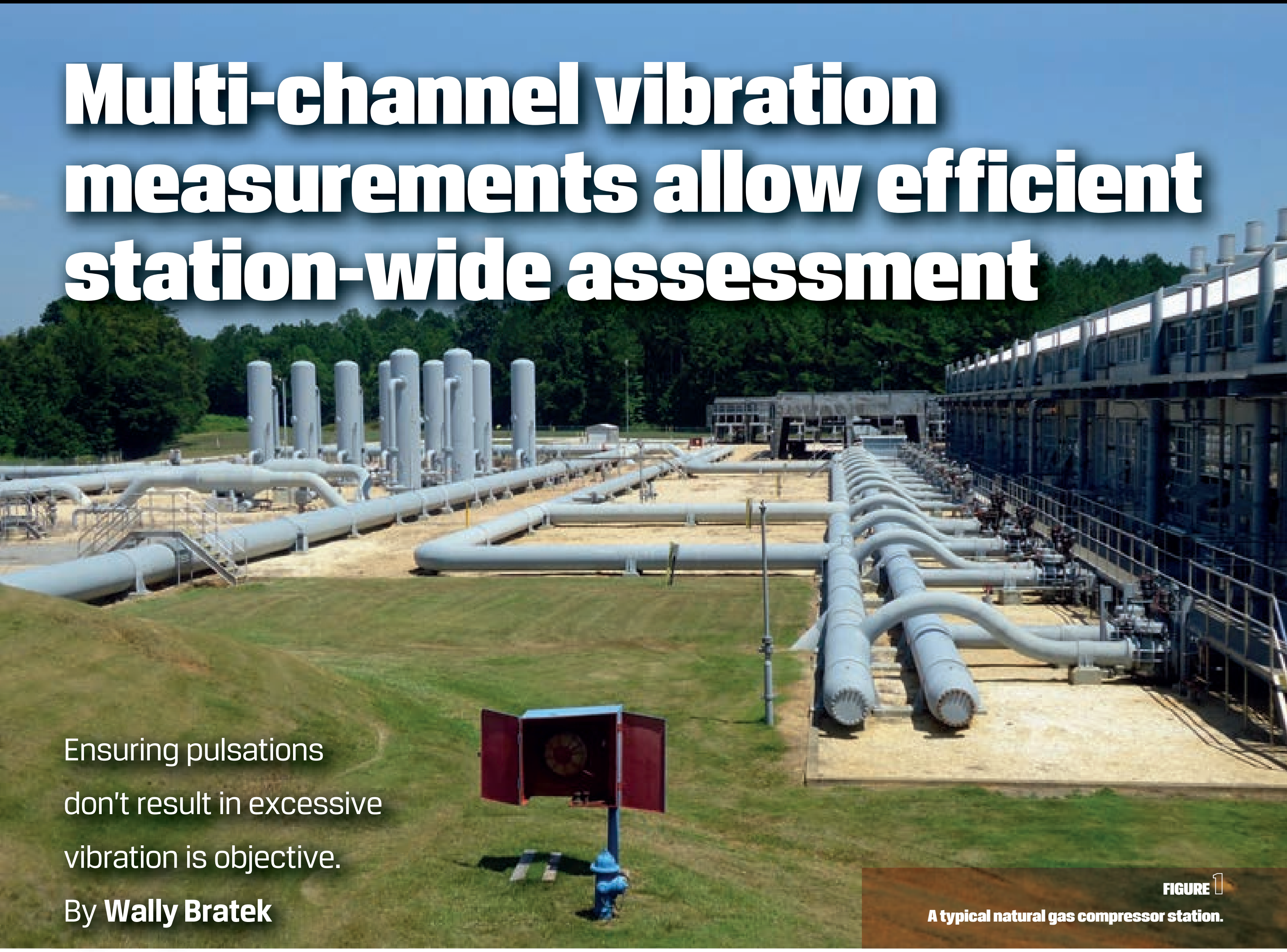
Multi-channel vibration measurements allow efficient station-wide assessment



Ensuring pulsations don't result in excessive vibration is objective.

By **Wally Bratek**

FIGURE 1
A typical natural gas compressor station.

AUTHORS CORNER

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Due to changing pipeline flow requirements and flow reversal trends in the natural gas industry, it is often necessary to modify the compressor stations feeding the pipelines. Sometimes, different operating pressures or additional load steps are required. In other cases, new compression, meter stations or coolers may be added. These changes can inadvertently create pulsation and vibration problems in the station.

As shown in Figure 2, changing compressor load steps or pressures will alter the flow from each unit as required, but this will also modify the pulsation source amplitudes originating at the compressors, both on the suction and discharge systems. Piping changes in the station will create different acoustic resonances. Each of these factors can cause a station that has run smoothly for decades to suddenly develop vibration problems.

To prevent potential vibration problems when changing operating conditions, a pulsation simulation study is recommended. However, options to control pulsation are limited, as existing pulsation bottles cannot be reconfigured to new conditions. As a result, many stations end up experiencing pulsation exceeding API 618 allowable amplitudes. The best way to ensure that these pulsations do not result in excessive vibration and fatigue failures is to measure vibration levels within the station, so that problem areas can be mitigated.

Challenges with vibration data collection

Measuring and analyzing vibration adequately throughout a station can be challenging. This is because most stations do not operate at a single, steady-state operating condition. Each compressor has multiple load steps to control capacity, and some compressors shut down under certain operating scenarios. Each compressor also has an operating speed range that will determine the excitation frequencies. Combined with changing pipeline pressures, the number of possible operating scenarios becomes overwhelming.

The most efficient way to measure vibration on a complex piping system with multiple operating conditions is to utilize a multi-channel vibration analyzer as shown in Figure 3.

A typical station may require 56 to as many as 240 channels of simultaneous vibration and pulsation measurements. Vibration specialists typically spend a day setting up transducers and mapping channels before they are ready to press the record button. Operators can then cycle the station through various scenarios and compressor speeds, and the multi-channel analyzer will record how the station reacts in terms of pulsation and vibration. These tests can usually be completed in one day, but more complex troubleshooting cases may require up to three days of data collection.

Advantages of multi-channel vibration analyzers

One advantage of the multi-channel approach is that disruption to operations is minimized. If a measurement campaign was to be undertaken with a 2- or 4-channel analyzer, operations would be forced to set up for one operating scenario, and then hold it for as long as it takes to move sensors and collect data throughout the station. If compressor speed sweeps are required, then the sweep would have to be repeated multiple times to capture the effect throughout the station. Completing the measurement process with a 2- to 4-channel analyzer could easily take weeks to complete, while severely limiting station availability. This is not only inconvenient for operations, but also expensive considering the number of person-hours required to collect all the data. The multi-channel approach is much more efficient.

The multi-channel approach also provides greater insight, as the data can be easily plotted and compared to process parameters such as pressure or flow. This is done by importing historical process data into the vibration post-processing database.

Further, the multi-channel approach allows capturing of transient events throughout a station while changing between different load-steps or bringing different units online, which can be critical for ensuring high station reliability.

Advanced post-processing tools turn vast amounts of data into actionable insights

While there is great value in obtaining such comprehensive data on pulsation and

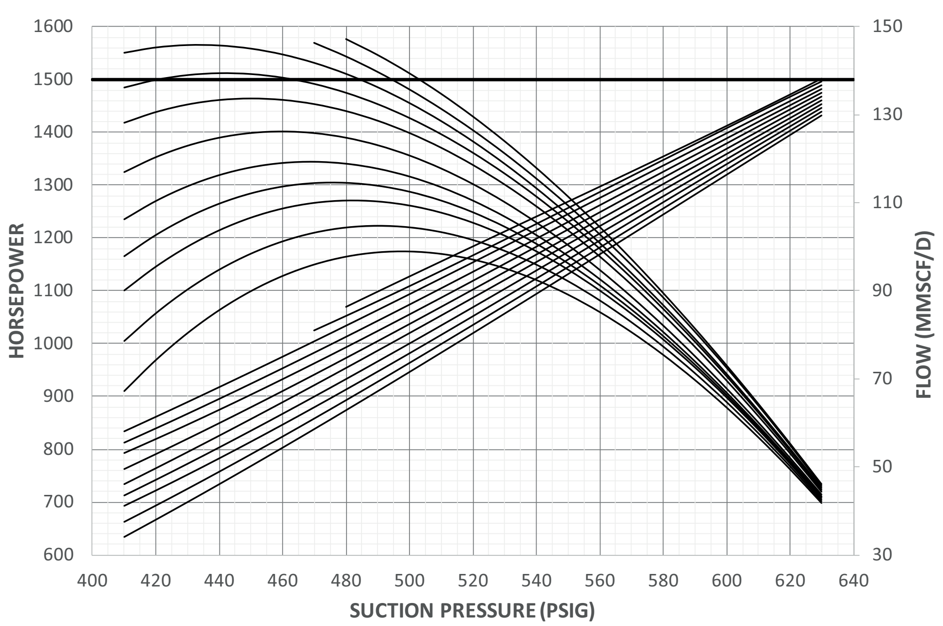
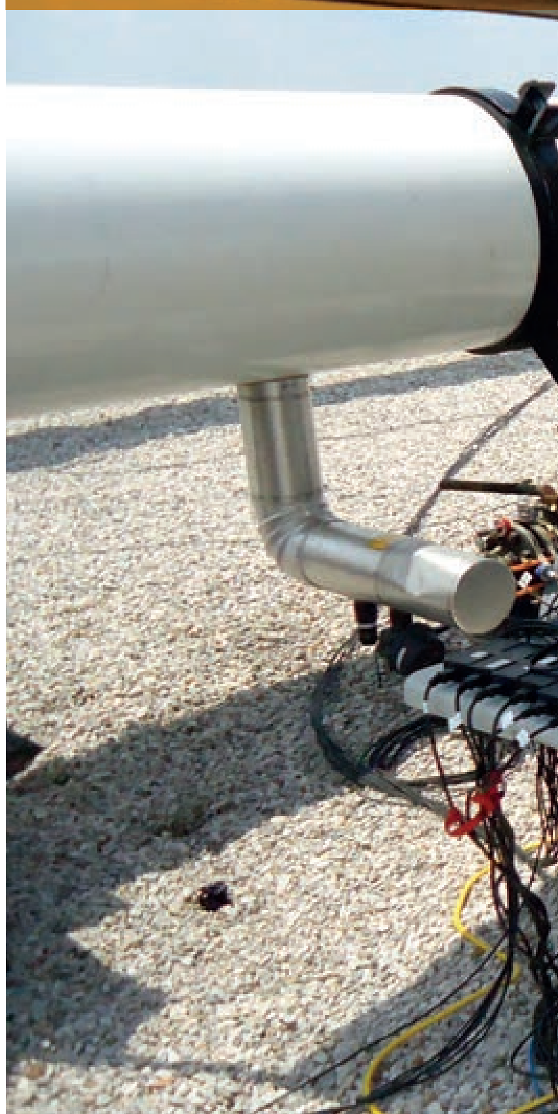


FIGURE 2

Reciprocating compressor loading curve.

FIGURE 3 **Multi-channel analyzer setup.**



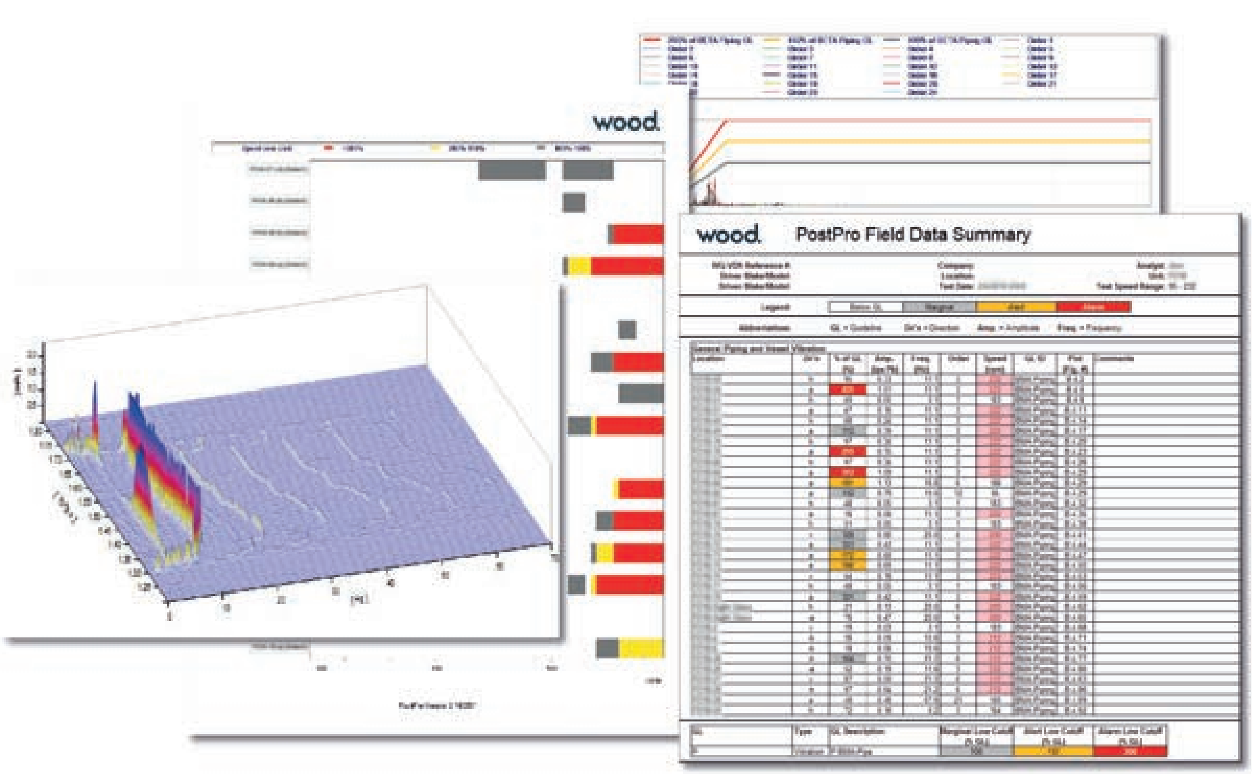


FIGURE 4
PostPro data processing results.

vibration in a compressor station, the volume of data can be difficult to process and analyze. To overcome this challenge, Wood has developed an advanced post-processing software tool. Data on vibration, pulsation, revolutions per minute (RPM) and process conditions is compiled into an aggregated database. The software then creates anomaly reports, listing the measurements and their values relative to applicable guidelines.

The tool also flags RPMs with high vibration amplitudes in a "speeds to avoid" chart, which allows operators to run equipment at safe speeds until corrective action is implemented in the field. Individual spectrum and waterfall plots are also produced, as shown in Figure 4.

Conclusion

The ability to collect, process, analyze and present hundreds of gigabytes of vibration test data in a short amount of time provides valuable advantages for facility owners. The summarized overview of key information helps vibration analysts and operators make meaningful and timely conclusions and determine appropriate actions to ensure a station's safe operation and optimize its long-term reliability. CT2