



# Analysis & Rating Solve Pipeline's Acoustic Resonance Problem





**The phenomenon occurs when a system experiences extreme vibration caused by excessive pump pressure and pulsation.**

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A North American natural gas liquids pipeline company was experiencing an acoustic resonance issue that cost up to \$35,000 a month in maintenance and repair. A six-week project resulted in rerating three American Petroleum Institute (API) designation between-bearing (BB3) horizontal multistage split-case mainline pumps and performing extensive and specific vibration analyses to identify the problem. The project involved designing and manufacturing new impellers using exclusive milled vane technology, conducting API hydraulic performance tests, and returning the pumps into service.

This midcontinent pipeline gathers, processes, stores and transports natural gas—in this case, propane. Because of its geographic location, extreme temperatures and conditions are a factor in the selection of major equipment and components. The pumps operate at 2,917 gallons per minute with 2,926 feet at 1,500 horsepower and 3,560 revolutions per minute (rpm).



### The Problem

The pipeline company was experiencing an acoustic resonance vibration problem at the pump crossover, causing major maintenance and repair issues. Acoustic resonance occurs when a system experiences extreme vibration due to excessive pump pressure and pulsation, with frequencies loud enough for humans to hear. This can happen with the use of variable speed drives.

The pulsations are caused by a non-uniform flow from turbulence, sudden change of flow structure, direction or cross-section.

The acoustic resonance had existed since the pumps were installed more than five years ago. Rather





than repairing or replacing them, the company performed continuous unscheduled maintenance that cost as much as \$35,000 in a single month.

Acoustic resonance is a reaction of the impeller to the liquid that is being pumped. It is a sound wave that passes through the crossover, creating a vane pass.

In this case, the acoustic resonance was causing the cracking of pipe nipples, tubing and flanges. It was also causing support system failures and frequent bearing issues.

High maintenance costs are not the only downside to acoustic resonance. An additional problem that can occur is a release of the product that is being transported. Cracks in the piping or joint breaks can cause the product to be released into the environment.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) and the U.S. Department of Transportation (DOT) are the regulatory agencies that monitor these types of releases, which cause risks for the environment. Because acoustic resonance causes stress and fatigue on the piping and structural components of the pump, the tubing can be sheared, causing the dangerous release.

The pipeline company commissioned a repair and service provider to rerate the pumps and investigate the historical acoustic resonance problem. Rerating involves rebuilding (or repurposing) the pump for a different condition that meets current operating requirements.

## **Finding a Solution**

While the pumps were being rerated at one of the repair company's Texas service locations, the firm's engineers began an extensive acoustic resonance evaluation and analysis to determine how the existing impellers reacted to the long crossovers. Once this was identified, a new design was created to change and improve the configuration of the impellers, the vane counts and the vane angles.

The engineers developed a complete analysis of the volutes, the impellers and the crossovers, as well as a detailed explanation of how the impeller interacted and reacted within the long and the short crossovers. The analysis took two weeks to complete.

The next step was to build a digital model of the impellers using an exclusive milled vane technology. Unlike casting, milled vane technologies eliminate the need and requirement for a pattern.

Using a traditional pattern in a cast pour, a shifting of the vanes can occur and cause inconsistencies within the design.

Milled vane technology uses a solid block material milled on a five-axis computer numeric control (CNC) machine. The homogeneous material does not have the inclusions inherent with a cast pouring. The material has no deviation from the design and is advantageous when custom building the hydraulics for a specific and unique application.

For this project, there were nine impellers—three impellers on each of the three pumps. Once the design was completed, the pumps were sent to the firm's Hydraulic Institute Pump Test Lab Approval

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