EMCOR Government Services

Reading your Chiller's Tea Leaves

Vibration analysis remains one of the most cost-effective ways to prevent loss of service, prolong equipment life, and ultimately save building owners money.

Shake, rattle, and roll may be great on the dancefloor, but when it comes to your chiller, excessive vibration in fans, pumps, motors, and other components can foreshadow impending failure. Depending on the location and the nature of the unwanted vibration, it can indicate motor rotor or impeller imbalance, bearing or gear deterioration, shaft misalignment, an open bar (not the fun kind!) in the motor's rotor, or other problems.

Most of these fateful vibrations are imperceptible to the human eye or touch, so diagnosing detrimental vibration requires a probe to measure the deflection of machine components along the X, Y, and Z axes. In order to properly interpret the vibration readings, training and certification on this test equipment is usually necessary. However, some of the newer vibration analysis equipment has onboard diagnostics that enable testing without formal certification. Nevertheless, for large equipment, such as chillers, any questionable readings should be verified through readings conducted by a certified individual.

> **"Establishing a baseline on your equipment is key to tracking its condition."**
>
> **Pat Baldwin**
> Vice President & General Manager
> EMCOR Services Combustioneer

Vibration analysis is a form of Predictive Maintenance (PdM) or Predictive Testing and Inspection (PT&I), which can be utilized on its own or as a component of a Reliability Centered Maintenance program or a Total Productive Maintenance program—the most comprehensive regimen in facilities maintenance. PdM or PT&I, by virtue of their names, are highly useful in predicting equipment failure on the horizon. Besides early failure detection, predictive services like vibration analysis can prolong equipment life, prevent downtime and loss of income, and ultimately save money, particularly if the equipment would have had to be replaced after a catastrophic failure.

Vibration analysis is increasingly being utilized by building owners and operators to improve equipment reliability and reduce operating expenses. The process involves placing a vibration measuring probe on various locations of the chiller where there are rotating components. If a flat surface is not available for the probe to rest, vibration-detecting nodes are affixed to the chiller, and the probe is placed on them to take the reading.

BAD VIBES

What your chiller's vibrations may be telling you

Motor rotor imbalance, although rare, can increase to the point that it damages bearings. In extreme cases, the motor's rotor comes in contact with the stator, causing the motor to fail.

Impeller imbalance can occur due to damage from refrigerant carryover, which is the pumping of liquid refrigerant from overcharge or expansion device malfunction. If not identified early, the impeller can touch the wall of the casting and result in a catastrophic impeller failure.

Bearing deterioration happens with age, or it can result from defects that lead to early failure. It can be caused by a number of factors, such as overheating, excessive load, misalignment, contamination, lubricant failure, corrosion, tight or loose fits, and other causes. If discovered while minor, a catastrophic failure can be averted.

Gear deterioration is part of normal wear and tear; however, it can be exacerbated by lubrication deficiencies, shaft misalignment, overheating, or excessive vibration of connected components, such as the motor or the impeller.

Shaft misalignment can occur from bearing wear, gear wear, or warping from undue stress caused by refrigerant carryover. It can lead to a catastrophic failure or, at minimum, to the need for an emergency repair at an inopportune time.

An **open bar** in the motor's rotor causes the motor to lose its driving force for a split second, and the motor falls slightly out of its correct rotation field. If not identified, it can cause bearing failure, shaft misalignment, and/or eventual motor failure, due to overheating or the rotor striking the stator.

Every rotating component has its own vibration signature, so any deviation can be measured and recorded to help diagnose the type and severity of a developing problem, well before more pronounced indicators emerge.

Vibration analysis is usually performed annually whenever the equipment is carrying the biggest load, such as during the height of the summer, for a chiller. By testing under these max conditions, there is the highest probability that a detrimental vibration will be detected, if present. In most cases, the test can be performed without taking the equipment out of service. However, if the asset must be taken offline to set up the vibration equipment, the test should be performed after hours or, in the case of a manufacturing plant, when the production line is down for seasonal maintenance.

According to Pat Baldwin, a baseline vibration reading should be taken on a brand new chiller (or any other rotating piece of equipment) to reflect optimal function. Once a baseline is established, vibration analysis should be performed on a regular basis to track trends and avert unexpected failures.

The average cost of a vibration analysis is between $1,000 and $1,500, which amounts to an investment ratio of a fraction of a penny on a $750,000 to $1 million asset like a chiller, when installation costs are considered.

"Vibration analysis gives a lot of bang for the buck on high-speed chillers, as they typically have gears that can deteriorate," explains Alan Spence, PE, RPA, CIT, Director Emeritus of EMCOR Government Services' Facility Solutions Group. "The impeller's high speed also doesn't tolerate as much vibration as that of a low-speed chiller."

Of course, this testing is equally valuable on smaller, less expensive pieces of equipment, like a $15,000 pump or a $60,000 compressor, since their function is just as critical to proper building operation. Many organizations can further reduce the cost per asset of vibration analysis by having multiple assets tested at the same time, or by scheduling another service with the vendor simultaneously, such as a semi-annual performance inspection.

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The low cost for vibration analysis makes it a very common sense investment for a wide array of buildings. Facilities that benefit most from this testing tend to be critical in nature, operating on a 24/7/365 cycle. This includes hospitals, research labs, data centers, and mission-critical government facilities in sectors such as aerospace, homeland security, and defense.

Profit-driven organizations, where uptime is vitally important, also derive a high return on investment from vibration analysis. This includes financial institutions, hotels, restaurants, retail stores, and manufacturing plants, among other uses, that require uninterrupted cooling. Commercial and multifamily residential buildings may also see a benefit from vibration analysis, though having equipment redundancy in any of these facilities can lessen the imperative.

Regardless of the size, location, or use of the facility, Baldwin reminds us that "a failure is a failure." It simply becomes a matter of how damaging, in both quantifiable and qualitative terms, that failure will be to owners, operators, and occupants. Further, there are no drawbacks to performing vibration analysis.

EMCOR Building Services offers vibration analysis through a number of its mobile service companies across the United States, such as EMCOR Services Combustioneer, EMCOR Services Mesa Energy Systems, EMCOR Services Fluidics, EMCOR Facilities Services, Viox, and many more. These companies also specialize in other forms of PdM or PT&I, such as thermography, oil and refrigerant analysis, insulation testing, active leak checks, and eddy current testing, all of which deliver high value at low cost.