Metrix Basic Machinery Monitoring Methodology

Metrix wants to provide early warning of a machine problem, so you can take action, and perform machinery diagnostics when you need to.

Purpose

This application note is intended to shed light on why more and more customers are choosing a transmitter vibration monitoring methodology in combination with their PLC (Programmable Logic Controller) or DCS (Distributed Control System) or SCADA (Supervisory Control and Data Acquisition) system for machine monitoring in lieu of a permanently rack based Vibration Monitoring System (VMS).

Questions Answered by the Application Note

Why would you need a dedicated Vibration Monitoring System if the existing Control System can monitor vibration parameters along with all the process parameters?

Since you absolutely need the Control System, why not just monitor and protect the machine, the process, personnel and the community with the Control System?

Why pay twice for protecting the machinery asset when the Control System can provide adequate vibration protection with the right sensors?

Introduction

When you ask operators at various industrial facilities (e.g. power plants, refineries, chemical plants, pipelines, water and wastewater facilities, etc.) they will tell you that most (+98%) of their machinery is working properly. The machinery is properly mounted, aligned, balanced, lubricated, operated and in most cases maintained to ensure it continues to provide its designed purpose.

In the past, Metrix would advocate a sensor solution with a vibration monitoring system (VMS) on critical, production limiting, rotating or reciprocating machinery, and in some cases, we still would. However, things have changed in the machinery monitoring world in the past 20 years.

The argument used to be that the PLC (Programmable Logic Controller) or DCS (Distributed Control System) did not have the scan rate necessary for machinery protection for vibration and position sensors. That is simply no longer the case, even though the scan speed is a key differentiator between DCSs and PLCs, either can now be adequately used for machine protection. PLCs are designed to meet the needs of applications that require scan rates of ten milliseconds or less *(0.01 seconds or less).* This allows them to accurately control motors and drives running at high speeds, and this is 10 times faster than many VMSs, certainly adequate for radial vibration and thrust monitoring. However, DCSs and SCADA systems do not need to be this quick because they control systems rather than individual devices. A DCSs and SCADA systems regulatory control loops generally scan in the 100 to 500 millisecond range *(0.1 to 0.5 second range)*, which is usually very adequate for monitoring changes in radial vibration, and can be adequate for thrust monitoring. When you consider most vibration, and thrust monitoring, has a three (3) second time

delay, or more, the scan rates of 0.1 to 0.5 seconds are certainly adequate (sources: Emerson - Delta V Distributed Control System, White Paper, Oct 2016; Siemens – DCS or PLC? Seven Questions to Help You Select the Best Solution, White Paper, 2007).

For non-critical rotating or reciprocating machinery, which marginally affects plant production, Metrix would advocate a transmitter based solution for monitoring and protection, or depending upon the asset an electronic or mechanical switch for protection. **We are starting to see more and more customers choosing vibration transmitters on critical rotating and reciprocating machinery. This includes those machines with fluid film bearings (also known as journal or sleeve type bearings) that utilize proximity probes.**

Customers are changing from vibration monitoring systems to transmitter / PLC / DCS / SCADA systems for their vibration monitoring needs for three reasons: Cost, ease of implementation, and exception based machinery diagnostics. The customers that are choosing the vibration transmitter route, even while using proximity probes, is because the machines that they are monitoring rarely fail, and they just need early warning if there is a change in vibration levels. If they see a change in the vibration trend using the output of the transmitter, they then use their portable diagnostic equipment to diagnose the possible problem. Let's investigate why customers are changing their vibration monitoring strategy to transmitters in lieu of sensors and vibration monitors.

Vibration Monitoring Shift

The vibration monitoring solution should depend upon the cost of **Unscheduled Downtime**. Unscheduled Downtime caused by a problem coming from a rotating or reciprocating machine is the costliest downtime for a plant. The plant loses money from lost profits (Lost Opportunity Cost = loss of profitable output), expedited repair, material and labor costs, standby labor costs, quality issues, customer trust / delivery issues, and most importantly personnel safety concerns. The sensory solution employed on a machinery asset depends upon the probability of an unscheduled downtime event. If the asset downtime does not present a risk to personnel, the facility or community, then the vibration monitoring solution is minimal (see Metrix Application Note "Monitoring Methodology" for more detail).

The change from a vibration monitoring system to the transmitter / PLC / DCS / SCADA solution is partly due to the improved scanning speed and what is already being monitored by the Control System.

Question: Of the shutdown parameters listed below (if monitored), how many are usually found in a Vibration Monitoring System (VMS), and how many are in the Control System?

Motor	VMS	PLC
Low lube oil pressure	No	Yes
High bearing temperature	Yes	Yes
High lube oil temperature	Yes	Yes
High current	No	Yes
High voltage	No	Yes
Low voltage	No	Yes
High radial vibration	Yes	Yes
Abnormal thrust position	Yes	Yes

Pump	VMS	PLC
Low lube oil pressure	No	Yes
High bearing temperature	Yes	Yes
High lube oil temperature	Yes	Yes
High / Low discharge pressure	No	Yes
Low flow	No	Yes
Low Suction Pressure	No	Yes
High radial vibration	Yes	Yes
Abnormal thrust position	Yes	Yes

The point made by the question above is, why would you need a Vibration Monitoring System if the Control System can monitor the same parameters? Since you absolutely need the Control System, why not just monitor and protect the machine, the process, personnel and the community with the Control System? Why pay twice for protecting the machinery asset when the Control System can provide adequate vibration protection?

The argument for a VMS is two fold; 1) Discrete vibration parameters can be simultaneously monitored along with the direct vibration, and 2) the plant asset can be connected to a Condition Monitoring System (CMS), possibly accessible via an Intranet. These two reasons especially apply to machinery assets, usually with fluid film bearings, that are using proximity probes as their means of machinery vibration protection.

Discrete vibration parameters like gap voltage, 1X amplitude and phase, 2X amplitude and phase, nX amplitude and phase have value, but the time and effort to set these parameters up, and maintain them, to make them meaningful, is not justified**. In most cases these parameters are present in the VMS, but are not used. Only the direct amplitude is used and it is fed to the Control System, like a vibration transmitter output. Only the direct amplitude from a rack based system is used for a vibration shutdown signal, just like a vibration transmitter output. The means of getting the discrete vibration parameters into the Control System is not justified, unless the parameters are maintained. Since, in most cases, they are not maintained, the expense for the VMS as an addition to the Control System is not justified.**

An online CMS is very convenient for those machinery assets where in which the cost of Unscheduled Downtime is very high – we call these assets Critical Assets (without these assets the plant does not operate). Keep in mind, it is highly unlikely the plant has the human resource capacity to perform diagnostics on machines that have shown no change in vibration behavior. This is evident from the fact that no action is taken on the discrete vibration parameters discussed above. Why should the plant spend hours looking at vibration plots (Dynamic Data), when no change in vibration behavior has been noticed? They shouldn't. Consider the actual sequence of events at a facility when the VMS detects a vibration problem, and a CMS is available:

1. VMS detects a significant change in vibration that is below the shutdown.
2. Expert in Machinery Diagnostics (often one person associated with the facility, maybe, and usually not one of the operators on shift) gets online, if possible, or goes to the plant to diagnose the change in vibration.
3. The Expert goes through the Machinery Diagnostic process looking at the Dynamic Data plots available, using the installed and dedicated CMS, and possibly makes a recommendation to solve the problem, live with the vibration change or shutdown the unit.

How is this different from when a vibration transmitter reports a problem via the Control System? The difference is the time it takes for the Expert to go to the plant to connect the portable diagnostic gear to the BNC's of the proximity probe vibration, position and phase transmitters of the asset. This delay time may or may not be significant to the plant, when you consider the portable diagnostic gear can be used on any asset at the plant, not just the critical assets covered by a dedicated CMS, the delay time in conducting diagnostics may not be significant. With some portable diagnostic gear the operators can be trained to connect to the BNC's of the transmitters and collect the data and send it to the Expert remotely. Since the Dynamic Data can be gathered with portable diagnostic gear from the vibration transmitter's BNC the expense for the VMS in addition to the Control System is justified only when the delay time for gathering diagnostic information is economically significant.

Conclusion

Metrix wants to provide early warning of a machine problem, so you can perform machinery diagnostics when you need too.