Risk check sheet

Vibration, fatigue, reliability and noise

When to contact the VDN team?

This checklist identifies vibration, reliability and noise risks for piping, structures and rotating machinery in greenfield/brownfield projects and operating facilities. It can be used during FEED, detailed design, planned changes (management of change), commissioning and operations.

Please contact VDN for questions or support (see contact details for your region below).

Rotating equipment vibration design studies

Reciprocating compressors

If any of the below apply, contact VDN for specific guidance:

- ❑ Torsional vibration analysis (TVA) must be done on all reciprocating compressors (check if not completed)
- ❑ Power > 75 HP / cylinder
- ❑ Variable speed machine
- ❑ Wide operating envelope (ie, > 200 PSI range of suction, discharge pressures, multiple load steps, etc)
- ❑ Facility operation is dependent on compressor, with no standby
- ❑ Fuel gas booster for gas turbine application
- ❑ Existing unit is being modified (eg, changes to piping, machinery configuration, operating conditions)

Centrifugal compressors

If any of the below apply, contact VDN for specific guidance:

- ❑ Inertia number < 100, try VDN's free inertia number calculator
- ❑ Multiple centrifugal compressors in facility
- ❑ Reciprocating compressor in series or parallel within the facility
- ❑ No surge control analysis completed by OEM
- ❑ Large-bore inlet/outlet (>14", >35.5 cm)
- ❑ Small-bore connections within 5 outer diameters of compressor
- ❑ Existing unit is being modified (eg, changes to piping, machinery configuration, operating conditions)

Screw compressors

If any of the below apply, contact VDN for specific guidance:

- ❑ Compressor is > 500 HP
- ❑ Variable speed machine
- ❑ Vessel wall thickness < ½" (1.3 cm), or vessel diameter >30" (76 cm) oil separator
- ❑ Existing unit is being modified (eg, changes to piping, machinery configuration, operating conditions)

Reciprocating pumps (plunger and diaphragm pumps)

If any of the below apply, contact VDN for specific guidance:

- ❑ Power > 25 HP
- ❑ Pump RPM > 200
- ❑ Variable speed machine
- ❑ Facility operation is dependent on pump, with no standby
- ❑ Existing unit is being modified (eg, changes to piping, machinery configuration, operating conditions)

Centrifugal pumps

If any of the below apply, contact VDN for specific guidance:

- ❑ Vertical turbine pump reed critical frequency (RCF) **must** be done (check if **not** completed)
- ❑ Throttling valve exists with the potential to have > 50% pressure drop across it
- ❑ A pump ESD, start-up scenarios and a water hammer study **has not** been completed
- ❑ Existing unit is being modified (eg, changes to piping, machinery configuration, operating conditions)

*see next page for structural/foundation vibration studies

Static equipment and structures

Piping systems: including offshore topside systems

If any of the below apply, contact VDN for specific guidance:

- ❑ A vibration screening has **not** been completed by a vibration specialist (typically ~10-20 hours).
  [Note: Veridian VS, a free, web-based screening software, is available for screening applications]
- ❑ **Must** include flow-induced vibration (FIV) (check if **not** completed)
- ❑ **Must** include acoustic fatigue (AIV) if vapour phase exists (check if **not** completed)
- ❑ **Must** include review of small-bore design and connections (check if **not** completed)
- ❑ All intrusive elements (such as thermowells, injection quill) should be designed to avoid vortex-induced vibrations, (check if **not** completed)
- ❑ A vibration screening identified requirements for advanced analysis
- ❑ Liquid system with fast acting valves, pump ESD, start-up scenarios and a water hammer study has **not** been completed
- ❑ Existing piping is being modified and has compressors or pumps in system

Piping systems: subsea piping risks

If any of the below apply, contact VDN for specific guidance:

- ❑ A vibration screening has **not** been completed by a vibration specialist (typically ~10-30 hrs)
- ❑ A vibration screening identified requirements for advanced analysis
- ❑ A vibration-induced vortex study has **not** been completed on the risers
- ❑ A corrugated riser with dry gas is used (flow-line-induced pulsation, FLIP)

Structural and foundational risks

If any of the below apply, contact VDN for specific guidance:

- ❑ Reciprocating equipment mounted on piles, gravel pad or steel foundation (ie, module or platform deck)
- ❑ Rotating equipment is mounted **without** anti-vibration mounts (AVMs), with multiple units on steel foundation or near vibration-critical areas such as living quarters

Support types and clamps

If any of the below apply, contact VDN for specific guidance:

- ❑ Supports are elevated and provide < 10,000 lb/in (1750 N/mm) stiffness in any direction of the pipe
- ❑ Pipe clamps are required for vibratory service (ie, clamps for piping upstream/downstream of reciprocating machinery compressors and pumps)
- ❑ Contact VDN for specifications on standard vibration clamps, damping clamps and supports (DamperX™)

Noise management

Environmental noise risks

If any of the below apply, contact VDN for specific guidance:

- ❑ Particular operational scenarios, weather conditions or time of day lead to the complaints or comments
- ❑ Noise limits applicable to the plant boundary
- ❑ Noise study has **not** been completed

Occupational health risks

If any of the below apply, contact VDN for specific guidance:

- ❑ High noise levels are affecting personnel's ability to communicate or complete tasks, cause fatigue
- ❑ Incidents occurred where high-noise environment was identified
- ❑ Hearing and understanding the PA/GA (public address, general alarm) system is difficult over plant noise
- ❑ Noise levels in muster areas (for emergency conditions) are too high for effective communication
- ❑ Noise levels within internal work areas, offices or accommodation are affecting work performance
- ❑ It is not clear where the highest noise risks are on site
- ❑ It is not clear where (double) hearing protection is required to protect against hearing loss
- ❑ Noise is affecting cabins and causing sleep disturbance

Field engineering, troubleshooting, monitoring

Operational issues

If any of the below apply, contact VDN for specific guidance:

- ❑ Changes planned for an existing site (eg, new or modified compressors or pumps)
- ❑ Commissioning and start-up checks have **not** been completed: site review, inspection, vibration baseline testing, noise compliance survey
- ❑ Concerns about vibration or fatigue: site engineering to help with troubleshooting
- ❑ Root-cause failure analysis (RCFA) or general problem solving required
- ❑ Noise concerns on any piping, machinery, structures or subsea areas
- ❑ Requirements for performance testing, reliability engineering support, FAT/SAT testing
- ❑ Condition monitoring: strategy, implementation support and ongoing monitoring programs required

Contacts for application support

Regions	VDN services						
	General enquiries	**Static equipment & structures** (piping vibration)	**Machinery analysis** (compressors, pump systems)	**Noise management**	**Rotating equipment reliability** (monitoring)	**Field engineering and troubleshooting**	**Anti-vibration products**
UK, Africa	Jonathan Baker	Rob Swindell	Ramin Rahnama	Graham Cowling	Mark Gillett	Colin McIlwraith	Ramin Rahnama
Middle East	Na'el Barghouthi						
US	Gary Maxwell	Mike Cyca	Rich Bennekemper	William Hesser	Matthew Brandon	Steven Crocker	Starr Dalton
Canada	Shelley Greenfield		Michael Hahn	Chris Bibby		Gufran Noor	Ron Carpendale
Latin America	Nick Cavadas						
Australia	Dave Lambert	Bruce Loneragan		Stephen Lloyd	Dave Lambert		Andrew Houghton
SE Asia	Paul Crowther						
China	Andy Li						

General inbox to request application support: info.vdn@woodplc.com
Website (articles, technical resources): woodplc.com/vdn