

Piping Vibration Integrity Primer

What is piping vibration?

Piping vibration is simply the movement of pipe away from its static, at-rest position. Some vibration can be seen by the naked eye, some vibration can be felt or heard, and some vibration occurs only occasionally under certain operating conditions, and **may not be recognized until** a piping failure has occurred.

Why should I care about piping vibration?

21% of hydrocarbon releases are due to vibration-induced fatigue failures (UK Health & Safety Executive). These releases can have a significant impact on public and employee safety, the environment, production and financial performance.

The piping system is by far the **leading source of failures** in facilities (Marsh & McLennan). This is in part due to the sheer quantity of piping in facilities, but also due to inadequacies in integrity programs to consider vibration and fatigue.

The situation is compounded by the fact that commonly used **design codes do not consider vibration in detail**. Overall, only a small portion of piping is of high risk of failure, but identifying those high-risk locations is the challenge.

Piping vibration risks can be identified at any stage of the asset lifecycle, but few companies have a **systematic approach** to evaluating these risks.

What piping is most at risk?

Around **80% of vibration-induced failures are associated with small-bore connections (SBCs)**. This is due to several reasons:

- ▶ Stress concentrations at the weld to the main pipe or vessel
- ▶ Large unsupported valves
- ▶ Lack of evaluation of vibration and fatigue risk, beyond a reactive approach after a failure
- ▶ Disconnects between the SBC design intent and site fabrication, particularly regarding local support/bracing.
- ▶ The remaining 20% are generally associated with parent pipe girth weld failure



Where does piping vibration come from?

Two main factors affect vibration: the **strength of the excitation** and the **flexibility of the piping** system. Therefore, there are always two methods to solve piping vibration problems: **reduce the level of excitation** to which the piping system is exposed or **support the piping system** so that it can withstand the applied dynamic forces.

The excitation mechanisms that cause vibration originate from three main sources:

1. **Acoustic/pulsation** – time-varying changes in fluid pressure
2. **Momentum** – time-varying changes in fluid density and velocity
3. **Machinery** – unbalanced forces from operating machinery

Table: Three main sources of piping vibration

Acoustic/Pulsation	Momentum	Machinery
<ul style="list-style-type: none"> • Dead leg pulsations (FIV) • Acoustic-induced (AIV) • Pulsations from rotating machinery • Rotating stall 	<ul style="list-style-type: none"> • Flow-induced turbulence (FIT) • Water hammer • PSV relief load • Multiphase or slug flow • Cavitation and flashing 	<ul style="list-style-type: none"> • Mechanical excitation from vibration transmitted to attached piping



How can I address piping vibration?

Risk-based assessments are the most cost-effective and reliable method to identify, quantify, inspect, measure and mitigate vibration and fatigue risks. These assessments look at the vibration integrity problems a facility faces, from start-up to shut-down.

The risk-based approach allows for a proactive management of vibration, only where there are risks present. Risk-based assessments integrate with and complement conventional integrity management programs that typically focus on corrosion/erosion – **saving time and money for operators**.

Design and in-service inspection standards typically highlight the risk posed by vibration but **fail to provide appropriate management strategies**, often leaving the identification of vibration issues to operators.

The Energy Institute document “*Guidelines for the Avoidance of Vibration Induced Fatigue Failure in Process Pipework*” is the **industry standard for evaluating vibration integrity risks**; Wood Group’s vibration experts were heavily involved in its development and understand its application.

Wood Group conducts risk-based assessments for major operators globally and can help augment your integrity management program to include vibration and start proactively addressing vibration risk.

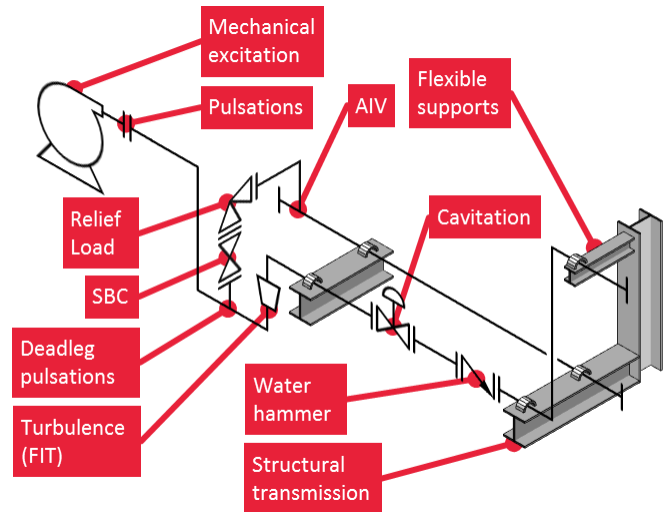


Figure: Typical vibration risks in a piping system

Contact Wood Group’s Vibration, Dynamics & Noise team to discuss the vibration integrity of your piping system:

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