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Avoiding Small Bore Piping Failures

Operators are becoming much more focused on reducing small bore failures, a high risk problem on pump or compression facilities. Small bore audits have become a popular approach to reduce these high impact failures. Small bore attachments, typically 2 inches in diameter or less, often crack due to excessive vibration, and are excited by vibration in the main process piping and/or vessels. The consequences of a small bore failure are severe. Here are three examples:

- A liquids pipeline experienced a crack on a relief line. This created a major media event due to the facility shutdown and expensive environmental remediation. The impact was a multi-million dollar expense.
- A scrubber recently experienced a cracked nozzle on the level controller. Again, this problem shut down the facility, and the repair costs were exorbitant.
- A gas release from a small bore pipe failure caused an explosion at a compressor installation. Luckily no one was killed.



A vibration audit of small bore attachments highlights high risk locations

Small bore piping and attachments include relief lines, pressure and temperature sensors, level controllers, drain piping, instrumentation lines and other small diameter piping attached to the main process pipe and/or vessels. The small bore piping layout is sometimes done on the shop floor and not analyzed during a pulsation/vibration study. While small-bore nozzles and attachment points may be shown on drawings, often the details of the small-bore piping and equipment connected to these nozzles are not provided; as a result, these areas are not given the attention they need at the design stage.

To avoid risks of failures, a small bore audit should be conducted once the equipment is running. The scope of the audit should include the pump or compressor package, and off-skid piping locations. Note that this audit is very different than a standard vibration route based survey. Two different screening techniques are needed to provide a more accurate assessment of the Likelihood of Failure (LOF). Specialized field techniques have been developed for this procedure, to make the process fast and effective.

Transient events such as Emergency Shutdown (ESD), valve actuation, relief valve releasing, bypass or other events should also be considered in the scope of work because they create a unique vibration risk. For one customer, the transient event included the throttling of the bypass valve, which in turn excited the instrumentation and a block valve (small bore attachments). Field measurements identified many emerging problems and proactively avoided cracks and an extended shutdown.

Beta has a dedicated field group trained in performing small bore audits. [Contact us](#) for more details.

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A Novel Way to View Pulsation Forces

BETA introduces a NEW approach to assess pulsation or cylinder gas forces across the compressor's operating map. A reciprocating compressor is intended to operate at many different pressures, load steps and speeds and pulsation (induced) forces are generated across the entire operating map. The magnitude and frequency of pulsations vary widely, so it is valuable to understand where pulsation forces exceed guideline, because if that happens, then vibration problems are likely to occur.

For most new packages, a handful of conditions are analyzed to size the compressor. These conditions are used to design a pulsation control solution (orifice plates, baffles, bottles, etc.) so forces are acceptable. But what about the hundreds of other operating conditions, at which the machine is capable of running, but that are not considered during the design stage? What is the vibration risk for these unanalyzed cases?



BETA calls this novel approach to examine the impact of pulsation forces across the entire operating map, a Force Map. In the chart below of the suction piping system at a pipeline compressor station, the operating map is suction pressure (Ps – horizontal axis) vs. discharge pressure (Pd – vertical axis). Areas of low pulsation forces are shown in GREEN, areas of marginal pulsation forces are shown in YELLOW, and areas that have high pulsation forces are shown in RED.

In this example, the customer would not have known about the high force areas without the Force Map. The handful of conditions used to size the compressor and used in the initial pulsation study all have low pulsation forces (green). Normally the design process stops there and the package is shipped and installed. The problem is that the customer will eventually operate the compressor in the RED area and, very likely, experience vibration problems.

Beta developed the Force Map as an extension of our sophisticated MAPAK software simulation program. Running the Force Map across more operating conditions is a small incremental cost compared to the traditional study based on a few design points. Our customers have found the Force

Map™ analysis to be a valuable tool for compressor system design. [Contact us](#) for more information, or to request your Force Map analysis.

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Pulsation Bottle Sizing - A New, FREE Service

We're excited to offer FREE online Bottle Sizing at our new **solutions** web site, www.solutions.betamachinery.com.

A new online program is available to size pulsation bottles for reciprocating compressor packages. Since this web-based program, offering two levels of analysis, was released, we have seen its use increase rapidly – for hundreds of projects.



Free online bottle sizing.

Level 1 is a free program for sizing pulsation bottles. Customers simply enter the project data and get immediate results. This program allows the user to have more confidence in the required bottle sizes when preparing the initial layout and bidding on a project. The program was tested by a number of customers during the summer, which helped identify improvements and additional features. A full release was made a month ago and, so far, the feedback from users has been overwhelmingly positive.

FAQs are available to explain terms and the how to use the program. We also provide onsite support (or web-seminars) to explain some useful tricks and approaches to bottle sizing. To request support, please contact [Chris Harper](#).

Level 2 is an advanced service, or “mini-pulsation study,” to design the final bottle size and evaluate pulsation forces and pressure drop. The benefit is that packagers can order long lead time items (heads and shells) early in the process, saving valuable time in the fabrication process. [Click here](#) to access Beta's [solutions web site](#).

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New Technical Papers

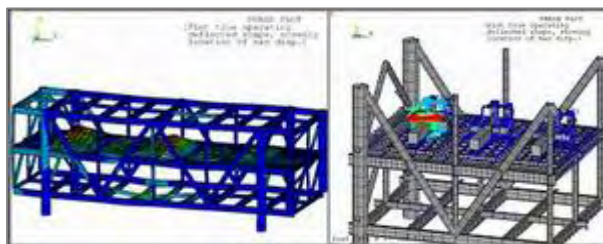
At the GMC and EFRC this past October, BETA's technical papers were well received:

1. [***Centrifugal Vibration Problems - AIV and FIV Case Study***](#)
2. [***Specialty Gases - Design Challenge for Reciprocating Compressors***](#)

For more technical papers from BETA, see our web site, www.BetaMachinery.com and from the Knowledge Center click on Articles, Papers.



For two years this centrifugal compressor experienced failures from vibration problems.



CNOOC platform, ODS at high vibration areas (compressor running).

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CNOOC Develops Design Standard for New or Retrofit Applications

China National Offshore Oil Company (CNOOC) designs and operates many offshore production facilities. Given the need to reduce vibration problems, CNOOC engaged BETA to provide

expertise in Structural Dynamics Analysis for compressor and pump applications. As a result of the success of this project, CNOOC has published a design standard for new or retrofit applications. Please **contact us** if you would like a copy of this offshore design standard.

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Beta Welcomes Larry Foran to Serve the US Pipeline Market

In his role as Business Development Manager, US Pipeline Market, Larry leads BETA's compressor station design, optimization, monitoring, and troubleshooting initiatives in the US. He looks forward to working with customers to deliver optimal solutions to their machinery problems. Larry has extensive experience with both reciprocating and centrifugal compressors, enabling him to work with customers to determine their needs and offer viable options. He invites pipeline customers in the US to reach him by email, **LForan@BetaMachinery.net** or call 815-980-6749.



Larry Foran

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From all of us at BETA, we wish you a happy, healthy holiday season!

