Best Practice in Electric Machines Life Cycle Management

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Abstract: Electric machines, such as motors and generators, are vital to the operation of industrial facilities, especially in critical segments like oil and gas. Effective life cycle management of such machines ensures operational efficiency, minimizes unplanned interruption, and supports long-term asset integrity. This paper outlines a structured approach to the life cycle management of such electric machines, based on an internal guideline of one of the largest oil & gas companies. The methodology involves a two-cycle condition assessment process that enables asset owners to evaluate machine health, identify performance deficiencies, and make informed decisions regarding maintenance, repair, or replacement.

Index Terms — Electric machines, life cycle management, maintenance, repair, replacement.

I. INTRODUCTION

Electric machines are subject to electrical, mechanical, and thermal stresses. Their insulation wear over time, which can compromise their performance and reliability. Proactive condition assessment along with proper maintenance are essential to ensure that these assets continue to operate safely and efficiently throughout their service life. The company best practice provides a comprehensive framework for assessing the condition of large motors and generators, enabling asset managers to implement a robust life cycle management strategy as shown in the next paragraphs.

LIFE CYCLE STAGES AND CONDITION ASSESSMENT

The life cycle of an electric machine typically includes design, installation, operation, maintenance, and eventual decommissioning. This best practice focuses on the operational and maintenance phases, offering a structured two-cycle analysis to govern the current condition of a machine for taking appropriate actions.

A. *First Cycle Analysis – Initial Screening*

The first cycle serves as a preliminary evaluation to identify machines that may be at risk of failure or have performance degradation. This stage includes the following key activities:

- **Historical Review**: Examining repair history, recurring issues, and past modifications to detect patterns that may indicate underlying problems.
- **Visual Inspection**: Inspecting external components such as frame, heat exchanger, cables, and connectors for signs of wear and damage.
- **Vibration Analysis**: Using vibration spectrum data to detect mechanical imbalances, misalignments, or bearing issues in accordance with internal guidelines.
- **Temperature Trending**: Monitoring bearing and winding temperatures to detect abnormal thermal behavior that could signal insulation degradation or lubrication issues.

Each of these indicators is scored using a standardized system (0 to 4), where a higher score indicates a greater need for corrective action. Machines scoring 2 or above on any parameter are flagged for further evaluation in the second cycle.

B. *Second Cycle Analysis – Detailed Assessment*

Machines identified as potentially problematic in the first cycle undergo a more in-depth inspection and testing process in the second cycle. This stage focuses on three major components: stator, rotor, and excitation system.

- **Stator Inspection and Testing**: This includes evaluating mechanical integrity (coil blocking, wedge condition, core etc…) and electrical performance (insulation resistance, polarization index, high potential test, partial discharge, etc...).
- **Rotor Inspection and Testing**: Mechanical checks (balance weights, end winding condition, retaining rings, etc…) and electrical testing (pole integrity, coil resistance, etc…) ensure the rotor remains within acceptable performance limits.
- **Excitation System Inspection and Testing**: For machines with brushless excitation systems, this includes verifying the integrity of thyristors, diodes, and associated wiring. Along with AVR panel obsolescence evaluation.

The findings from this detailed assessment are analyzed by subject matter experts to determine the most appropriate course of actions, which may range from minor repairs to full machine replacement.

APPLYING THE LIFE CYCLE MANAGEMENT BEST PRACTICE

One example of applying the life cycle management was with a large motor that initially scored low during the screening process. When a detailed assessment was conducted, insulation damage was detected. Upon opening the motor, visual inspection revealed significant issues with the winding insulation. The motor was partially repaired and then returned to service.

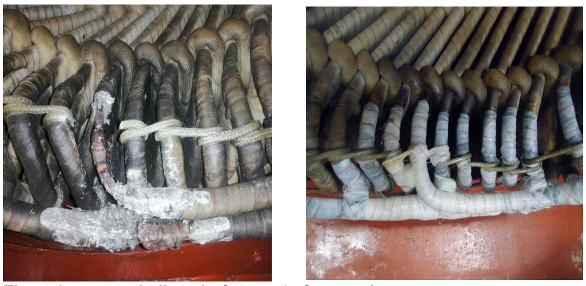

Figure1: motor windings before and after repair

SPECIAL CONDITIONS AND REPLACEMENT CRITERIA

The best practice also defines specific conditions under which a machine may be considered for replacement without the need for second cycle analysis. These include catastrophic failure involving the rotor or core, irreparable design deficiencies, or when repair costs exceed 70% of the cost of a new machine.

INTEGRATION INTO ASSET MANAGEMENT STRATEGY

To be effective, the condition assessment process must be integrated into a broader asset management strategy. This includes maintaining accurate records of inspection findings, test results, and maintenance actions in systems such as SAP.

CONCLUSION

The life cycle management of electric machines using the internal best practice provides a systematic and data-driven approach to maintaining asset integrity. By employing a two-cycle assessment methodology, assets owner can make informed decisions that enhance equipment reliability, reduce downtime, and optimize maintenance expenditures. This structured process, when combined with expert evaluation and historical data, supports the long-term operational excellence of critical electrical assets.

III. REFERENCES

- Saudi Aramco Best Practice SABP-P-035
- SAER-5659 – Guidelines for Setting Acceptable, Alarm and Shutdown Vibration Limits
- IEEE Std 56 – Guide for Insulation Maintenance of Large AC Rotating Machinery
- ANSI / IEEE Std 43 – Testing Insulation Resistance of Rotating Machinery

IV. VITA

Yousef O. Al-Rasheedi: received his B.S. and M.S. degrees in Electrical Engineering from King Fahd University of Petroleum & Minerals in Dhahran, Saudi Arabia, in 2006 and 2014, respectively. He joined Saudi Aramco in 2006 and initially served in the Abqaiq Plants Operation Department as a Technical Support Engineer, where he gained valuable experience in electrical systems operation and maintenance. In 2012, Yousef transferred to the Consulting Services Department, where he has been actively involved in the design, evaluation, and optimization of electrical infrastructure across various facilities.
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