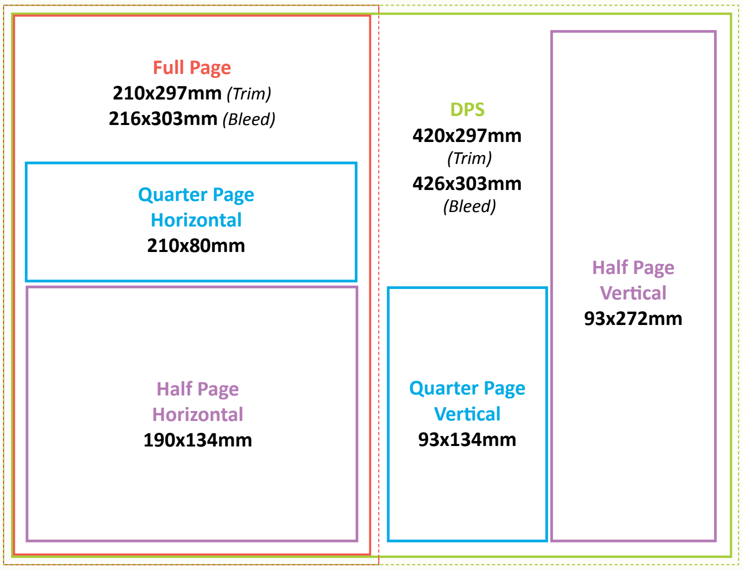
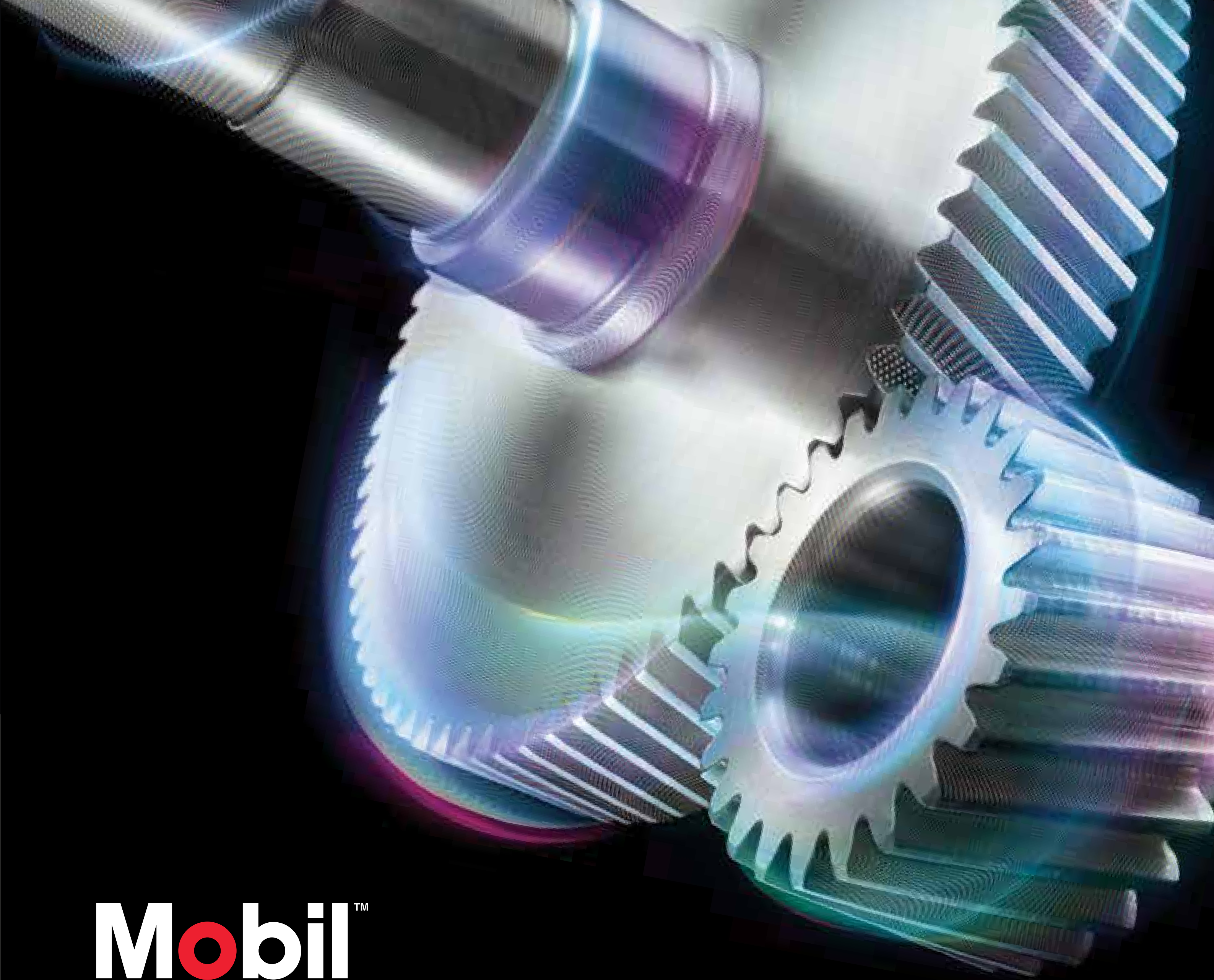


Carlton Technology Quiz 80: 1D, 2C, 3A, 4A, 5D, 6B, 7D, 8D, 9D, 10C
Word Builder: Option, Potion
Word Ladder: 1. TEA 2. SEA 3. SEE 4. SUE 5. CUE 6. CUP



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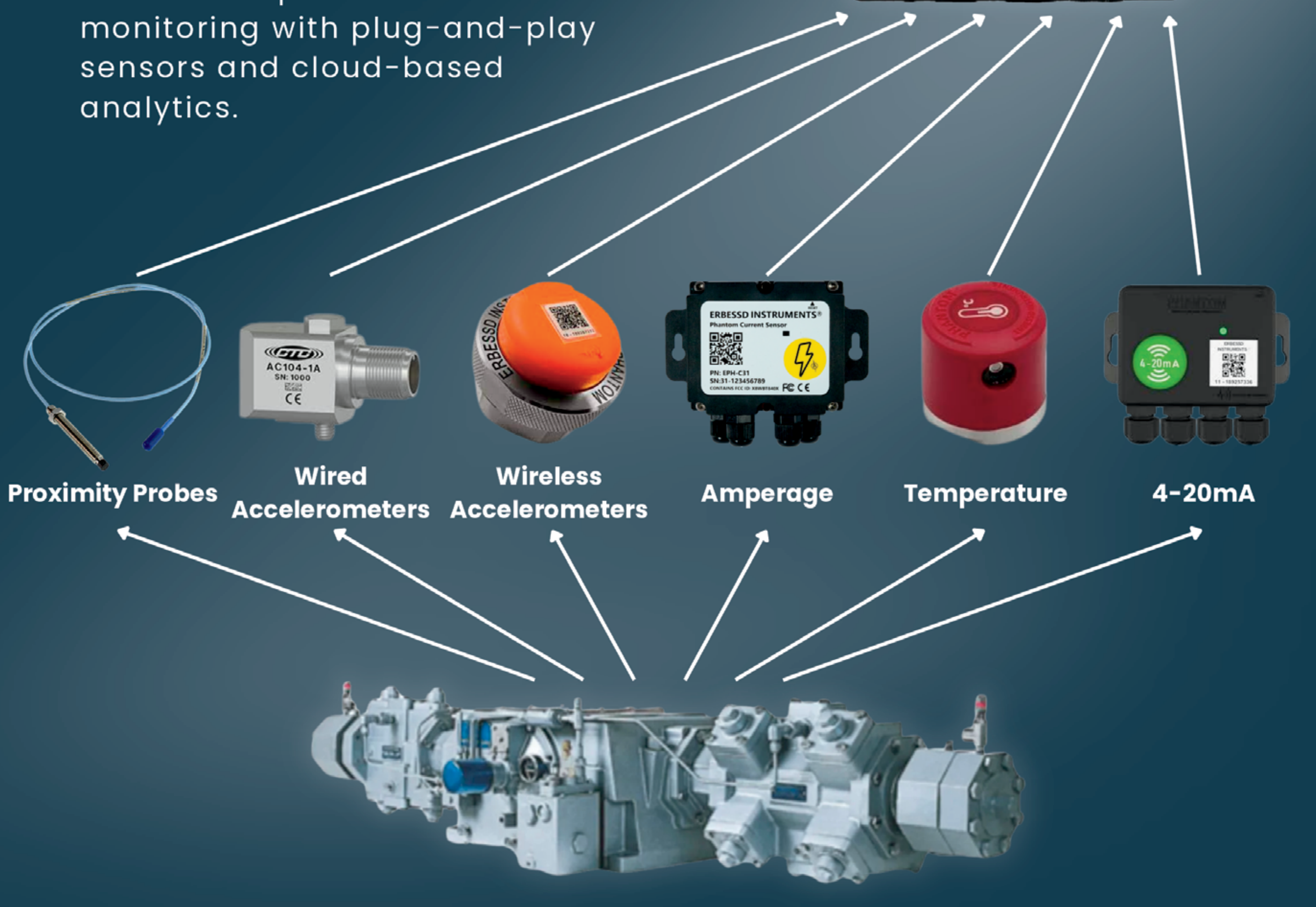

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