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.

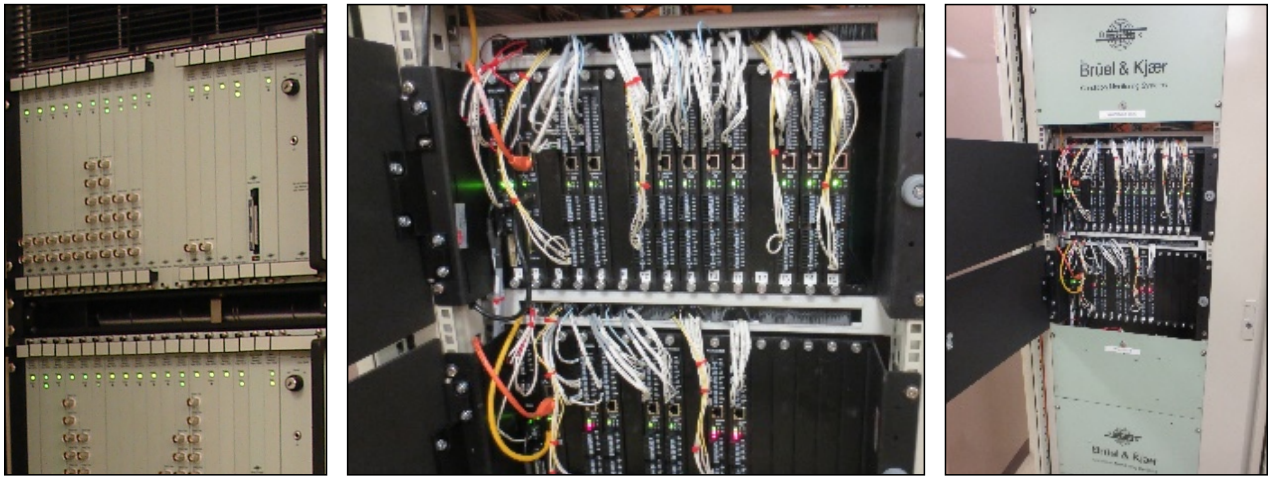

Figure 3. Left; two racks installed on Unit 1 showing the legacy Compass Classic monitoring system from 1994. Centre and right; VC-8000 Setpoint installation in 2019.

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 >

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(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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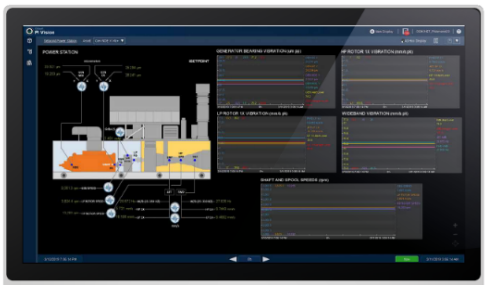

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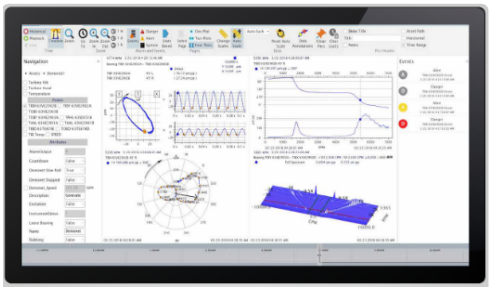

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