

# When and how to use and set up vibration monitoring on assets

Breaking down the process and rationale for successfully adding these sensors for condition monitoring

By John Bernet

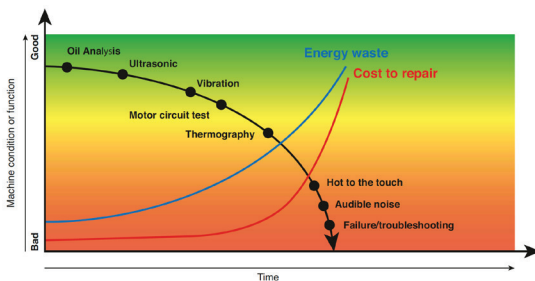
The need for actionable data in plants and other facilities is typically unquestioned by most reliability and maintenance teams. Where people typically diverge is in a few areas:

- When to measure/gather data
- How frequently to measure
- Technologies to add to assets

## Why select vibration monitoring?

The P-F Curve (see Figure 1) illustrates a more practical view to consider the time between potential failure and when the asset can no longer perform all functions per the specifications. Many reliability industry leaders feel using this P-F interval is important because:

- Long before an asset fails, it usually begins to consume more energy and lose overall performance.
- The earlier a problem can be detected and corrected, the less it costs to repair (an ounce of prevention is worth a pound of cure).



**Figure 1.** The P-F curve shows the time interval between potential failure on the upper left until machine failure occurs on the lower right. Most assets follow a curve in their lifecycle, from good to progressively worse, until they completely fail.

Certain technologies have the ability to detect emerging failures long before the asset fails. These are often called “predictive technologies,” and are typically part of condition monitoring programs. This is a theoretical framework that may vary from asset to asset, and the point is not to say that personnel should repair a machine at the earliest sign of failure because it may be too early. These early indicators simply signal that additional maintenance actions, such as lubricating the bearings or beginning to plan and schedule maintenance, may help avoid unexpected failures and downtime.

These technologies include:

- Oil analysis
- Ultrasound
- Vibration
- Motor circuit testing
- Thermography

Each technology may be used in combination or individually.

## When should vibration screening be used?

Every machine component produces a unique vibration signal. Signals displayed in the spectrum often form characteristic patterns. Pattern recognition is a key part of vibration analysis, but significant training and experience are necessary to recognize and read the patterns. Vibration analysis can watch bearing wear across 12 to 18 months as they go from slight wear (no action) to extreme wear (replace bearings immediately). Oil analysis can only be performed on oil-cooled bearings (fewer and fewer are used every day). Ultrasound finds bearing wear too early to replace the bearings (use to know when to grease the bearings instead).

Table 1 is a simplified overview of the patterns used to recognize the four most common machine faults, particularly in rotating assets.

	Machine fault	Frequency and Axis	Component found	Advanced Severity
1	Imbalance	1X - All radial directions	On affected component	Higher amplitude 1X
2	Misalignment	Parallel	Both sides of coupling	Higher amplitude 2X
		Angular	Both sides of coupling	Higher amplitude 1X
3	Looseness	1X harmonics—all directions	On affected component	Higher harmonics
4	Roller bearings	Non integer—all directions	On affected component	Harmonic, sidebands, noise hump, noise floor

**Table 1.** Patterns of common machine faults

Vibration screening can identify abnormalities caused by most of these faults as they begin — in the early stages, providing precipitous warning of impending failure. The severity of the four common faults can be tracked over time based on the history from hundreds of thousands of machines that have been analyzed by many vibration experts over 30 years. This knowledge and experience have been incorporated into rule-based algorithms and a baseline database that have been proven to be effective on standard

rotating machines — motors, pumps, fans, compressors, blowers and single-shaft spindles.

Handheld vibration meters can be used for route-based, preventive strategies. A more flexible method is screening with continuous remote, wireless sensors. Regardless of the method used, vibration technology can provide reliability and maintenance teams with actionable data that can help determine when further analysis is required to decide when steps such as relubrication, repairs or replacements should be made.

**How should sensors be set up on assets?**

Triaxial sensors are placed on assets throughout the facility, perhaps initially focusing on problem equipment to determine the best way to improve their operation. Application is simple, and setup can typically be completed in under an hour. All rotating machines can experience vibration. Pumps, fans and motors have different faults that vibration screening can identify. For a complete list of equipment that may benefit from vibration screening, see “Ideal assets candidates for vibration screening” in this article.

**What happens to all the data?**

To mitigate lost time and data entry errors, the sensors should send data, via cloud-based software and a Wi-Fi connection, directly to a source viewable on a PC or using a connected mobile device. These data are available within seconds so that personnel can assess asset health. All stakeholders can view the data whenever they would like and wherever they are.

Ideally, this data can be automatically delivered to an enterprise asset management system or a computerized maintenance management software system. With direct feeding This integration can be the first step toward connected reliability, in which all disparate data sources within a facility are captured and aggregated in one storage location and viewable anywhere on any type connected device.



## Ideal asset candidates for vibration monitoring

### Pumps

1. Vertical pump (12' to 20' from grade to top of motor)
2. Vertical pump (8' to 12' from grade to top of motor)
3. Vertical pump (5' to 8' from grade to top of motor)
4. Vertical pump (0' to 5' from grade to top of motor)
5. Horizontal centrifugal end-suction pump (direct-coupled)
6. Horizontal centrifugal double-suction pump (direct-coupled)
7. Boiler feed pump (turbine- or motor-driven)
8. Positive displacement horizontal piston pump (under load)
9. Positive displacement horizontal gear pump (under load)

### Fans

10. Belt-driven fan (1,800 to 3,600 rpm)
11. Belt-driven fan (600 to 1,799 rpm)
12. General direct-drive fan (direct-coupled)
13. Shaft-mounted integral fan (extended motor shaft)
14. Axial flow fan (belt- or direct-driven)
15. Large forced draft fan (fluid film bearings)
16. Large induced draft fan (fluid film bearings)
17. Vacuum blower (belt- or direct-driven)

### Compressors

18. Reciprocating chiller (open motor and compressor)
19. Reciprocating chiller (hermetic motor and compressor)
20. Reciprocating air compressor
21. Rotary screw air compressor
22. Centrifugal chiller (hermetic or open motor)
23. Centrifugal air compressor with or without a gearbox
24. Centrifugal air compressor – internal gear (axial measurement)
25. Centrifugal air compressor – internal gear (radial measurement)

### Blowers

26. Lobe-type rotary blower (belt- or direct-driven)
27. Multistage centrifugal blower (direct-driven)

### Cooling Tower Drives

28. Long, hollow-shaft (motor)
29. Belt-drive (motor and fan – all arrangements)
30. Direct drive (motor and fan – all arrangements)

### Generic Gearboxes

31. Single-stage gearbox

### Machine Tools

32. Machine tool motor
33. Machine tool gearbox input
34. Machine tool gearbox output
35. Machine tool spindle – roughing operations
36. Machine tool spindle – machine finishing
37. Machine tool spindle – critical finishing



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