You Have a Motor Tester – Now What?

The best programs, whether vibration, infrared, or otherwise, all have one thing in common; a solid foundation on which they were built.

According to the U.S. Department of Energy Industrial Technologies Program, "motor-driven equipment accounts for 64% of the electricity consumed in the U.S. industrial sector." A major manufacturing company noted across just one of its business units, almost 1300 motors were replaced over one year. This equated approximately 108 per month, and cost this particular business unit $1.9 million dollars. Considering these statistics, motor circuit analysis (EMT) has become a very attractive and necessary technology in the industrial sector.

Your company has seen the value and decided to invest in EMT as part of their predictive maintenance program. They have selected you to introduce this new technology into their process. How do you effectively establish EMT as an integral part of your predictive program?

Program Start-up

The best programs, whether vibration, infrared, or otherwise, all have one thing in common; a solid foundation on which they were built. The largest obstacle companies face in implementing a program is identifying where to start. There are consultants available to help guide your company in program development. Some consultants will even be able to aid you in some of the specific aspects of your foundation. Ultimately, it will be up to your company to determine its foundation. In general the EMT program requires consideration the following elements of its development:

1. Good procedures
2. Trained personnel
3. Site survey (walk-down)
4. Quality motor repair shop

1. Good procedures

If you told two construction companies to build you a house, they would be able to provide you with a structure suitable to live in. It probably is not the house you had envisioned, and neither may look alike. However, if you specify the layout, how many bedrooms/bathrooms, kitchen and living room features you desire, the houses you receive would start to look more like what you had in mind and would look somewhat similar.

Good procedures for your EMT program are no different. They should be clearly written and detailed enough to provide the desired results. These procedures are also more likely to be repeatable in similar operating conditions for trend analysis.

All of your limits and specifications should be defined in your procedures. Two organizations that govern all motor manufacturing and testing procedures are the National Electrical Manufacturers Association (NEMA) and the Institute of Electrical and

Figure 1: PPE requirements are taken into account per NFPA 70E

Electronics Engineers Standards Association (IEEE-SA). These two organizations offer standards which you should refer to when establishing your own specifications.

Finally, safety should be well defined throughout all testing procedures. Some of the testing done will be done on live circuits. Other tests will be done on de-energized equipment that must be verified de-energized prior to making any test connections. NFPA 70E will provide all guidelines on appropriate PPE and testing procedures (Fig. 1).

2. Trained Personnel

In addition to quality procedures, knowledgeable personnel are needed to execute your program. They should have a basic knowledge of electrical theory, and be familiar with different electrical circuits and how they function. Your technicians should also receive training on the circuit testers you have purchased. While the electrical theory is the same with each tester on the market, there are some interfaces and spectrums that the technician must learn to recognize and interpret in order to determine whether or not a problem exists. The technician must be familiar with the limits established in the procedures that have been developed. They should know why they are testing for these limits, and how to acquire them with the tester provided. Finally, the technician must also understand the safety guidelines of NFPA 70E and the plant's local safety procedures.

3. Site Survey (walk down)

Once the "how" (quality procedures) and "who" (trained personnel) are established, the plant must decide what assets to monitor. Your plant should be "walked down", identifying all assets and their function. This will aid your company in establishing a critically for each asset and deciding where to place its emphasis in monitoring. Another consideration is the horsepower rating of each motor. By performing a cost analysis on motor repair/replacement based on horsepower, a decision can be made between an asset's criticality and its horsepower. You should also be aware of any special connections to be made in order to test the motor circuits. For instance, if a motor circuit operates at 4160 Vac, a special connection may need to be established to prevent damage to the tester and injury to the technician. Most testers are not rated to handle medium-voltage. There may be other circuits with difficult connection points. All these factors must be considered when deciding which circuits to monitor.

4. Quality Motor Repair Shop

The final piece of a EMT program's foundation should be the selection of a quality motor repair shop. This may be one of the least thought about, but one of the most crucial aspects to your EMT program. If a quality relationship is established and nurtured with the repair shop you select, they will be able to assist you with your program's quality. You should be willing to inspect their shop, and you should have them come to your site and provide any advice with respect to motor storage and installation.

One of your selection factors might be location of the repair shop relative to your site. Additionally, a shop's commitment to repair turnaround time should be considered. The most important consideration is to find a motor repair shop that can meet your expectations in all new and rebuild specifications you established with your procedures. If they cannot provide you with the reliable product you expect to install in your plant, another repair facility should be considered.

Routine Monitoring

After you have built a quality foundation, it's time to start monitoring your assets. You should expect your technicians to test per the quality procedures you have developed. By following these procedures verbatim, repeatable data can be collected that may be trended for potential faults.

Once you have collected and analyzed the data, you must be able to relay the status of the asset (or, its "health") to the rest of the plant. It would also aid your program if you determined metrics to measure the performance of your program. These metrics should show both strengths and areas where improvements can be made. They may also provide the plant with the program's effectiveness.

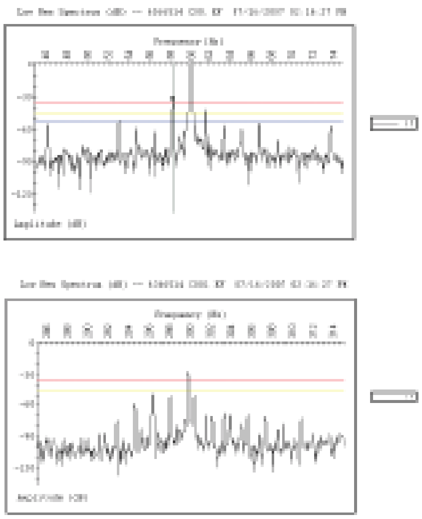

Fig. 2 – EMT spectrum showing signs of a rotor issue

EMT and Other Technologies

While each of the predictive technologies measure their own unique parameters, there are many pieces of data that overlap. For instance, a rotor issue or a single-phase condition could be detected with infrared because of the extra heat generated in components of the system. Some testers have the ability to acquire a demodulated signature. This signature will show not only the motor's running speed, but also other mechanical frequencies where defects may be detected and even correlated with vibration data. Examples include motor misalignment or coupling element failures. Based on this knowledge, EMT could give you the ability to monitor assets that either may have limited or no access for vibration analysis. Here is an example to show how data could be correlated to confirm a fault. A motor driving a centrifuge was inspected during routine testing. EMT online data was taken and it was determined the motor had a severe rotor bar issue and needed to be replaced (fig. 2).

Fig. 3 – Vibration data showing an electrical defect (rotor issue)

Though the data was very clear, vibration data was also taken which indicated a rotor issue was present (fig. 3). An infrared survey done in this time period showed a raised heat signature on the motor (fig. 4). The motor was replaced at the next available maintenance period and sent to the motor repair shop for refurbishment. Per request, the motor shop ran a test that revealed two broken rotor bars (fig. 5).

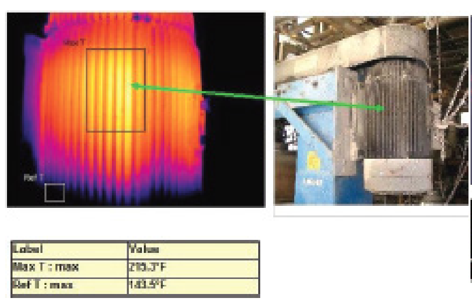

Fig. 4 – Infrared survey showing an increased heat signature

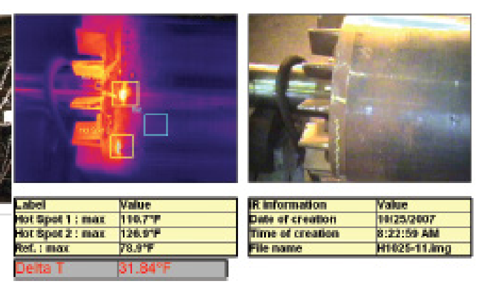

Fig. 5 – Infrared image of the rotor tested at the repair shop. The two hot spots show the locations of the rotor issue detected with EMT

Special Situations

In addition to providing valuable data during routine operations, EMT can be used for other situations. EMT can be a valuable troubleshooting aid in situations where other instruments may not be effective.

Test Date	02/27/2007	03/28/2007
Test Time	02:14:55 PM	11:26:02 AM
Frequency	1200	1200
Mohm Ph 1 to Gnd		
Charge Time	60	60
Voltage	1000	1000
Motor Temp	24	56
Measured Mohm	5772.0	694.9
Corrected Mohm	1900.0	2100.0
pF Ph 1 to Gnd	68500	73750
ohm Ph 1 to 2	0.04150	0.04050
ohm Ph 1 to 3	0.03650	0.04100
ohm Ph 2 to 3	0.03950	0.04050
mH Ph 1 to 2	2.425	2.840
mH Ph 1 to 3	2.745	2.520
mH Ph 2 to 3	2.775	2.455
Avg. Inductance	2.648	2.605
% Res. Imbalance	6.81	0.82
% Ind. Imbalance	8.43	9.02
$ Power Loss	283.36	28.34
Test Location	T-Leads	T-Leads
MCE #	030573HV	030573HV
User	JBACKER	JBACKER

Fig. 6 – Data and visual evidence of a faulty motor connection

This was proven during routine, offline EMT testing. A phase-to-phase resistive imbalance, greater than specified limits was noted at the MCC bucket for a motor circuit. To verify the imbalance was not internal to the motor, a follow-up test was taken at the motor junction box from the motor leads. A poor connection was found and corrected. When the motor junction box cover was removed, a strong "burnt" smell was noted. The data, and subsequent visual evidence supported the suspicion of a high resistance connection (fig. 6). All of the connections were felt for warmth and only one was found. The poor connection was broken, and all contact surfaces were inspected and cleaned, and re-torqued. The retest was taken at the MCC bucket, the results were satisfactory and the motor was returned to service. This connection would have eventually failed without any corrective action, possibly severe enough to damage the motor. Not only was this a 200 Hp motor, but also an explosion-proof model. The replacement cost would have been significantly greater than the cost of a normal high efficiency motor.

Another application EMT is useful in is new equipment commissioning. A new blower was installed and the plant was performing start-up testing. The blower failed to complete its start routine and remain running. In addition to a valve issue being discovered, it was also found the motor was connected improperly when installed. The motor was re-connected properly, the valve issue resolved, and the blower started and operated as designed.

Conclusion

Motor Circuit Analysis is a valuable tool in your predictive toolbox. Because motors drive most industrial equipment, EMT is very effective in providing data on the health of your plant's electrical assets. Used properly, EMT will help your company save precious resources and increase profitability through reduced maintenance costs and improved asset reliability.

For additional information about electric motor testing, visit www.thesnellgroup.com or contact The Snell Group at 1-800-636-9820.