The official journal of the Vibrations Association of New Zealand

Spectrum

Spring 2025 | Issue 117

Understanding your oil analysis

PART II

MAKING SENSE OF YOUR LAB REPORT

Steam turbine blade breakage – maintenance + monitoring challenge

Part 2

Implementing Electrical Preventative Maintenance

+ CONFERENCE 26

Rydges Rotorua
19th - 21st May 2026

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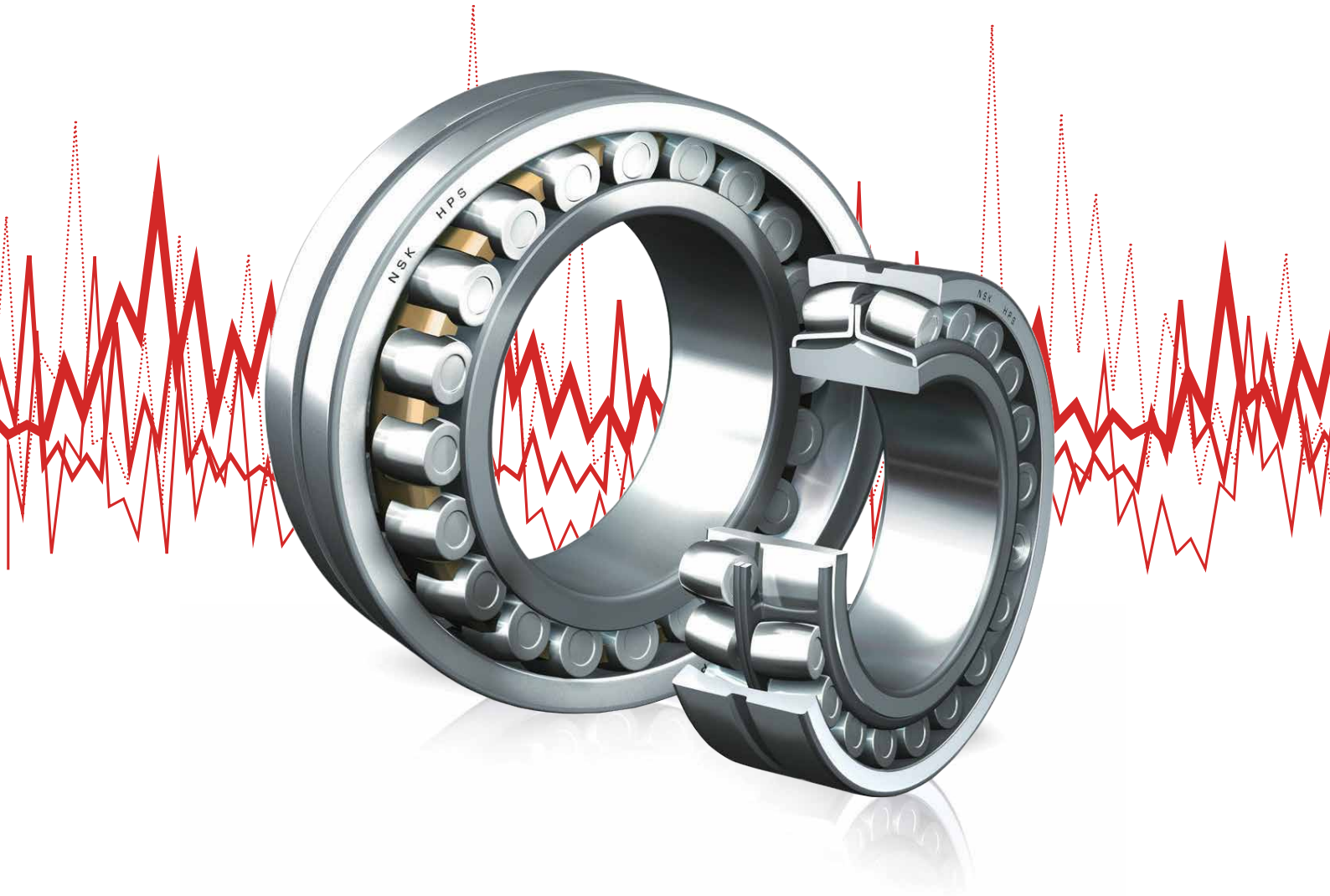

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Spectrum

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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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Plant condition monitoring

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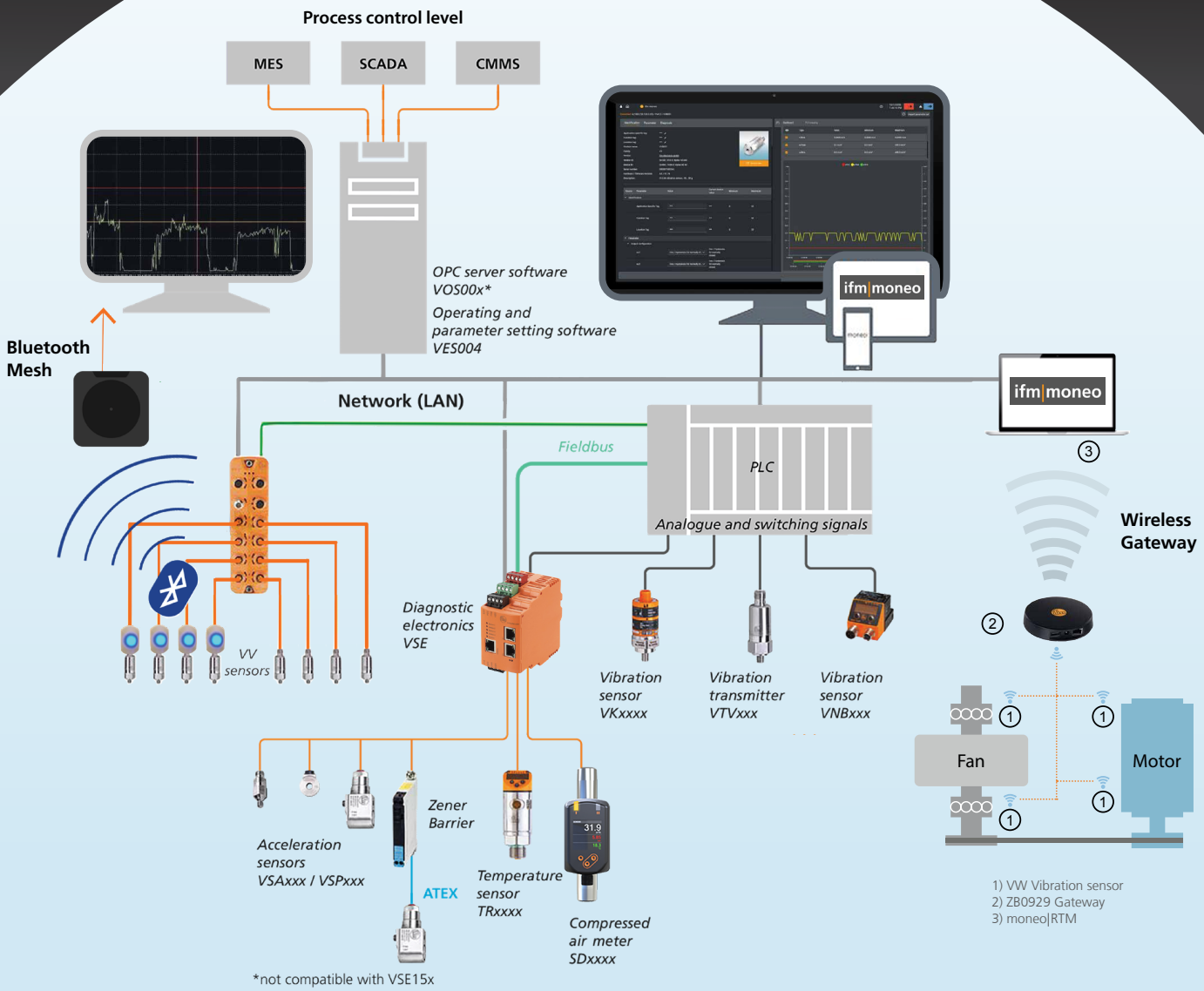

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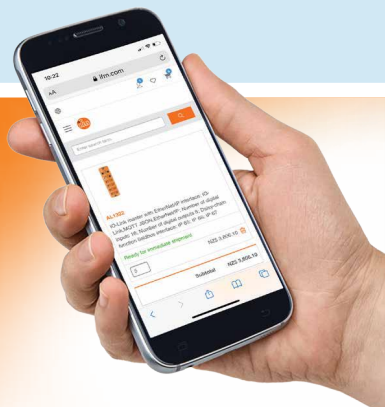


Comprehensive condition monitoring in a (3-axis) device!

ifm's latest 3-Axis condition monitoring sensor, VVB3 series, when combined with moneo analytical software, provides a cutting-edge solution for maintaining machinery. With continuous, real-time assessment, 24/7, of both machine vibration and surface temperature.

Providing plant management with crucial data on each machine's health. The wide frequency range of 5,600 Hz, detects early signs of potential issues such as wear, bearing damage, or insufficient lubrication early, helping prevent expensive plant repairs and downtime.

Predictive maintenance is becoming more essential, as industry rely on the longevity and efficiency of their equipment. By employing VVB3 sensors, companies can make informed decisions, and take proactive steps to avoid equipment failure, extending the life of their machinery.

Condition indicators

Obtain digital indicators for fatigue, impact, friction, crest and temperature from one sensor

Early fault detection

3-axis MEMS technology with 5600 Hz frequency range

Interoperability

IO-Link facilitates real-time usage of data

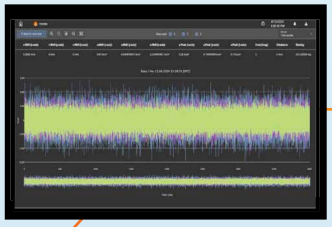
Smart analytics

Rolling bearing analysis and unbalance detection directly in the VVB3xx

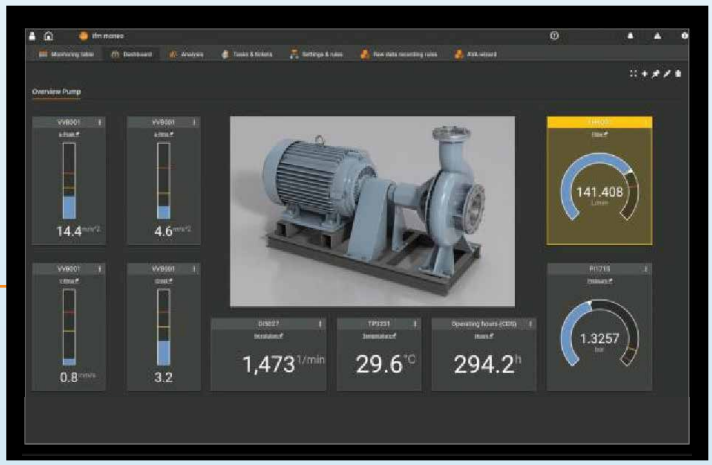
Machine health LEDs

Turn your data into actionable insights

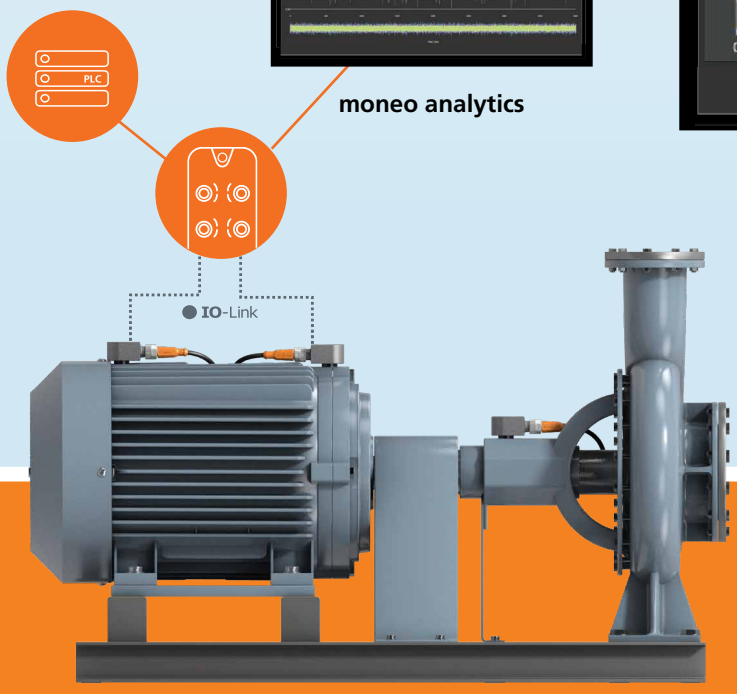
- Machine health - continuous transparency of machine reliability.
- With the new VVB and the IIoT platform moneo, maintenance is easier than ever before.



moneo analytics



moneo: your maintenance co-pilot



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PRESIDENTS' REPORT

By Tim Murdoch | VANZ President

As the President of VANZ, I have been reflecting on the past year of New Zealand's challenges with industry. It's clear that the landscape for our industry, and indeed for many sectors across Aotearoa, has continued to shift and challenge us. VANZ has remained committed to supporting our members through change and education, ensuring that the essential disciplines of vibration analysis and condition monitoring continue to deliver value and reliability across New Zealand industries.

This year has seen a few difficulties for many businesses. Across multiple sectors, we have seen companies closing their doors or making difficult decisions to reduce staff. These developments remind us of the critical role that predictive maintenance and condition monitoring play in cost savings and operational efficiency.

In times of financial pressure, vibration analysis and other condition monitoring tools can make the difference between unplanned downtime and sustained productivity. Our community's knowledge and expertise are more important than ever in helping organisations do more with less.

> **"Our community's knowledge and expertise are more important than ever in helping organisations do more with less."**

One of our significant undertakings this year has been the review and updating of our constitution to align with the new Incorporated Societies Act. This has been no small task, and we ask for your support through this process.

The new requirements have challenged us to revisit how we operate, govern, and engage with our members. While the process has been demanding, requiring careful consultation and consideration, it has also provided a valuable opportunity to modernise our structure and ensure that VANZ remains strong, transparent, and compliant well into the future.

I'd like to thank everyone who contributed their time and expertise to this important work. A reminder that we still have voting in process for the new constitution at our Special General Meeting on 9 December 2025. The time of consultation has been completed and I would ask that you please attend the online meeting at 6:30PM on Dec 9 and put your vote forward - if you can't make this please send your vote to secretary@vanz.org.nz prior to this date.

On a personal note, I recently spent time hiking in the Southern Alps. Standing among those vast, rugged peaks, I was reminded of the extraordinary beauty of our country and the resilience of both our landscape and our people. It's a timely reminder of why we do what we do, maintaining the machinery and systems that keep New Zealand running, safely and efficiently, in harmony with our environment.

Looking forward, we've been working hard to prepare for next years conference in Rotorua. We're excited to once again bring together professionals from across the country and around the world to share knowledge, innovations, and experiences. If you're interested in presenting a paper or sharing a case study, I warmly encourage you to get in touch. Your insights and contributions are what make our events so valuable.

For those who don't already know, the conference details are as follows:

Conference '26
Rydges Hotel, Rotorua
Tuesday, 19th May - Thursday 21st May 2026.

Don't forget to mark it in your calendar/ diaries and register your interest early!

Thank you to the committee, members, sponsors, and all who continue to support the Association. Your engagement ensures that VANZ remains a vital hub for technical excellence and collaboration in both New Zealand and the International industry.

VANZ

PRESENTS

THE NO.1 EVENT IN THE VIBRATIONS ASSOCIATION CALENDAR IS BACK IN 2026.

ROTORUA

AT RYDGES HOTEL

19–21 MAY 2026

CONFERENCE 26

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CALL FOR PAPERS

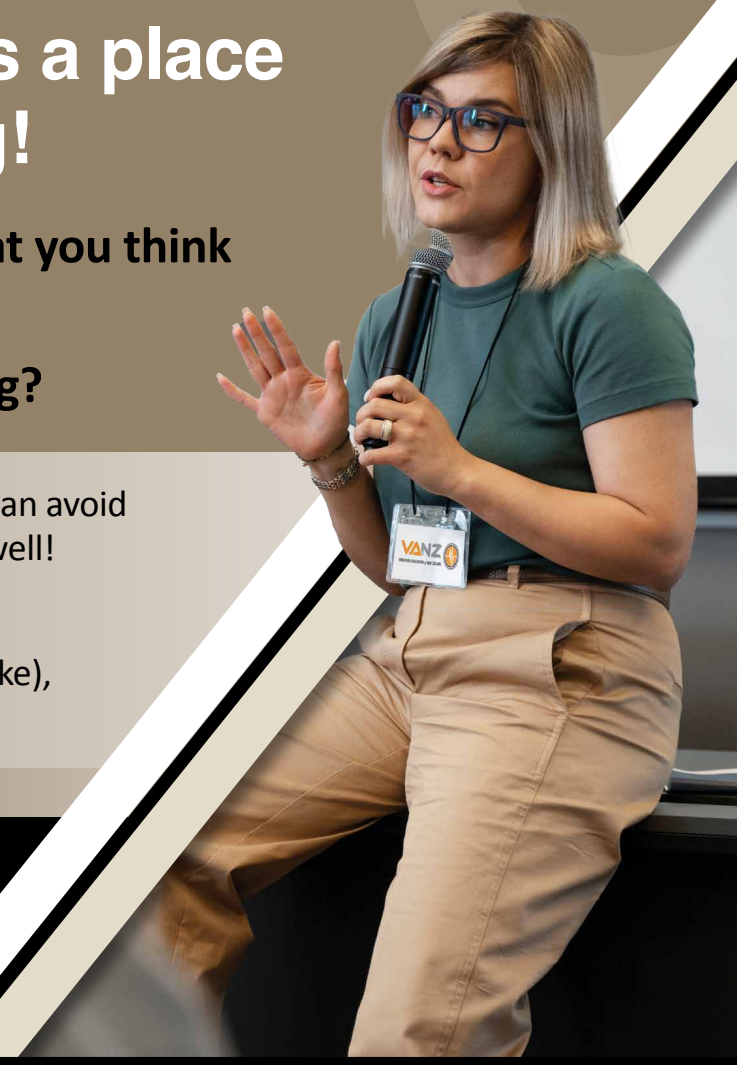
ROTORUA 2026

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.



CONFERENCE 26

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Conference'26

RYDGES ROTORUA

Exhibitor Packages

19th - 21st May, 2026

All conference pricing excludes GST.

Package	Gold	Silver	Bronze
Price	$3,455	$2,495	$1,815
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Platinum primary sponsorship on key online & offline promotional material before and during conference*			
Platinum official role at the opening of the conference and five minute speaking opportunity			
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Signage opportunities at conference & dinner			
Pre conference Spectrum advertising opportunities (early registrations only)	✓		
Acknowledgement as sponsor & vendor	✓	✓	
Company literature in delegates goodie bags	✓	✓	
Brand on conference programme (early registrations 1 month before event)	✓	✓	✓
Sponsorship on key online & offline promotional material before and during conference**	✓	✓	✓
Logo on VANZ conference publications & website***	✓	✓	✓
Post conference Spectrum advertising opportunities	✓	✓	
Conference entry for staff	x2	x1	x1

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Booth size (Silver)	1.2 x 2.4 metres
Table top size (Bronze)	1.8 x 0.6 metres

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Networking Session Sponsor (Tuesday night)	$2,000	Lanyard sponsor	$520 + lanyards
Networking Session Sponsor (Wednesday night)	$2,000	Bag sponsor	$520 + bags
Dinner Sponsor	POA		

Note. All exhibitors have the annual dinner included for the number of delegates associated with the respective category. *Example: Gold 2 delegates, Silver 1 delegate, Bronze 1 delegate.*

There will also be provision for extra annual dinner attendee purchases at $129 per person.

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CONFERENCE'26

VANZ Conference'26
PRESENTER PROFILE...

Introducing Keynote Speaker: Barry Robinson

Engineering Qualifications: Trade Certificate in Toolmaking, NZCE in Mechanical Engineering, and Marine Engineer 3rd class (steam). Other Quals: Ocean Yachtmaster.

Worked for 38 years running heavy engineering and metal-product manufacturing specialising in hot-forging, heat-treatment & failure analysis. Made high-spec customised critical components for every industry imaginable. Also worked on research projects for Titanium alloy powder consolidation, and co-founded RAM3D, a world-leading production manufacturer of full-strength metal 3D-printed products in Stainless 316L & 15-5-PH, Inconel 718 and Titanium 6-4 alloys.

Currently working as an engineering consultant on Materials, Manufacturing & Repair Methodology, Failure Analysis, and use 40 years of industrial learning & experience to run 1-day intensive Training Courses for all engineers on best practices to avoid failure in steel components and fasteners.

This training is extremely practical and loaded with real examples. It is suitable for everyone in the engineering industry: Engineering Directors & Managers, Tradies & T/A's, Designers, Specifiers/Purchasers, Apprentices/ Trainees, Maintenance Engineers, Welders, and Graduates.

Topics covered include: Preventing Welding Failure, Failure of Fasteners, Poor Quality and Incorrect Material, Stress Raisers, Steel Processing Problems, Fatigue & Fracture Analysis, Material Selection & Ordering, Understanding Additive Manufacturing (AM) or "3D Printing" of Metal Products, Special Material Recovery & Heat-Treatment Techniques, Material Certificates (and how badly they can be wrong), Steel Grade & Properties Charts-Diagrams.

The intention of this training is to alert engineers to very important basic principles to help avoid built-in failure, and to some scary issues to be aware of when sourcing bolts, nuts, and steel (incl stainless and alloy steel). It is extremely beneficial for young engineers to get the benefit of decades of experience without having to make expensive mistakes! ■

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CONFERENCE 26

EDITORS' CORNER

By Angie Delfino | Spectrum Editor

Greetings dear readers, this being the last issue of the year we here at VANZ hope you've all had a productive 2025 and the next few months before the Christmas holidays eases you into the new year.

As another year passes we look back and reflect on the last 12 months within the industry, the changes that have been made, the new technologies discovered and the trials and tribulations that we've faced.

Check out the latest quiz from Carl and our President's latest musings in his end of year report, as well as having a read through the interesting articles that have been contributed for this issue from Mark Gurney and Part 2 from Simon Hurricks

As we start planning for the new year we have a busy team organising everything for the 2026 conference, the info we currently have available can also be found on our website **www.vanz.org.nz** so keep checking back for more details!

VANZ would like to wish you all a very Merry Christmas, Happy Holidays, Season's Greetings and a happy and safe New Year. Make the most of the holiday season by spending time with family and friends and take a well deserved break.

Many thanks go to the companies that advertise with us, we greatly appreciate your support for another year and hope to continue with you all next year, happy reading!

> **VANZ would like to wish you all a very Merry Christmas, Happy Holidays, Season's Greetings and a happy and safe New Year.**

V-Ring Seal Installation

The V-ring seal is one of the most frequently used dynamic seals when using plummer blocks, although its installation, and performance are probably areas where they are mostly misunderstood.

Properly selected and installed, V-ring seals can provide excellent service life and sealing capabilities, but if installed incorrectly then problems associated with friction, shaft and seal wear, noise, and leakage can be expected.

V-Ring seals are a critical part of the bearing design to keep the bearing contamination free; it is the first line of defence against airborne particles.

The V-ring is designed to run with the lip sitting against the sealing plate, figure 1a shows the correct way where the collar allows the V-ring to slide into the bearing housing enough so that any dirt does not drop into the V of the seal. It is also a guide in telling you when you have pushed the V-ring up against the sealing plate.

General rules for installation

1. The V-ring, the V-ring seal plate and the shaft must be clean.
2. The shaft must be dry and free from grease or oil, particularly when the V-ring is mounted without axial support.
3. The face of the seal plate must be lubricated with a thin film of grease this allows for a good seal between the v-ring and seal plate.
4. Ensure that the V-ring is mounted with a uniform stretch around the shaft.
5. Push the V-Ring along the shaft evenly until the seal slides into the plummer block. Stop pushing the seal once the straight edge of the rubber is level with the

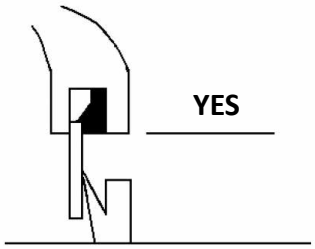


Fig. 1a

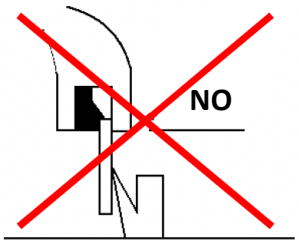


Fig. 1b

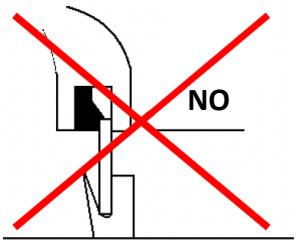


Fig. 1c

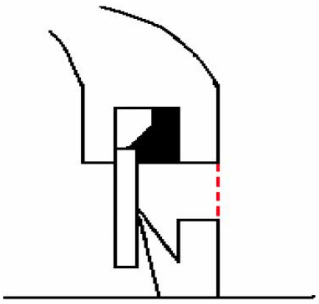


Fig. 2

Axially located using collar > 7 m/s < 12 m/s	
Speed	**Shaft diameter**
1000 RPM	110mm
1500 RPM	80mm
3000 RPM	35mm

Retaining Ring > 12 m/s	
Speed	**Shaft diameter**
1000 RPM	200mm
1500 RPM	140mm
3000 RPM	65mm

Article prepared by Rod Bennett.

plummer block. This is the indication that the V-ring tip is against the seal plate as figure 2 indicates with the red line.

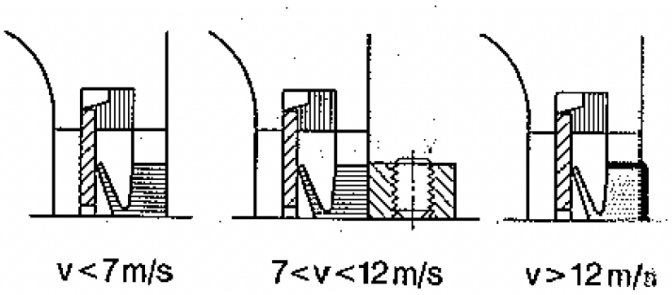
Precautions when nominating a V-Ring seal for a certain shaft speed.

V-ring seals can operate at up to 7m/s without the need for a retainer. When you get to speeds between 7 and 12 m/s then you require a lock collar to stop it from moving axially along the shaft. At speeds over 12 m/s you require a retaining ring so that the body of the V-Ring seal will not lift away from the shaft. Note that the speeds mentioned above are the linear speeds at the seal lip. The tables on page 10 give some general guidance on the maximum shaft diameter possible for a number of different linear speeds and RPMs.

For example, on a fan turning at 1500 RPM, a V-ring seal can be used without any retainer provided the shaft diameter is 80 mm or less. If the shaft diameter is between 80 and 140 mm the V-ring requires a collar. If the shaft diameter is greater than 140 mm, then a retaining ring is required.

Some storage precautions

In order to avoid deterioration of the material, the V-ring should be stored in a dust free and dry atmosphere. They must be kept in their original envelope, which should only be opened just before installation. Always repack V-rings after inspection. Do not drop V-rings on shelves or boxes, nor hang seals on hooks, wires or nails, since in either case the seal can be damaged. Avoid storage near sources of heat or near electrical equipment that may generate ozone. Also keep away direct sunlight. Avoid unnecessary compression of the lip during storage.



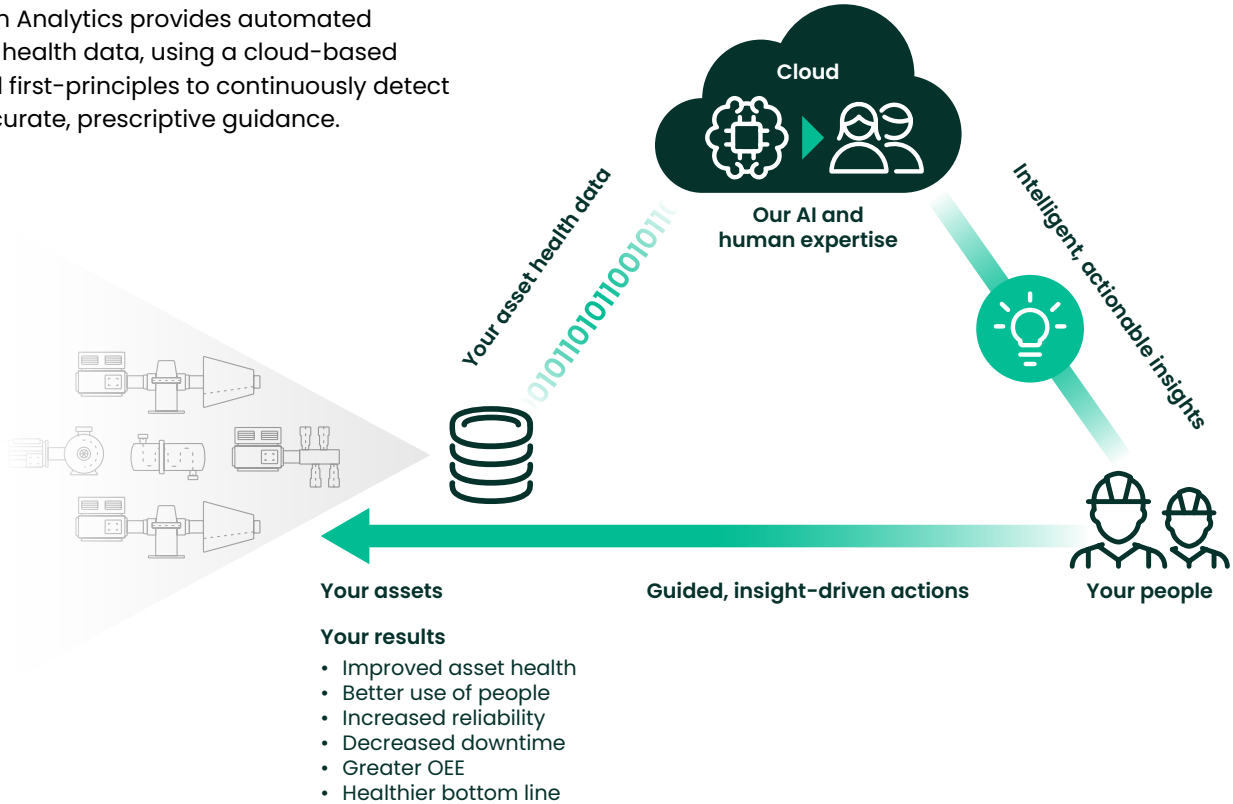
Courtesy of SKF.

Cordant™ Baker Hughes

Cordant™ Asset Health Analytics

What is it?

Cordant™ Asset Health Analytics provides automated analysis of your asset health data, using a cloud-based combination of AI and first-principles to continuously detect issues and deliver accurate, prescriptive guidance.



Your results

- Improved asset health
- Better use of people
- Increased reliability
- Decreased downtime
- Greater OEE
- Healthier bottom line

Why do I need it?

Cordant™ Asset Health Analytics addresses two things in short supply within most organizations: **time and expertise**. Even if you have the deep expertise to analyze data yourself, you rarely have the time.

Use your people to do the things **only they can do**.

Use powerful AI with our embedded expertise to offload the things **it can do for you**.

Baker Hughes

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The Cordant™ Analytics difference

With so many providers offering AI assistance—and so many customers embracing it—it's important you understand what makes our solution different. Here are six ways that Cordant™ Asset Health Analytics stands apart.

1 Unmatched domain expertise

AI is great at spotting anomalies, but most AI doesn't differ in its ability to diagnose problems. That's where deep subject matter expertise comes in: nobody is better equipped to tell you not just that **something is wrong**—but precisely **what it is** and **what to do about it**, answering the vital questions "**why** this happened and how can I prevent it from reoccurring?" We've embedded 60 years of know-how honed over tens of thousands of successful machinery diagnostic jobs into a solution that delivers unmatched results.

2 Unrivaled breadth

Cordant™ Asset Health Analytics can identify **more than 250 issues** and isn't limited to just **rotating equipment**—it is equally at home with the health of fixed assets like heat exchangers and valves.

3 The power of process data

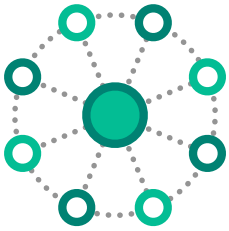
Most other solutions limit themselves to just vibration data or just process data. Cordant™ Asset Health Analytics uses both, enabling the **1+1=3 synergy** that spots more asset anomalies and delivers superior results. Whether you have only process data, or only vibration data, or both—our ability to mine **all available data** ensures maximum insights are extracted.

4 Provider agnostic

Many providers are limited to data generated by their own sensor ecosystem—but not Cordant™ Asset Health Analytics. Wherever your data comes from, we can use it. That means your **investment** in other providers' wireless IIoT, or wired systems doesn't have to be abandoned: **it is accessible** to Cordant™ Asset Health Analytics.

5 A true ecosystem

Managing assets is more than just the intelligence to extract insights. Cordant™ Asset Health Analytics is part of the Cordant™ **ecosystem** that can ingest data, store data, analyze data, and then deliver the case management and workflow tools you need to coordinate actions across your organization—allowing **collaboration** at scale. Our solution portfolio is also more than just asset health. The Cordant™ ecosystem encompasses asset strategy management, asset defect elimination, process optimization, emissions management, and more.



6 Here today. Here tomorrow.

AI is a crowded space, with dozens of providers. But will they be here tomorrow? **We will**. Our substantial size, longevity, and global footprint means that we're everywhere you are. We deliver results—just as we have for more than 60 years.

BakerHughes_Cordant_AssetHealthAnalytics_Infographic-PRINT-071625

Baker Hughes

bakerhughes.com/cordant

Cordant™

Product overview

Cordant™ Asset Strategy

Build, deploy, sustain optimal asset strategies to achieve a step change in performance.

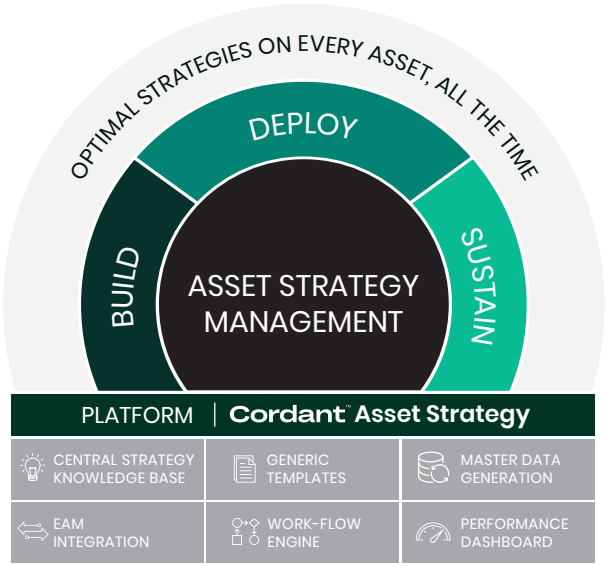
Cordant™ Asset Strategy is an Asset Strategy Management (ASM) platform that enables you to gain control and continuously improve the availability and reliability of assets, cost-optimize maintenance, and effectively manage risk to deliver performance.

Cordant™ Asset Strategy enables the three phases of ASM;

BUILD: Consolidate, structure and augment data to develop optimal asset strategies, fast.

DEPLOY: Connect asset strategies to your EAM system and rapidly deploy optimal strategies across all assets, anywhere.

SUSTAIN: Dynamic strategy management where strategies remain optimized over time for sustained performance improvement and to manage cost and risk.



Connect strategy to performance

Create a link between performance you see, maintenance plan Master Data in your EAM system, and the reliability analysis that supports it for continuous performance improvement.

Effectively manage risk

Gain control and governance over strategy execution, ensure maintenance tasks and intervals are not changed without oversight and justification, minimizing exposure to risk.

Reduce reactive maintenance

Your best strategies on all assets, across all sites, and data driven intelligence to evolve asset strategies, means less time in reactive maintenance mode.

Improve productivity through efficiencies

Centralization of strategy content and generic templates means not recreating the wheel time and time again. Reduce manual, laborious tasks and divert time to value adding activity.

Reduce operational & maintenance costs

When optimized strategies are applied to all assets, you spend less on reactive maintenance, ensure assets are not over maintained, and carry a lower risk, with fewer accidents.

Create data from experience

One platform to capture reliability content, allowing you to future-proof against workforce churn and leverage learnings organization wide.

Utilize global standard strategies

Develop and deploy best in class asset strategies, by asset type, while supporting local operating contexts.

Baker Hughes™

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FEATURE

Checklist for implementing an

Electrical Preventative Maintenance Programme

Electrical equipment failures especially motors account for nearly half of facilities downtime, and the difference between a poor Electrical Preventative Maintenance programme and an excellent one is approximately 12 times. See my blog: www.3phi-reliability.com/blog/electric-motors-failure

Failure rates from 1983 Electric Power Research Institute (EPRI) project performed by General Electric (GE) [1] where 4797 motors were evaluated with 1227 failures. State failure rates of Motors range from 9.3% to 0.8%, with an average of 3.4% per annum. My experience as a Motor Analyst suggests this is similar to all Electrical Assets (Circuit Breakers, Drives, Isolators, Cables and Terminations etc).

Even at the Average a facility with 500 motors that's an electrical failure every 21 days which if critical will take your plant down.

An Electrical Preventative Maintenance Programme is considered excellent if the failures rates are less than 1%, that's one failure every 2 Months.

Best Practice Motor Management can achieve failure rates well below 1% which means your facility can run without downtime between outages.

My question is as a Reliability Professional, what Is that acceptable failure limit to your enterprise?

Continued over page >

Article prepared by Mark Gurney, 3Phi Reliability.

Implementation & People
This is often overlooked in your Preventative Maintenance Programme and why your initiatives don't gain momentum and sustainability. Successful Implementation of your Electrical Preventative Programme pivots on good engagement of people.

The most important first step is gaining support from the customer (Usually the Owner or Executive) of your facility. Where do I focus, Where do we make the Profit, What is Critical. What is the current failure rate of the plant and can we improved on 0.8% failure rate?

Second is to research the current practices, What is being checked and How. Do you have the Skills & Resources to make a success?

Engagement: Armed with you data (Root Cause Analysis, downtime etc) engage you electrical team in a open non controversial manner to discuss the how you can move forward. After the initial discussion a subject matter expert may be engaged to provide "the how to" & "What".

Typical Problems: What are the problems in Implementing Electrical Preventative Maintenance, its a battlefield and nearly always time is precious. "The cry for resources is endless".

How do you free up time to start, when you know the efforts will result in less reactive work which frees up time. Reactive Maintenance is a vicious cycle which if not managed falls quickly back to attending Breakdowns.

Solution: An Electrical Preventative Maintenance Programme requires resourcing which you may think isn't available. A solution is to Examine exactly what your team is doing, are the current tasks adding to reliability. erg. That Calibration done weekly never drifts much so can it be monthly.

If Scoping of work is done well so your Electrician isn't spending hours in the storeroom, and When the job starts is it suitable for the Operations or does your skilled trade go and have another cup of tea. The reason you got your your executive engaged first is sometimes ironing these issues out requires their support. You don't need much wriggle room to make a start, a couple of these issues solved may give you a couple of hours per week. That's enough to start.

> "If you have a Champion, who is interested and keen to learn new skills and ways of doing work, your Electrical Preventative Maintenance will shine."

The Who: If you have a Champion, who is interested and keen to learn new skills and ways of doing work, your Electrical Preventative Maintenance will shine. If you spread the tasks too thinly you'll fail to get traction. You will need to invest in some skills even if it is a refresher this will support your Champion.

Tools: To ensure the Electrical Preventative Maintenance programme doesn't stall,the workshop needs a tool review, matching what you want to achieve. These might include a low range torque wrench 1 to 25Nm, Hydraulic Crimper, MilliOhm meter, Motor testing meter, and some decent hand tools like torque drivers.

Procedures: Procedures are important to for the smooth working of your Electrical Preventative Maintenance Programme, Is the Lock Out Tag Out process optimized

and taking longer than the planned job, is my Champion a competent electrical worker, what tests are you going to conduct and What are the expected defects to be identified. Will my procedure improve reliability?

Electrical Preventative Checklist

Visual: A visual check of you Electrical Assets is required annually, and the reason for this is most of the defects are detected by our eyes,feel,smell,ears, but not Taste (I'm not keen on licking electrical stuff).

What to look for visually in you Electrical Preventative Maintenance Programme varies tremendously between technicians, until a checklist is made and some skills transfer completed many potential defects are going to be missed. Checking the bottom nut on a motor termination for looseness is not often done, and is a common defect.

The reason why motor terminations aren't checked is because no has pointed out the problem and shown the technician it is a common problem. This is why a checklist is important to standardized your Electrical preventative maintenance programme, it ensures each technician is conducting the same quality of work.

There's a checklist within IEEE 1415:2006 but really only covers motors, **www.3Phi-Reliability.com/** has further developed this checklist and it is available on request for clients.

A good quality checklist should identify known common failure modes and can include:

1. PE (Protective Earths) should be not corroded or placed on painted surfaces. Visually follow the entire length for any high resistance defects.
2. Visually check for any exposed live conductors, eg. Cable damage from when conductors have been pulled through cabinet penetrations, excessive insulation tape is often a dead give away.
3. When first opening the cabinet take a smell of the enclosure. Capacitors often will vent, or visually the ends will dome when defective. Overheating of circuit breakers, poor terminations will have a plastic smell.
4. Separation of Supply and Drive Output cables often shown signs of blooming (White Powder or burning near terminations). Insulation tape that has gone brittle is also a indicator of degradation.
5. Dirt on the cooling fans exits of Drives is an indicator that the Cabinet filters are missing. Dirt within Drives is the most common failure mode as it causes tracking.
6. Drives fans need to be checked for airflow. Fan bearings have a finite life and should be checked regularly.
7. Cabinets exposed to vibration accelerates component failures especially in drives.
8. Cable strain either on Communications or Power terminations. Communication plugs not making a good connection because of cable strain or terminations were conductor strands are broken (Normally hidden under tape.

Cleaning: Do not attempt to clean an electrical cabinet with Compressed Air, the results can be disastrous as debris can lodge into Contactors, Circuit Breakers and Isolators. In my previous role a maintenance supervisor did this and afterwards came to me to advise other sites not to do it. Electrical Cabinets need to be clean, meaning filters regularly checked and changed.

Ensure doors are closed and seal correctly for the filter to work. One of the most common failures in drives is

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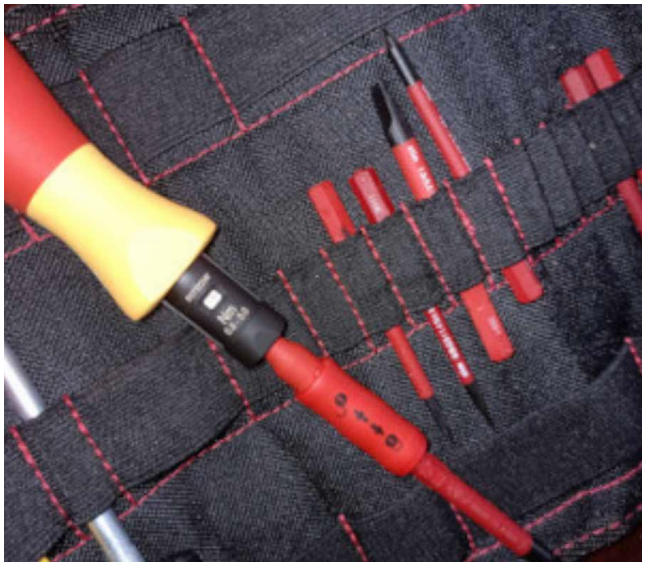

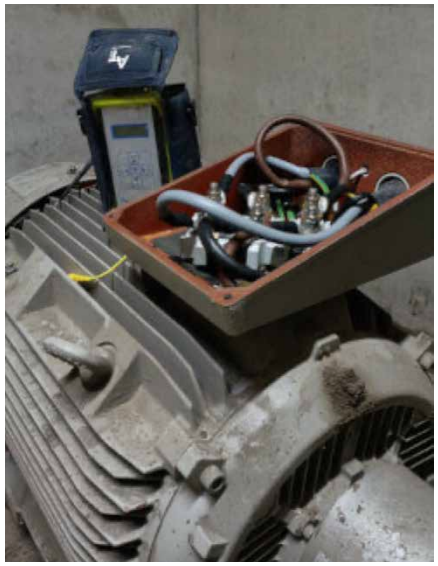

dirt buildup which impedes heat dissipation and can cause tracking especially around the IGBT's (switching components).

Removal of Insulation Tape: My experience tells me that Insulation tape is used to hide installation defects. If tape has become brittle be on the lookout for drive emission problems, high frequency currents degrade insulation and this tape is usually at the point where this current is trying to exit (Around terminations).

Testing of Electrical Equipment: What should be included in your Electrical Preventative Maintenance Schedule?
You should be targeting common failure modes which include:

- Isolators connections contacts and wear
- High Resistive Terminations at Motors Motor Insulation Quality
- Motor Winding degradation
- Circuit Breaker Contact degradation Contactor Wear
- High Resistance Screw Terminals Cable degradation
- Motor Rotor defects
- Drive Emission attack on Motors, Cables,and Terminations Earth Loop Impedance & R1 + R2 ensuring safe grounding.

Resistance Testing: On average 22% of Motor circuits have a resistive defect, and therefore this testing procedure is the most rewarding. The use of a Micro Ohm or MilliOhm meter from the Electrical Cabinet will identify imbalances in the entire circuit. When an imbalance of more than 3% is measured, the test is then repeated at the motor terminals. This method quickly identifies where the defect exists.

> **"If you spread the tasks too thinly you'll fail to get traction. You will need to invest in some skills even if it is a refresher this will support your champion."**

Resistance imbalances affect the voltages each winding receives and this greatly stresses the winding.

Motor sizes 75kW or above have resistances below 10 milliOhm therefore a micro Ohm meter is necessary to measure imbalances. As a guide these motors may have balanced resistances above 10 milliOhm but an opportunity exists to check all terminations. Often the termination practice has defects on all connections.

Panel Screw Terminals: Why is connections in Electrical panels so important? Many preventative maintenance programmes check for tightness, but what is tight. The use of torque drivers set on an agreed setting enables monitoring. If a known tightness screw becomes loose this should be noted on the Work Order for followup.

It is very common on the first scheduled work to find 50% plus connections loose.

Impedance Testing: Impedance determines how much current will flow in each winding, and in turn create magnetic flux which drives the mechanical function of the motor.

This magnetic flux needs to be balanced for the motor to operate efficiently. A imbalance above 3% means your motor is likely not to meet energy efficiency requirements that are regulated in many countries. If your motor circuit is balanced <3% impedance imbalance and you measure a current imbalance when the motor runs this suggests you have a drive defect or supply problem.

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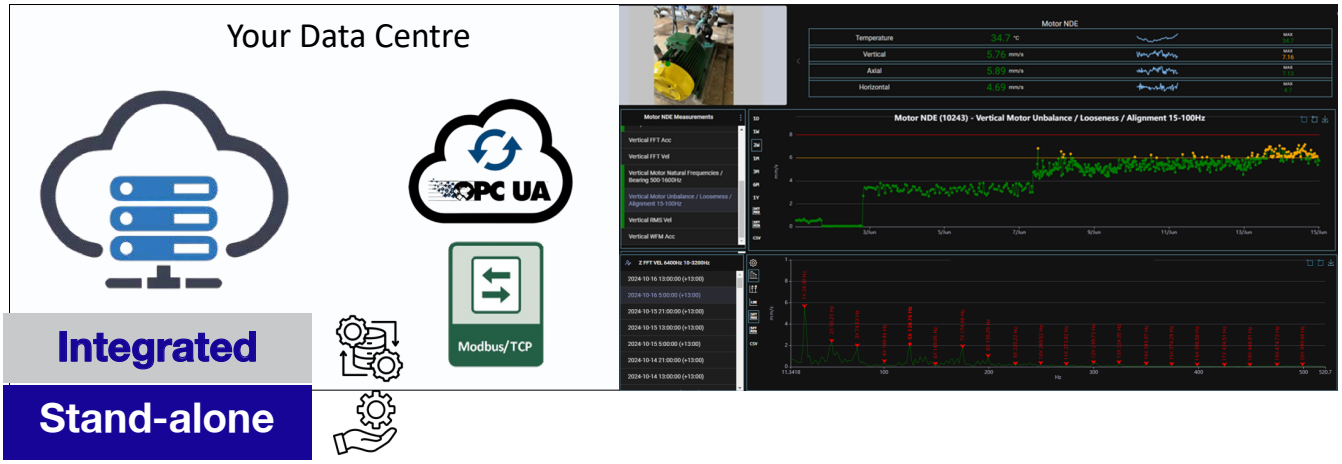
The Complete Wireless Solution for Machine Predictive Maintenance



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Note: When measuring variable speed drive current, a meter is needed with a low pass filter and ability to measure at the operating frequency. Standard current clamps do not have this function. Measuring Motor In Rush current on each phase under starting conditions often amplifies a defect and makes it easier to detect.

Winding Testing: The most common winding test is surge testing, unfortunately the instrument is quite bulky and expensive. There is an alternative which uses a stepped frequency method validated under IEEE standards. This portable battery operated instrument makes testing very efficient. The total test takes less than 3 minutes and are fraction of the cost.

A winding test enables the condition of the coil and insulation to be assessed long before an Insulation Resistance picks up a change. Most winding defects develop while staying above 500 megaOhm phase to ground. This winding test is the electrical equivalent of Vibration Analysis and compliment each other in a predictive maintenance programme.

Insulation Resistance: This is a well known test for electrical workers and determines if a circuit is near failure.
A slightly earlier method is to measure phase to phase without the link connected. See **www.3phi-reliability.com/blog/using- a-megger-as-a-predictive-tool**

3Phi Reliability recommend limits of circuits that are:
1. Trending below 100 MegaOhm
2. Absolute limit of 40 MegaOhm.

Thermal Image: What are the limitations of Thermography?
1. You must stand in front of a board while its Live, that has risks.
2. The heat emitted is a function of I^2R losses, so that means the load needs to be relatively high, that has risks.
3. Many of the connections in a circuit are hidden or have limited access. eg. Isolators, Motor Terminations, Cable joins in conduit.

While Thermography is a good tool for detecting hot spots in Motors, Mechanical defects, and Process problems Resistance Testing is far more effective in detecting the Electrical Circuit defects. Arguments around infra Red windows can be installed but I've never seen one on a motor or Isolator.

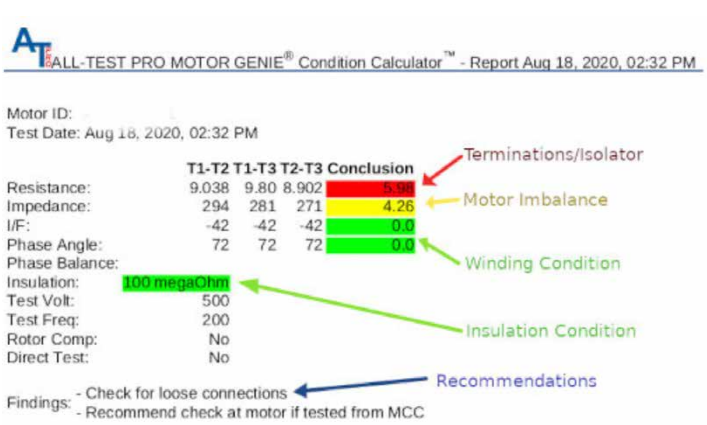
Asset Strategy: How often should Electrical Equipment be checked? The regulatory requirement for Industrial facilities is a three year schedule. When first implementing an Electrical Preventative Maintenance Programme you are likely to be in a reactive style of work, with majority of technicians attending breakdowns. You haven't time to wait three years!

The recommended solution is to target larger critical Motor systems that are on drives. Data shows 37% of Motors are on Drives but account for 82% of winding defects.
Then Star Delta Starters where high starting exist, and then motors with a high number of starts. Alternatively during your next outage get the assistance of **www.3phi-reliability.com/** to test your total site while its available for testing.

Reporting and Remedial Work: Why is it so essential to report your Electrical Preventative Maintenance measurements?
1. It is a regulatory requirement to show proof of the Preventative Maintenance Programme.
2. When your programme has matured and showing results your facility may wish to seek re rating of the Insurance Risk. This can have significant financial reward for good work. An Audited programme requires each test to be date and time stamped. An Electrical Preventative Maintenance Programme often reduces the ignition risk and that is the basis of Insurance re rating.
3. Recording the measurements allows for monitoring, if you find a defect you want to be able to go into the history showing previous tests of that same circuit and see if a change has occurred.

Analysis: Why will Your customer (Owner or Executive) be very interested to know "What are the numbers" and results of the Electrical Preventative Maintenance Programme?
1. Is it worth spending the Resources on this work?
2. Has there been a reduction in failure rates?
3. Where do we rank with failure rates, are we below 0.8% per annum.
4. How can we improve?

Lastly a documented Electrical Preventative Maintenance Programme that you have implemented is a great achievement and should be front and center on your CV. ■



FEATURE

Steam turbine blade breakage –

Maintenance and Monitoring Challenge Part 2

Repair

The IP was not repairable in the short term as this would require extensive re-blading of both the rotor and the stationary blade diaphragms. No spare blades were available, and the original manufacturer is no longer in business.

The only real option considering the time constraints was to use the Unit 3 IP turbine as a spare part (Figure 7) to replace the defective Unit 2 IP section. In fact, there were much less running hours on Unit 3 than Unit 2. To save time, the decision was made to undertake the move without opening the IP section to inspect it, and without lifting the Unit 2 HP turbine section lid for the installation.

Results

The defective Unit 2 IP turbine section was successfully replaced by the Unit 3 spare IP section, and testing was done immediately after, as shown in Figure 8 (over page).

The unit was successfully put back into service relatively quickly, considering the time pressure and the limited component repair options. There were, however, lessons learned:

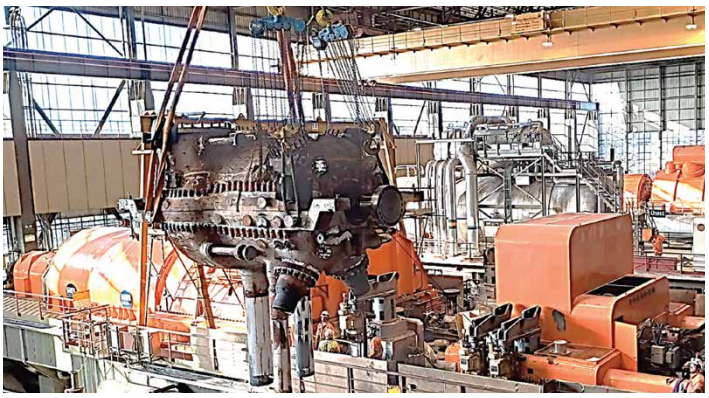


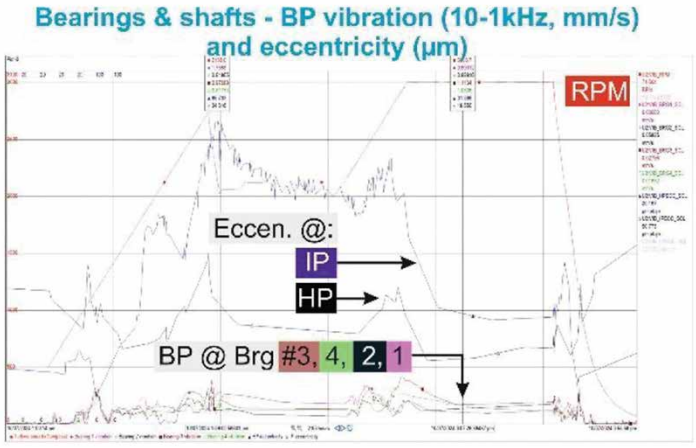
Figure 7. Unit 3 IP turbine section being moved to replace the Unit 2 IP section.

- Import more data to control room and modify restrictions - The vibration data visible to the operators in the control room was not sufficient for evaluating if the unit should be manually shut down or not. If it were not for the quick action of the Operator and Predictive Maintenance Engineer, Unit 2 would have been allowed to operate further until more damage occurred. The problem: 1X velocity was in alarm but not visible to the

Continued over page >

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

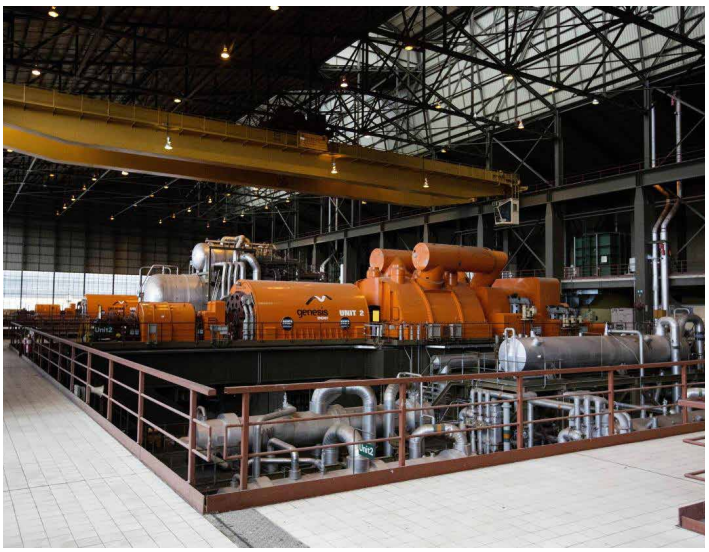
Figure 8 (right). DCS plot during runup showing HP and IP turbine section BP vibration and eccentricity after replacing the defective IP section. The IP shaft eccentricity, 31.396 µm, is much lower than before (56.60 µm). The BP vibration (0.069 to 1.113 mm/s) is also much lower than before (5.604 to 6.540 mm/s).



operators, 1X displacement data wasn't visible either in the DCS, BP velocity was visible but was not in an alarm mode, and eccentricity, which proved to accurately detect and localize the condition, was not displayed in the control room after 600 RPM. This has been changed following the event. Eccentricity, which also acts as a type of backup to the 1X displacement data, now displays continuously on the DCS trends (the 600 RPM limit have been removed on all units). The 1X and 2X alarms will be set up to trip Unit 2, but this will be done using the state monitoring functionality in SETPOINT, when this system is installed as described further on.

- Optimize diagnostics - Although only the IP turbine section had broken blades, this condition also affected the HP section vibration levels, so for this reason, multiple measurements are needed to isolate the problem.

  For detecting blade breakage in the turbine section, it was demonstrated that eccentricity (and 1X displacement) provided the most reliable measurement for detection and pinpointing the location. For this reason, eccentricity has been enabled in the DCS for all speeds on all units. Conversely, the 1X velocity values



can be a bit misleading in the diagnostics because two of the missing blade packages were actually opposite each other, thus cancelling out some of the imbalance effects, so this has to be taken into consideration in similar future issues.

- Limitations to the monitoring system - The Compass system only stores time waveform and spectral data at user defined time intervals, so important diagnostic information could be missing at specific events outside these time intervals. It is possible that the Unit 2 event would have shown up as a time waveform change which could have been missed.

  Other limitations include data that that is reduced in resolution over time, but this was partially resolved in this case story, in the case of eccentricity. If the 1X displacement data is not available due to a reduction in resolution, then eccentricity can be used as a backup in the Compass system, and vice versa.

- Future monitoring considerations - Blade cracking can be monitored to a limited degree by blade tip timing probes, but for the Huntly units, this was deemed not applicable as the HP and IP blades are shrouded.

Full NDT inspection, which includes shroud and tenon crack testing and repair is being undertaken on all HP and IP rotors which have extended running hours. The SETPOINT system (Figure 1) is currently being installed for Unit 2 to replace the legacy system to resolve its limitations (eventually it will be done for all units):

- Time waveforms are saved based on events, not just on time-based intervals as is done in Compass. Orbit and spectrum analysis can then be done for that specific event
- Data is directly stored in the PI system
- State-based monitoring with acceptance region monitoring and alarms
- Full spectrum for more reliable rub diagnostics
- Programmable relay voting logic
- Detailed alarm, relay and event logging.

> **It is possible that the Unit 2 event would have shown up as a time waveform change which could have been missed.**

Conclusion

Up until now, Unit 2 has been fully operational without problems since the repair, and this is expected to continue with the changes that have been made. Although the event described in this case study was resolved quickly and successfully, there are many other thermal power stations in the world with aging turbo-generating units that could break down under similar conditions, but with a higher risk of extended downtime if there are no spares available.

The maintenance considerations that have to be taken to avoid this are unique for every power plant, but regardless of this, one point is very important, it is vital that there is effective machine protection, condition monitoring and diagnostic tools implemented for watching over the aging units. ■

FEATURE

PART. II

MAKING SENSE OF YOUR LAB REPORT

Understanding your Oil Analysis

If you are using oil as a lubricant on your site and it has been decided that it needs to be tested if an issue is suspected, you will receive a report back from the laboratory. This report will display results from various tests performed. Our aim is to understand these results and what we can do to remedy the situation.

What tests are performed

Depending on the laboratory that you use there are different tests performed that will help identify potential issues in the oil. These tests might include:

- Elemental analysis - This will display the elements of the periodic table with the units of PPM or parts per million.
- Ferromagnetic analysis - This test is used to detect metal or steel parts that are large and likely indicate major wear. This test produces an indicator PQ or particle quantifier that indicates the amount of iron detected in the sample.
- Infrared analysis - for detecting soot or oxidation of the oil.
- Particle counting - Using the ISO 4406 coding system to indicate the oil cleanliness or quantity of particles detected of certain sizes.
- Titration analysis - This is used to determine the concentration of a dissolved substance like water using the Karl Fischer method. This method is also used for TAN total acid number or TBN total base number.
- Viscosity - This test is the most important for effective lubrication and measures the viscosity at a specific temperature, usually at 40 degrees C or 100 degrees C.

Your site can implement acceptable limits for each of the tests that would deem the oil fit for purpose or unacceptable in its current state. These are also often called condemning limits. Once a sample is found to be unacceptable, an action is needed to rectify the situation. Let's look into some of these tests to discuss why we test, what would cause the undesirable state and what action we can take.

Article prepared by Rico Van Niekerk.

Viscosity

This is the most important test result to look at. Oil viscosity maintains the oil film thickness, or the distance between metal surfaces. These have tight tolerances usually between ±10% variation of the baseline sample. Sudden increases can be caused by incorrect oil being added and an upward or downward trend can indicate oil degradation.

Possible cause: Incorrect oil added, oil degradation over time, water in oil.

Proposed action: Replace the oil if this falls outside the tolerances.

Water content

Water is an oil killer! If excess water is detected in the oil, action is required immediately. If your oil is looking milky or opaque, there is no need to test/sample, as this is indicative of excessive water content, please change the oil. Karl Fischer is the most widely used and accurate technique to measure an absolute quantity of water present. The crackle test(a drop of oil on a hot plate) is a lot less accurate and more of a rough indicator of small or large quantities of water present.

> **Water is an oil killer! If excess water is detected in the oil, action is required immediately.**

Possible cause: Seal leak, aggressive washdown, improper oil sampling.

Proposed action: Change the oil for new oil. Ensure flushing/cleaning is carried out to ensure all water content is removed.

Additives

There are various additives that can be added to oil to improve efficacy such as: coating the metal surfaces (EP additives in gear oil), oxidation inhibitors, anti-foaming and viscosity improvers. Ask your supplier for the specific additive package for your oils. These levels can trend up and down often as oil is changed or significant top ups occur. The ideal is to maintain your additives within allowable limits to ensure they still perform their tasks and are available to the system.

Possible cause: Sudden shifts in additives is likely caused by top ups or oil changes. Additives deplete over time and with regular sampling the appropriate time can be scheduled for oil replacement.

Proposed action: Once additives are depleted an oil change is recommended. Top ups will also have a positive effect.

Oil cleanliness

Clean oil keeps equipment healthy! Oil cleanliness is predominantly measured with ISO 4406 and indicates the amount of particles larger than 4µ/6µ/14µ. Thus it shows quantities of smaller and larger particles in the oil. This is one of the oil attributes that can be influenced and improved even before it enters the equipment. Maintaining cleanliness starts at the point of delivery, as newly supplied oil. Storage and handling also needs to be kept clean to ensure the oil within the system stays clean and when cleanliness deteriorates within the equipment it can be indicative of leaks or ingress.

Possible cause: Leaks or seal wear. Incorrect sampling or oil handling.

Proposed action: Filtering large capacity systems or changing oil if necessary.

Continued over page >

Dirt or Dust
Silicon (Si) levels are usually an indicator of dirt in the oil and is externally introduced. (Si can be an anti-foaming agent, so ensure you check your baseline sample. It can also indicate seal wear for certain seal types)

Possible cause: Incorrect sampling (like placing the lid on a dirty machine or floor when topping up), improper lubrication storage and handling, dirty machines by wiping the machine with a cloth when the lid is open.
Proposed action: Particles can be filtered out of the oil. If it's a small capacity system, replacing the oil will be easier. Avoid running continuously without action as sand particles are harder than metal and can cause wear or indents on bearings and gears.

Metal particles or PQ
Detection of metal particles in oil can indicate two issues. Firstly it indicates the presence of wear within your equipment or system. This is likely bearing or gear wear or similar parts. Secondly, the presence of metal particles presents a risk to the equipment. These particles will cycle through the bearings and parts with tight tolerances and are likely to cause damage.

In special circumstances you can ask the lab to check the shape and size of metal pieces with a microscope to determine the type of failure mode occurring and on which equipment by determining the shape of the metal, e.g. cutting, spheres, sliding rubbing etc.

Possible cause: Wear on the metal parts or in rare cases contamination.
Proposed action: Filter or replace the oil. Ensure the source of the metal is identified and understood to avoid failure.

TAN/Oxidation
The total acid number represents the acidity of the oil and is an indication of the oxidation that occurs within the oil. This can be affected by water in the oil and excessive temperatures. This is often accompanied by a burnt smell.

Possible cause: Thermal event, water in oil.
Proposed action: Change the oil as this is the only cost effective way to reset your TAN.

Wear Metals
Wear metals like Iron (Fe), Tin (Sn), Lead (Pb), Copper (Cu), Chromium (Cr) will be reported as PPM. These will indicate where the wear within the system is taking place in order to repair the machine. Bearings often produce Iron as spalling occurs while Copper and Tin can indicate bearing cage wear as an example.

Possible cause: Wear within the equipment.
Proposed action: Determine the cause and location of the wear and rectify. An oil change may be required if the values are excessive.

VI
Viscosity improvers or modifiers are added polymers used to improve the viscosity of the lubricant over the temperature range for that oil. This can be thought of as polymer strings within the oil maintaining the viscosity at high and lower temperatures. Specific machines can wear VIs more than others, like gears as an example, which cut the polymers strings and over time they have less of an effect.

Proposed action:Over time with wear VIs can be less effective and will require an oil change. Significant top ups also add these and will prolong oil life.
Important to note.

Oil Compatibility
Compatibility of oils is when two oils can be mixed together without affecting the effectiveness of the oil. Though compatibility is not tested for, this is definitely something to check at every sample analysis due to the high likelihood and high consequence of adding incorrect and/or incompatible oils. This can cause solids to form within the machine and more importantly radically affect the viscosity resulting in rapid failure. The easiest ways to spot when two different oils are present is by a sudden change in viscosity since the last test, or an additive package change (drop in known additives and increase in another type).

Possible cause: Top up of incorrect oil, oils used during shipping and site are different, residual oil after maintenance.
Proposed action: Change the oil and ensure proper cleaning or flushing before start up.

TIP: Only keep oils on site that are compatible if possible. If this is unavoidable, colour code the oil lids or the entire container with the immiscible oils to avoid confusion.

Oil level
Though not on the lab report, the oil level within the equipment is still one of the most important, and easiest, attributes to keep correct. Ensure the oil is maintained at the correct levels to keep lubrication effective.

Possible cause: Oil leaks, seal wear.
Proposed action: Top up oil.

Summary
These are some of the laboratory results that you will likely see on the report. Hopefully you have some more insight into the meaning of some of the reported values and can determine the possible causes and necessary actions to take to ensure prolonged equipment life. ■

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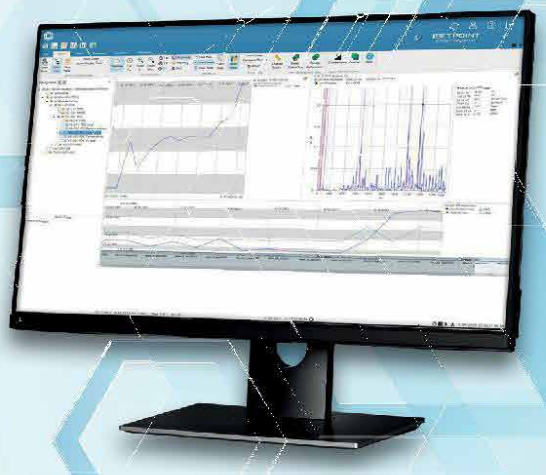

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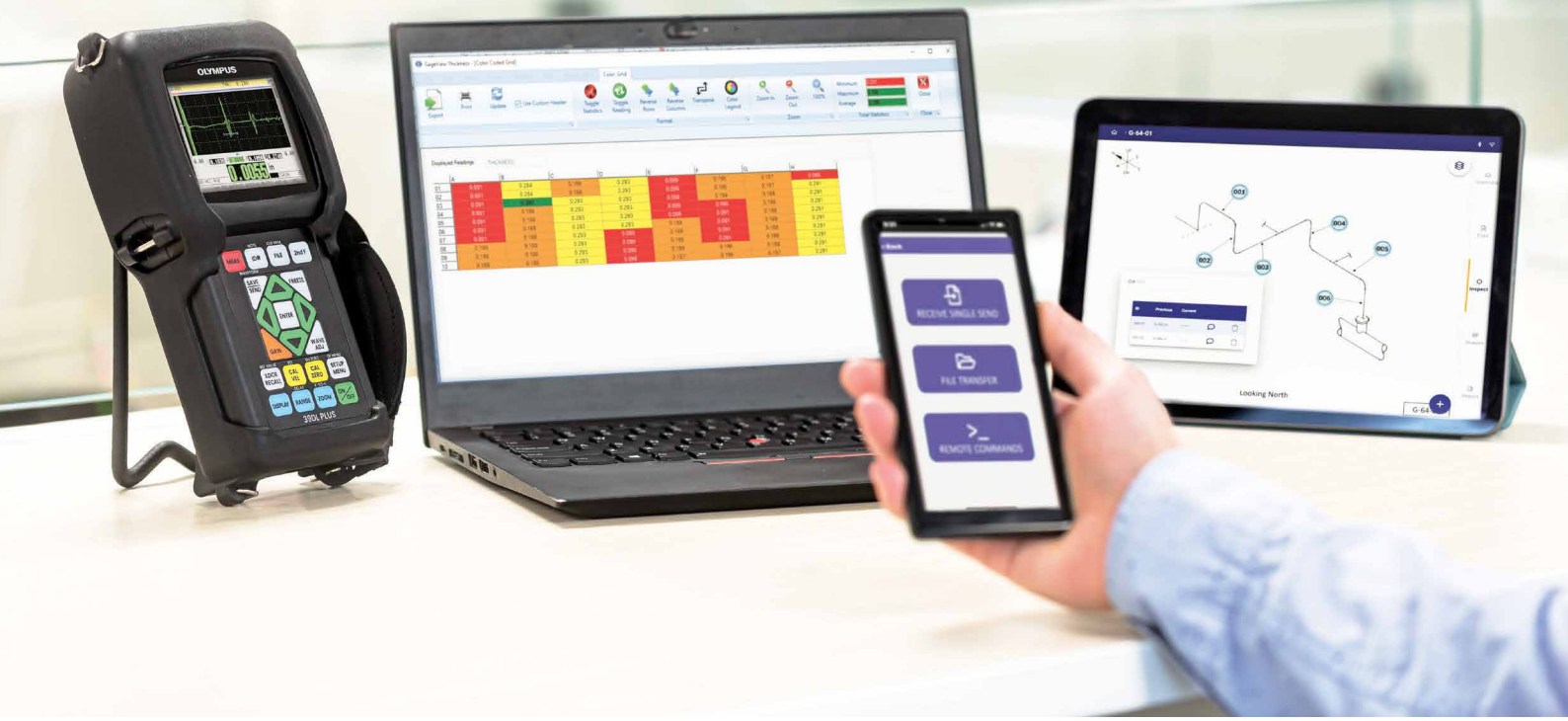

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PUZZLE CORNER

Solutions on page 36

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 | 20 - Very Good | 24+ - Excellent

A	R	W	M	R	E

There's 28 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.

1 HERB
2
3
4
5
6 SAGE

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**

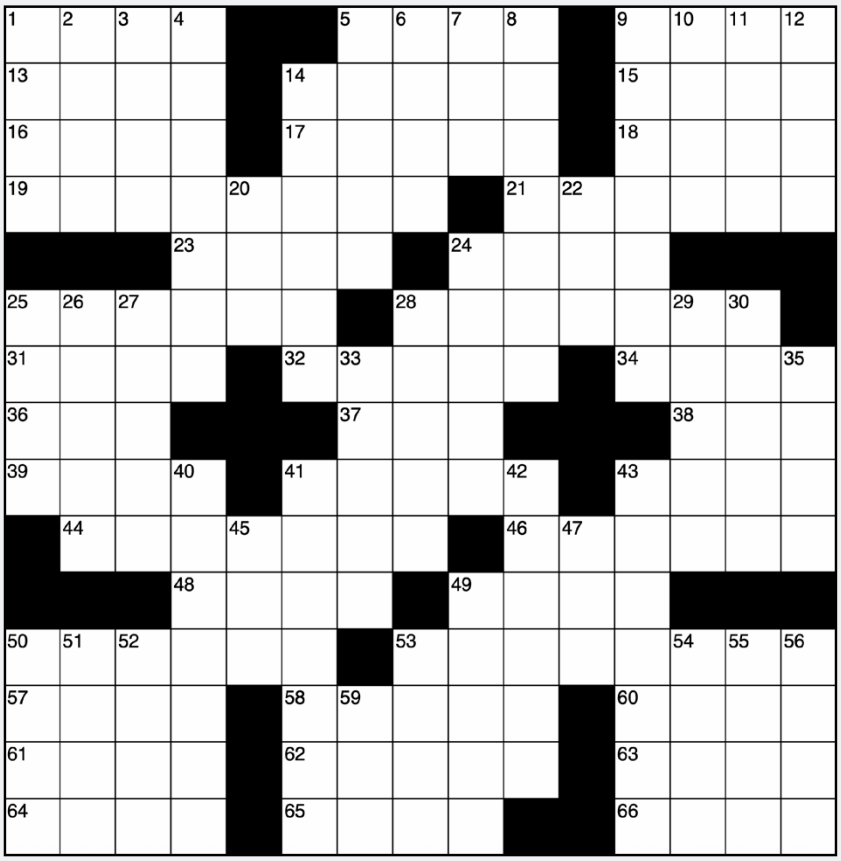
No number can be repeated twice in a box, row or column. Difficulty: **Real Hard**

Only 57.2% of puzzlers can solve this. Can you?

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

BONUS HOLIDAY CROSSWORD

Have a crack at our bonus **'Spring themed'** holiday crossword puzzle below.
Clues for ACROSS and DOWN are supplied. (_,_) refers to the answer being two words.



ACROSS

1 Time periods
5 Balmy
9 Shellfish
13 Setdown
14 City
15 Employ
16 Italian currency
17 Boredom
18 A cozy room (_,_)
19 Hide
21 Capital of the Bahamas
23 Toy flown in the air
24 Wading bird
25 Ailing
28 Revere
31 Origination
32 Furnish with an income
34 Deliver by post
36 Female sheep
37 Moray
38 __ Lanka
39 Remake
41 Crick
43 Speck
44 Musical
46 Chronicles
48 Not warm
49 Breeze
50 Hindu god
53 Airfoils on airplane wings
57 Negative *(prefix)*
58 Shekel
60 Fencing sword
61 Type of tea
62 Selfish desire
63 Buckle
64 Dozes
65 Aborts
66 Gap

DOWN

1 Women's magazine
2 Shower
3 Ventilates
4 Ate
5 Yard surrounder
6 Green Gables dweller
7 Promissory note
8 Colored arch in sky
9 Body
10 Caps
11 Region
12 Restaurant dinner listing
14 Docile
20 Lubricate
22 Cause of sickness
24 Heathen gods
25 Drug doer
26 Stairway post
27 Overgrown
28 Perfect
29 Saltine cracker brand
30 Register
33 Asian nation
35 Fades
40 Showy flowers
41 Flog
42 Sent
43 Actress Julie
45 Charged particle
47 Compass point
49 Misleads
50 Conceited
51 S.A. Indian
52 Tier
53 Bedroom furniture (_,_)
54 Opaque gem
55 Roman emperor
56 September *(abbr.)*
59 Vase

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TEST YOUR KNOWLEDGE - PART 81 OF A SERIES

1 When carrying out a balancing procedure, the balance runs generally have names attached to them. What sequence would you normally expect those runs to be in?

A. Reference Run, Trial run, Trim Run
B. Trial Run, Reference Run, Trim Run
C. Trim Run, Trial Run, Reference Run
D. Reference Run, Trim Run, Trial Run.

2 Reflective tape has been applied to a shaft in preparation for a balancing job to be undertaken outdoors. You set up an infrared phototach to obtain phase measurements with the sensor pointing directly at the tape from a distance of 300 mm, but good data is not obtained. Which of the following changes might you make to improve your chances of getting good phase data?

A. Move the phototach back to a distance of at least 2 metres from the shaft
B. Angle the phototach so that it is not tangential to the shaft, but is perhaps at an angle of 10 – 15 degrees
C. Place a 2nd piece of tape on the shaf
D. None of the above.

3 There are calculations available to provide a guide for a safe trial weight when balancing. The centrifugal force generated by a safe trial weight is often considered to be...

A. 1% of the weight of the rotor
B. 5 or 10% of the weight of the rotor depending on whether the rotor is flexible or rigid
C. 20% of the weight of the rotor
D. 25% of the weight of the rotor.

4 When conducting cross-channel phase analysis using a reference and a roving transducer, which of the following might be a good rule for the placement of the reference transducer?

A. The reference transducer should always be mounted horizontally
B. The reference transducer should always be mounted vertically
C. The reference transducer should be placed where the amplitude of the vibration you wish to measure is at its highest level on the structure
D. The reference transducer should be placed where the amplitude of the vibration you wish to measure is at its lowest level on the structure.

5 Two adjacent spindles are running at almost identical speeds. Just a single high-amplitude "1x" peak is showing in a spectrum collected from the structure. How can you determine which of the spindles is

A. Increase the frequency resolution of the spectrum until the single peak splits into two peaks and then attribute the vibration of each peak to each spindle based on accurate measurements of their speeds
B. Conduct time-synchronous averaging on each spindle in turn
C. Either A or B could be useful
D. Neither A or B will be useful.

6 When conducting in-situ balancing, which of the following might ensure you get good results?

A. Ensure that the transducers are not moved during the balancing process
B. Ensure that the phototach is not moved during the balancing process
C. Ensure that the machine is run up to the same speed throughout the balancing process
D. All of the above.

7 You are conducting route-based vibration data collection outdoors on a windy day. Your transducer cable is waving around in the breeze. Will this affect your measurement?

A. It's quite possible that the cable motion could generate low-frequency signal
B. It's quite possible that the cable motion could generate high-frequency signal
C. It's quite possible that the cable motion could generate signal at 50 Hz
D. The cable motion is unlikely to affect the measurement.

8 A motor drives a centrifugal pump via a coupling. You notice during a maintenance inspection that the keys on both coupling hubs are full-length – i.e. they both fill the entire length of the milled keyways. When mating the motor to the pump, what might be the best relative angular positioning of the two keyways?

A. The motor and pump keyways should be in-line with

TEST YOUR KNOWLEDGE

Further enquiries can be directed to: Carl Townsend at Carlton Technology Ltd.
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one-another

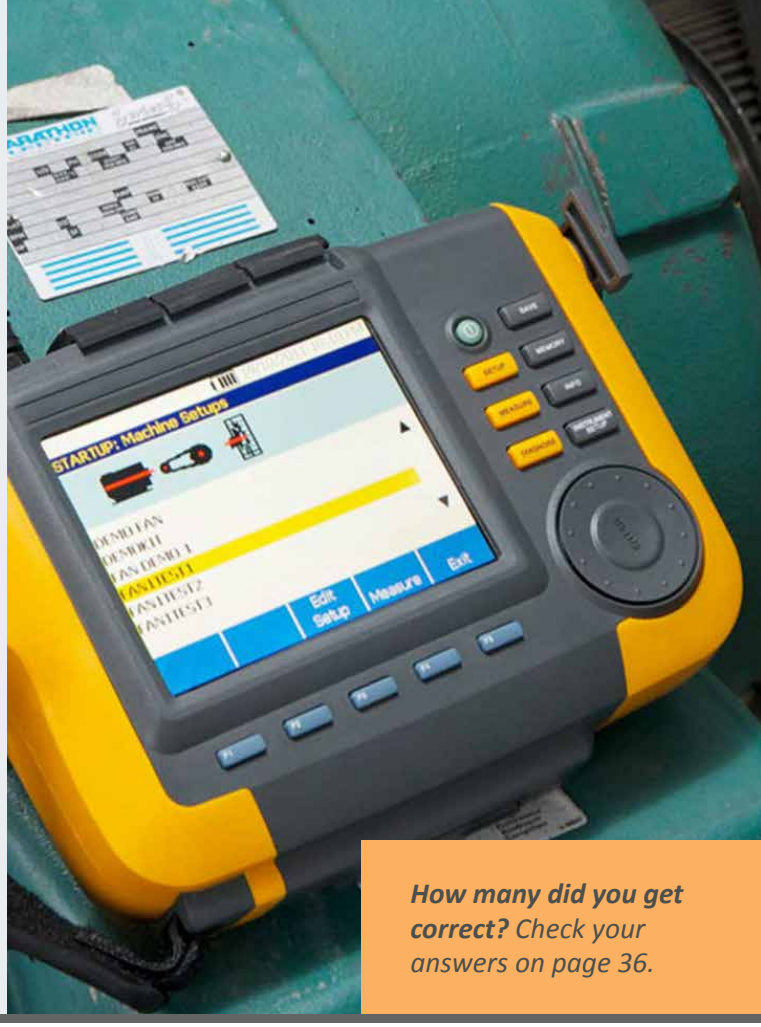
B. The motor and pump keyways should be off-set by 90 degrees from one-another
C. The motor and pump keyways should be off-set by 180 degrees from one-another
D. The angular positioning of the motor and pump keyways is not important.

9 A rotor is unbalanced, but when it is placed in frictionless bearings it does not consistently run to a heavy spot. What type of unbalance do you think the rotor has?

A. Static unbalance
B. Quasi-static unbalance
C. Couple unbalance
D. Could be A or B.

10 You wish to purchase a vibration analyser that can measure very low-amplitude signals in the presence of high-amplitude signals. Which of the following specifications would best achieve this?

A. 8-bit signal processing
B. 12-bit signal processing
C. 16-bit signal processing
D. 24-bit signal processing.



How many did you get correct? *Check your answers on page 36.*

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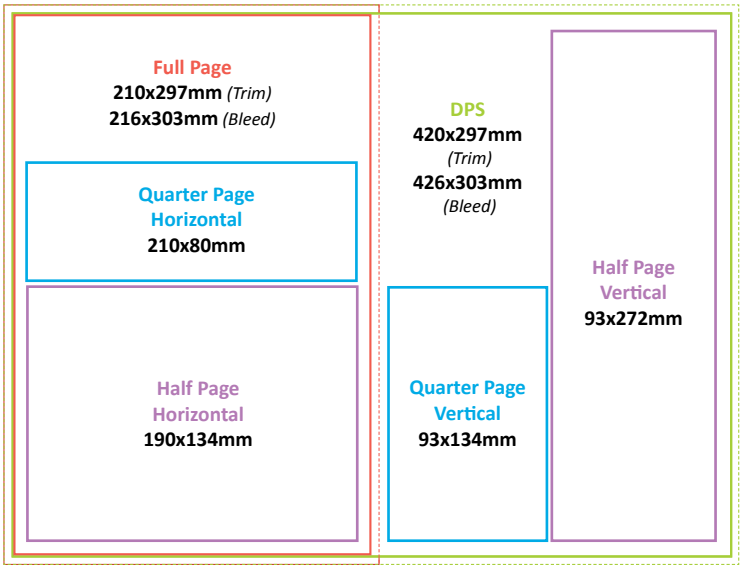

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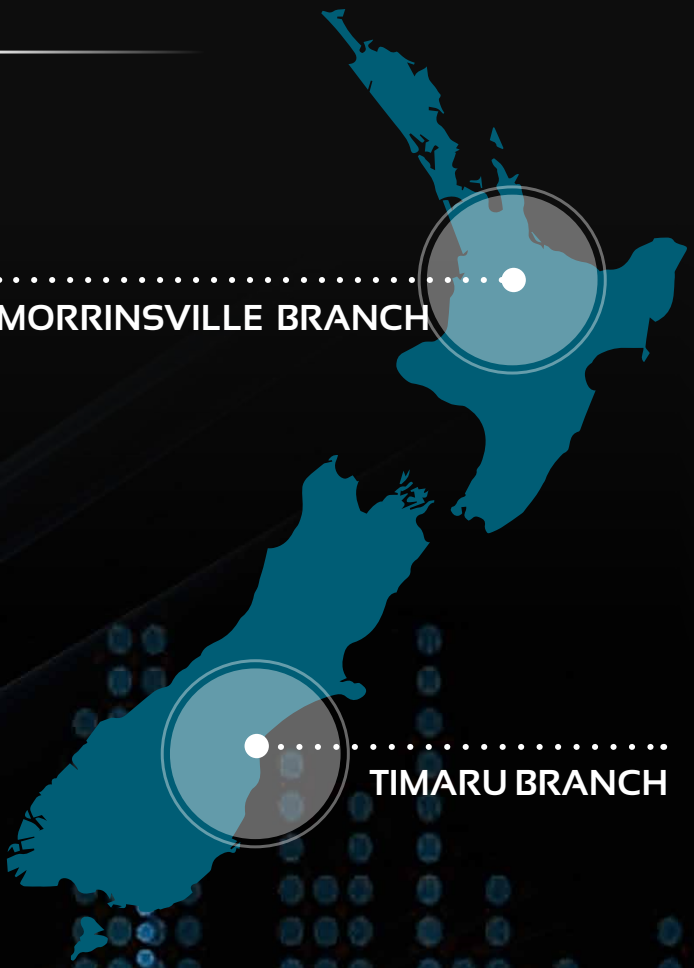
Carlton Technology Quiz 81
1A, 2B, 3B, 4C, 5C, 6D, 7A, 8C, 9C, 10D

Word Ladder: 1. HERB 2. HERE 3. HARE 4. HAKE 5. SAKE 6. SAGE

Word Builder: WARMER, REWARM

Bonus Holiday Crossword solution >

MBS



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