The official journal of the Vibrations Association of New Zealand

Spectrum

Summer 2022 | Issue 102

Monitoring makes sense

Conference 2022
Taupo date change!

See page 4–5 for details.

and...

Installation tips for...

Bearing adapter sleeves

+

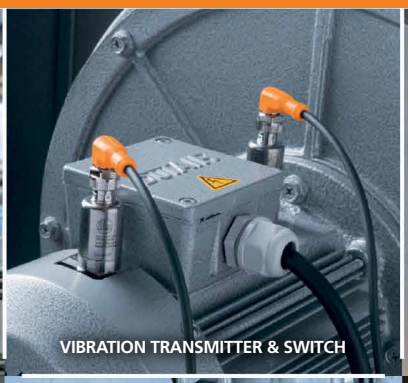
Critical engineering solutions

with more inside...

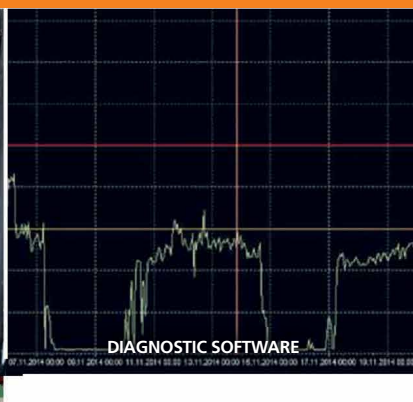
VANZ
VIBRATIONS ASSOCIATION of NEW ZEALAND

Machine Vibration & Plant Condition Monitoring Solutions


VIBRATION SENSORS


VIBRATION TRANSMITTER & SWITCH

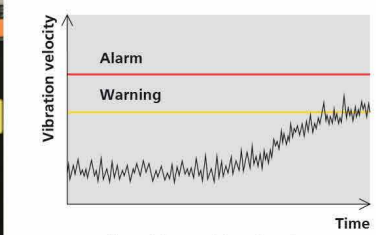

VIBRATION MONITORING & DIAGNOSTICS


DIAGNOSTIC SOFTWARE


VIBRATION SENSOR WITH MEMORY CAPACITY

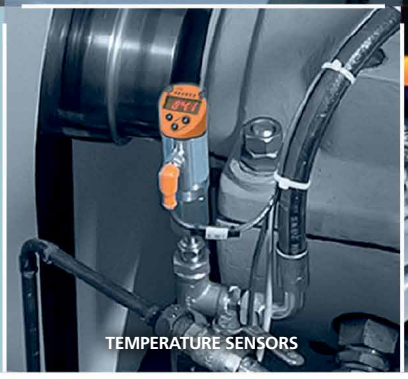

VIBRATION TRANSMITTER & SWITCH

VIBRATION MONITORING & DIAGNOSTICS



Trending of the machine vibrations to ISO 10816

GAS FLOW / TEMPERATURE / PRESSURE


TEMPERATURE SENSORS


FLOW / TEMPERATURE SENSORS


PRESSURE SENSORS

Looseness, unbalance

Misalignment

Rolling element bearing

Gearbox Meshing, tooth fault

Pump Eccentricity, cavitation

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PRESIDENTS' REPORT

By Rodney Bell, VANZ President

Greetings to you all, I hope you have all had a great break over the Christmas period. 2022 certainly feels better than 2021 and I feel confident it's this year we break through the difficulties of the worldwide Covid 19 pandemic. It has been a 'topsy-turvy' time as we risk manage our way through Covid variants. Let's continue to manage our way through these challenging times!

Due to the onset of Omicron variant, we have had to change our conference dates from mid-May to **August 16th, 17th & 18th.** Planning is going well for the VANZ 2022 Conference at the Wairakei Resort with CSE-W Arthur Fisher as the corporate sponsor. VANZ, a not-for-profit society, recognises and greatly appreciates the consideration and support from our principal sponsor CSE-W. Arthur Fisher and the Wairakei Resort venue management.

> **"Due to the onset of Omicron variant, we have had to change our conference dates from mid-May to August 16th, 17th & 18th."**

Conference keynote and Guest speakers are still being confirmed. As we work through the detail, we will update the VANZ website with this info. At this stage I thinks it's looking exciting, and I look forward to announcing these key people in due course. The VANZ website vanz.org.nz, will have Conference 2022 registration pages up and running for both Exhibitors and Delegates as soon as possible.

A call for papers for this year's Conference is necessary now, I remember my first paper and how nervous I was prior to presentation. But I also remember how great it felt to share some specific knowledge which also made for interesting chats with other CM technicians over a beer. Have a think about a machine that was behaving poorly and maybe still is, share this knowledge and you might be surprised.

As usual there is an award for the best first presenter and this year there will be several other prizes included. Don't hold back contact Simon Hurricks Simon.Hurricks@genesisenergy.co.nz or 021 681 361 to discuss and register your spot. For now, we should all continue to enjoy our New Zealand summer months, we will continue to update conference planning details as event transpire through our Spectrum magazine Epub [Feb and May] and our pre-conference print hard copy for delivery in early July.

Stay safe, wherever your travels may take you, and have some fun along the way! ■

EDITORS' CORNER

With the start of a new year we hope that things around the world continue to get better. A certain aspect of uncertainty still over-shadows us all as our normal way of life can become fragile and up-ended with the threat of another outbreak. However, our optimism and support of each other during this time needs to hold strong.

The committee are making plans to organise a conference at Wairakei again this year, hopefully this one won't be so abruptly disrupted. You can read more about this in Rodney Bell's President's Report and also keep an eye out for more details in the next issue.

In this issue you can puzzle your grey matter again with Carl's Quiz, read up on Rod Bennet's latest Skills & Practices and see what Barry Robinson from S.A.F.E Ltd has been doing with Critical Engineering Solutions.

VANZ greatly appreciates all those companies that are able to continue supporting us thru advertising, thank you. If you are in area that continues to be affected by Covid-19 then please, continue to take all the measures to practice public health and safety along with common sense hygiene guidelines, we cannot become complacent as it's up to everyone to help protect the vulnerable before they are lost to us. Take care of yourselves and each other and get your loved ones vaccinated so we're another step closer to eliminating this horrible scourge.

Happy reading! ■

IT'S BACK!

CONFERENCE'22

Condition Monitoring in a Changing World

COVID-19 may have been an unwelcomed guest in 2021, but we're back in 2022; better, stronger and safer than ever!

Register your interest online at www.vanz.org.nz today!

Together, let's make Conference'22 a smashing success!

Wairakei Resort, Taupo

NOW 16th, 17th and 18th August 2022

Apprentices/Trainees can take advantage of free Awareness Day Hands-On Training! Discounts may be available for to Delegates and Exhibitors that attended the Wairakei Resort 2021 Conference. Check website for details and updates.

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Bearing adaptor sleeves – Installation tips

Adapter sleeves provide a convenient way of installing a bearing on a shaft, but like all things, it has to be done properly if we are to avoid introducing a DEFECT into our machine. So, here are some tips to help make the task easier to get right.

1. Check the shaft diameter.
The shaft diameter must be within tolerance or else the adapter sleeve will not get a full grip on the shaft. The result is that the assembly will come loose and will have to be redone. It may also lead to failure of the shaft if it gets hot from the sleeve and shaft rotating on each other. *See example above.*

The tolerance for the shaft is h9. For example, on a 50mm shaft this is +0.0, -0.062 mm (or +0, – 2.5 thou.). So, remove any burrs and grime carefully but do not take to the shaft with emery cloth in an attempt to make it shiny and new. This is not necessary, and it doesn't take much before the shaft is undersize! If the shaft is undersize then it must be repaired or replaced, otherwise there will be ongoing bearing/ sleeve related problems.

2. When assembling the components, use a very light smear of never seize between the lock washer and the lock nut, and on the adapter sleeve thread. This will reduce the considerable effort required to tighten the adapter sleeve and set the clearance in the bearing *(see fig 1. right).*

3. When assembling the components, use a very light smear of oil between the sleeve O.D. and the bearing I.D. *(see fig 1. below.)* This will also reduce the considerable effort required to tighten the adapter sleeve and set the clearance in the bearing.

4. The O.D. of the shaft, and the I.D. of the Sleeve, must be kept dry *(see fig 1 below)* **in order to maximise the friction between the shaft and the I.D. of the sleeve.** To achieve this you must wipe the packaging oil from the I.D. of the sleeve.

5. The clearance must be set correctly in order to achieve 3 things.

1. To get the correct number of rolling elements in contact with the raceways. If the clearance is too high then the load is carried by fewer rolling elements and a lower bearing capacity (and life) results.
2. To get the adapter sleeve tight on the shaft.
3. To prevent overheating and failure of the Bearing due to insufficient operating clearance.

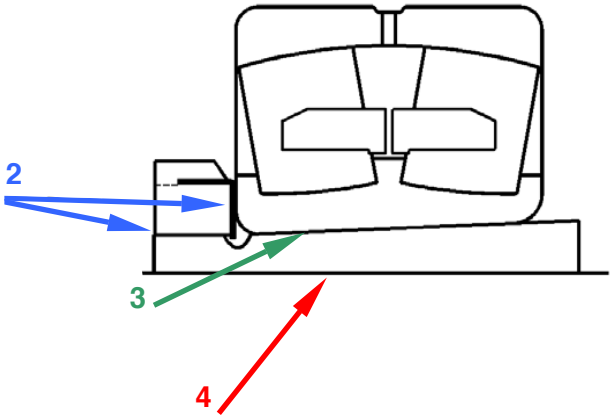
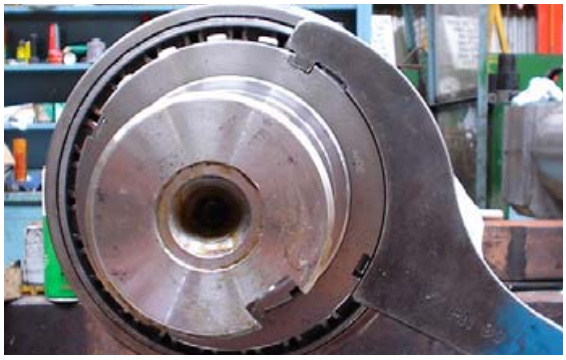


fig 1.



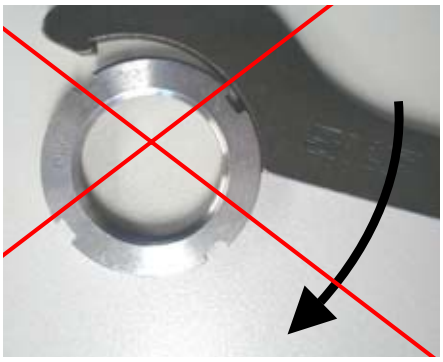


fig 2.

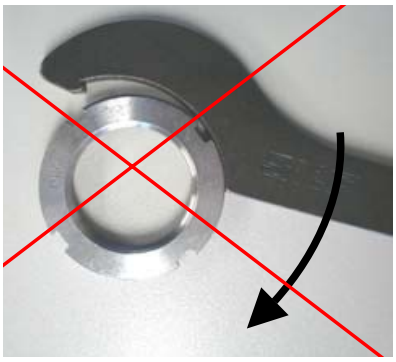


fig 3.

fig 4.

6. On spherical roller bearings, use a set of feeler gauges that is suitable for the task. i.e. one that has the correct range of thicknesses.
A suitable feeler gauge is available in the stores system. Material no. 10171447 is for a set of 20 blades from 0.03 to 0.5 mm. This set of blades is particularly good because they are 300 mm long. Alternatively, Kinchrome make a set of 32 blades ranging from 0.03 to 1.0mm, which is not in the stores system. The Kinchrome part no. for this set is 412092.

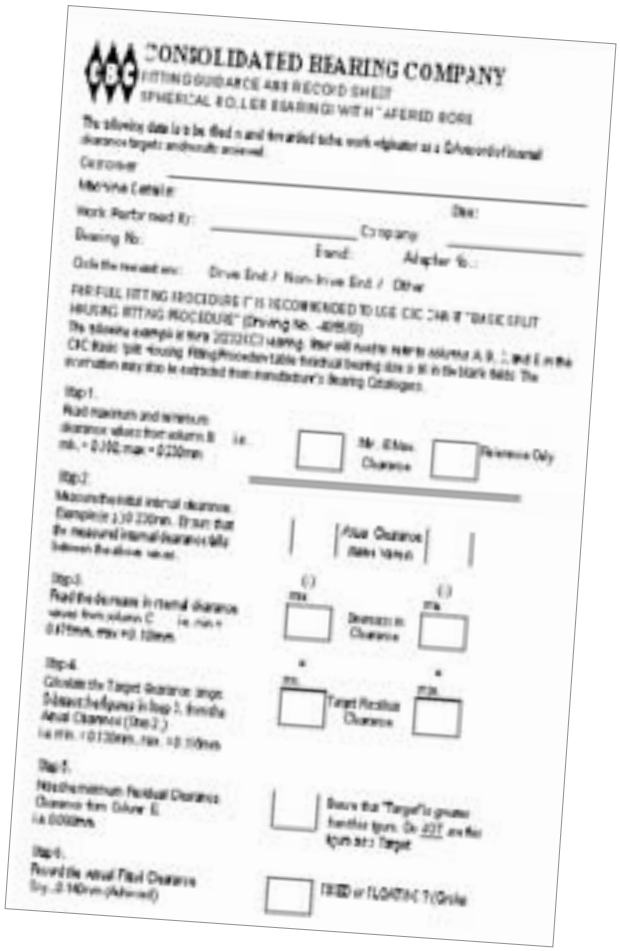
7. Use the correct tools for the job.
When tightening the lock nut, use a 'C' spanner of the correct size. A 'C' spanner gives you good, safe control over the tightening process.This picture *(top right)* shows a correctly sized 'C' spanner.

Note that the 'C' spanner size (HN30) matches the locknut size (AN30). These codes are stamped on the spanner and locknut.

The pictures above *(fig 2 and 3)* show how the 'C' spanner will slip if it is not the correct size for the job.

If you absolutely, positively can't get the right 'C' spanner for the job, use an angled key steel to tighten the lock nut as shown *(fig 4.)*. Do not use other materials as these may generate swarf that will contaminate and damage the bearing.

8. Follow the procedure and use the record sheet and clearance tables that are supplied with the bearing!


CONSOLIDATED BEARING COMPANY

Prepared by Bluescope Steel.

Are you a VANZ member?

You could be. Anyone with an interest in the area of mechanical and electrical machine condition monitoring, to facilitate predictive asset management is eligible to join VANZ. In-house technicians, consulting engineers, suppliers and distributors of specialised equipment, engineering students can all contribute and gain from membership.

Technology, materials and manufacturing processes are continually developing. And so too has the engineer skills and knowledge developed. Today the engineering role has evolved to where the analyst, by diligent use of multiple Condition Monitoring tools and principles, can empower Predictive Asset Management. But it is a challenging role! So much is at stake with the high cost of downtime, equipment replacement costs, and the potential safety risks. The future of the business can hinge on the Predictive Asset Management achieved by this special group of people. Yet detecting, diagnosing, and preventing these faults takes training, knowledge, skill and experience.That is why VANZ exists, and why VANZ constantly evolves!

> **Membership ranges from a business with a line of small water pumps to personnel from some of the largest plants running million dollar machines.**

VANZ recognises that the engineers who apply the technology are one half of the equation. Equally important are the industries and businesses served by it, with their varied experiences and evolving requirements. The size of the operation and the machinery it runs are not an issue either.

For Analysts and Predictive Asset Management specialists

VANZ is a volunteer-run, not-for-profit, membership group of like-minded people from New Zealand and Australia. VANZ as an organisation evolved from a Workshop Conference held in New Plymouth in 1989. From this Workshop Conference the Vibrations Association of New Zealand was registered as an Incorporated Society and the first annual technical conference held in Rotorua 1990. From this beginning VANZ has continually developed to provide a platform for people to discuss their challenges with their fellow analysts and learn from their peers and industry experts.

Annual conference for networking and learning

The core function of VANZ is the annual conference held every year in May. Like a family reunion, over 100 people gather in a friendly environment to participate in technical presentations, round-table discussions, and at times debate. Keynote speakers from Australia, Europe, America, and Turkey have, and continue to present technical papers at conference. And importantly New Zealand presenters add a New Zealand context.

VANZ is quite a unique society – it has withstood the 'test-of-time' – and has every year, for twenty-nine years run an Awareness Day training for apprentices and trainees. It is a reasonable 'track-record' which VANZ has consistently promoted for New Zealand and Australian industry.

GETTING IN TOUCH IS EASY...

For more information about membership, contact the VANZ secretary by emailing:

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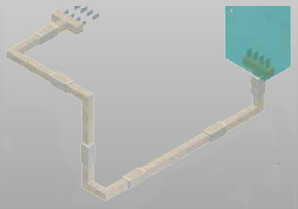

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Monitoring makes sense

Chris Hansford, Managing Director of Hansford Sensors, explains why it makes good business sense to protect automated production lines with vibration monitoring equipment.

Automation has become an essential tool for industry, delivering benefits that include increased productivity, consistent quality and cost reduction. Yet automation also brings a new set of challenges, as more and more companies become increasingly dependent on physical rather manual assets. In particular, machinery has to be constantly available – downtime costs money – which in turn places ever greater emphasis on the importance of effective maintenance.

Given the current economic climate, the challenges faced by manufacturers in 2012 – especially the pressures on operating costs ¬– look set to continue for the foreseeable future, so an effective maintenance strategy is critical.

Vibration monitoring is one of the key tools for plant and equipment maintenance, providing a reliable tool with which to maximise machine uptime. In some circumstances where vibration is carefully monitored it is also possible to extend operating life beyond recommended maintenance intervals, while in others a rapid increase in vibration must be taken seriously if a catastrophic failure is to be avoided. Automation, meanwhile, has become increasingly affordable for SMEs as well as larger operations but the investment still justifies a solid vibration monitoring regime to support it. Vibration is a common problem in machines across applications, sometimes resulting from misalignment of rotating equipment due to poor installation, sometimes the consequence of natural wear and tear. However, it is increasingly possible to reliably identify sources of wear with the use of vibration monitoring equipment.

Mounted in a number of key positions on mechanical equipment, vibration sensors offer the potential for continuous monitoring and analysis, an inexpensive option when balanced against the potential cost of downtime on an automated line, and when condition monitoring measures are in place to detect factors

Hansford Sensors Ltd specialise in the design and manufacture of accelerometers for monitoring vibration and temperature levels of industrial machinery, playing a key part in the role of predictive maintenance. Products include intrinsically safe models for approved use in Group I (Mining) and Group II (Petrochemical). Hansford Sensors Ltd also supply multi-sensor switch boxes, vibration sensor modules, portable vibration meters, accessories for sensors, vibration condition monitoring protection systems and custom built vibration sensors. Tel +44 (0) 1296 660080 I Web: www.4cm.co.uk I Email: info.hansford@4cm.co.uk

such as vibration, machine downtime can virtually be eliminated.

Accelerometers are typically easy to install and use but a little knowledge goes a long way so it is well worth pausing to consider what an accelerometer is in order to understand how it works and ultimately achieve the best possible installation and management of your vibration monitoring equipment.

Accelerometers contain a piezoelectric crystal element, which is bonded to a mass. When subjected to an accelerative force, the mass compresses the crystal, and this causes the crystal to produce an electrical signal that is proportional to the force applied. This output is then amplified and conditioned by inbuilt electronics to produce a signal that can be used by higher level data acquisition or control systems either 'online' or 'offline'. An online system is one that measures and analyses the output from sensors that interface directly with a PLC. An offline system is created by mounting sensors onto machinery and connecting them to a switch box; engineers can then use a hand-held data collector to collect readings.

For rotating machinery, vibration analysis has proved a convenient and highly effective method of measurement with which to assess machine condition.

The first thing to consider when specifying accelerometers is that there are two main categories: AC accelerometers and 4-20mA accelerometers. AC accelerometers are typically used with data collectors for monitoring the condition of higher value assets such as turbines, while 4-20mA components are commonly used with PLCs to measure lower value assets, such as motors, fans and pumps. Both AC and 4-20mA accelerometers can identify misalignment, bearing condition and imbalance, while AC versions offer the additional capability to detect gear defects, belt problems, looseness and cavitation. Hansford Sensors offers AC and 4-20mA accelerometers that are intrinsically safe, being ATEX and IEC Ex certified, and can be used to monitor vibration levels on pumps, motors, fans and all other types of rotating machinery.

Continued over page >

For rotating machinery, vibration analysis has proved a convenient and highly effective method of measurement with which to assess machine condition. Accelerometers can be easily mounted on casings to measure the vibrations of the casing and/or the radial and axial vibration of rotating shafts. A typical technique in vibration monitoring has been to examine the individual frequencies within the signal that correspond to certain mechanical components or types of malfunction, such as shaft imbalance or misalignment, so that analysis of this data can identify the location and nature of a given problem. A typical example would be a rolling-element bearing that exhibits increasing vibration signals at specific frequencies as wear increases.

Careful consideration must be given to issues such as the vibration level and frequency range to be measured, while environmental conditions, such as the temperature and presence of corrosive chemicals, will affect the specification. Once the most appropriate sensors have been selected it is important that advice is followed and care is taken during installation to ensure the maximum level of performance. For example, accelerometers should be located as close as possible to the source of vibration. Also, devices should be mounted onto a flat, smooth, unpainted surface, larger than the base of the accelerometer itself and this surface should be made free from grease and oil.

“Condition monitoring depends on stability and readings from a poorly mounted accelerometer may relate not only to a change in conditions but also to the instability of the sensor itself.”

Condition monitoring depends on stability and readings from a poorly mounted accelerometer may relate not only to a change in conditions but also to the instability of the sensor itself.

Once you have specified the right equipment and installed carefully in order to yield the most repeatable and consistent measurements, machine reliability data can easily be analysed to predict potential problems before they occur. Increases in vibration indicate deteriorating operating conditions, such as wear or misalignment, and vibration sensors can identify these changes swiftly and with exceptional reliability.

The massive potential for these tools to benefit the engineering industry has dramatically increased demand, which, in turn, has driven the manufacturers of vibration monitoring devices to enhance and adapt their products to suit a broadening range of industries and specifications, resulting in accelerometers that are increasingly easy to install and use.

Far from being an expensive option, the use of vibration monitoring can enable companies to operate with enhanced performance and increased flexibility, both vital attributes at a time when industry is coming under increasing pressure to boost productivity and cut operating costs. ■

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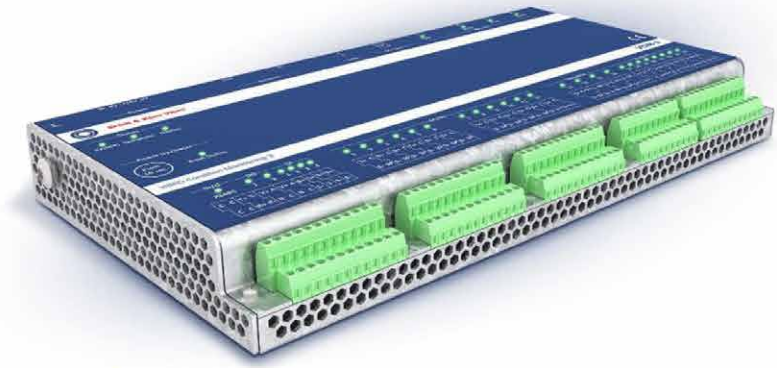

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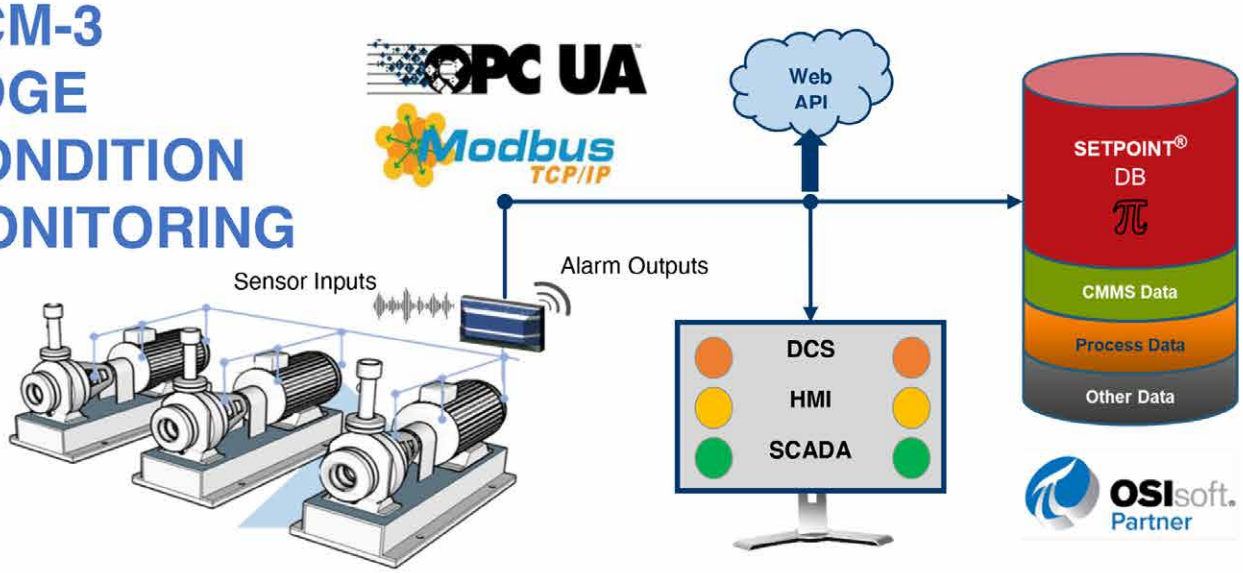

For more information, please refer to BKVibro Website:

https://www.bkvibro.com/product/vcm-3/

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CSE W Arthur Fisher

a division of CSE New Zealand

Critical Engineering Solutions

S.A.F.E operate a low-volume specialised forging & heat treatment plant in Drury. They specialise in custom-made critical componentry for virtually every industry in New Zealand. Barry gained his Toolmaking, NZCE(mechanical), and Marine Engineers qualifications with S.A.F.E. Passionate about failure correction & prevention, Barry seeks to pass on knowledge gained by witnessing thousands of mistakes – many of them his own.
A failure presents a great learning opportunity. It is only a great shame when no lesson is learnt or passed on to others.

Bolt Failure caused by Drunken Nuts.
Most nuts in NZ are now imported. There is a huge prevalence of 'drunken' nuts whereby the axis of the thread is a long way out of square with the thrust face of the nut. The problem causes extremely premature failure on even the best bolt by creating highly localised over-stressing in the root of a couple of threads during tightening.
This leads to an early fatigue failure and can be disastrous if not detected by routine checks. It is ridiculous that a cheap nut can cause failure of a very expensive bolt in this manner.

Check all nuts before use, preferably by spinning them on a threaded mandrel in a lathe, and take a small corrective facing cut on the pressure face if necessary. (Caution – beware of machining the nut undersize).Similarly, ensure that the job faces are flat and square (ie, spot-faced or counter-bored) before tightening the nut/bolt.

Stress Raisers
Stress Raisers are a massive contributing factor in many failures, and yet can be very easily recognized and rectified. A stress raiser can come in many forms,

Article by: S.A.F.E Ltd I Ph. (09) 2948437 I Email. Barry@safegroup.co.nz I www.SafeGroup.co.nz

“Serious stress raisers & major causes of failure”.

– Barry Robinson, S.A.F.E Ltd

and there could be more than one of these in your failure:

1. Cold-Work Stress

A piece of wire will break after just a few bends. Cold working or bending creates huge stresses in a metal. This is simply because you are stretching the material to somewhere between its Yield Point (the load at which it begins to stretch permanently) and its Ultimate Tensile Strength (its breaking load), ie, just short of breaking. To leave the product in that condition and send it out to work can be disastrous. It should either be hot worked, or stress-relieved after cold work. Standards specify that critical components for lifting, transport, propulsion, etc MUST be hot forged.

So what is critical for you? What parts do you make or have made, that are cold bent around a tight radius? Cold-headed bolts can have their heads pop off. Imagine the cold-work stresses that are in a cold-headed bolt.

2. Heating Damage

Localised heating by gas torch (as in trying to remove an old bearing, or straightening or re-shaping, etc) can destroy the heat treatment and thus severely reduce the strength of the component at that point.

A brief explanation of hardening and tempering will make it clear: When a high tensile component is made it is heated to (for example) 850degC and quenched, which makes it hard and brittle, followed immediately by tempering at (for example) 600degC to make it tough.

Any subsequent heating over 600degC will destroy that heat treatment and make the component weak. A good way to safely remove these items without heat damage to the shaft is to use High Frequency Induction Heating. Induction heating heats and expands the outer collar (or bearing, gear, etc) quickly and uniformly, allowing it to come free long before heat damage to the shaft occurs. This can also enable recovery of these components. At S.A.F.E we use this method to recover gears or collars that may have been shrink-fit on.

> “Subsequent heating over 600°C will destroy that heat treatment and make the component weak. A good way to safely remove these items without heat damage to the shaft is to use High Frequency Induction Heating.”

3. Poor Radius. Insufficient Radius. No Radius!

A poorly formed radius at the shoulder causes so many shaft failures. Sudden changes in section should be avoided where possible. Imagine your loaded part is hollow, and that it is filled with thousands of tiny fibres that carry the stress within. Are you satisfied that the tightly stretched fibres won’t be cut on that small, rough radius, or sharp edge?

Use as generous radii as possible, and make sure they are machined smooth with a fine feed rate and radius-edge tool.

Continued over page >

The prevalence of CNC lathes in a lot of shops has done away with the old radius tool, and it is very easy for the operator to generate a radius with a sharp turning tool (thus saving a tool change). This can be costly if the feed rate is high – giving a coarse surface finish.

For a really high stressed component (or one that will cost a lot to fix again) consider a few minutes spent with the die-grinder to make the surface 'lay' (machining marks) run parallel to the direction of stress. Turning marks from a lathe will virtually always be in exactly the wrong direction! There is often no real need and hence no excuse for sharp section changes. Circlip and O-ring grooves, and thread roots are an ideal notch point from which a crack can start. Design to have them at low-stress areas rather than high-stress (like on the unloaded side of a bearing if possible). Even a minute corner radius is better than none.

5. Rough Surface Finish

A rough or pitted surface contains hundreds of little stress-raisers where a crack can start from. Watch for pitting from surface corrosion. It can be blended out to reduce the problem.
On a highly stressed job the surface must smooth, so as to give no advantage to the crack looking to start. Make sure the machining or grinding 'lay' marks run parallel to the stress direction.
And the BIGGIE….

6. Weld

A weld is the very worst kind of stress-raiser in many ways, as it combines most of the above-mentioned stress-raisers, plus a few more! - Especially a circumferential weld.

As the cooling weld contracts it creates huge stresses within itself and the surrounding material.
Unless stress-relieved after welding, those stresses will forever be in the job – detracting from the job's ability to carry its load. Imagine buying a pre-stressed bolt or shaft! The heat-affected zone (HAZ) of the weld can create hard and soft spots, altering the strength of the material at that point. The molten weld pool destroys the grain flow present in rolled, forged and extruded products.

\Welding is a great means of joining metals, but it comes with great responsibility...
A welder is also very much a Steelmaker and a Heat-treater, but is often unaware of this.

As a Steelmaker
The act of welding usually involves up to three metals being combined in a molten pool. The resultant chemical make-up of the weld metal is very often not considered, nor is it consistent as it varies across the weld. But if the component is going to be subsequently heat-treated then this becomes vital to the process.

As a Heat-treater
Not only is the weld metal heated, but also the steel immediately next to the molten weld metal (known as the Heat-Affected Zone or 'HAZ'). The heat in this zone varies from approx 1400degC right down to ambient temp. It follows that somewhere within this zone the parent material will be up at 850-900degC (which is hardening temperature). It is then chilled by the cool mass of parent metal and so it acts as if it has been quenched and if it is medium tensile (1040) or better it can readily harden to 55 HRc!

This hard and brittle quenched martensite is doubly dangerous as the cooling weld contracts and creates extremely high stresses – often leading to cracking after welding.

So what about the ones that don't quite crack?
How much load can they take in service before they crack too? The creation of hard martensite can be reduced by a good pre-heat. But only a proper post-

weld heat-treat (PWHT) can:

1. Temper the martensite.
2. Lower the hardness.
3. Relieve the weld contraction stresses.

It is a myth that a weld can 'stress relieve' or 'temper' itself with the residual heat from welding.
Which brings us to…

Post-Weld Heat Treatment (PWHT)

After welding, the fabrication may need to be post-weld heat-treated, especially if is in either:

1. A highly stressed situation
2. In a dynamic or vibrating situation.

PWHT can be called various names depending upon the desired outcome:

- Stress Relieving

For basic stress-relief the whole idea is that as steel is heated it begins to lose its strength.As it loses its strength it also loses its ability to contain its internal stresses, and so begins to 'give up' those stresses. The more it is heated, the more stresses it gives up. It cannot give up all its stresses until it is a puddle on the floor.

Naturally at some point the job will lose its ability to stay in the shape you want it, and so the heat treater must strike a balance between removing as many stresses as possible, and causing distortion. Distortion is not usually a problem unless the job is slender and cannot support its own mass sufficiently at a dull red heat. Similarly (and contrary to popular belief), a bent job will not straighten itself during stress relief. If it is simply a mild steel fabrication then it requires a simple stress-relief of approx 600degC.

The general rule of thumb is 1-hour soak per 25mm of section thickness. This will allow most, but not all, internal stresses to be relieved. This process is also sometimes referred to as 'annealing'.
**Note. Make sure you have 'created' all the stresses you can before stress relief. By this we mean try to have done as much of the following stress-creating activities that you intend to do BEFORE getting the job stress relieved:*

- Plate cutting
- Heavy machining
- Cold working (including bending, straightening, pressing, thread rolling, etc)
- Welding

The general rule of thumb is 1-hour soak per 25mm of section thickness. This will allow most, but not all, internal stresses to be relieved. This process is also sometimes referred to as 'annealing'.

Fracture

When something breaks you have the ideal opportunity to improve on a possibly flawed situation. You can look at the type or 'mode' of failure and work backwards to figure out why, and what caused it? A lot can be learned from the fracture so try to preserve the broken faces until they have been 'read'.
A common type of fracture is FATIGUE:
This type of fracture has a 'smooth' appearance across a large part of the fracture face. Looking closely you will see many curved lines making up the smooth surface. These curved lines mark the progress of what started out as a tiny crack or imperfection.

Generally you can retrace the curves to their smallest origin to find out where the crack began. Something will have caused it to start, usually a stress raiser such as a sharp section change, notch, weld, de-carburisation, or even rough surface finish on highly stressed components. Or it could be a phenomenon such as a sudden overload or shock load. But from the moment the crack starts it propagates further with each load cycle, until finally there is not enough material left to carry the load, and final fracture occurs.

By comparing the % of smooth fatigue failure area to final fracture area we can get an understanding of how stressed the component is in normal service.

There are many simple ways of improving a component's 'fatigue life':

- Remove stress raisers.
- Shot-peen the surface to create a surface compressive stress.
- Ensure the surface is free of decarburisation.
- Reduce the % of applied load to the UTS/Yield Strength.
- Alter the design to allow flexure to take place over a longer span, reducing localized flexing.

The Wrong Material!

Different types of steels are designed for different jobs. You can exceed what is recommended, but suffer the consequences of possible premature or catastrophic failure. There are 3 parts to 'The Wrong Material'….

Continued over page >

Part A. Ordering the Wrong Material.

Before you buy new material to make a new part or repair, make sure you know what stuff to buy! Most of the time the material cost will be virtually insignificant in relation to the rest of the job, but if it is not the right stuff the whole job could easily be compromised. Know what to get and check your new material before you use it. Because here is the scary bit….

Part B. Being Supplied the Wrong Material.

Mistakes are often made at the steel merchant's despatch. At S.A.F.E we have a spectrometer we use for chemical analysis, and we quarantine, analyse and hardness test all our incoming raw material.
And we often find we have been sent the wrong material!! If you send something to be heat-treated and it is not what you tell the heat treater it is, failure may well follow – and if you are lucky it will crack before it leaves the Heat Treatment shop.

Part C. Being Supplied Poor Quality Material

There is a lot of material that is of poor quality, being produced in steel mills of dubious reputations. It may be cheap, but it may be dirty also, with non-metallic inclusions inside it. This material passes the chemical analysis or hardness test just fine, and it may even hold together during hot forging.

It may heat-treat OK, and pass hardness tests and even mechanical tests like tensile and Charpy impact. But it fails prematurely in service, and only a post-mortem metallurgical examination shows the problem.
Again, we hope it is bad enough to make it fall apart during forging or heat treatment, before it goes into service where failure damages reputations and costs so much more to put right.

Critical Components

Don't take risks when making critical components. If the part you are making or repairing is used for lifting, pressure vessels, transportation, etc then take particular care to ensure you are doing it right.

What is a critical component?
Imagine the consequences of failure of that component, and what a prosecutors' investigation report might say,
Or a news headline,
Or a judge's decision. ■

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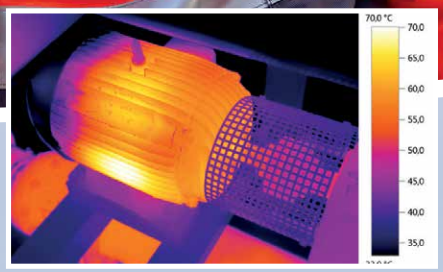

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TEST YOUR KNOWLEDGE - PART 66 OF A SERIES

1 Some intermittent / random effects could be heard through the listening device attached to your analyser. You are certain that bearing fault frequencies will show in the spectra, if only you can capture the moments the effects occur. Which of the following might help to make that capture?

a Change the averaging type to negative averaging
b Increase the number of summation averages
c Change the averaging type to peak-hold averaging
d Change the averaging type to time-synchronous averaging

2 A sound-level meter with spectral capability was set-up in an office so that it could be determined if a noise being heard in the office was actually at the gearmeshing frequency of a gearbox on the production floor some 50 metres away. The meter was calibrated first. What type of signal does a typical sound calibrator emit?

a Sine wave
b Square wave
c Saw-tooth wave
d Impulse signal

3 Where might you choose to use a charge-mode accelerometer in place of a more traditional type?

a Where vibration levels are high
b Where phase data needs to be accurate
c For greater accuracy in readings taken in the vertical direction
d In high temperature environments

4 A vertical pump has very high 1 x vibration. You are trying to decide whether it is unbalanced, or whether it is resonant. What things might you do to assist with your understanding?

a Compare vibration levels in different directions (north-south vs east-west)
b Bump test the pump
c Observe vibration levels at different running speeds (VSD) or carry out a coast-down test
d All of the above could be useful

5 Assessing the condition of rolling element bearings operating at very low rotational speeds can be challenging. Which of the following might be your best tool to assist with this process?

a An analyser which is capable of processing signals up to 40 kHz
b An analyser which is capable of cross-channel phase analysis
c An analyser / software package which allows for good collection and diagnostics of demodulated / h-f conditioned waveforms
d Both A and B

6 A 4-pole, 3 phase induction motor operated for many years without being driven by a VSD. Once it was, the overall acceleration levels as measured at the routine monitoring points (i.e. close to the rolling element bearings) increased significantly. Which of the following is likely to be most accurate?

a The VSD is faulty – replace the VSD
b The VSD has been wired up incorrectly – correct the wiring
c The rolling element bearings are damaged due to EDM – replace the bearings
d Without further diagnostic capabilities (waveform, spectra etc) the cause of the increase is unclear

7 A special modal impact hammer which has a range of removable tips of different hardness's is used to strike an industrial steel beam. The spectral response from a strike with tip #1 extends well up into the high-frequency range, whilst the response from a strike with tip #2 does not extend as far. Which of the following is most-likely to be true about tips #1 and #2?

a Tip #1 is likely to be harder than Tip #2
b Tip #1 is likely to be softer than Tip #2
c Tip #1 is unsuited to the testing of this beam
d Tip #2 is unsuited to the testing of this beam

8 A stroboscope is tuned to a speed so that it "freezes" the image a rotating shaft which has a single keyway. If the shaft appears stationary (i.e. frozen), but the image shows 2 keyways, which of the following is true?

a The strobe has been tuned to half the rotational speed
b The strobe has been tuned to the rotational speed
c The strobe has been tuned to 2 x the rotational speed
d The strobe has been tuned to an even-numbered multiple of rotational speed (e.g. 2x, 4x, 6x etc)

9 What is the word "Helmholtz" most-likely to be associated with?

a A resonator
b A dampener
c An electric coil
d A city in Brazil

10 Analysis of a P-V curve can be useful in conjunction with vibration analysis when assessing the condition of combustion engines. What do the letters P and V represent?

a Pressure, volume
b Pressure, vibration
c Peak, vibration
d Peak, volume

Answers on page 23

Further enquiries can be directed to: Carl Townsend at Carlton Technology Ltd.
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PUZZLE CORNER

WORD BUILDER

How many words of three or more letters can you make, using each letter only once? Plurals are allowed, but no foreign words or words beginning with a capital. There is at least one 5 letter word.

6 - Good | **10** - Very Good | **14+** - Excellent

R	T	N	H	O

WORD MARCH

Draw a path from one square to another to find the secret nine letter word. You may move in any direction. Each square can only be used once.

There are approx. **58** words (three letters or more) that can be made from the combination of letters below. How many can you make?

Solution on page 23.

T	H	O
R	O	D
Y	X	O

Nine letter word is...

SODUKU

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. Why not time yourself? See how well you go.

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

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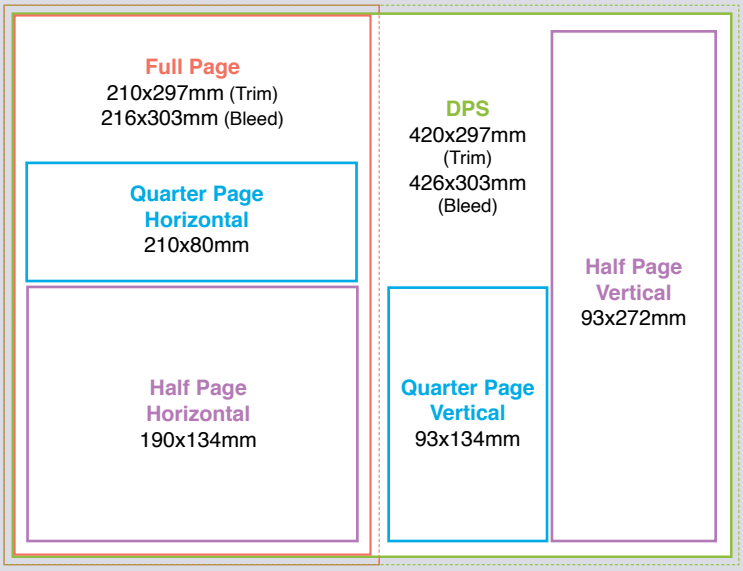

Answers to Carlton Technology Quiz 66:
1C, 2A, 3D, 4D, 5C, 6D, 7A, 8C, 9A, 10A

Answer to Word March: Orthodoxy | **Word Builder:** Thorn or North

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