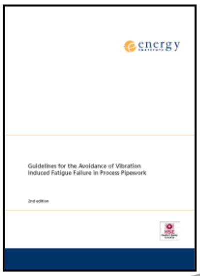
VibTech *Technology for Pipework Failure Prevention*

QUANTITATIVE ASSESSMENT TOOL

VibTech Ltd provides practical on-site training and support based upon the good practice guidelines in the Energy Institute publication:

'Guidelines for the Avoidance of Vibration Induced Fatigue Failure in Process Pipework', 2nd edition 2008

Supplemented by over 30 years' professional experience of on-site measurements, assessment and pipework problem solving.



Powerful Tools for Calculating Likelihood of Failure (LOF)

The Energy Institute guidelines contain 3 sections which provide really powerful 'Quantitative Assessment' methods for calculating the Likelihood of Failure (LOF) of pipework for the following cases:

- Section T2 for 12 No. main line excitation mechanisms
- Section T3 for 4 No. types of Small Bore Connections (SBC)
- Section T4 for 3 No. geometries of Thermowell

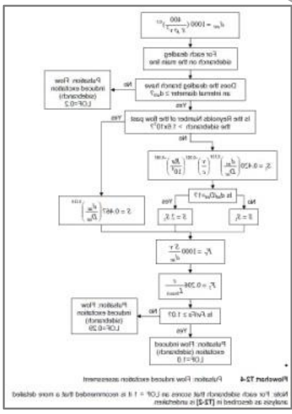
These calculation methods are really useful in the following assessments

- Calculations at the design stage
- Assess excitation possibilities during trouble-shooting
- Design of Corrective Actions

Unfortunately, these calculation methods can be quite daunting and require considerable mathematical skill to accurately negotiate the various Flowcharts.

The calculation methods are presented as a series of linked Flowcharts, containing multiple calculation and decision steps culminating with a theoretical LOF value.

One of the problems in following the flowcharts is that the flow is not continuous. At each step, the calculations will often yield a decision process, often requiring additional calculations outside of the current flowchart, before the process can be continued.



VibTech - Keeping it Simple

VibTech believes that these powerful calculations of LOF should be available to all design and pipework assessment engineers and so has produced a simple to use Microsoft Excel® based engineering tool (Quantitative Assessment Tool – QAT) which completely takes away the requirement to perform a single calculation.

No sooner than the last input value has been entered, the calculated LOF value is displayed.

Pipework Vibration Assesment

By selecting an analysis code corresponding to the required LOF calculation, the user is presented with a clear and concise data input form, which asks in advance for all data required for every stage for the selected Quantitative LOF Assessment calculations.

Analysis Options

Category	Analysis Code	EI Section	EI page	Description	Fluid
Flow	FIV1	T1.1	36	Flow Induced Turbulence (Qualitative)	All
Flow	FIV2	T2.2.3	49	Flow Induced Turbulence - Quantitative	All
Mechanical	MEC	T2.3	54	Mechanical Excitation from machinery	All
Flow	FIP1	T2.4	55	Reciprocating/Positive displacement pumps and Compressors	All
Flow	FIP2	T2.5	56	Rotating Stall of Centrifugal compressor	Gas
Flow	FIP3	T2.6	57	Flow Induced Pulsation - Deadleg Branch	Gas
Acoustic	AIV	T2.7	59	Acoustic Induced Vibration - High Frequency Acoustic Excitation	Gas
Valves	GVO	T2.8.3.1	66	Surge - Gas valve opening	Gas
Valves	LVC	T2.8.3.2	66	Surge - Liquid valve closing	Liquid
Valves	LVO	T2.8.3.3	68	Surge - Liquid valve opening	Liquid
Cavitation	C&F1	T2.9	69	Flashing - Likelihood of Failure	Liquid
Cavitation	C&F2	T2.9	69	Cavitation - Likelihood of Failure	Liquid

The QAT accepts inputs from 100 columns of data at a time, enabling easy analysis of multiple pipe sections and enabling powerful ‘what-if’ comparisons. For example by entering data for one pipe section over several columns, the user can easily evaluate the effects on LOF of modifying any of the input parameters such as pipe diameter, wall thickness, span length, flow rates, valve closure times etc.

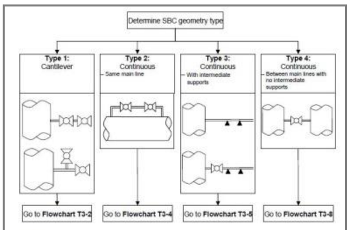
Multiple Assessment Types

Section T2 of the Energy Institute Guidelines offers Quantitative Assessment methods of calculating the ‘Likelihood of Failure’ of **Main Line** pipework for several common excitation mechanisms, including:

1. Flow Induced Turbulence (Qualitative)
2. Flow Induced Turbulence - Quantitative
3. Mechanical Excitation from machinery
4. Reciprocating/Positive displacement pumps and Compressors
5. Rotating Stall of Centrifugal compressor
6. Flow Induced Pulsation – Dead-leg Branch
7. Acoustic Induced Vibration - High Frequency Acoustic Excitation
8. Surge - Gas valve opening
9. Surge - Liquid valve closing
10. Surge - Liquid valve opening
11. Flashing
12. Cavitation

Section T3 relates to 4 types of **Small Bore Connections** (SBC), including:

- Type 1 - Cantilever
- Type 2 - Continuous – Same Main Line
- Type 3 - Continuous – Same Intermediate Supports
- Type 4 - Continuous – Between Main Lines



Flowchart T3-1 Overview of SBC Assessment Methodology

Section T4 relates to 3 geometries of **Thermowells**, including:

- Straight
- Tapered
- Stepped

Problems result when the flow induced Vortex Shedding frequency is close to the Thermowell Natural Frequency

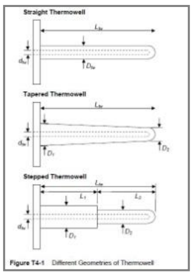


Figure T4-1 Different Geometries of Thermowell

Simple Step-by-Step Method

The VibTech QAT process is simply as follows:

1. Ideally arrange for key personnel to attend a VibTech 2 or 3 day training course (even though the calculations are done for you, the person doing them should still be deemed to be competent)

2. Purchase a commercial copy of the VibTech 'Quantitative LOF Assessment' spreadsheet (see price list in 'Downloads' section)

3. Select a 3-digit Code corresponding to the required Quantitative LOF Assessment excitation Mechanism.

e.g.

- Flow Induced Vibration FIV
- Flow Induced Pulsation FIP
- Acoustic Induced Vibration AIV

Analysis Options

Category	Analysis Code	EI Section	EI page	Description	Fluid
Flow	FIV1	T1.1	36	Flow Induced Turbulence (Qualitative)	All
Flow	FIV2	T2.2.3	49	Flow Induced Turbulence - Quantitative	All
Mechanical	MEC	T2.3	54	Mechanical Excitation from machinery	All
Flow	FIP1	T2.4	55	Reciprocating/Positive displacement pumps and Compressors	All
Flow	FIP2	T2.5	56	Rotating Stall of Centrifugal compressor	Gas
Flow	FIP3	T2.6	57	Flow Induced Pulsation - Deadleg Branch	Gas
Acoustic	AIV	T2.7	59	Acoustic Induced Vibration - High Frequency Acoustic Excitation	Gas
Valves	GVO	T2.8.3.1	66	Surge - Gas valve opening	Gas
Valves	LVC	T2.8.3.2	66	Surge - Liquid valve closing	Liquid
Valves	LVO	T2.8.3.3	68	Surge - Liquid valve opening	Liquid
Cavitation	C&F1	T2.9	69	Flashing - Likelihood of Failure	Liquid
Cavitation	C&F2	T2.9	69	Cavitation - Likelihood of Failure	Liquid

4. The spreadsheet will then produce a concise input form, including all parameters required for calculations plus all data required for any decision making processes.

Inputs

Analysis Code	Symbol	Symbol	Units	Parameter	Set 1	Set 2
LVC,FIV2,FIP3,AIV,LVO,GVO			1, 2 or 3	Fluid Type: Gas = 1, Liquid = 2, Multiphase= 3	2	2
LVC,LVO,FIV1,FIV2, FIP3	Rho	ρ	kg/m^3	Fluid Density	1000	152.28
FIV2, FIP3	μ_{gas}	mugas	Pa.s	Gas Dynamic Viscosity	0.000017	0.000017
LVC,FIV1,FIV2, FIP3		v	m/s	Steady State fluid velocity	20	20
,LVO,FIV2,AIV,GVO		W	kg/s	Mass flow rate	500	5.314166667
LVC,FIV2,FIP3,AIV,LVO,GVO		T	mm	Main line wall thickness	10	3.9
LVC,FIV2,FIP3,AIV,GVO		D_{ext}	mm	Main line External diameter	350	26.7
LVC,FIV2,LVO,GVO		L_{span}	m	Maximum span length between supports	5	5

5. Fill in the input form with the relevant process data and mechanical data

6. As soon as the last value is input, the calculated LOF is displayed together with several intermediate results (useful for data validation).

7. The spreadsheet enables calculations to be performed for up to 100 conditions at a time and is very useful for performing 'what-if' assessments. i.e. copy same data into the next columns but vary some key parameters such as flow velocity, pipe diameter or wall thickness to immediately see the effects on calculated LOF.

8. An overall combined results table shows LOF results for each position for each excitation mechanism.

Outputs

Analysis Code		EI Section	EI page	Description	Set 1	Set 2
FIV1	LOF	T1.1	36	Flow Induced Turbulence (Qualitative)	High	High
FIV2	LOF	T2.2.3	49	Flow Induced Turbulence - Quantitative	9.26	out of range
MEC	LOF	T2.3	54	Mechanical Excitation from machinery	0.90	0.80
FIP1	LOF	T2.4	55	Reciprocating/Positive displacement pumps and Compressors	0.4	1
FIP2	LOF	T2.5	56	Rotating Stall of Centrifugal compressor	0.4	1
FIP3	LOF	T2.6	57	Flow Induced Puslastion - Deadleg Branch	0.29	0.29
AIV	LOF	T2.7	59	Acoustic Induced Vibration - High Frequency Acoustic Excitation	0.82	0.29
GVO	LOF	T2.8.3.1	66	Surge - Gas valve opening	gas only	gas only
LVC	LOF	T2.8.3.2	66	Surge - Liquid valve closing	0.61	17.37
LVO	LOF	T2.8.3.3	68	Surge - Liquid valve opening	0.00	5.83
C&F1	LOF	T2.9	69	Flashing - Likelihood of Failure	0	0
C&F2	LOF	T2.9	69	Cavitation - Likelihood of Failure	0.7	0.7

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Pipework Vibration Assessment

Licensing

The Quantitative Analysis Tool is supplied under the terms of a signed Licence Agreement and is available in 2 commercially licensed versions:

- Cost-effective 100-day project license (useful for one-off design or evaluation projects and for trouble-shooting projects)
- Perpetual license (paid annually in advance)

Competence

The VibTech Quantitative LOF Assessment Tool (QAT) has been designed to remove the need for the user to perform a single calculation, however, the Quantitative Assessment Tool should only be undertaken by engineers who are deemed competent to perform such analysis and so VibTech would always recommend that engineers have received a suitable level of training, such as one of the following:

- VibTech 2-day Analyst Course
- VibTech 3-day Intermediate Course
- VibTech 4-day Advanced Course

Contact Us

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