Piping Vibration Design Considerations

The following services apply to facility piping design, including both static and dynamic engineering.

Static Design This involves thermal effects on the piping system, as well as pressure, weight and other applicable loads (e.g., seismic). The design methodology and approach includes the following features:

- Accurate assumptions in piping models. BETA understands that actual pipe support stiffnesses vary dramatically depending on the application. Based on our field and design research, BETA uses precise piping support stiffnesses compared to traditional approaches that assume "rigid" supports resulting in less conservative piping designs. This helps to end significant project design inefficiencies involved with solving problems that are not there in reality, or, missing critical risk areas.
- Consideration of vibratory loads as well as thermal loads (see next section, Dynamic Design).
- Use of specialty restraints and pipe clamps that effectively achieve requirements for both vibration and thermal growth design aspects.

Dynamic Design There are many applications where dynamic concerns should be addressed in the design stage by investigating both normal operating and transient cases. Areas to consider include:

- Pressure pulsation and vibrations affecting the piping near reciprocating compressors and pumps
- Centrifugal compressor surge control dynamic simulation and evaluation
- Piping vibration due to Flow Induced Vibration (FIV), Acoustic Induced Vibration (AIV), Flow Induced Turbulence (FIT), etc.
- Transient events in the system causing vibration, pressure surge (water or fluid hammer), cavitation, and pipe collapse due to valve swings, emergency shut downs, PSV lifting, and other transients in gas or liquid systems.
- Excitation of transverse acoustical modes and shell modes of the pipe by vane-passing pulsations (also called Shell Transverse Acoustical analysis).

The following chart provides recommendations on when these engineering services would be required.

Engineering Analysis	System	When required
Piping Stress Analysis	All fluids	High temperature/pressure variation
Machinery and Equipment Nozzle Load Analysis	All fluids	Machinery and equipment with low allowable nozzle loads
Small Bore Connection (SBC)	All fluids	All connections not reinforced or braced
Flow Induced Turbulence (FIT)	All fluids	High flow systems with flexible and infrequent supports
Pulsation and Mechanical Analysis	Reciprocating compressor/pump; Screw compressor	High pressure, high power, complex or critical systems
Shell Transverse Acoustical (STA)	All fluids (but gas systems typically)	Thin walled pipe or vessels near compressors and pumps
Flow Induced Vibration (FIV)	Gas systems only	High flow systems with dead legs
Acoustic Induced Vibration (AIV)	Gas systems only	Pressure reducing devices like valves and orifice plates
Compressor Surge Dynamic Simulation	Centrifugal compressor systems	Low inertia, high pressure ratio, complex systems
Cavitation/Flashing	Liquid systems only	Pressure reducing devices like valves and pumps
Transient Vibration Analysis (Gas Systems)	Gas systems only	Blowdown or PSV releasing events, momentum changes
Water hammer	Liquid systems only	Fast acting valves and emergency shutdown events

BETA is a specialist engineering consultancy that provides Piping Vibration and Integrity Assessment per the Energy Institute 2008 *Guidelines for the avoidance of vibration induced fatigue failure in process pipework* (AVIFF).