

Tips for a Lean Approach to Motor Reliability

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Introduction

Maintaining the highest reliability standards for electric motors is the goal of every company. Unfortunately, in an era that emphasizes lean operations, too many businesses fall short. When they do miss the mark, the costs for either repair or replacement can be prohibitive. The former most often requires the use of a crane, always an expensive proposition, while the latter, the purchase of a new motor, is even more costly. Both are detrimental to the bottom line, particularly replacement of a suddenly non-functioning motor, which has not been included in the current budget's capital outlays. When these issues arise, the usual aftermath includes a review of maintenance and testing procedures to see if the problems that led to the shutdown could have or should have been detected. While important, such reviews tend to overlook other causes that may not be readily apparent.

Maintenance should be a priority, and any review may find it to be inadequate for a variety of reasons, such as reliance on the traditional formula of 80 percent of technician time for testing and the remaining 20 percent for monitoring. In recent years, that formula is drawing closer scrutiny as a growing number in the industry argue in favor of an alternative approach—concentrating more on monitoring to get an accurate forecast of reliability and lifespan. However, the debate of maintenance percentages is only part of the problem. Another is a workforce that is diminishing in experience as baby boomers retire, leaving maintenance to the inexperienced and the company scrambling to find better ways to assure motor reliability.

Historical Context: The Challenge of Reliability

The concept of lean manufacturing has been around for nearly two decades. The goal was and still is the reduction of wasted costs, materials and manpower. At first, it may seem that the lean concept runs counter to motor efficiency and reliability. Keep in mind that lean implies a more limited application of resources to achieve efficiency. Unfortunately, it's not that simple.

Take for example today's workforce, which is in transition. Baby boomers are leaving the workforce while their replacements, for the most part, lack the expertise gleaned from all the years of experience their predecessors had. In 2015, Gallup reported that "older boomers are retiring in large numbers just as Americans in the mid- to late 60s did a few years earlier."¹ Although many are opting to stay in the workforce on a part-time basis and the average retirement age is increasing, still there is an exodus underway, and its impact on business will be felt for a long time according to Gallup. "It also means the U.S. could face a shortage of workers," the report said.²

These statistics do not bode well when applied to motor operations, which were no doubt kept at a high efficiency rate by the experience of older workers as well as the maintenance protocols of enlightened companies. A joint study prepared by Harvard University and the Rand Corp. bears this out. "Rapid retirements deprive companies of critical experience and knowledge, which undermines productivity across the entire economy," the study found.³ Its authors point out that productivity of older workers tends to increase the productivity of their younger

counterparts. A report on the study said the loss of these skilled workers will have a negative impact on productivity and the economy for years to come. “(It) will cost the U.S. economy by reducing per capita GDP growth by an estimated 1.1 percent in this decade,” the report stated. “Its impact will continue to be felt in the 2020s when growth will continue to be slower as a result of the continuing loss of experienced older workers.”⁴

The Challenge

Management and ownership should be concerned that while they may be able to replace the skills, they may not be able to replace the experience. This is a trend that needs to be addressed in just about every facet of business including motor efficiency and reliability. The same is true for the dwindling of those human resources who understood all the fundamentals for ensuring a motor’s efficiency and long life.

What is needed is coordination and balance of maintenance procedures and human resources in a manner designed to eliminate potential costly shortcuts that may negatively impact motor operations—and that does not change with a company’s efforts to run lean. Even with fewer resources, it can be done, but only through rethinking the entire strategic approach to motor maintenance. That means identifying potential faults with fewer people and less money without jeopardizing motor efficiency and lifespan.

Overview of Considerations: Reliability and the Motor Maintenance Trifecta

The motor maintenance trifecta plays a pivotal role. Its components are well known throughout industry: quality control, trending and troubleshooting. Where companies unwittingly get into trouble is with their priorities for each individual component. Generally, the one that gets the most attention is troubleshooting. Troubleshooting is the component most often applied. The other two components get less attention or none at all—an oversight likely to increase the cost of repairs or waste valuable production and workforce time; e.g. installing a defective motor that quality control testing could have revealed.

Motor health should not be based solely on troubleshooting because that part of the trifecta excludes important factors such as the changing motor operational environment. An unhealthy environment for motors, including heavy dust, dirt, poor ventilation, etc., is bound to have a negative impact and probably result in a shorter lifespan. In addition to the environment, there are plenty of other factors to consider, among them voltage, load and temperature. It is true that troubleshooting may detect an abnormality among one of the three, but effective and accurate analysis depends upon the entire spectrum of motor operations. Troubleshooting may detect an anomaly and prevent a catastrophic failure, but identifying the problem late in the game will negatively impact the motor’s projected lifespan.

The trending component does not get the attention it deserves for two very basic reasons: money and manpower. Many companies do not have the labor and/or the data or analytic resources for an accurate trending analysis. In these lean days of extremely tight budgets, the costs associated with an experienced labor force that fully understands a trending analysis tends to be a red flag for chief financial officers. The company may think it is saving money by allocating its resources elsewhere, but such savings are likely to evaporate should repair require the use of a crane or if replacement is the only other option. Trending is proactive. Its purpose is to analyze what is happening to the motor on an ongoing basis so that the data can be accurately

determined along with the analytics from the quality control and troubleshooting components of the trifecta.

Businesses have other options such as relying on contractors who test and trend using their own analytics platforms. This, too, can be expensive over time since motors require ongoing analysis. Another approach, based on lowering the company's labor costs, is to hire others to run the equipment. This scenario, though not unusual, does not satisfy the combined need for an experienced workforce and sophisticated analytics to conduct a comprehensive and cost-saving maintenance trifecta program.

The Solution: Fault Zone Analysis

So where should the focus lie? The answer is on fault zones.

The saying “monitor motors—focus on faults” is an industry cliché, but it is more than just good advice. It is, in fact, the key to optimal motor performance. While fault zones are well known to anyone working with motors, it is a good idea to take another look at each of them to identify potential signs of trouble on the operational horizon.

Power Quality: Serious telltale signs include harmonic distortion, power imbalance and power spikes. Any one or all will likely have a negative impact on operations and motor lifespan. None of them should be overlooked.

Power Circuit: The study of circuit components, which include conductors and connectors, can reveal quite a bit about the state of the motor. Analysis should encompass everything from testing point to motor connection. In fact, studies have revealed that power circuit deficiencies tend to be among the highest percentage of motor efficiency faults.

Insulation: One does not have to be an electrical engineer to understand that insulation is an area of concern for motors. Keeping insulation clean and dry is always challenging in an industrial environment. The penalty for not overcoming this major obstacle is higher motor temperatures and lower life expectancy. The plant environment is among the biggest issues because so many facilities, even the modern ones, tend to wind up as repositories of excessive moisture and dirt. Contamination of the winding insulation inside the motor frame is bound to follow.

Stator: The composition of the stator merits discussion if for no other reason than the risk it poses. The stator's copper windings and solder joints can be the source of potentially serious issues such as shorts and imbalance. When something goes wrong with these basic materials, the motor is at risk for an outage that, frankly, merits the term “catastrophic.” The results are waste and downtime that could affect productivity, production and the bottom line.

Air Gap: Efficiency depends upon even distribution of the gap between stator and rotor around 360 degrees of the motor. Uneven distribution will result in an unbalanced magnetic field, the subsequent failure of the bearings and possibly the stator windings. It is surprising that more attention is not paid to the air gap, which deserves as much analysis as the other fault zones.

Rotor: Issues with the rotor may not have as rapid an impact as other fault zone deficiencies but will erode efficiency and develop into a catastrophic fault if left unattended. An increase in reflected impedance and rising pole pass sidebands around line frequency are two of six possible warning signs of rotor defects. This anomaly may not be considered production limiting, but a relatively minor deficiency should not lessen the importance of awareness of possible defects.

Analysis of each of the fault zones can be predictive for assessing the motor's operational quality and longevity, but there is one other item that should be on everyone's checklist: a communication protocol by which all involved in testing are made aware of the potential deficiencies, warning signs in each zone, and the steps that will be taken to identify and address them especially for the most critical assets. At a time of reduced human and financial resources, communication among all parties is as critical as expertise and analytics for root cause analysis.

The Future: A Different Look at Testing and Monitoring Percentages

The standard for time allocation for motor technicians is 80 percent for collecting and testing data, and 20 percent for monitoring. It's been that way for years because many believe the former is a more productive use of the technician's time particularly with respect to motor operations. It is time to rethink that proposition.

The percentages should be reversed for several reasons. The first is history. Data, no matter how comprehensive, requires historical perspective. Are some findings anomalies, or are they indicators of something serious that requires immediate response? Historical context allows for more accurate and comprehensive data interpretation, which underscores the importance of monitoring as opposed to testing in a vacuum that lacks context.

The second, also indicative of the importance of monitoring, is assigning the data a condition for future reference. Again, this is an example of analytical assessment of the bigger picture that only monitoring can provide. Based on the assigned condition, the data provides a more accurate view of the state of the motor for root cause analysis or determining inefficiencies. However software platforms and analytics, regardless of their sophistication, are not enough. They cannot replace the human element. Yet companies that promote lean operations feel they have little choice but to rely on data due to the unavailability of experienced personnel unless they decide to rely on outside contractors. Instead, a hybrid approach combining the human elements and analytics is recommended. That way companies that lack the internal resources for testing and data technicians have options available to combine the best of both.

The installation of technology to greatly reduce motor testing time is one solution. A motor test access panel (MTAP) is a permanently installed online alternative that allows the technician to easily connect and test without opening the starter cabinet and exposing an energized electrical source. The MTAP eliminates safety issues that tend to arise when testing is conducted in the vicinity of energized equipment. In addition, the time required for tag-out and lock-out procedures is greatly reduced.

A similar solution is infra-red testing in which cameras are placed on a viewing window for video of the internal mechanisms without having to open the cabinet—another safety feature.

Technology manufacturers now offer permanently installed automated testing devices designed to eliminate nearly all of the testing time required by a technician. The analytics are often sufficient enough for early warning signs that can at least direct a trained analyst to investigate the data for a more complete severity assessment.

Another possible solution is a centralized repository for data analysis. For data storage, companies can either use their corporate servers or turn to the cloud as a low cost alternative to storage. With the flexibility of the cloud, asset data can be easily shared with trained analysts on or off site—another example of an effective hybrid approach.

Conclusion: Making Lean Motor Operations Work

It may seem overwhelming to try to achieve cost-efficient and long-lasting motor reliability at a time when the emphasis on lean threatens to leave the company at a resource disadvantage. Challenging times require companies to improve their ability to identify and eliminate faults. Failures will continue to happen despite thorough and detailed monitoring and testing. However management's efforts to maintain and improve the bottom line through the leanest use of resources does not have to exacerbate the possibility of outage or catastrophic failure. Technology such as the MTAP shows that there are options available for efficient reliability improvements to maintain motor life expectancy.

Reliability begins with balancing the motor maintenance trifecta of quality control, trending and troubleshooting. Establish and review asset criticality, both of which apply to quality control and the collection of trending data. Troubleshooting does come with a caveat. Do not make the mistake of relying mostly on troubleshooting data and de-emphasizing the other two trifecta components. To do so is to risk losing much of the value technology offers.

It is time for motor reliability management to shift the percentage in favor of using today's technology for monitoring motors and focus the remaining resources on fault zone analysis diagnostics—a much better way to ensure more reliable electric motors, and to do more with less.

About the Author:

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Resources:

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3. "America's Aging Workforce Poses an Economic Double Whammy." Greg Ip. *The Wall St. Journal*. August 3, 2016.
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