Best practice

Assessing the likelihood of failure of small bore connections

VIBRATION-INDUCED FATIGUE OF PROCESS PIPING SYSTEMS ACCOUNTS FOR 21% OF ALL HYDROCARBON RELEASES IN THE UK SECTOR OF THE NORTH SEA. ONSHORE, AVAILABLE DATA INDICATES THAT 10–15% OF PIPEWORK FAILURES RESULT FROM THE SAME CAUSE. HOWEVER, FOLLOWING BEST PRACTICE GUIDELINES AS LAID DOWN BY THE ENERGY INSTITUTE CAN HELP TO MINIMISE PIPEWORK FAILURE AND RESULTING RELEASES, WITHIN THE OIL, GAS AND PETROCHEMICAL INDUSTRIES.

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For early identification of problems or potential problems, petrochemical plants and offshore platforms need to establish a condition-based approach to assessing the likelihood of failure of small bore connections through vibration-induced fatigue. By adopting this best practice they can then hope to avoid the pipework failures and product leakage which can stem from excessive vibration. Which means they can then also avoid the associated liabilities and plant downtime, as well as improving safety and reliability, and complying with statutory duties.

The best practice guidelines were published in 2008 by the Energy Institute, based on the Marine Technology Directorate Guidelines issued in 1999. These have been a key element in helping to maintain integrity in the design and maintenance of process pipework within the industries concerned.

The guidelines recommend assessments which can be broken down into proactive and reactive.

Proactive assessments should be used routinely to assess all pipework on a site. These assessments will establish whether or not good practice has been adopted, and will also enable identification of possible areas of concern. Reactive assessments can be used to further investigate and assess known vibration issues, or to troubleshoot actual failures.

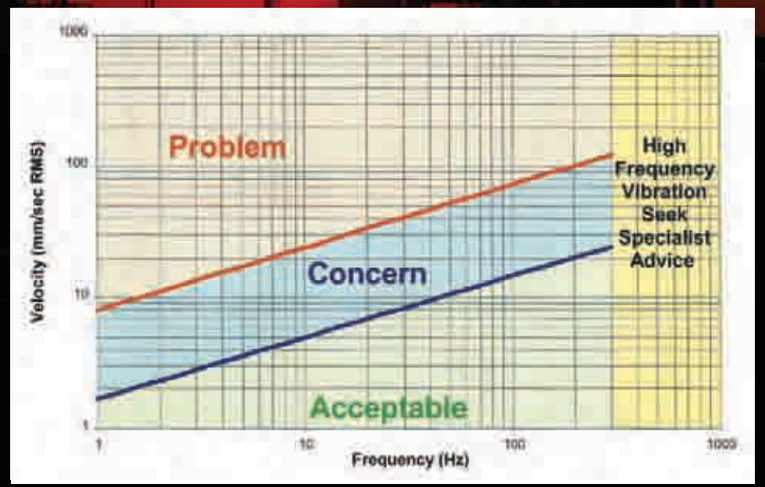
The assessments can in turn be broken down into the following key phases:

- ***Qualitative***
- ***Visual***
- ***Basic vibration monitoring***
- ***Specialist measurement techniques***
- ***Specialist predictive techniques***
- ***Corrective actions***

Qualitative assessment is possibly the most difficult. It involves calculations for assessing the likelihood of the occurrence of a vibration-induced fatigue problem, based on various factors. These include fluid energy, flow velocities, process machinery, types of valves, chances of flashing or cavitation, construction quality and cyclic operation. Together with a calculation process for scoring likely 'excitation factors' and 'conditional and operational factors', the qualitative assessment leads to a prediction of the Likelihood of Failure for each pipe branch.

The second phase – visual assessment – is far simpler and far quicker, but is a highly effective way of identifying potential problems. Many pipework vibration problems arise from failure to follow best practice – such as installing effective pipe supports, bracing small bore connections correctly, avoiding fretting, repairing poor condition or damaged supports, avoiding poor geometry, or allowing for thermal expansion of tubing. These can generally easily be identified by an experienced engineer during a visual inspection.

The next phase is basic vibration monitoring. This is a simple method of identifying areas of concern. Vibration levels are recorded and the results presented as vibration amplitude versus frequency. Comparisons against vibration assessment criteria can then enable classification of the vibration as 'acceptable', a 'cause for concern', or a 'problem'.



Vibration at concern or problem levels (as shown in the graph above) should be further assessed with specialist measurement techniques.

Even basic vibration monitoring and measurement requires specialist knowledge and suitable instrumentation, both of which ERIKS has. Using a single axis accelerometer connected to a portable data collector, ERIKS' experienced engineers can gather the relevant data and, if necessary, carry out the further assessments, which comprise:

- **Dynamic strain measurement and fatigue analysis**
- **Experimental modal analysis**
- **Operating deflection shape analysis**
- **Dynamic pressure (pulsation) measurement.**

ERIKS' engineers usual process is to record vibration velocity at a number of locations, including those which subjectively appear to have the highest amplitude. Recording measurements at a number of locations ensures that the maximum value is captured.

For main lines, they will position the transducer at the location exhibiting the highest level of vibration, and the maximum vibration amplitude obtained from measurements in three axes will be used. For small bore connections, the measurements will be carried out at the end flange of the cantilever arrangement.

The vibration velocity spectra will then be assessed against the criteria in the graph (see left).

Only when the measurements have been obtained and compared to the guidelines is it possible to make an informed decision about what corrective actions are necessary.

If the measurements and analysis show that the vibration amplitudes fall within acceptable levels, there is no need for further action. However, monitoring and trending should continue, to provide an early warning if any faults do begin to develop. If, on the other hand, the results show that there is a problem, more tests can be carried out to identify the cause, or steps can be taken to rectify the problem.

Proper bracing of the small bore connection, in line with best practice, is usually sufficient to resolve the issue.

Naturally, from initial assessments of all kinds, to whatever remedial measures are required, ERIKS has the expertise, the experience and the equipment to make following best practice relatively effortless, yet highly effective.