

# Spectrum



Autumn 2021 | Issue 99

## 5000t Bump Test

The largest machines on earth

### How to buy those expensive 'toys'

...and keep the bean counter happy



### VANZ Conference 2021

Full registration details

**VANZ**

VIBRATIONS ASSOCIATION of NEW ZEALAND





# Machine Vibration & Plant Condition Monitoring Solutions



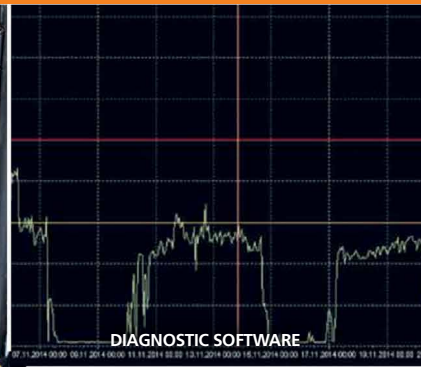
VIBRATION SENSORS



VIBRATION TRANSMITTER & SWITCH



VIBRATION MONITORING & DIAGNOSTICS



DIAGNOSTIC SOFTWARE



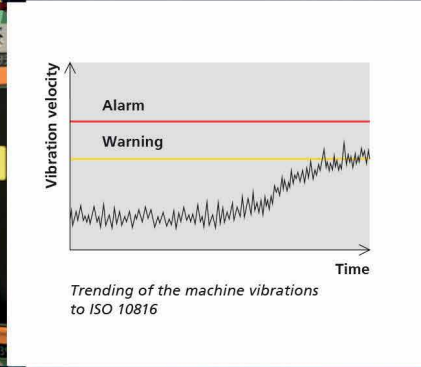
VIBRATION SENSOR WITH MEMORY CAPACITY



VIBRATION TRANSMITTER & SWITCH



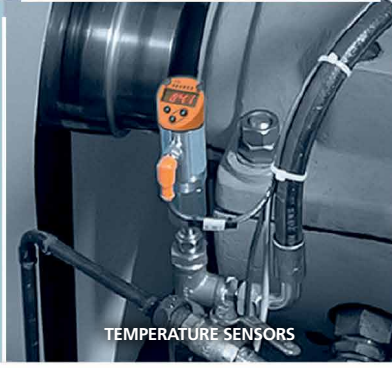
VIBRATION MONITORING & DIAGNOSTICS



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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16



20



11

# CONTENTS Autumn 2021

## Features

### Conference 2021

Key speaker profiles and registration forms 10

### 5000t bump Test

The largest machines on Earth 16

### How to buy those expensive 'toys'

A structured approach to justifying instrument purchases... 20

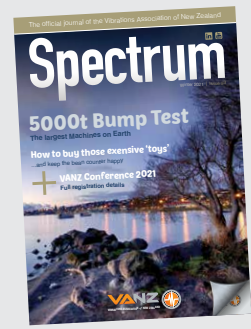
## Regulars

From the president 4

Editor's report 6

Puzzle corner 23

Test your knowledge 24



# Spectrum #99

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Spectrum is published quarterly in a digital medium and printed twice yearly by the Vibration Association of New Zealand (VANZ). 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. Contributions to Spectrum are welcome.

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### Missed an issue of Spectrum magazine?

Simply scan the QR code here to link your device directly to the VANZ website. There you will find Spectrum issues available to view or download\*.

A QR code reading app will need to be installed on your device first.



# PRESIDENTS' REPORT

By Rodney Bell, VANZ President

Welcome everyone to the VANZ Spectrum edition 99, only 1 off the big 100 issues. This is an exciting time for us to mark the 100th and we are already making plans to include additional material from our archives in this issue. Our theme for 2021 conference is "The Future of Condition Monitoring" and with the addition of earlier Spectrum features will help display the passage Condition Monitoring has followed over time.

Planning for our 31st annual conference at Wairakei Resort, on August 17th, 18th & 19th, is now well underway which is also an exciting time as we endeavour to get life back to some form of normalcy post-COVID. This venue has been chosen because of its location, which is basically isolated, endeavouring to keep everyone in one location.

By now you will be able to visit our website **www.vanz.org.nz** to view conference planning and online registration. The online registration option is another first for VANZ which will work well for all I am sure, the exception to this is the companies that left a credit with VANZ after the cancelled 2020 conference. In this circumstance you will need to make direct contact with VANZ to work through this process and we look forward to assisting. Also keep an eye out for our 3 day/night inclusive package for \$1485.00, which includes breakfast, and the line-up of confirmed Keynote, Guest and general speakers. As usual the Awareness day is free to all Students/Apprentices. VANZ is very much looking forward to

bringing back our Premier 3-day Predictive Asset Management Conference to all those people working in the plant maintenance & reliability industry.



Prior to our conference we are running a special Regional Technical Forum at HERA House Manukau City, Auckland. This is a one-day event to be held on 28th May from 9am to 3pm with highly experienced speakers presenting on topics including Vibration Analysis, Ultrasonics, Infrared Fundamentals, Lubrication & Shaft Alignment. The cost for this event is \$75.00 and with a maximum of 50 attendees, you will need to register soon if you would like to take advantage of this opportunity.

“  
**Planning for our Wairakei Resort 31st annual Conference August 17th, 18th & 19th is now well underway, By now you will be able to visit our website [www.vanz.org.nz](http://www.vanz.org.nz) to view conference planning and online registration.**  
”

It's great to see that most industries are again working at full capacity which is keeping staff and contractors busy. Still, we find in most walks of life there is long delivery times for almost all our imported products which can be frustrating, but if we look on the positive side this does tend to sharpen our planning skills. Hopefully, we will see some improvement in the not-so-distant future.

For now, we will all batten down the hatches for winter and we hope you all stay safe and well through this period. Look out for our 100th edition of Spectrum to be released early August prior to the conference at Wairakei. ■



MOTION & CONTROL™

**NSK**



As we approach the middle of another year we hope that the vaccine roll-out continues successfully so it gives us the freedom and safety we need to be able to gather as we once used to do.

VANZ has a technical forum on the 28th May in Auckland, for those able to attend we look forward to sharing some thoughts and ideas involved in the engineering business. The committee is also working on getting the annual conference back up and running this year, our principal sponsor CSE New Zealand together with BkVibro will be providing our keynote speaker and it will be happening in August at the Wairakei Resort hotel. You can find out more info on it in this issue or on our website where you can register.

In this issue you can get an update from our President Rodney Bell, puzzle your grey matter again with Carl's Quiz, read up on How to Buy Those Expensive 'Toys' by Simon Hurricks from Genesis Energy, also you can go over an updated version of the 5,000 Ton Bump Test from Matt Fallow at Asset Quality.

VANZ greatly appreciates all those companies that are able to continue supporting us thru advertising and

sponsorship of varying degrees.

If you are in an 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. Keep up to date on the vaccination programs in your region and get protected so we can reach herd immunity and get thru this. We cannot become complacent, it's up to everyone to help protect the vulnerable before they are lost to us, take care of yourselves and each other.

Many thanks and happy reading! ■



## VANZ is holding a special Regional Technical Forum

*We'd love for you to join us...*

**WHEN:** Friday, May 28th 2021

**WHERE:** HERA House (Heavy Engineering Research)  
17-19 Gladding Place,  
Manukau City, Auckland

Register your interest! [www.vanz.org.nz](http://www.vanz.org.nz)



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## Machinery Protection & Condition Monitoring System

### Key Features:

- Full API 670 compliance
- Totally open data access
- Native to OSIsoft – PI historian
- 19" rack or bulkhead mounting
- Up to 56 channels
- On-board flight recorder mode with 32GB SD card and 32GB solid state HDD as default option
- Multiple, segregated processors
- Can be retrofitted to replace existing system
- IIoT and EIoT Enabled Solution

### Applications:

- Gas, Steam and Hydro Turbines
- Generators, other Rotating Machineries
- Reciprocating and Radial Compressors
- Balance of Plant – Pumps/Fans/Others

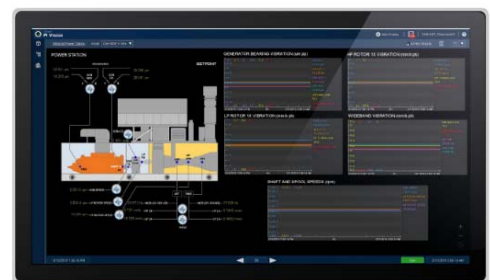


No servers.  
No networks.  
No hassles.

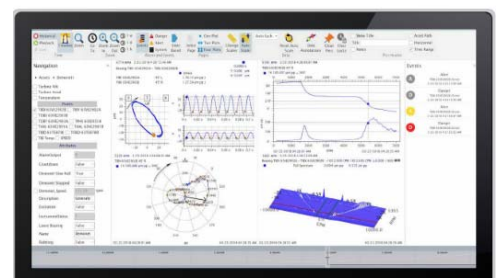
All diagnostic data available  
when needed and viewed  
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CMS Clients





# Conference Taupo 2021

**Wairakei Resort: 17th – 19th August 2021**

Australasia's Premier Annual 3-Day Predictive Asset Management and Reliability Condition Monitoring Event.

THE FUTURE OF **CONDITION MONITORING?**

**REGISTER  
ONLINE!**

[www.vanz.org.nz](http://www.vanz.org.nz) 

Share knowledge, passion and successes. Network and totally immerse yourself in this 3-day event!

*Special offer to students and apprentices: No-cost option for the Awareness Day and a massive 50% discount option for the main conference available!*

**Register your interest today!**



Principal sponsor:

**CSE**W Arthur Fisher  
a division of CSE New Zealand



**Brüel & Kjær Vibro**

# VANZ Conference Taupo 2021

## Key Speaker Profiles

Here is a little background on the key presenters you'll hear at the upcoming VANZ Conference in Taupo later this year.



### Terry Siggins

> Global Marketing & EMEA Sales Director with Brüel & Kjær Vibro

Terry is a sales & marketing professional with over 40 years of industrial experience. His career spanned the evolution from analogue to digital systems to the advent of the Industrial Internet of things. Beginning with Kodak, in maintenance, production and project management, he migrated into industrial automation and software, spending over 20 years in senior leadership roles. Today he leads digital business development at Brüel & Kjær Vibro, harnessing 60 years of expertise, augmented by new Artificial Intelligence offerings, to turn vibration into business value for the rotating equipment industry.



### John van Zwielen

> Regional Sales Manager with Brüel & Kjær Vibro

John is a CAT IV Vibration Analysts with more than 43 years experience in many aspects of the vibration business including roles in Services (Instrumentation and Machinery Diagnostics), Training and Sales.



### Frank May

> Environmental Test Facilities Manager

Auckland University Space Institute



### Dr Iain Epps

> Managing Director

Mobolo Technology Limited, New Zealand



### Matthew Fallow

> Owner of Asset Quality

Australia



### Clyde Volpe

> International Trainer

Vibration Institute of Australia



### Simon Hurricks

> Predictive Maintenance Engineer

Genesis Energy Ltd



### Mike Yardley

> Owner of Yardley Consulting Limited



### Colin Gracie

> Owner of Inspyer Limited



### Craig Carlyle

> Senior Consultant at HasTrak Health & Safety New Zealand



### John Lawrence

> Engineer with GVS Reliability Product



### Bruce Shepherd

> Condition Monitoring Engineer

ABB Limited

# Conference Taupo 2021

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‘THE FUTURE OF CONDITION MONITORING?’

## CONFERENCE OPTIONS



Get in quick for our off-season price grab on our accommodation deal at Wairakei Resort  
See page 3 for details.

### TIMETABLE

\* All prices exclude GST.

Tuesday,  
August 17th

Wednesday,  
August 18th

Thursday,  
August 19th

3  
DAY

**Technology  
Exhibition**

Visit 20+ world-leading condition monitoring and reliability providers showcasing their latest technologies all under one roof over all-three days of the conference.

3  
DAY

### Three-Day VANZ Conference Pass

Predictive Asset Management and Reliability Condition Monitoring Conference & Technology Exhibition. Also incl: Wednesday evening dinner. Additional benefits with 3-day registration include Tuesday evening light meal, and three nights accommodation, including breakfast.

**\$1,480/pp**

1  
DAY

### One-Day - Opt. 1

Practical Hands-on Awareness

**\$200/pp**

or Student/Apprentice\*

**FREE!**

2  
DAY

### Two-Day VANZ Conference Pass

Case-studies, Presentations, Knowledge-transfer & Technology days. Also incl: Wednesday evening dinner.

**\$800/pp**

or Student/Apprentice/Trainee: **\$400/pp\*\***

1  
DAY

### One-Day - Opt.2

Reliability/Asset Management

**\$350/pp**

**Networking**

**Networking**

**Main Conference Dinner**

**Social Activity**

**Networking**

**Informal Welcome Evening**

pp = per person. \* Student/Apprentice/Trainee ID required for eligibility.  
\*\* Cost all inclusive including the Wednesday night dinner.

ID number required below for day 1 and/or day 2 special offer eligibility..

**Student/Apprentice ID Number: (If applicable)**

### Student/Apprentice/Trainee Details



For further info or to secure your position please contact our conference team: email us at [conference@vanz.org.nz](mailto:conference@vanz.org.nz)

Principal Sponsor:



# Conference Taupo 2021

Wairakei Resort: 17th – 19th August 2021

Australasia's Premier Annual 3-Day Predictive Asset Management and Reliability Condition Monitoring Event.

‘THE FUTURE OF CONDITION MONITORING?’

## PRICING

\* All prices exclude GST.

1 DAY

### Practical Hands-on Awareness Day - Tue 17th August 2021

FULL DAY ENTRY to the Practical Hands-on Awareness Day. See below for extra benefits (1). **NZ\$200**

Qty  \$

#### Special Offer - No Cost! – Open to all students/apprentices and trainees with ID

Full Day entry to the Practical Hands-on Awareness Day. See below for additional benefits (1). Student ID Required. See page 1.

Sign up online. [www.vanz.org.nz](http://www.vanz.org.nz)  
Enter the code: STUAPP to automatically receive discount!

**FREE!** Qty

**FREE!**

1 DAY

### Asset Management/ Reliability Implementation Day - Tue 17th August 2021

FULL DAY ENTRY to the Asset Management/ Reliability Implementation Day.

See below for extra benefits (1).

**NZ\$350** Qty  \$

2 DAY

### Main Conference - Wed 18th and Thu 19th August 2021

Conference attendance for two days.

Includes 1x ticket for each dinner event! See below for additional benefits (2).

**NZ\$800** Qty  \$

#### Half Price Offer! – Open to all students/apprentices and trainees with ID

Full Day entry to the Practical Hands-on Awareness Day. See below for additional benefits (2). Student ID Required. See page 1.

Sign up online. [www.vanz.org.nz](http://www.vanz.org.nz)  
Enter the code: STUAPP to automatically receive discount!

**NZ\$400** Qty  \$

**1/2 PRICE!**

3 DAY

### Full 3-Day Attendee - Tue 17, Wed 18th and Thu 19th August 2021

Predictive Asset Management and Reliability Condition Monitoring Conference & Technology Exhibition.

Also includes: 1x ticket for Wednesday evening dinner.

Additional benefits with 3-day registration include:

- Tuesday evening light meal
- Three nights accommodation, including breakfast.

**NZ\$1,480** Qty  \$

**BEST VALUE**

## Additional benefits

1. Entry to the Awareness Day afternoon networking session.  
All Awareness Day papers will be available to download from [www.vanz.org.nz](http://www.vanz.org.nz).  
One day complimentary parking at the venue.
2. Complimentary parking at the venue.  
One Wednesday evening dinner ticket per registration.  
All conference papers will be available to download from [www.vanz.org.nz](http://www.vanz.org.nz).  
One year membership of VANZ included with attendance.

# ACCOMMODATION

Use VANZ booking discount code: **vanz2021**



## SPECIAL Early Bird 3-Day All Inclusive Accommodation Deal!

All-inclusive 3-day Conference pass and 3-Nights' accommodation offer, including breakfast and Tuesday evening light meal. Subject to room availability so don't delay, first in get the best Deluxe rooms.

**NZ\$1,480**

Early bird accommodation deals available for student/apprentices, go to [vanz.org.nz](http://vanz.org.nz) registration page for more info.

For the conference, we've secured all the rooms at Wairakei Resort, Taupo for a great rate if you need to book accommodation separately, but it's only for a limited time and availability will reduce closer to the conference date.

**Don't delay. To reserve your room(s), simply visit [www.vanz.org.nz](http://www.vanz.org.nz)**

**There is limited rooms available, so first in will be first served.**



# CONFERENCE EVENING EVENTS

We will be hosting two event evenings.

## TUE Informal Welcome Evening - Tue 17th August - Wairakei Resort

**\$25 for additional tickets**

Please advise attendance numbers for catering.

Attending:

## WED Main Conference Dinner Event (Additional Tickets) - Wed 18th August

**Special event in planning**

Extra tickets are available at \$125 each. Please fill out if applicable.

**NZ\$125**

# 2021/22 MEMBERSHIP ONLY

Full year. Otherwise included in the main conference attendee pass. Pricing excludes GST.

**NZ\$100**

# TOTAL PAYABLE

Don't forget to add the GST content (+15%) to your total.

**\$**  **incl. GST**

# PAYMENT DETAILS

## MAKE YOUR PAYMENT ONLINE

Simply scan the QR code\*\*\* to the right with a mobile device, or go to [www.vanz.org.nz](http://www.vanz.org.nz) to make your payment quick and easy online.



### PAYMENT DETAILS:

**Pay by Cheque to:** Vibrations Association of New Zealand.

**Postal Address:** P.O Box 2122, Shortland Street, Auckland 1140, New Zealand.

**Account details:** Vibration Association of NZ Inc Conference. No, 06-0329-0706287-01. Please use your name and/or company purchase order as reference.

PAYMENT OPTIONS:  Cheque  Credit Card\*  Direct Credit  Company Purchase Order

CREDIT CARD NUMBER:     -     -          CARD TYPE:  Visa  Mastercard

EXPIRY DATE:   /   CVV\*\* No.     NAME ON CARD:

SIGNATURE:

\*3% surcharge applies. \*\*3 or 4 digit number printed on the back of your card. \*\*\* A QR Code reading app is needed on your mobile device to scan the code.



For further info or to secure your position please contact our conference team: email us at [conference@vanz.org.nz](mailto:conference@vanz.org.nz)

Principal Sponsor:





# Conference Taupo 2021

Wairakei Resort: 17th – 19th August 2021

Australasia’s Premier Annual 3-Day Predictive Asset Management and Reliability Condition Monitoring Event.

‘THE FUTURE OF CONDITION MONITORING?’

## ATTENDEES (Conference or Exhibitor)

Tick the option that best suits your requirements.

### 1<sup>ST</sup> ATTENDEE

**CONTACT DETAILS:**

**First Name:** ..... **Title:** .....

**Surname:** .....

**Phone:** ..... **Mobile:** .....

**Company:** .....

**Website:** .....

**Work P.O Box Address:** .....

**State/Region:** ..... **Country:** ..... **Postcode:** .....

**Home Address:** .....

#### Tick applicable:

Hands On Apprentice and Training (Day 1) >

Asset Management (Day 1) >

Main Conference >

**Exhibitor >**

### 2<sup>ND</sup> ATTENDEE

**CONTACT DETAILS:**

**First Name:** ..... **Title:** .....

**Surname:** .....

**Phone:** ..... **Mobile:** .....

**Company:** .....

**Website:** .....

**Work P.O Box Address:** .....

**State/Region:** ..... **Country:** ..... **Postcode:** .....

**Home Address:** .....

#### Tick applicable:

Hands On Apprentice and Training (Day 1) >

Asset Management (Day 1) >

Main Conference >

**Exhibitor >**

### 3<sup>RD</sup> ATTENDEE

**CONTACT DETAILS:**

**First Name:** ..... **Title:** .....

**Surname:** .....

**Phone:** ..... **Mobile:** .....

**Company:** .....

**Website:** .....

**Work P.O Box Address:** .....

**State/Region:** ..... **Country:** ..... **Postcode:** .....

**Home Address:** .....

#### Tick applicable:

Hands On Apprentice and Training (Day 1) >

Asset Management (Day 1) >

Main Conference >

**Exhibitor >**

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‘THE FUTURE OF CONDITION MONITORING?’

## EXHIBITOR INFORMATION

\* All prices exclude GST.

PACKAGE <input checked="" type="checkbox"/> Tick the option(s) that best suits your requirements.	Gold \$2,950	Silver \$2,100	Bronze \$1,450
Naming rights of conference	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Primary sponsorship on key online & offline promotional material before and during conference*			
Official role at the opening of the conference and five minute speaking opportunity			
Trade stand that offers sponsors the opportunity to showcase products, services and ideas	Premium	Standard	Table
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

Booth size (Platinum and Gold)	1.8 x 3.0 metres
Booth size (Silver)	1.2 x 2.4 metres
Table top size (Bronze)	1.8 x 0.6 metres

**Website\*** Animated landscape panels @ 460px wide x 200px high  
**Website\*\*** Animated landscape panels @ 460px wide x 200px high - x1  
**Logo file\*\*\*** To be supplied as either a vector eps or hi res tif/png/jpeg  
 Files to be supplied to specifications.

For any assistance or enquiries, email [conference@vanz.org.nz](mailto:conference@vanz.org.nz)

## ADDITIONAL SPONSOR OPTIONS AND INFORMATION

Tick if applicable

Lanyard sponsor	\$500 + lanyards	<input type="checkbox"/>
Bag sponsor	\$500 + bags	<input type="checkbox"/>
Dinner sponsor	POA	<input type="checkbox"/>
Informal Welcome Event (Tues night)	\$2,000	<input type="checkbox"/>



**LIMITED OFFER!**

**SPECIAL**

### Early Bird Exhibitor Accommodation Special!

3 nights/ 4.5 star accommodation incl. breakfast at special exhibitor price of \$550 per room.  
 Subject to availability. Book fast!

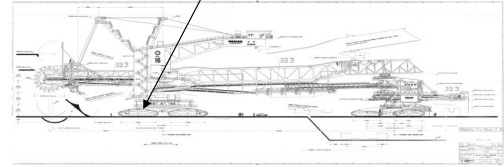
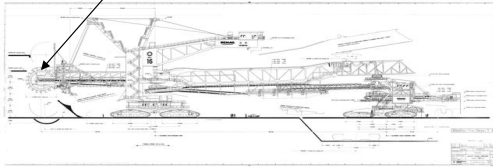
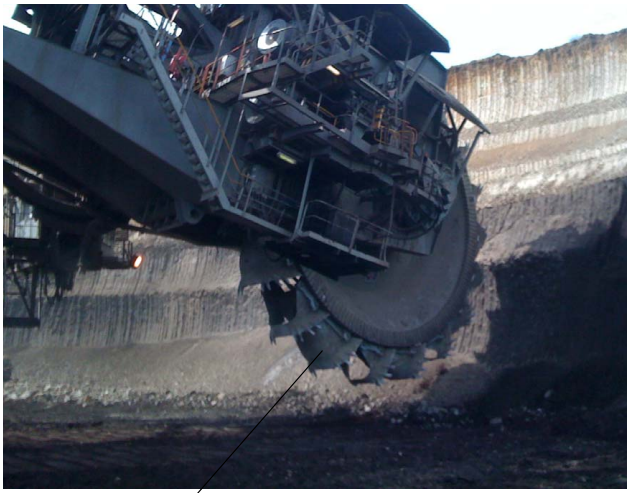
**NZ\$550**

Qty

\$







# 5000 ton Bump Test

## – The largest Machines on Earth

### Background

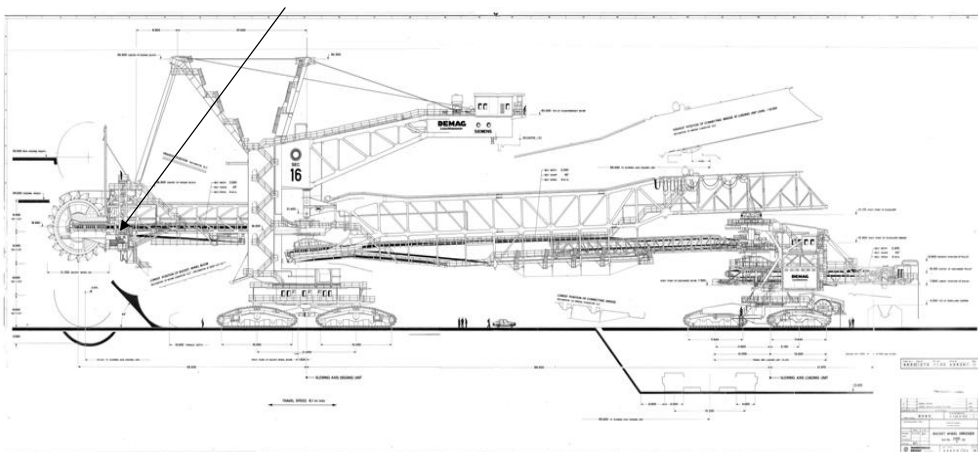
This machine had reports of excessive vibration (called a “bounce” by the operators) in the bucket/boom since commissioning. These levels have been high enough for operators to cease cutting for fear of the machine catastrophically failing or the bucket wheel trips on motor over current.

We were asked to attend site and take a look at this vibration and make comment as to what type of vibration it is and the source using a simple, objective, common sense approach.

### Observations

We spent 2 days on site talking to operators (3 off) about their experiences with this machine and the characteristic of the vibration. This determined that the vibration experienced by the operators was in the ‘vertical’ plane on the bucket/boom and generally occurred when working over burden which contained sandstone. The bucket/boom would vibrate in this vertical plane until the buckets were plunged too deep into the face and the machine tripped on over current or the operator ceased production due to the high vibration concerns.

*Continued on page 18 >*



Left: 5000+ tons, 200m long, 16 storey's high, slew bearing 15.2 diameter.



Normal cut position



Bounce

We had an operator mimic these conditions for us in the clay overburden which contained some sandstone. He was able to predictably cause the bucket/boom to vibrate (1.5m pk to pk!) in the vertical plane until overload of the bucket wheel drive was tripped. After doing this a number of times it was noted that the vibration was always at the same frequency and the amplitude would increase very quickly. The frequency of vibration was very low and we were able to measure it over a period of time (say 30 seconds) and determined it to be approximately 22 cpm. To measure the frequency we used the clock on my mobile phone and not a vibration analyser. Resonance was suspected!

**“ A resonant condition is to be avoided at all times as amplitudes are highly unpredictable. This also includes when travelling around the pit. ”**

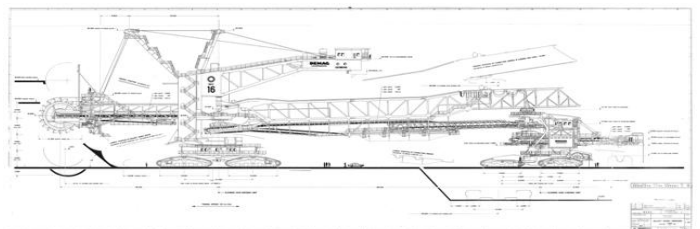
We then sought to observe the bucket/boom system Natural Frequency (free vibration to prove theory), as after experiencing the vibration we suspected a resonant condition. A Bump Test was carried out in order to excite the bucket/boom natural frequencies with the machine pulled away from the face. Initially we tried using the mass of three people on the end of the boom but were unable to generate enough force. Finally we used the boom itself by winding it down at full speed and then applying the e-stop or ‘travel up’ then e-stop, this provided enough force (a single bump) to excite the natural frequencies.

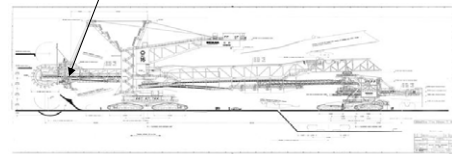
A very low frequency was observed (again using the mobile phone to time it) and the test repeated many times with a prominent natural frequency measured at approximately 22 cpm. This is the same frequency as the “bounce” reported by the operators and observed by us during production.



[Click here for a video of the natural frequency](#)

or scan the QR code to link directly.





So it would appear that the excessive vibration (called a “bounce” of the bucket/boom by the operators) is the result of a resonance condition. The Natural Frequency (free vibration) of the bucket/boom system is being excited by the specific operating conditions into resonance. The ‘exciting’ or ‘forcing frequency’ which is a key part in a resonance condition was unclear, but likely related to the depth of cut and type of overburden which ‘grabs’ or ‘pulls’ the wheel/boom to the face.

A resonant condition is to be avoided at all times as amplitudes are highly unpredictable. This also includes when travelling around the pit, this should

be done carefully to ensure excessive excitement of the boom (and other machine components) is avoided.

To avoid a bucket/boom system resonance during production:

1. Change the bucket/boom natural frequency – difficult/unpredictable/impractical/costly..
2. Remove or avoid the ‘exciting’ or ‘forcing’ frequency – can be done with operating procedures.

So there you have it! No matter how big a machine is, they all have natural frequencies which can be measured. ■

## Interested in joining **VANZ**

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.

**For more information about membership please contact the VANZ secretary by emailing [secretary@vanz.org.nz](mailto:secretary@vanz.org.nz)**





# How to buy those expensive 'toys'

## A structured approach to justifying instrument purchases

### Introduction

It is a perplexing paradox that there is never any money in the budget to prevent a machine failure, but money is no object to fix it once it has failed.

It is also a fact that conferences such as this one can be quite demoralising, you see all the “toys” you get all enthusiastic about putting into practise what you have learnt, that is, until you get a reality check from the “bean counter” by way of a CBA form. Cost Benefit Analysis.

Bean counters are wired differently to Engineers, bean counters see only costs, engineers see only benefits.

It is also a well known (except to bean counters) fact that to detect a failure you must have the equipment installed before the failure.

If your plant is forever having breakdowns then equipment purchase is relatively easy to justify, if on the other hand your plant is new or you have few problems, so far, then justification is a bit more difficult.

Another perplexing fact is that there is never enough money for your project but near the end of the financial year some “priority” projects don't get off the ground and money becomes available. You finally get the “green” light as long as you can get it



on site within financial year. There are a few tricks of the trade but that is another story.

This paper gives a structured approach to justifying equipment that even the bean counters will have a hard job refuting.

### The Purchasing Process

Most large organisations and in particular government bodies, have a very regimented process for large purchases. The bigger the value, the more rigorous the process.

This process will involve all or most of the following.

- Identify the need
- Check out the market
- Budget estimate
- Get budget allocation
- Write specification
- Write CBA
- Go out to tender (Usually minimum of three)
- Assess tenders
- Get approval from tenders committee
- Purchase equipment.

This process for larger items can take in excess of 12 months. There are a few base rules. Always ask for more in the budget, the price will always go up. If more than one meets the specification the cheapest one will be purchased.

Quite often checking out the market will generate a need. Before you write the specification know exactly what you need and why you need it. To get what you want, write the specification around what you want. Do not go out to tender to find out what's on the market.

### Accountant Lingo

In order to be successful, you must be familiar with a few key project killing phases, such as,

- NPV or net positive value. (The value of the asset

over the life of the project

- PI or Performance index (How good is the project, used to compare with others)
- IRR or internal rate of return (How fast will it generate revenue)
- Payback period (How soon will the benefits pay for the capital cost).

In general for a project to go ahead the NPV must be as high as possible, the PI must be as high as possible, the IRR must be as high as possible and the Payback period must be as short as possible.

The key thing is to find out the ideal range of values for each. If the values are too low then the project will not get off the ground, too high and the figures will not be believed.

### CBA

The CBA is quite often a complex spreadsheet which the accounts section has dreamed up to make your life awkward. The costs for a project (purchase) are easy, the benefits over an extended time frame are often difficult to quantify and especially difficult to justify to the final jury, the dreaded tenders committee.

The key to success is to structure the benefits such they are both high enough to justify the project and at the same time defensible against all challenges. The following is designed mainly for machine monitoring equipment but the same approach can be tailored for any equipment.

### Benefits

Let us say your industry is power generation and your plant is a number of large turbo-alternators on which you want to install on line vibration and diagnostic equipment. Your plant is say, 13 years old and there is little history of major failures and the OEM vibration system is old and obsolete.

*Continues on page 22 >*

The problem is that the new equipment has a fairly hefty price tag, in excess of \$1m. To justify this expenditure, the benefits you use in the CBA must be large enough, believable and above all else defensible if challenged.

- Step one is to list all of the possible failure scenarios however unlikely
- Step two is to eliminate all failures modes which cannot be detected by vibration
- The next step is to assign a believable MTBF (mean time between failures) in years. A probable event may have 2 years whereas a unlikely event maybe 50 years. The thing to remember is that although unlikely an event is, it is still possible
- Step three is to write down the current age of the plant
- Step 4 is to assign a beta factor to each failure mode. The beta factor is assigned such that a beta of 1 is for events which remain a constant probability with age. Beta of 2 is for events which increase in probability with age. Beta of 3 is assigned to completely random events
- Step 5 is to assign a loss of production cost to the event in the case of power generation this will be in terms of MWs, times the value of that generation (This figure will vary depending on the time of year but an average value can be assigned)
- Step 6 is to assign a duration for the event if the new gear was not available and secondly if the new gear was available (Naturally the second figure will be smaller)
- Step 7 is to guesstimate the repair cost of the event firstly with no new equipment and secondly with the new equipment
- Step 6 is to assign a realistic event detection certainty with the new equipment. i.e 20% of the time the new equipment will pick up any given fault.

All of the above data is entered into a spreadsheet which calculates a Weibull probability of that event occurring in any one year over the life of the new equipment, say 10 years. This probability is

multiplied by the detection certainty and by the saving of using the new equipment over the status quo to give a benefit for each event for each year. These benefits are added together and entered in the CBA.

### Additional Benefits

The attractions of this calculation are many. If the CBA is too low or too high the factors in the probability are very easily “tweaked” ie an event could be more likely or the duration can be varied to suit. All this can be done easily and as they are best guesses they are difficult to argue with. The resulting Weibull probability function is generally too complex for most to argue with and is based on standard probability theory. The big benefit is that using this method a \$ saving can be placed on an event which may never happen.

### Does this Approach Work?

I can, in all honesty, say yes it does. This approach was used to justify \$1.4 M to install an online monitoring, protection and diagnostic system at a power station which had had few major problems.

### Appendix 1. List of failure modes

- Shaft Crack
- Shaft to Casing Rub
- White metal bearing failure
- MBFP Gearbox failure
- Rotor Earth fault
- Shaft bend
- Loss of rotating part (ie blade etc)
- Alignment shift

### Appendix 2

Typical Weibull probability calculation, spreadsheet cell formula (see fig. 1 below).

$$=(((\$E13*(\$F13-\$H13))*M\$6)+(\$G13-\$I13))*J13*((1-EXP(-(((U\$12+\$D13)/(\$C13/EXP(GAMMALN((1+\$B13)/\$B13))))^{\$B13}))- (1-EXP(-(((U\$12-1+\$D13)/(\$C13/EXP(GAMMALN((1+\$B13)/\$B13))))^{\$B13}))))$$

Who's going to argue with this? ■

fig. 1

Loss Event	Probability		Working Age in '96 (years)	Predicted Status Quo Loss			Potential New System Losses	
	Beta	MTTF (years)		Loss MW	Loss Duration (days)	Loss Repair Cost	Duration	Repair Cost
Shaft Crack	3	50	13	250	90	\$1,018,400	50	\$788,000
Shaft to Casing Rub	1	5	13	250	5	\$19,200	2	\$7,680
White metal bearing failure	2	15	13	250	20	\$10,000	3	\$5,000
MBFP Gearbox failure	2	10	13	100	3	\$65,760	2	\$6,840
Rotor Earth fault	3	20	4	250	120	\$941,200	14	\$54,760
Shaft bend	1	20	13	250	2	\$7,680	1	\$3,840
Loss of rotating part (ie blade etc)	2	20	13	250	30	\$125,200	6	\$28,040
Alignment shift	1	5	5	250	2	\$2,880	1	\$1,440
Foundation or bearing pedestal crack	2	20	13	250	14	\$53,760	7	\$26,880
Feedpump mechanical seal failure	1	3	2	100	3	\$51,520	1	\$1,920
Transducer replacement @\$4k each		0.5		0		\$16,000		\$0
Endcap shift	1	10	13	250	3	\$2,000	2	\$1,000

## 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.

10 - Good | 14 - Very Good | 17+ - Excellent



Can you place the name?

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## 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. **110** words (four letters or more) that can be made from the combination of letters below. How many can you make?

*Solution on page 31.*

E	U	T
R	V	N
D	A	E

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.

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

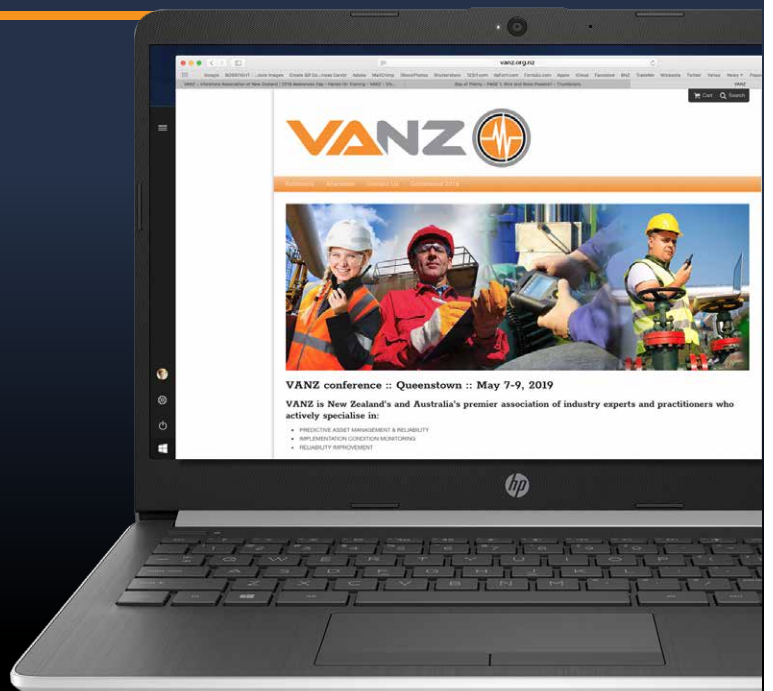
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TEST YOUR KNOWLEDGE - PART 63 OF A SERIES

- 1 A graph which depicts the time-line of the departure from the healthy state of an asset through to failure is known as what?**
  - a A-Z Curve
  - b X-Y Curve
  - c P-F Curve
  - d H-D Curve
- 2 As a general rule when making measurements of vibrations (including sound), the source frequency and the measured frequency are identical. There is an exception to this however. In which of the following might this be so?**
  - a When measuring very low-frequency signals
  - b When measuring very high-frequency signals
  - c When the source object is moving closer or nearer relative to the position where the measurement is being taken
  - d None of the above
- 3 If there are no structural influences, what is the likely phase relationship between the horizontal and vertical vibrations (at 1x) on a supporting bearing housing of unbalanced horizontally-mounted rotor?**
  - a 45 degree difference
  - b 90 degree difference
  - c 180 degree difference
  - d 270 degree difference
- 4 What are some of the factors that might influence whether or not machinery faults can be detected at an early stage via a vibration analysis programme?**
  - a The frequency of testing
  - b The accuracy/consistency of transducer placement at the measurement points
  - c The utilisation of software capabilities such as statistical alarms
  - d All of the above
- 5 How many stages of bearing failure are there?**
  - a 3
  - b 4
  - c 5
  - d 6
- 6 A dust-scrubber fan generates tonal noise at blade-passing frequency. For this fan this frequency is 188 Hz. Which of the following rankings (best to worst) would apply to the effectiveness (in terms of frequency identification) of three different measurement methods deployed to measure this tone?**
  - a FFT – 500 Hz fmax and 400 lines, third-octave, octave
  - b Octave, third-octave, FFT 500 Hz fmax and 400 lines
  - c Third-octave, octave, FFT 500 Hz fmax and 400 lines
  - d FFT 500 Hz fmax and 400 lines, octave, third-octave
- 7 A rolling element bearing was removed from a machine and found to have extensive wear in the cage pockets. What is the most-likely cause of this wear?**
  - a Unbalance
  - b Misalignment
  - c Stray electrical currents
  - d Poor lubrication
- 8 A belt-driven industrial fan has an overhung impeller (i.e. the impeller is outside of the supporting bearings). The 1x vibration is high and there is a 180 degree difference in the horizontal phase readings on the two supporting bearings. What might you conclude from this?**
  - a The fan has a couple unbalance
  - b The fan has a static unbalance
  - c The fan has a dynamic unbalance
  - d Without knowing the structural responses, no conclusion can be reached with complete certainty
- 9 Which of the following unbalance conditions can (in theory) be resolved by balancing in one plane?**
  - a Dynamic unbalance
  - b Quasi-static unbalance
  - c Couple unbalance
  - d None of the above
- 10 An unbalanced rotor operates above its first critical. Which of the following is true?**
  - a Multi-plane balancing may be required
  - b The rotor can be balanced in a single plane
  - c The rotor can be balanced in two planes
  - d The rotor will “auto-balance” at its operating speed.

Answers on page 25



# Spectrum

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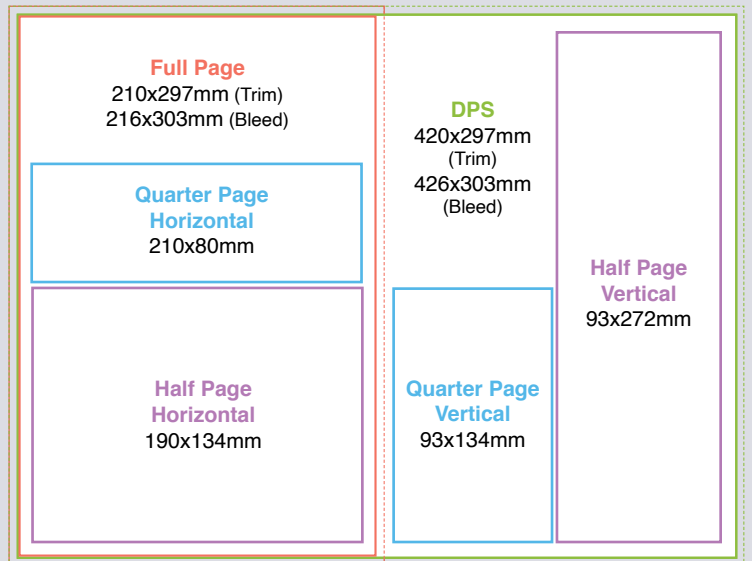
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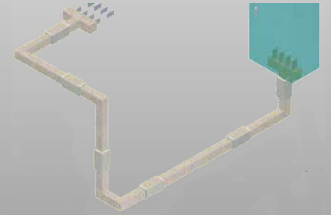
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Answers to Word March #99: Adventure  
1C, 2C, 3B, 4D, 5B, 6A, 7D, 8D, 9B, 10A  
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