Condition Monitoring Specialists

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UNPACKING VIBRATION ANALYSIS - a case study

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INTRODUCTION

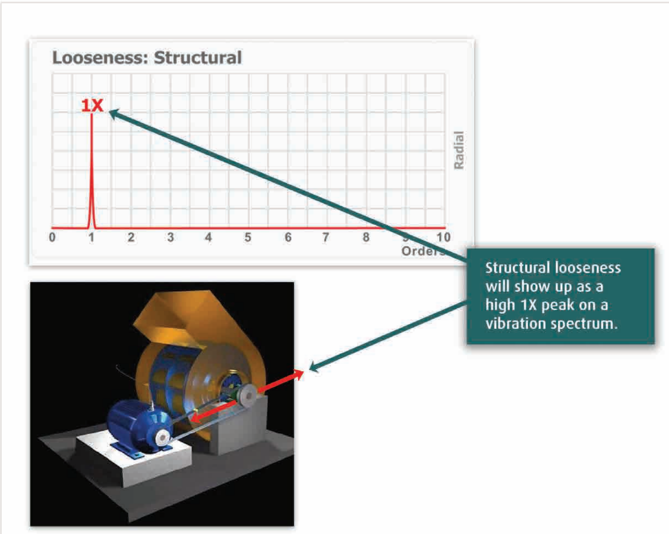
During routine vibration data collection on a Boiler ID fan, it was noticed that severe structural vibration was emanating from the unit. Upon further visual inspection it was apparent that most of the base bolts were loose or completely missing. A request was raised by WearCheck to the relevant mechanical workshop to inspect the machine base of the Boiler ID fan and fasten/replace all bolts as required. This Technical Bulletin demonstrates the usefulness and accuracy of condition monitoring applications on a plant.

WearCheck uses a wide variety of condition monitoring applications to diagnose machine defects and advises asset owners and managers how best to rectify the defects.

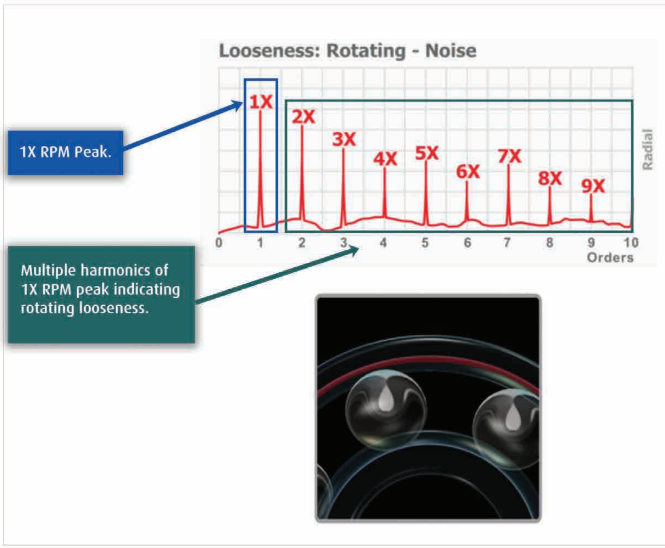
In this case study, the company's asset reliability care (ARC) services team uses vibration analysis to determine what is wrong with a component used in the mining industry.

THE CASE STUDY

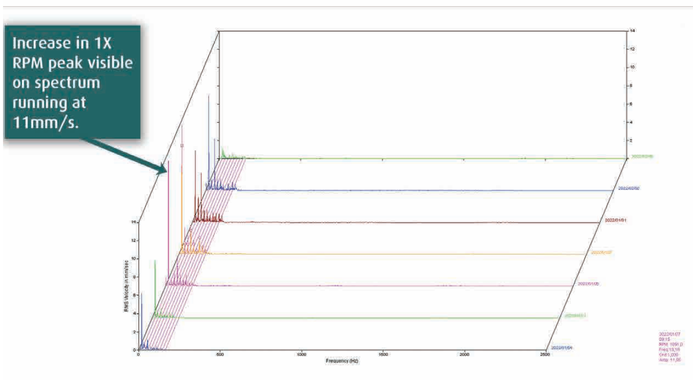
Structural looseness is caused by a weakness in the foundation (e.g., cracks in concrete or, in this particular situation, the loose/missing bolts). This weakness allows the machine to vibrate more freely in the direction where the weakness is greatest and therefore vibration at turning speed, or 1X as we like to call it, will be elevated.



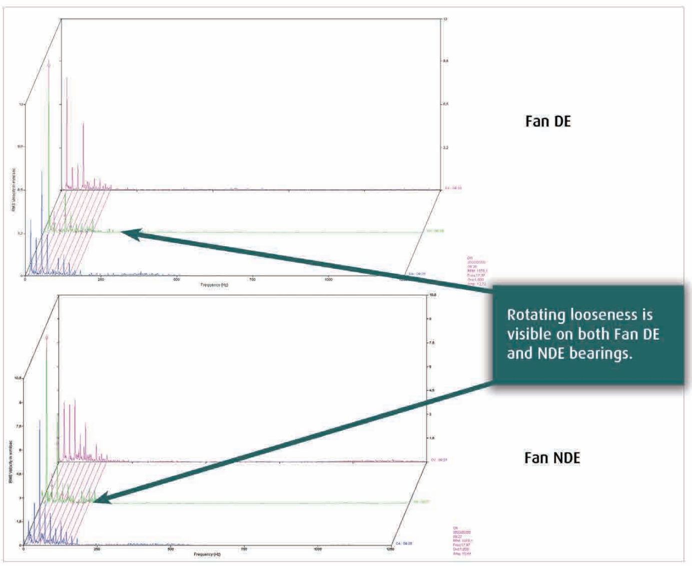
This increase in vibration is always dangerous as this can cause secondary damage to other components of the machine. In this particular case, another defect started to develop, called rotating looseness. Clearance in journal and rolling element bearings will produce harmonics of the 1X peak and will start to occur when there is bearing damage present.



Below is an image of the vibration data from the Boiler ID fan. As can be seen in the graph, there was a clear increase in amplitude of the 1X RPM peak on the spectrum. Our visual inspection of the unit can now confirm the vibration we are seeing on the graph. The loose/missing bolts will definitely be a contributing factor towards the increase in amplitude of the 1X RPM peak.



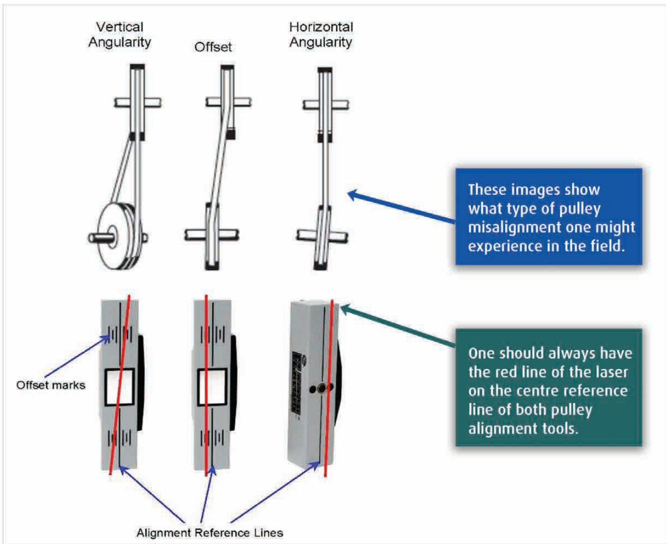
Below is another image of the vibration data that was captured from the Boiler ID fan. In this image, it is evident that secondary damage has occurred to the fan bearings and thus we are now detecting rotating looseness due to bearing wear that was initially instigated by the structural looseness.



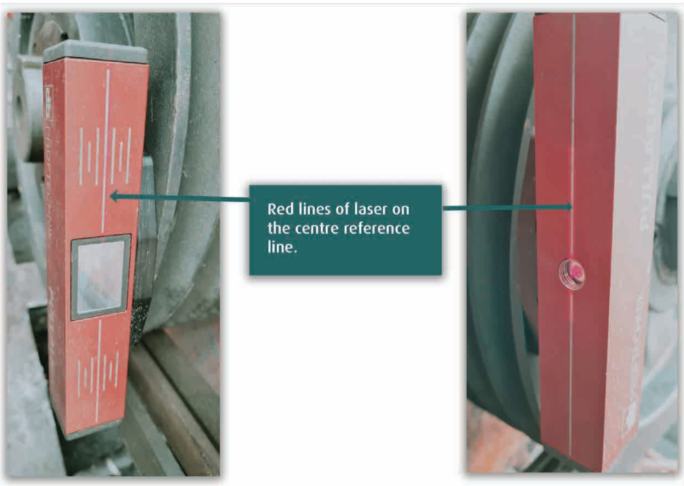
Information about this defect was conveyed to the relevant department, and it was then decided that they would be changing out the fan DE and NDE bearings. After the fan bearings and pulleys were swopped out, WearCheck was requested to do a pulley alignment.

It is always very important to perform an alignment when new components are installed, to avoid any misalignment taking place. Misalignment can cause severe damage to bearings and, when left untreated, can lead to a catastrophic failure of the unit.

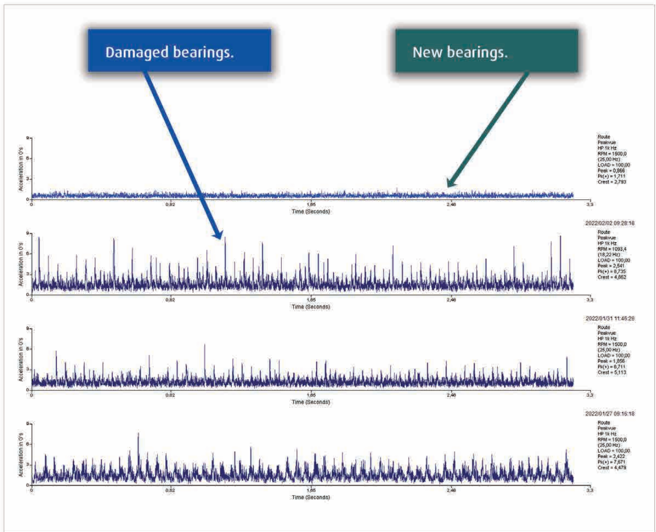
When one performs a pulley alignment, the end result will have both red lines of the laser in the centre of the reference lines. This means both the laser and the reflection of the laser should be on the middle reference line to indicate that the pulleys are correctly aligned.



The following images show the pulley alignment tools after the alignment was completed on the Boiler ID fan, indicating that the alignment was in spec.



After the alignment was completed, another set of vibration readings was taken on the Boiler ID fan. In the following image, it is clear that the bearing damage that was previously visible on the old bearings, is no longer present, which is to be expected seeing that the fan is now running with a new set.



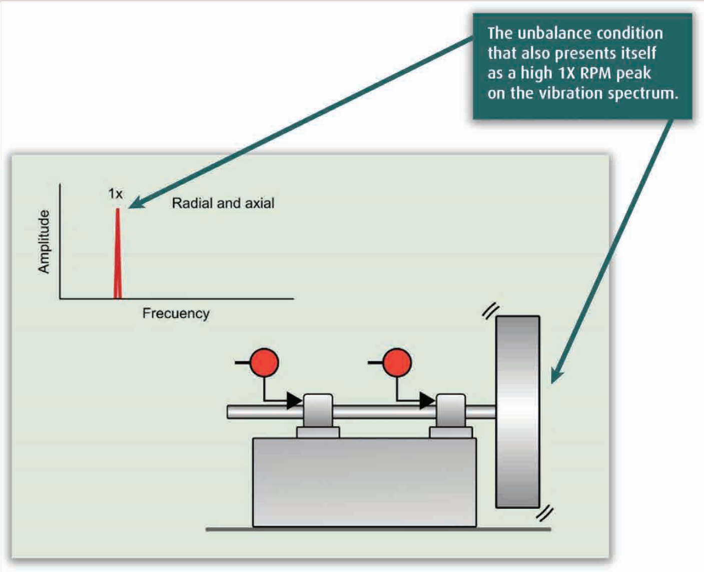
At this moment the Boiler ID fan's

- Base has been repaired and there are now no loose/ missing bolts.
- Bearings have been replaced.
- Pulley alignment was done.

Unfortunately, after all this work was completed ,we still had a problem of a high 1X RPM that was present on the vibration spectrum. This can now only mean one thing - we have an unbalance condition on the fan.

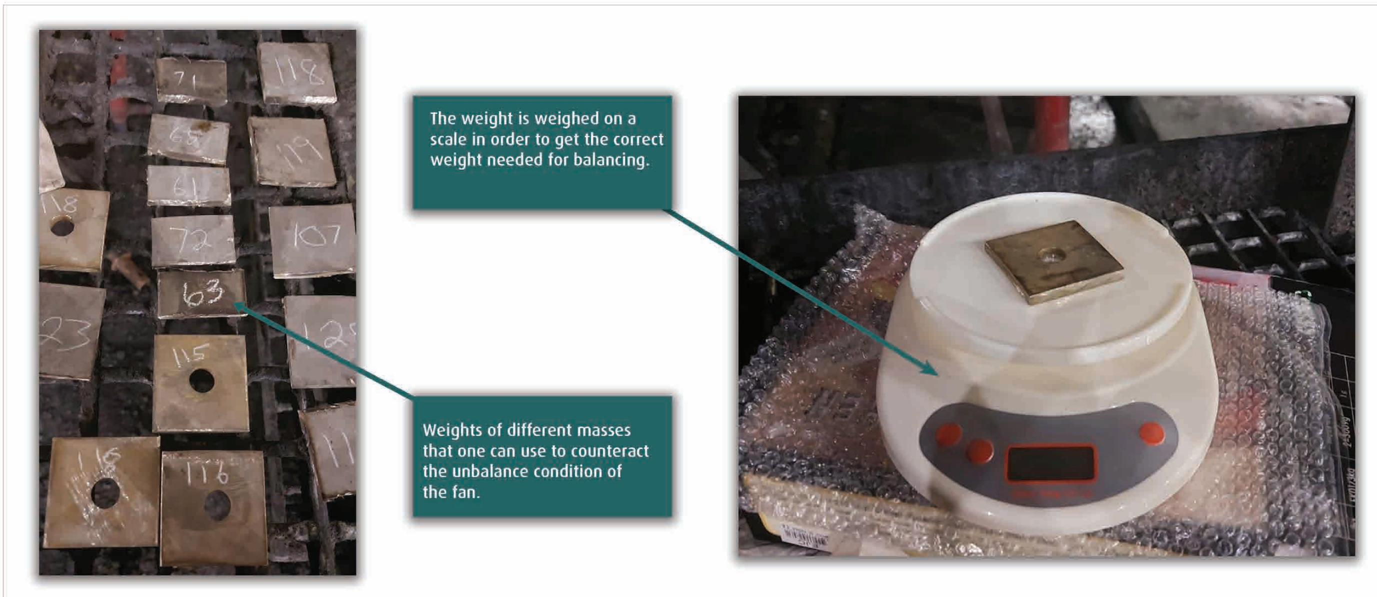
In vibration analysis, different defects will have a similar defect pattern on a vibration spectrum. When we see a high 1X RPM peak, we normally report a structural looseness defect as this is the most common problem we encounter in the field. Other defects like pulley misalignment will also present as a high 1X RPM peak, however, as stated earlier, we have already addressed this problem. Thus, using a process of elimination, it is then safe to say that we have an unbalance condition on the fan.

We will see a high 1X RPM peak on the vibration spectrum, because the unbalance condition on the Boiler ID fan creates a bending moment on the shaft. This then causes the bearing housing to move axially.

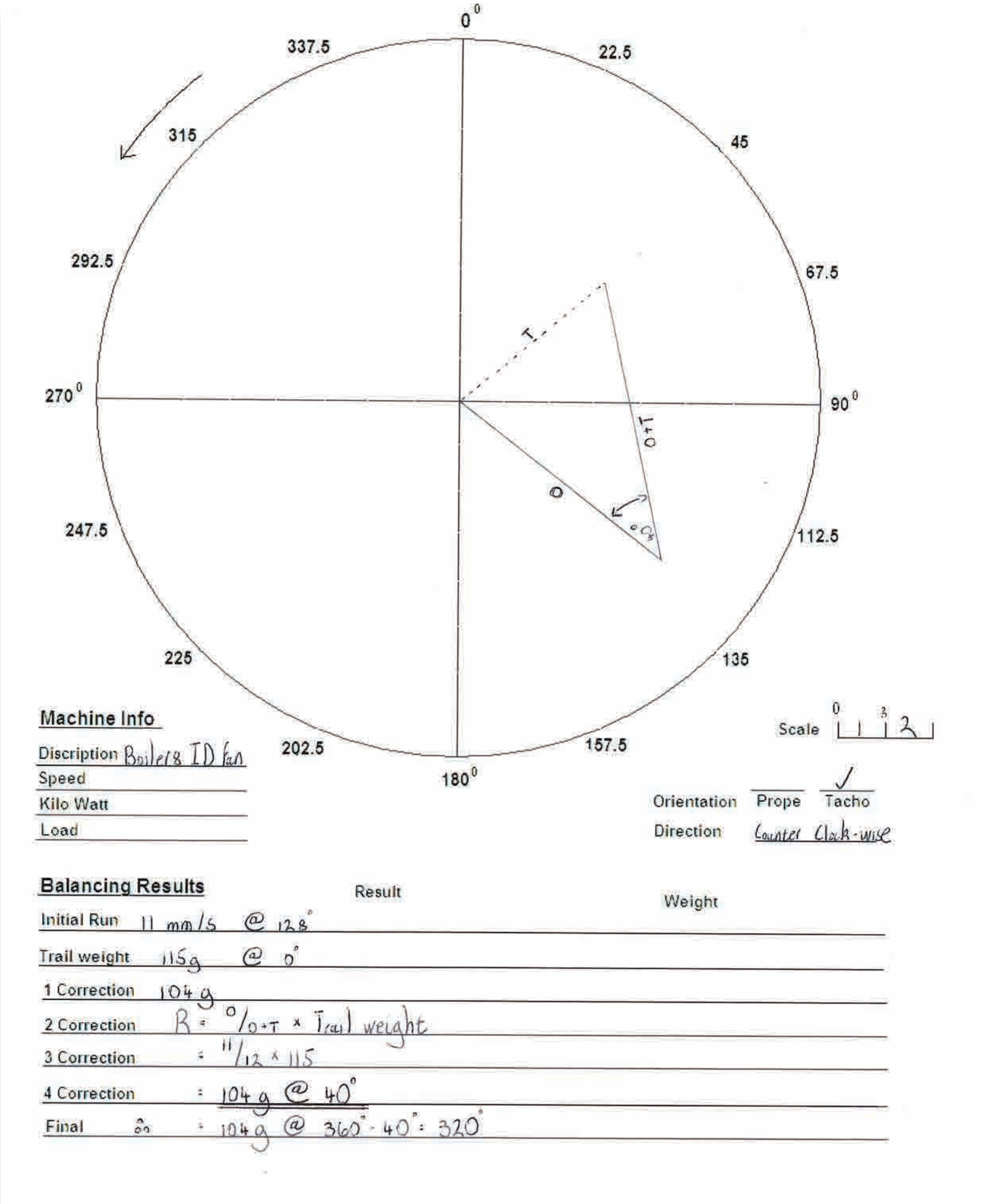


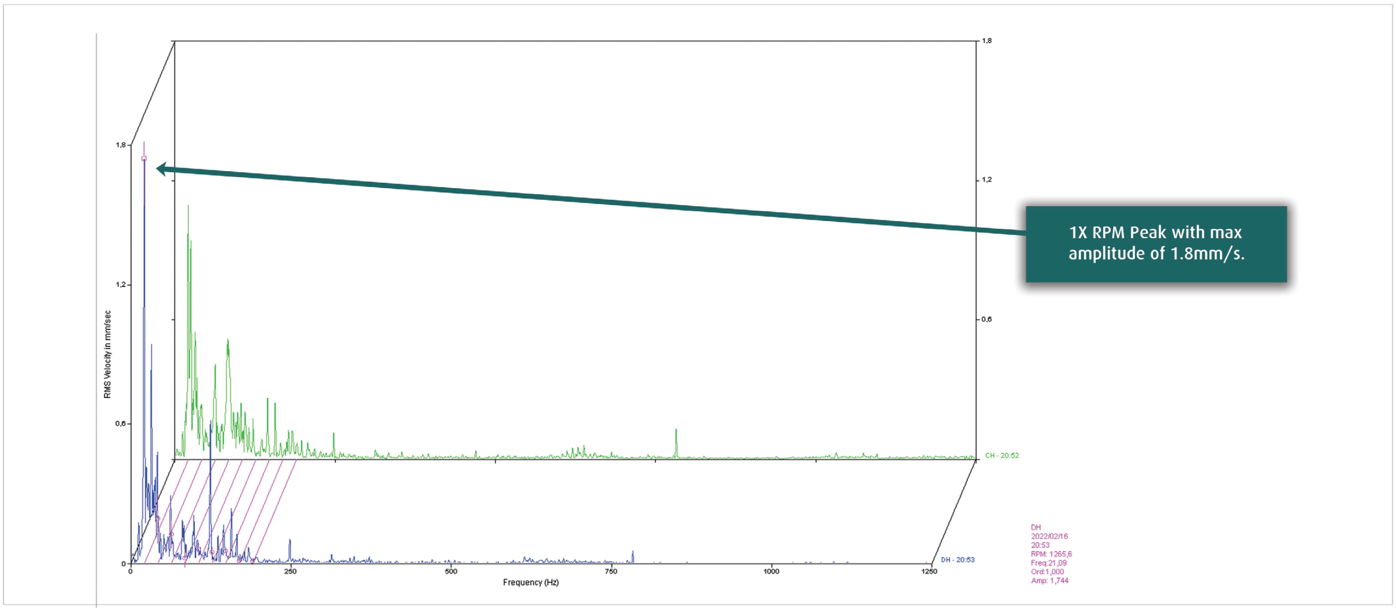
When one performs a balancing job on a machine, there is a sequence of steps that needs to be followed:

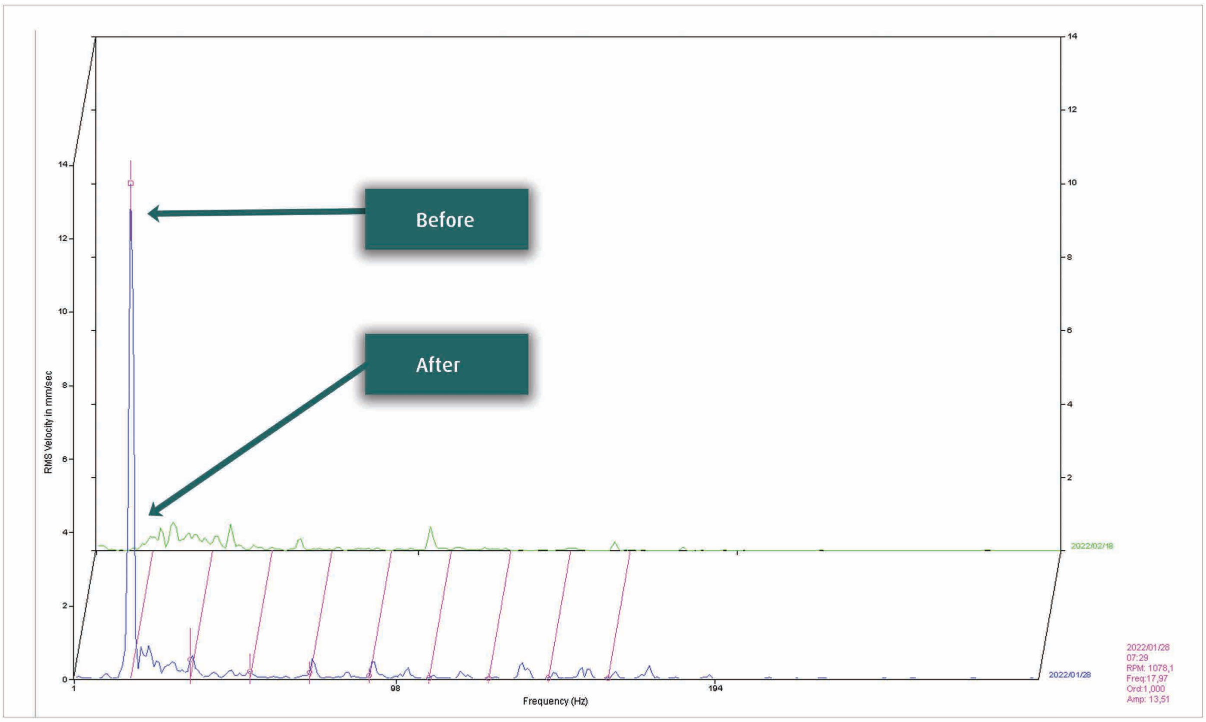
1. With an accelerometer and tacho connected to the vibration data collector, take an initial reading on the machine. This data will be presented as a velocity reading in mm/s as well as a phase reading presented in degrees. Our initial reading on the Boiler ID fan was 11mm/s @ 128 degrees.
2. The next step is to add a trial weight to the fan impeller to force an increase/decrease in vibration amplitude and then take another set of data. We then added a trial weight of 115grams to the impeller and got a reaction of 8mm/s @ 50 degrees.
3. With this information at hand, we were then able to calculate the appropriate mass needed to counteract the unbalance force as well as where exactly to put it on the impeller. We then calculated that the impeller needed a correction weight of 104 grams @ 320 degrees.



Below is a vector diagram that is drawn in the field while the balancing job is taking place. We plot the data collected from the vibration data logger on the vector diagram to calculate the final correction weight, as well as the location of where the said weight must be applied.







In the above image one can see the latest data taken on the Boiler ID fan DE & NDE bearings. The spectrum clearly shows a dramatic decrease of the fan 1X RPM peak, which is now at 1.8mm/s- a big improvement on the initial reading of 11mm/s. This case study demonstrates yet another way that condition monitoring can impact and improve machine reliabilty on your plant.

CONCLUSION

By using different condition monitoring techniques, we were able to find the root cause of the vibration coming from the Boiler ID fan. With the fan balancing now complete and the fan running in equilibrium, there was a drastic improvement in vibration amplitudes allowing for the commissioning of the Boiler ID fan, and it can now be used as normal.

About the author...

Reinier Kalp is a vibration analyst at WearCheck, where he has worked since 2014. In addition to his CAT 3 certification in vibration analysis through the Mobius Institute, he is highly knowledgeable and has extensive experience in a range of other condition monitoring techniques, including thermography, laser alignment, balancing and oil sampling. Reinier finds great job satisfaction in witnessing the positive impact that condition monitoring has in the industry

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