

























INTERGRAPH

INTERGRAPH

## Reduce risk of piping failure by controlling natural frequencies

- In many cases it is our "dumb luck" that our systems respond to any one of the many harmonic sources
- We can evaluate risk of response by monitoring system natural frequencies
- We can better reduce risk of failure by increasing system natural frequencies
- CAESAR II modal analysis of new designs can be used to improve system reliability

## Qualifying new designs using modal analysis

- Modal analysis calculates the natural frequencies and mode shapes
- The lowest natural frequency (LNF) indicates the likelihood of piping vibration.
- Typical acceptance criteria: keep LNF > 3 to 5 Hz
- Based on experience
- This method and acceptance criteria is not reflected in traditional piping codes and standards































































Achi resp											
<ul> <li>Mass distribution review</li> <li>Coarse distribution misses a mode (shape) and</li> <li>Locks up more mass at restraints</li> </ul>											
	Coarse & Lumped Coarse & Consistent					Lumped					
	Mode	Freq (Hz)	Mode	Freq (Hz)	Mode	Freq (Hz)	Mode	Freq (Hz)			
	1	3.674	1	3.56	1	3.287	1	3.282			
	2	5.517	2	6.017	2	5.864	2	5.861			
	3	9.344	3	9.25	3	9.501	3	9.471			
	4	11.795	4	11.425	4	10.923	4	10.886			
$\rightarrow$					5	11.758	5	11.709			
	5	13.926	5	12.923	6	13.86	6	13.857			
	6	16.585	6	14.62	7	16.704	7	16.721			
	7	17.294	7	17.196	8	20.147	8	20.262			
	8	19.299	8	18.515	9	22	9	22.02			
	9	21.381	9	23.174	10	24.297	10	24.433			
	10	23.932	10	26.63	11	28.526	11	28.776			
	11	34.174	11	36.036	12	34.719	12	35.098			
									INTERGRAPH		



















LNF F	Rule /	Applie	d – 3	St	ati	ist	ic	S	
Pipe Series / Area	Pipe Size Range	Pr. Rating Class	No. of Systems	3 - 4	LNF 4 - 6	(Hz) 6 - 8	>8	Remarks	Overall
Compressor	DN 450 - DN750	Class 600, 900	20	0%	20%	80%	0%	High LNF desired for compressor Piping	80%
Topside Process	DN100- DN600	Class 600, 900	32	0%	22%	19%	59%	High LNF desired for HP Process Piping	78%
Bridge & Expn Bay	DN50- DN600	Class 600, 900	19	58%	42%	0%	0%	Low LNF due to large expansion loop	0%
HP Flare	DN200- DN900	Class 150-Heavy Sch & 600, 900	20	0%	20%	15%	65%	High LNF desired for HP Flare System	80%
LP Flare	DN100- DN250	Class 150	3	0%	100%	0%	0%	Acceptable LNF range for LP Flare	0%
Sea Water	DN200- DN700	GRP, Class 150	6	0%	0%	33%	67%	High LNF due to more supports for GRP Piping	100%
Service Water	DN150- DN350	GRP, Class 150	6	0%	50%	17%	33%	Acceptable LNF range for Service Water	50%
Tempered Water	DN200- DN900	GRP, Class 150	30	0%	17%	37%	47%	High LNF due to more supports for GRP Piping	83%
Haz Drains Open	DN100- DN350	GRP, Class 150	7	0%	71%	0%	29%	Acceptable LNF range for Open Drains	29%
Fire Water	DN100- DN600	GRP, Class 150	9	0%	11%	22%	67%	High LNF due to more supports for GRP Piping	89%
	Source: Nigel M	arsh of Peak Engine	eering Ltd.					INTE	RGRAPH









