STI Vibration Monitoring Inc.

Field Application Note

Piping Vibration PV

Piping vibration can be an annoying problem, which can consume unnecessary maintenance activity and can affect pumping system performance and endurance. The system includes the pipe, all piping supports, hangers, snubbers, pipe-to-pipe interfaces, and machinery or devices attached to the pipe. All these items can influence the pipe vibration patterns.

This testing method will determine the piping system vibration amplitudes, frequencies, nodal points, and the pipe modal shape. It can, also, be used to identify defective supports, incorrectly placed supports, and the locations of maximum deflection requiring additional supports.

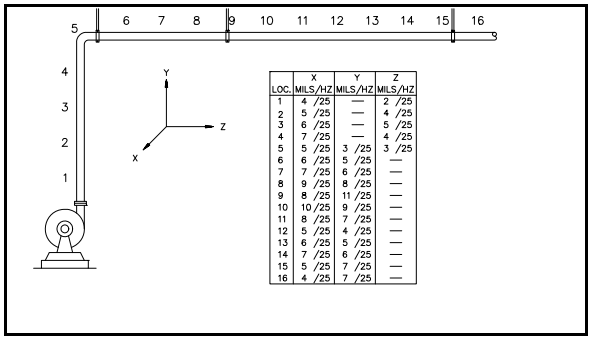
Analyzer/Data Collector

Many data collectors have internal circuitry with low frequency range limitations: output displays in acceleration units are 2 Hz and output displays in velocity and displacement are 5 Hz. This circuitry is an internal high pass filter set for a 2 Hz roll-off frequency for acceleration signals and 5 Hz as the velocity and displacement roll-off frequency. The filter eliminates excessive noise from being displayed.

This means that if an accelerometer is connected to the data collector and the display is setup for acceleration units, the low frequency signals are correctly displayed down to 2 Hz. If the accelerometer signal is integrated to velocity or displacement the low frequency limitation is 5 Hz. Similarly, a velocity transducer has the velocity low frequency limitation and the integration limitation also applies.

Methodology

Piping vibration analysis involves describing how much the pipe is moving and at what frequency the motion exists. The piping motion can be further described by showing the motion as a modal plot. Pipes can vibration in three orthogonal directions just like a machine. Vibration data should be collected in the X, Y, and Z-axis. Since most data collectors do not have the capability of calculating transfer functions collected from impact/response input signals, all data collection should be taken while the pumping system is operating.



LOC.	X MILS/HZ	Y MILS/HZ	Z MILS/HZ
1	4 /25	—	2 /25
2	5 /25	—	4 /25
3	6 /25	—	5 /25
4	7 /25	—	4 /25
5	5 /25	3 /25	3 /25
6	6 /25	5 /25	—
7	7 /25	6 /25	—
8	9 /25	8 /25	—
9	8 /25	11 /25	—
10	10 /25	9 /25	—
11	8 /25	7 /25	—
12	5 /25	4 /25	—
13	6 /25	5 /25	—
14	7 /25	6 /25	—
15	5 /25	7 /25	—
16	4 /25	7 /25	—

The vibration transducer may be attached to the pipe using a magnetic mount without affecting the lower frequency response of the transducer. The overall pipe length should be separated into equal spaced lengths 3-5 feet (1-2 meters) for this test and plotted on a graph sheet. The pipe hangers/restraints and their orientation to the pipe should be noted on the plot.

Setup the data collector for a frequency range for a 0-12,000 CPM (0-200 Hz) and display units of acceleration (G's). Collect spectra at each measurement point. Evaluate the spectra for the components at common frequencies noting their amplitude and frequency.

Corrective Actions

Generally, the pipe supports should be a nodal point with little or no motion. Excessive motion at these locations indicates that the support is faulty or improperly installed. Vibration amplitudes

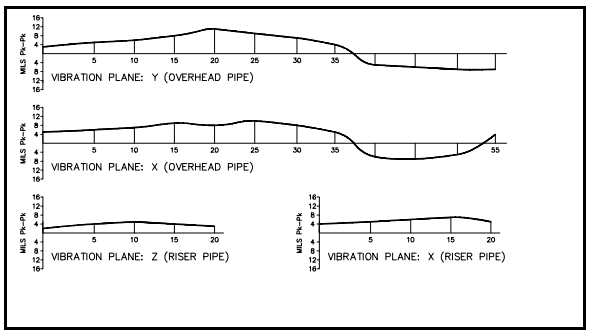
should decrease as a complex joint, such as atee connection, an elbow, or machine connection, is approached.

Convert all the collected data to displacement units using the formula:

$$A = 14.2 \times 10^{-9} \times D \times F^2$$

Where:

D = Displacement (mils pk-to-pk)
A = Acceleration (G's pk)



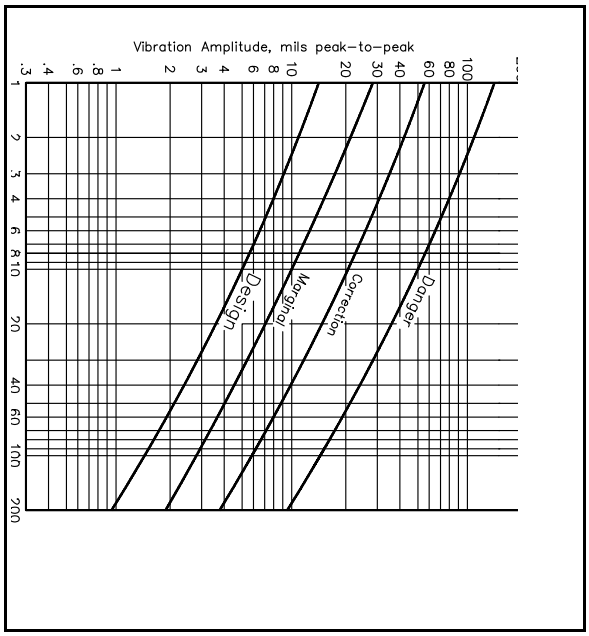
F = Frequency (Hz).

Plot all the amplitude information, which is at a common frequency on the graph to determine the modal shape at which the pipe is vibrating. Compare the calculated amplitudes and frequencies with the allowable piping vibration levels chart to determine if corrective action is warranted.

Wachel, J. C. and Bates, C. L., T echniques for Controlling Piping Vibration and Failures, ASME Paper 76-PET-18.

The listed ASME Paper includes a "severity chart" which could be used as a starting point in determining the piping system acceptability. This chart was compiled from 25 years of data and may be overly conservative for long flexible piping systems commonly found in power stations.

Pipe vibration correction will involve re-tuning the pipe system to a different frequency. This may be accomplished by re-locating the pipe supports, installing different supports, isolating the pipe from its hangers or joints, or installing expansion joints in the pipe. Before any modification is undertaken another pipe analysis should be carried out to determine that the modification does not violate other design parameters such as machine coupling momentums or connection stresses.



Testing Checklist

1. Piping System Defined ..
2. Proper Accelerometer ..
3. Graph Paper ..
4. Analyzer Set-up ..