The official journal of the Vibrations Association of New Zealand

Spectrum

Autumn 2020 | Issue 96

31st annual conference cancelled by COVID-19

See inside for full details...

+ New B&K Vibro system commissioned at Huntly Power Station

Monitoring makes sense

and much more inside...

VANZ
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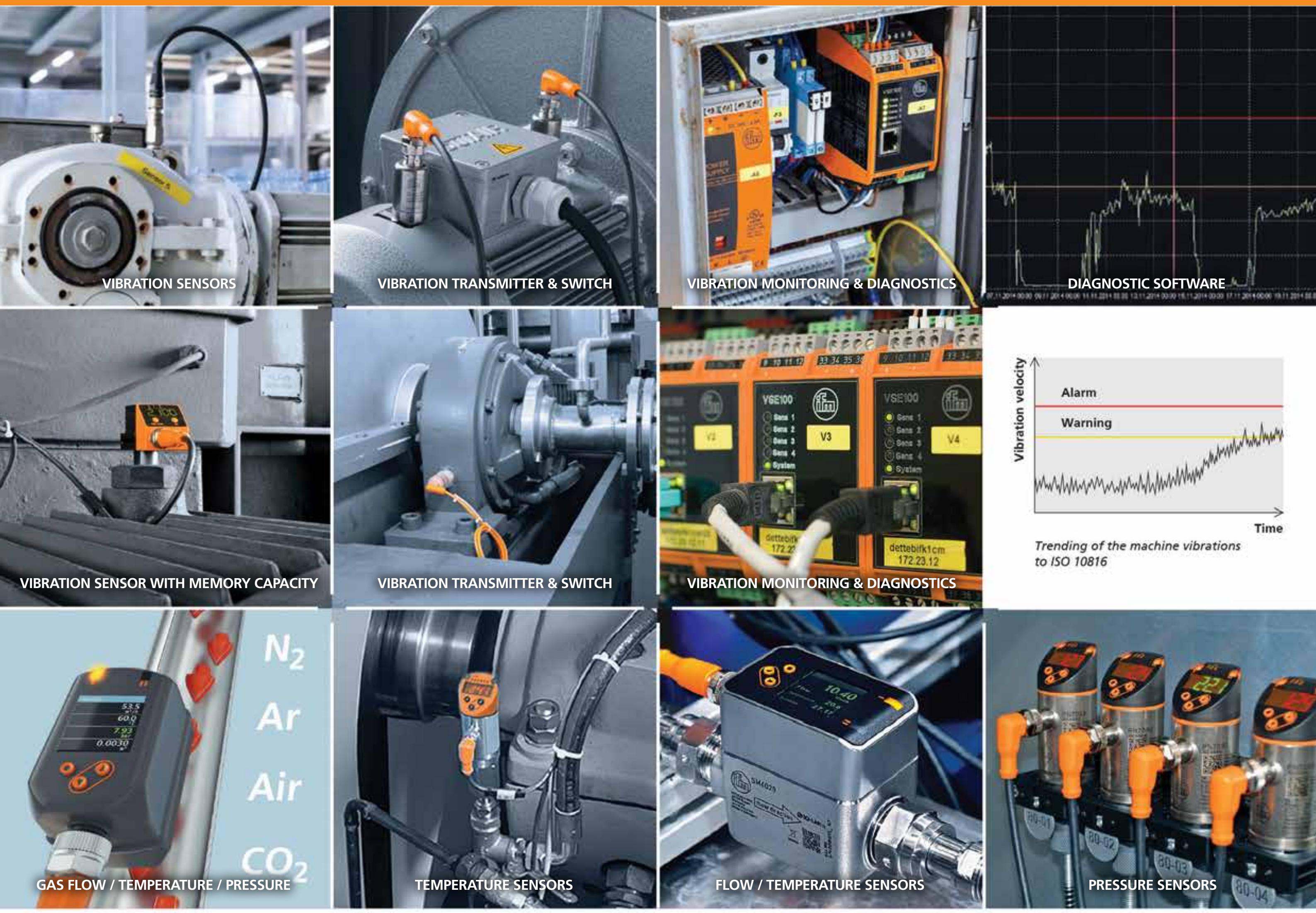

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Spectrum #96

ISSN 1173-793X

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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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VANZ
VIBRATIONS ASSOCIATION of NEW ZEALAND

PRESIDENTS' REPORT

By Rodney Bell, VANZ President

Hi everyone, I'm not sure how to find the words for a Presidents report while we as a country work through this terrible pandemic. COVID-19 has dealt some catastrophic blows to families, businesses and the global economies, I trust I speak for all the VANZ committee and its wider community that we can all work together to help eradicate or at least minimise the effects of this crisis and come through the other side stronger as a nation.

As the impact of Covid 19 restrictions unfolded during March, the conference committee were forced to initially postpone then cancel the VANZ 2020 Tauranga Conference for the safety and wellbeing of all concerned and this was well before the government announcement. Whilst a difficult decision to make at those early stages, we can all now see, it was the right call to make.

At this early stage, VANZ plans to reschedule our 2020 annual conference to the same timing next year in mid-May 2021 at the same venue, Trinity Wharf Hotel, Tauranga, but only once we work out the finer details. For those that have registered as an Exhibitor or Attendee for the 2020 conference, we have requested holding these funds with VANZ as a credit to be used for the 2021 conference, but we also understand some organisations will require a refund and this will be available on request.

For now, everyone's focus must be on keeping our families safe and looking forward to re-invigorating our businesses for the sake of New Zealand's economic future. The VANZ committee wishes you all the best in achieving a successful outcome to this global pandemic and hope to see you at the 2021 conference.

As the impact of Covid 19 restrictions unfolded during March, the conference committee were forced to initially postpone then cancel the VANZ 2020 Tauranga Conference.

EDITORS' CORNER

In these unprecedented times it can be hard to find perspective, whether we're thinking about events that have been cancelled, jobs/projects that we've had to abandon, maybe travel plans or time with loved ones that have been quashed because of the pandemic that is causing such chaos. It does us no good collectively to speculate about the future with so many variables, even predictive maintenance specialists can't help with that one, but following guidelines that have been set out by those in the field of epidemiology and the like is a sure place to start.

Protect those in your bubble, especially the elderly and immuno-compromised, stick to the social distancing at all times and do what you can for those who are in great need due to loss of income, loss of a friend or family member from the virus. Do your part to help stop the spread of this invisible enemy and we can start to recover sooner rather than later.

With that said, in the following pages you will find a collaborative article from Michael Hastings and Simon Hurricks about the Setpoint system commissioned at the Genesis Energy Huntly Power Station, also you can read the next two instalments from Bluescope Steel. In this issue you will also find more pearls of wisdom from our President and be sure to check out Carl's Quiz for another opportunity to wrack your brains.

Many thanks to our advertisers who continue to support us, not only thru Spectrum but also with sponsorship at past conferences and trade stands.

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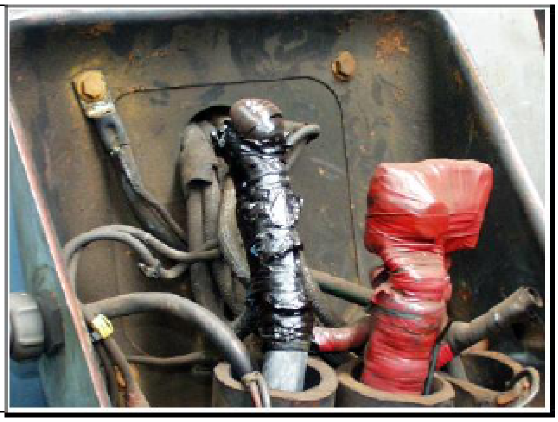


#2 BRIDLE - #2 ROLL | PKL - CRD

IR Info	Value
ems	0.86
dist	1
envtmp	25
Date	2004-1-14
Time	16:0:46
Label	Value
Max:Temp	270.03

Dangerous heating, (270.03°) is occurring at the negative connection inside the motor terminal box.

This heating is caused by a faulty crimp lug which needs to be replaced as soon as possible....

Load ??? Amps

Temperature is approx. 270.03° Celsius
URGENT

Lug connection practices

Thermal imaging performed on electrical connections across the plant has revealed some common inconsistencies with regard to lug connection practices. High temperatures detected on electrical connections highlight the potential for poor equipment reliability.

Inspection of these connections revealed inconsistencies such as;

- Connection preparation not understood
- Incorrect lugs and fasteners (hardware) used in connection
- Fastener torque settings not known or understood

All of these issues were DEFECTS, which had the potential to cause failures and reduce UPTIME.

We remove these defects by assembling the parts using the correct hardware, in the correct order and tightening the nuts to the correct torques using tension wrenches.This thermogram (above) is an example of how assembly problems reveal themselves. This initial experience shows that we need to be aware of the correct method for lugged connections, and that there are many more of these defects out there (waiting to bite us) that must be eliminated.

Correct preparation, hardware selection and order of assembly

ALUMINIUM CABLE + ALUMINIUM LUG – ALUMINIUM BUS

1. Only Zinc passivated High Tensile bolts, nuts, Belleville washers & flat washers are to be used.
2. Jointing compound such as Alminox (Store Stock item # 340828) is to be used as follows.

Prepared by Bluescope Steel.

(a) Select the correct size Aluminium Lug for the Aluminium Cable.
Appendix 2. BSL Employee Development Module E2.1.1 – Power Terminations.
(b) Strip Aluminium cable to suit selected lug ferrule. Do not damage cable strands.
(c) Brush, the exposed cable surfaces using a Stainless Steel Wire brush (scratch brushing).
(d) Immediately after brushing, apply joint compound to Aluminium contact surfaces. This prevents the formation of non-conductive Aluminium Oxide layer.
(e) Remove protection plug from Aluminium Lug. Aluminium Lug is already primed inside ferrule with joint compound.
(f) Insert cable into ferrule and crimp immediatetly with correct crimp die for lug size. Appendix 2. BSL Employee Development Module E2.1.1 – Power Terminations.
(g) Thoroughly clean contact surfaces and remove burrs (Aluminium Lug Palm and Aluminium Bus Bar).
(h) Brush, the contact surfaces using a Stainless Steel Wire brush (scratch brushing).
(i) Immediately after brushing, apply joint compound to Aluminium contact surfaces. This prevents the formation of non-conductive Aluminium Oxide layer.
(j) Assemble joint without removing compound. Use Flat and Belleville washer as shown in Diagram 1.
(k) Nuts to be tightened as specified in the table 1.

COPPER CABLE + COPPER LUG (tinned) – COPPER BUS or COPPER LUG

1. Only (Fine Thread – UNF) Zinc passivated High Tensile, nuts, spring & flat washers are to be used. Belleville washers and Joint compounds are NOT REQUIRED.

(a) Select the correct size Copper Lug for the Copper Cable.
Appendix 1. BSL Employee Development Module E2.1.1 – Power Terminations.
(b) Strip Copper Cable to suit selected lug ferrule. Do not damage cable strands.
(c) Prepare cable and crimp lug using the correct die.
Appendix 1. BSL Employee Development Module E2.1.1 – Power Terminations.
(d) Lug termination - Thoroughly clean contact surfaces and remove burrs.
(e) Assemble joint fasteners (Fine Thread) with Flat and spring washer as shown in Diagram 2. Belleville washers are NOT REQUIRED.
(f) Nuts to be tightened to the torque values specified in the table 2.

ALUMINIUM CABLE + BI-METAL LUG – COPPER BUS or COPPER LUG

Select the correct size Copper Lug for the Copper Cable.
Appendix 3. BSL Employee Development Module E2.1.1 – Power Terminations.
Lug Preparation as per ALUMINIUM CABLE + ALUMINIUM LUG.
Lug termination as per COPPER LUG – COPPER BUS or COPPER LUG.
Use Flat and spring washers as shown in Diagram 2.

COPPER (bare) – ALUMINIUM

Bare Copper to Aluminium connections are to be avoided, due to the galvanic reaction between these metals leading to corrosion of connection and high resistance of joint.
A Bi-metal sheet (30% Copper / 70% Aluminium) can be inserted between copper component and aluminium component. Sheet size cut to exceed aluminium component contact area by 5mm around perimeter. Connection as per ALUMINIUM - ALUMINIUM.
If Bi-metal sheet is unobtainable change connection type to Copper (tinned).
Use the Flat and Belleville washer as shown in Diagram 3.

BOLTING TORQUES FOR LUGS

- Bolt holes for M10 must always have a clearance of at least 0.8mm (1/32") .

Continued on page 8 >

Table 1. Combination of Bellville Washers and Flat Washers		
Bolt Size mm	Backed off from flattened Belleville (But Not exceeding)	
HT Steel	Coarse thread	Fine thread
M10	1/6 turn	1/4 – 1/3 turn
M12	1/6 turn	1/4 – 1/3 turn
M16	1/6 turn	1/4 – 1/3 turn

Table 2. Flat and Spring Washers only		
Bolt Size mm	Recommended Torque	
HT Steel	lb ft	Nm
M10	15	20
M12	30	40
M16	60	80

- Bolt holes for M12 and over must always have a clearance of at least 1.6mm (1/16") .
- Bolt thread to extend from nut face by greater than 1 thread and not greater than 6mm (1/4").
- Bolts are High Tensile Steel, Grade is SAE 8.8 , Zinc Passivated.

Holes in all connected components must be the same dimension. If different size cable lugs are terminated together either;

1. 1. Use a flat link (bus bar section) of compatible material and correct sizing for current carrying capacity, to interconnect lugs. Diagram 4.
2. 2. Select lugs with palms pre-drilled with the same dimension hole or select the larger lug with a BLANK palm and drill hole dimension to suit smaller lug. Diagrams 5 – 6.

All bolts must be torqued up in stages, in order to ensure good contact between lug and bus bar surfaces. Do not tighten to final torque setting in one step. It is recommend to tighten all bolts to 50% torque and then to final torque setting.

Note. There is an alternate method for tensioning connections with Belleville washers without a torque wrench. Nuts may be tightened down to flatten the Belleville washer and then backed off;

- *Not exceeding one sixth of a turn for coarse (Metric Coarse & UNC) threads*
- *Not exceeding one quarter to one third of a turn for fine (Metric Fine & UNF) threads.*

Diagram 1.

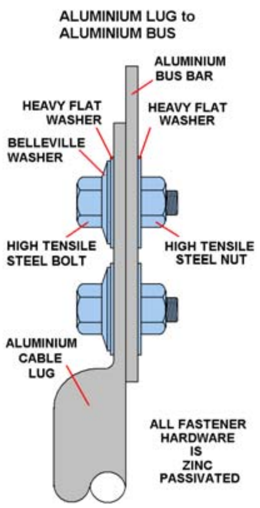


Diagram 2.

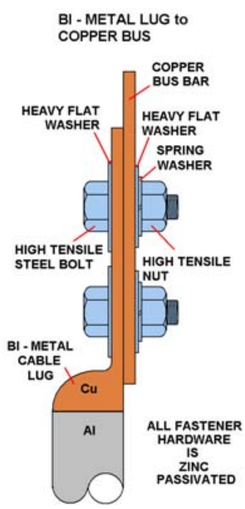


Diagram 3.

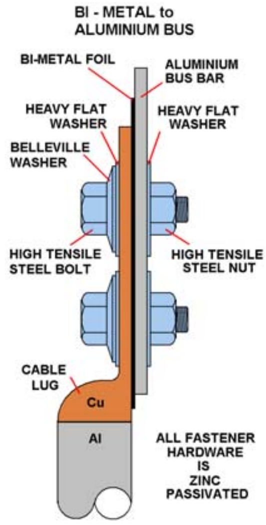


Diagram 4.

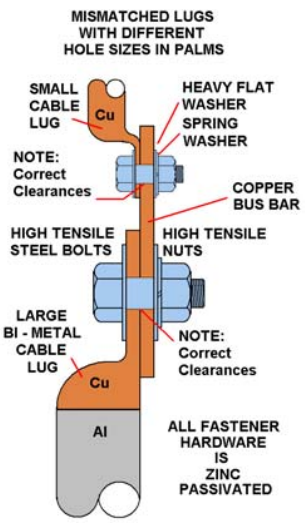
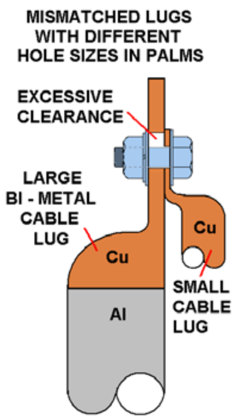


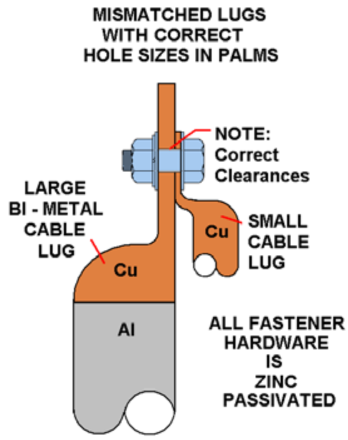
Diagram 5.



This is not good practice!

Lug from thermogram on page 1, viewed from both sides.

Diagram 6.



This is good practice!

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. And that is why VANZ exists, and why VANZ constantly evolves!

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.

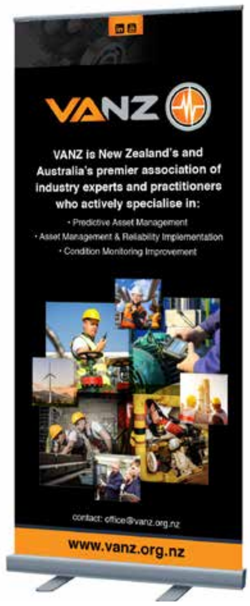
The size of the operation and the machinery it runs are not an issue either. VANZ membership ranges from a business with a line of small water pumps to personnel from some of the largest plants running million dollar machines.

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.

For more information about membership please contact the VANZ secretary by emailing secretary@vanz.org.nz

Brüel & Kjær Vibro Setpoint system commissioned at Huntly Power Station

The largest thermal power station in New Zealand, Huntly Power Station is now under new watchful eyes. The Brüel & Kjær Vibro (B&K Vibro) Setpoint system was installed and commissioned for condition monitoring and protection of turbo-generator Unit 1.

Legacy monitoring systems

In 1994 Genesis Energy installed the B&K Vibro Compass Classic monitoring system on all four 250 MW turbo-generators at Huntly Power Station (see Figure 3). There was condition monitoring and protection for the steam turbine, generator and feed pump for each unit. In 2010, as part of the control system upgrade, the monitoring systems on Rankine Units 2 and 4 were upgraded to B&K Vibro VC-6000 Compass 6000 system.

Since then Unit 3 was retired from service and Units 1 and 4 have been operating to system requirements with Unit 2 dry-stored. In 2019 Unit 1 was to have a 3-month maintenance outage which was the ideal time to install a new monitoring system (see Figure 2).

Figure 2. Rankine Unit 1. Rankine refers to the thermodynamic cycle of the steam turbines, which are Units 1 to 4. Other generating units at Huntly include Unit 5, which is a 385 MW combined cycle plant (Rankine and Brayton cycle) and Unit 6, which is a 50 MW gas turbine for peaking (Brayton open-cycle).

Figure 1. Genesis Energy Huntly Power Station.

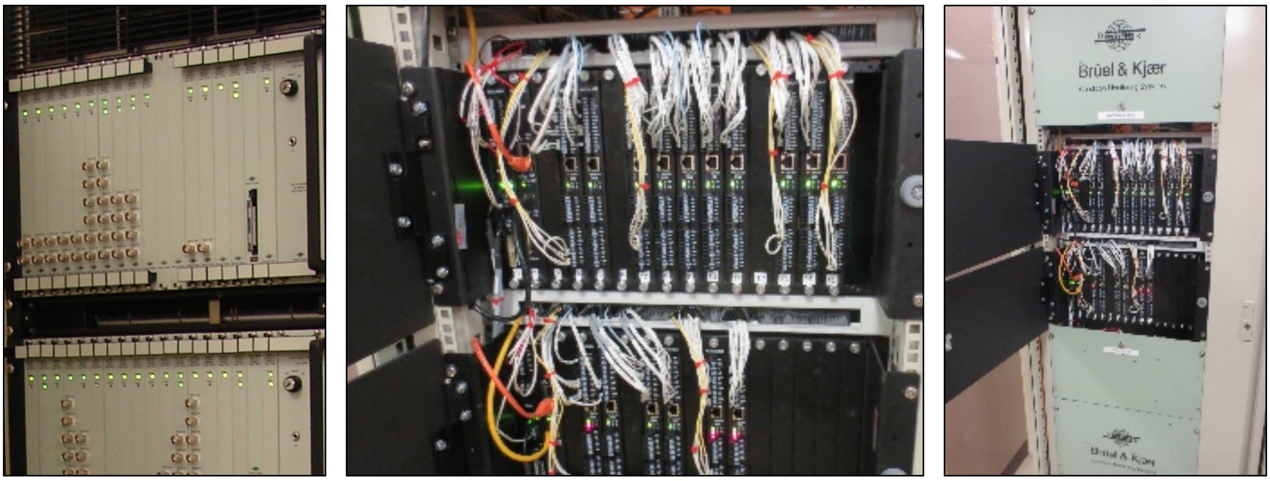


Figure 3. Left; two racks installed on Unit 1 showing the legacy Compass Classic monitoring system from 1994. Centre and right; VC-8000 Setpoint installation in 2019.

Challenge

Unit 1 still had the 25-year-old Compass Classic monitoring system installed, which was already obsolete with no spare parts available. In 2018 an investigation was done to determine the functionally best and most cost-effective replacement for the existing system. Some of the important requirements for selecting a new system were:

- Transient speed monitoring – The unique rotor-dynamics of the generators results in a run up to operating speed that passes through a couple of critical speeds and a bearing resonance, some of which occurring very close to one and another at running speed. The monitoring system is required to individually monitor these peaks within various speed bands during run up (i.e. profile alarming) to detect anomalies
- Storing data in the PI data historian – Monitoring data should be stored in the existing PI system for correlation and trending purposes
- Remote monitoring – Remote access is required for accessing condition monitoring data and diagnostic functions and plots, as well as for remotely configuring monitoring and alarm setup functions.

Results

Genesis Energy looked at viable options to upgrade the Unit 1 monitoring system and the B&K Vibro VC-8000 Setpoint system was ultimately selected to replace the legacy Compass Classic system.

Up until December 2018 there was no budget allocated for the upgrade. A very strong case was put forwards to carry out the upgrade during the Unit 1 outage, which included a risk analysis detailing the consequences that could result due to a failure of the existing monitoring system. A budget was subsequently allocated, approved and a contract signed within two weeks, which is record time considering it was done over the Christmas period. Setpoint was installed and later commissioned in June 2019 (see Figure 3). Since it was commissioned, the Setpoint system has been providing the functionality and benefits described below.

PI data historian – Setpoint already has a PI data interface, so the physical installation was both cost-effective and fast since there was no proprietary condition monitoring server that was needed to be installed. All data can be stored in PI. The existing Genesis Energy PI system consists of the local PI database server at the power station and the corporate network server. Setpoint transfers both single-point data (static data) and time waveforms (dynamic data) into the local PI server, but only static data is being transferred to the corporate network server to minimise network traffic and hard drive space. The static data, which consists of vibration amplitude and phase measurements

Continued on page 12 >

Simon Hurricks is the Predictive Maintenance Engineer with Genesis Energy. He has been with Genesis and its predecessors for 49 years and based at Huntly Power Station for the last 39 years. He has extensive experience in the last 41 years in vibration analysis, condition monitoring, balancing and has also worked in modal balancing and resonance testing. He has presented numerous papers and written many articles within his area of expertise and has held various positions in the Vibrations Association of New Zealand.

The Setpoint system has taken over the role of the Compass legacy system by successfully fulfilling the special monitoring requirements at Huntly.

(overall, running speed, running speed harmonics), axial displacement, eccentricity, differential expansion, etc., is correlated and trended with process data which includes temperature, condenser vacuum, active load, reactive load, etc. All diagnostic analysis such as orbit plots, shaft centreline plots, Bode plots, etc., is currently done in the Setpoint system, not in PI, although the dynamic data is stored in the local PI sever.

Differential thermal expansion - Setpoint plays an important role in monitoring the differential expansion of the steam turbine rotor in relation to the casing during start-up. This is critical for the high-pressure portion, since the loading sometimes has to be put on hold until the expansion evens out. Setpoint has the necessary resolution to monitor this condition accurately and can activate relays when necessary. Alert alarm relays are programmed in the distributed control system (DCS) to put a hold on loading during start-up if the differential expansion limits exceed the alert alarm limits. If the danger alarm limits are exceeded, the unit is tripped.

Balancing – This is a challenge for the generator as the 2nd critical speed is so close to running speed. As a result, a balance weight of only 200 g has a considerable effect when balancing the 42-ton rotor. Even the endcaps on the generator have a significant effect as the balance can change when the endcaps settle into position after a balance weight change. The profile alarming function of Setpoint enables the entire balancing process to be accurately and safely monitored between weight changes. (It takes approximately 24 hours between weight changes because the generator casing is hydrogen filled).

Transient speed monitoring – Setpoint can accurately monitor resonances and critical speeds during run up and activate relays when limits are exceeded. Monitoring is done on the entire drive train but is particularly important for the generator. Similar to the differential expansion monitoring, the alert relays for transient speed monitoring are programmed in the DCS to reduce speed if the vibration amplitude exceeds the alert limits. The unit will trip if the danger limits are exceeded. As in the case for the differential expansion, the Predictive Maintenance Engineer is notified to do diagnostic root cause analysis if there is an alert alarm issued or the unit is tripped.

Conclusion

The Setpoint system has taken over the role of the Compass legacy system by successfully fulfilling the special monitoring requirements at Huntly. Plans are currently underway to look at the possibility of installing Setpoint on Unit 5 (385 MW Combined cycle unit) as the operation of this unit changes from base load to two-shifting operation.

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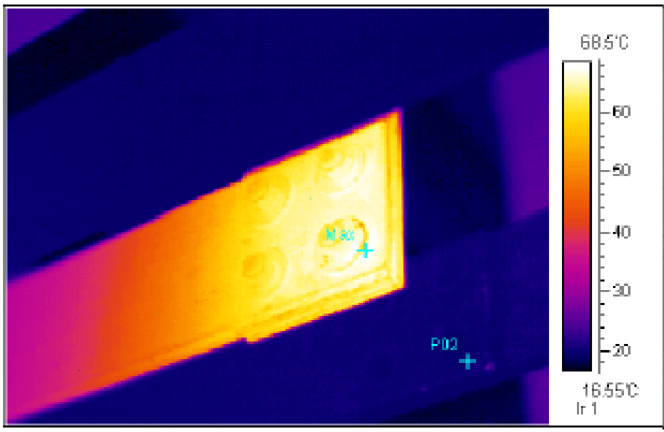
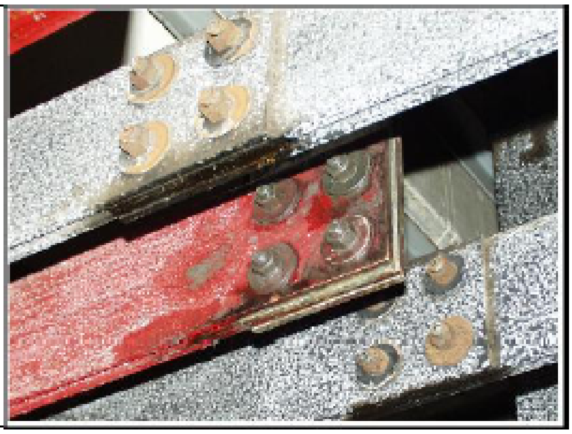




STAND 2 - POSITIVE BUSBAR FSM BASEMENT | FSM - CRD

IR Info	Value
ems	0.86
dist	1
envtmp	25
Date	2004-1-12
Time	11:17:6
Label	Value
Max:Temp	68.5
P02:Temp	20.21

Severe heating, (68.50°) is occurring at the bolted joint shown in this image. Apart from the fact that it connects to Stand 2, there is no simple way to identify it apart from pointing out that an arrow has been scratched into the steel support frame below the connection.

This connection also appears to have been recently overhauled, however it is still heating.

Load ? Amps

Temperature rise approx. 48.29° Celsius
URGENT

Aluminium & copper bus bar connection practices

Thermal Imaging Performed On Various Bus Bar Systems Across The Plant Has Revealed Some Common Inconsistencies With Regard To Connection Practices With These Systems.

High temperatures detected on electrical connections highlight the potential for poor equipment reliability. Inspection of these connections revealed inconsistencies such as;

- Connection preparation not understood
- Incorrect fasteners (hardware) used in connection
- Fastener torque settings not known or understood

All of these issues were DEFECTS, which had the potential to cause failures and reduce UPTIME. We remove these defects by assembling the parts using the correct hardware, in the correct order and tightening the nuts to the correct torques using tension wrenches. The thermogram (above) is an example of how assembly problems reveal themselves. This initial experience shows that we need to be aware of the correct method for bus bar connections, and that there are many more of these defects out there (waiting to bite us) that must be eliminated.

Correct preparation, hardware and order of assembly

ALUMINIUM – ALUMINIUM

1. Only Zinc passivated High Tensile bolts, nuts,

Prepared by Bluescope Steel.

Table 1.

Bar Width mm		Bolt Config. Diag 3	Bolt Spacing mm				No. Bolts	Bolt Size mm	Recommended Torque **Spring Washer and Flat Washers** only		Backed off from flattened **Belleville Washer** (But not exceeding)		Maximum Current Capacity AMPS	
A	B		C	D	E	F		HT Steel	lb ft	Nm	Coarse Thread	Fine Thread	Al	Cu
50	25	1A	12.7	25			2	M10	25-30	34-41	1/6 turn	1/4 –1/3	180	371
50	38	1A	12.7	25			2	M10	25-30	34-41	1/6 turn	1/4 –1/3	291	598
50	50	1A	12.7	25			2	M10	25-30	34-41	1/6 turn	1/4 –1/3	393	809
76	25	1A	19	38			2	M10	25-30	34-41	1/6 turn	1/4 –1/3	291	598
76	38	1A	19	38			2	M10	25-30	34-41	1/6 turn	1/4 –1/3	459	945
76	50	1A	19	38			2	M10	25-30	34-41	1/6 turn *	1/4 –1/3*	613	1263
76	76	2	19	38	19	38	4	M10	25-30	34-41	1/6 turn	1/4 –1/3	913	1880
100	50	1A	25	50			2	M12	40-60	54-81	1/6 turn	1/4 –1/3	804	1555
100	76	2	25	50	19	38	4	M10	25-30	34-41	1/6 turn *	1/4 –1/3*	1227	2527
100	100	2	25	50	25	50	4	M12	40-60	54-81	1/6 turn	1/4 –1/3	1610	3315
127	50	1A	32	64			2	M12	40-60	54-81	1/6 turn	1/4 –1/3	1034	2128
127	76	2	32	64	19	38	4	M10	25-30	34-41	1/6 turn *	1/4 –1/3*	1576	3245
127	100	2	32	64	25	50	4	M12	40-60	54-81	1/6 turn	1/4 –1/3	2069	4260
127	127	3	32	64	32	64	5	M12	40-60	54-81	1/6 turn	1/4 –1/3	2628	5411
152	50	1B	32	45			3	M12	40-60	54-81	1/6 turn	1/4 –1/3	1244	2562
152	76	4	32	45	19	38	6	M10	25-30	34-41	1/6 turn *	1/4 –1/3*	1867	3843
152	100	2	38	76	25	50	4	M12	40-60	54-81	1/6 turn *	1/4 –1/3*	2494	5134
152	127	3	38	76	32	64	5	M12	40-60	54-81	1/6 turn *	1/4 –1/3*	3169	6524
152	152	4	32	45	38	76	6	M12	40-60	54-81	1/6 turn *	1/4 –1/3*	3793	7809
203	100	4	32	70	25	50	6	M12	40-60	54-81	1/6 turn	1/4 –1/3	3315	6825
203	127	4	32	70	32	64	6	M16	75-100	102-136	1/6 turn	1/4 –1/3	4151	8546
203	152	4	32	70	38	76	6	M16	75-100	102-136	1/6 turn	1/4 –1/3	5013	10321
203	203	5	32	70	32	70	9	M16	75-100	102-136	1/6 turn	1/4 –1/3	6659	13709

Bolt holes for M10 must always have a clearance of at least 0.8mm (1/32") .
Bolt holes for M12 and over must always have a clearance of at least 1.6mm (1/16") .
Bolt thread to extend from nut face by greater than 1 thread and not greater than 6mm (1/4").
Bolts are High Tensile Steel, Grade is SAE 8.8 , Zinc Passivated.

Belleville washers & flat washers are to be used.

2. Jointing compound such as Alminox (Store Stock item # 340828) is to be used as follows.

(a) Thoroughly clean contact surfaces and remove burrs.

(b) Brush, the contact surfaces using a Stainless Steel Wire brush (scratch brushing).

(c) Immediately after brushing, apply joint compound to Aluminium contact surfaces. This prevents the formation of non-conductive Aluminium Oxide layer.

(d) Assemble joint without removing compound. Use Flat and Belleville washer as shown in Diagram 1.

(e) Nuts to be tightened to the torque values specified in the table 1.

COPPER – COPPER

1. Only (Fine Thread – UNF) Zinc passivated High Tensile, nuts, spring & flat washers are to be used. Belleville washers are NOT REQUIRED.

2. Joint can be made dry if installation conditions are acceptable.

(a) Thoroughly clean contact surfaces and remove burrs.

(b) Assemble joint fasteners (Fine Thread) with Flat and spring washer as shown in Diagram 2. Belleville washers are NOT REQUIRED.

(c) Nuts to be tightened to the torque values specified in the table 1.

Continued on page 18 >

COPPER (tinned) – ALUMINIUM
Copper component must be tinned. (tinned area to extent 25% past point of contact). Connection as per ALUMINIUM – ALUMINIUM. *BUT do not abrade or scratch brush tinned copper surface.*

COPPER (bare) – ALUMINIUM
Bare Copper to Aluminium connections are to be avoided, due to the galvanic reaction between these metals leading to corrosion of connection and high resistance of joint.
A Bi-metal sheet (30% Copper / 70% Aluminium) can be inserted between copper component and aluminium component. Sheet size cut to exceed aluminium component contact area by 5mm around perimeter. Connection as per ALUMINIUM - ALUMINIUM. If Bi-metal sheet is unobtainable change connection type to Copper (tinned).
All bolts must be torqued up in stages, in order to ensure good contact between bus bar surfaces. Do not tighten to final torque setting in one step. It is recommend to tighten all bolts to 50% torque and then to final torque setting.
** Denotes a Double Washer Arrangement (Diagram 4.)*

Alternate method for tensioning connections with Belleville washers, without a torque wrench. Nut may be tightened down to flatten the Belleville washer (this is readily felt by hand through the spanner) and then backed off;

- Not exceeding one sixth of a turn for coarse (Metric Coarse & UNC) threads
- Not exceeding one quarter to one third of a turn for fine (Metric Fine & UNF) threads.

Connection Configurations

Diagram 1.

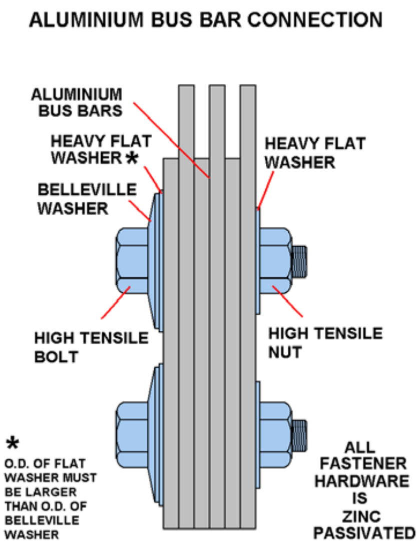


Diagram 2.

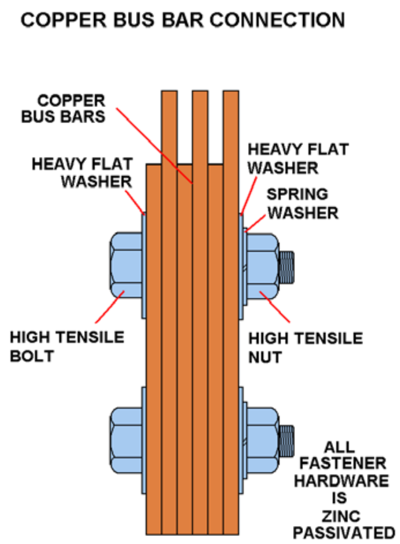


Diagram 3. Bolt configuration.

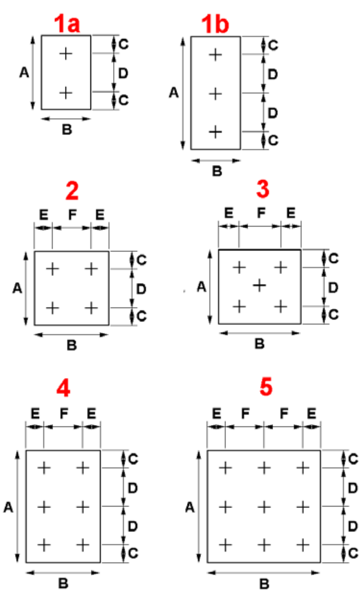
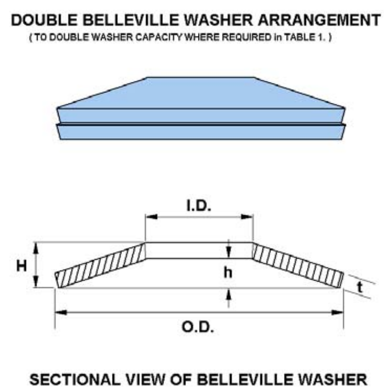


Diagram 4.



Reference: Bluescope Steel Employee Development Module E2.1.1 – Power Terminations.

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

Continued on page 22 >

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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 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.

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 on page 24 >

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The first thing to consider when specifying accelerometers is that there are two main categories: AC accelerometers and 4-20mA accelerometers.

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.

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.

TRADE DIRECTORY

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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.

15 - Good | **20** - Very Good | **25+** - Excellent

T	S	R	P	I

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 is **182** words (three letters or more) that can be made from the combination of letters below. How many can you make?

Solution on page 29.

I	R	T
K	U	S
S	T	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.

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

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TEST YOUR KNOWLEDGE - PART 60 OF A SERIES

1 The letters ODS are most likely to represent which of the following when referencing machine or structural vibrations?

a Operational (or Operating) Deflection Shape
b Overall Digital Signal
c Over-exposure to Daylight Syndrome
d Optimal Design Shape

2 For machines driven by induction motors on VSD control, adding high frequency bonding connections between the installation and known earth reference points to equalise the potential of affected items can be helpful. What are these bonding connections most-likely to look like?

a Braided, flat, copper straps of 50 to 100 mm in width
b Braided, flat, steel straps of 50 to 100 mm in width
c Copper wires whereby the conductor is circular in cross-section
d Copper wires whereby the conductor is star-shaped in cross-section

3 Vibrations which are thought to have beneficial effects on the human body can be induced by which of the following?

a Vibrations from a high-revving, 2-stroke, petrol driven chainsaw
b Vibrations from a jack-hammer
c Low-frequency vibrations emitted by wind-turbines used for electricity generation
d Vibrations emitted by a Tibetan singing bowl

4 How might a modern-day vibration data-collector/ analyser be more advanced than one made 30 years ago?

a It is likely to have higher signal processing speeds
b It is likely to have increased data storage capacity
c It is likely to have improved dynamic and frequency ranges
d All of the above are quite likely

5 In which of the following frequency ranges are you most-likely to find the switching frequencies for a modern VSD drive?

a 40 – 60 Hz
b 80 - 120 Hz
c 2000 – 6000 Hz
d 10000 – 20000 Hz

6 A uniform steel beam is simply supported on trestles at each end. You wish to determine the beam's natural frequencies by means of a bump test. For best results, where would you choose to hit the beam?

a At its centre-point (i.e. mid-span)
b At either end of the beam
c At a point quarter-way along from either end
d Perhaps just to either side of the centre-point might be best

7 For coherence tests, which of the figures below represents full coherence?

a 0.1
b 1
c 10
d 100

8 The natural frequency of your 2-pole magnet/ accelerometer combo is 3.5 kHz. What does this mean if there are data-collection points set-up in your route that have an fmax of 10 kHz?

a The data-base points are wrongly set up – the fmax is too high
b All data above 3.5 kHz for these collected measurements should be ignored
c Signals in the range above 3.5 kHz cannot be trended reliably
d None of the above is necessarily correct

9 Your vibration analyser/ data-collector has an audio output. On one particular machine under test, you can hear impact events but they are not showing in the collected waveform. What might be the reason for this?

a The impact events are missed because the collected time-block is too short
b The impact events are missed because the set

Answers on page 29

Further enquiries can be directed to: Carl Townsend at Carlton Technology Ltd.
Phone: 64-6-759 1134 | Email: ctownsend@xtra.co.nz | Address: P.O. Box 18046 Merrilands, New Plymouth 4360, NZ

measurement frequency range is too low

c The accelerometer you are using does not have sufficient dynamic range

d Either a or b could be correct

10 You might utilise time-synchronous-averaging to assist with identification of which of the following faults?

a Rolling element bearing defects

b Oil-whirl in machines with journal bearings

c Gear teeth defects

d Rotor-bar defects in induction motors

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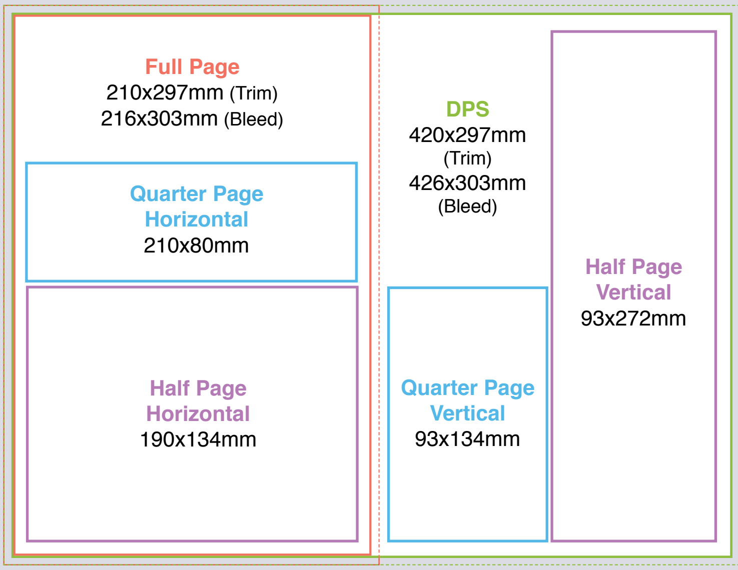

Answers to Carlton Technology Quiz 60:
1A, 2A, 3D, 4D, 5C, 6D, 7B, 8D, 9D, 10C
Answer to Word March #96: Outskirts

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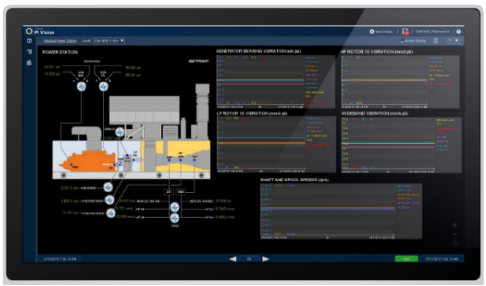

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