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CONDITION MONITORING FOR PUMPS

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ABSTRACT

The OM Code contains a check valve condition monitoring (Reference Code Appendix II) that has been utilized by Owners at numerous nuclear power plants to improve testing of check valves. Use of this similar approach for pumps is expected to also improve testing of pumps.

Comprehensive Pump Testing was originally intended to address not just the pump, but the use of the pump drivers and associate pump electrical system components to monitor pump health as is currently done for motor actuated valves. The draft comprehensive test requirements included taking motor current pump electrical components, as well as an oil sample, but those requirements were not allowed to go into the final Code language, e.g., motor current signature requirements. The reason was that this was considered including the motor in IST and was not in the OM scope. However, the motor, in that case, was used to verify acceptable pump operation only. Also, enhanced vibration techniques, such as spectral analysis were also considered.

This paper will present the use of Pump Condition monitoring as a method to enhance IST and, in some cases replace traditional pump IST intervals, similar to what is done for check valve condition monitoring. The proposed Pump condition monitoring program will rely on the revised OM-14

1. INTRODUCTION

This paper provides a discussion of the need for a Code Case that establishes pump condition monitoring (PCM) program requirements for those pumps tested in accordance with Division 1, OM Code Subsection ISTB or ISTF, of ASME Operation and Maintenance of Nuclear Power Plants, hereinafter referred to as the Code.

This paper additionally establishes that the current O&M Subgroup on Rotating Equipment draft of OM-14, is the main contributor to, and source of the largest part of the proposed PCM program.

2. THE CASE FOR A CONDITION MONITORING OF PUMPS

The OM Code contains a check valve condition monitoring program (Reference Code Appendix II) that that has been utilized by Owners at numerous nuclear power plants to improve testing of check valves. Use of a similar approach for pumps is expected to also improve testing of pumps such that Owners will be able to enhance detection of degradation and machine faults.

The following issues are associated with the development of the Code Subsection ISTB Comprehensive Pump Test (CPT). The CPT was intended to include both improved and additional testing technologies than those currently required by the Code. (1) CPT was originally intended to address not just the pump, but the use of the pump driver and associated pump electrical system to monitor pump health as is currently done for motor actuated valves. Pump drivers and their associated electrical components would require utilization of additional test and examination technologies. An Oak Ridge presentation on nuclear industry pump failures was presented to the OM Standards Committee that identified a need for the Code to include pump electrical system components, since many were a large contributing factor for nuclear pump failures. And, excepting deep draft pumps, electrical system components were usually the cause of a pump failing Inservice Testing (IST). The draft CPT requirements included taking motor current, e.g., motor current signature requirements, but those requirements were not allowed to go into the final Code language. The reason was that the draft CPT inclusion of motor IST caused concern that the motors were not within the OM scope. As evident by the success of IST of motor operated valves, the pump and associated electrical system components, including the motor, need to be part of pump IST.

(2) CPT were originally intended to address use of vibration equipment that would provide state-of-the-art vibration testing, i.e., spectral analysis was not required, nor is it currently required, by the Code for some of the most important pumps in the world. The OM Standards Committee has had several presentations that advised that the Code should be requiring spectral analysis when monitoring nuclear safety related pumps. The original comprehensive testing schemes included use of state-of-the-art vibration testing, but those requirements were not allowed to go into the final Code language because they required expert interpretation of results (i.e., they were not ‘go- no go’).

(3) CPT were also originally intended to include sampling of oil as a tool of IST. That too, although part of the original ASME Section XI IWP, was kept out of the Code, again, because it required the interpretation of results.

2.1 What does Pump Condition Monitoring look like?

(a) The first steps in establishing PCM is an assessment of the design, test history, and maintenance history of a pump, and the pump electrical system, to determine those additional pump condition monitoring technologies, acceptance criteria, and equipment to be included in the pump condition monitoring program that will enhance detection of degradation and machine set faults.

(b) The technologies and parameters to be considered, in addition to Code hydraulic test, include enhanced vibration analysis, lube oil analysis, thermography, motor current signature analysis, motor electrical parameters, and process and equipment parameters.

(1) Vibration Analysis. Vibration analysis involves the Owner utilizing state-of-the-art equipment for collecting and analyzing spectral vibration data to monitor the mechanical condition of rotating equipment. Vibration analysis is the primary technology, along with lube oil analysis, used in a condition monitoring program.

(2) Lube Oil Analysis. Lube Oil Analysis involves analyzing oil properties, including those of the base oil and its additives, and identifying the presence of contaminants and wear debris.

(3) Thermography. Thermography is used for detecting and measuring variations in the heat emitted by various regions of a body and transforming them into visible signals that can be recorded photographically. Thermography can be used as a tool for identifying potential equipment faults, performing post maintenance retests, and trending the condition of equipment components subject to temperature degradation.

(4) Motor Current Signature Analysis. Motor current signature analysis involves analyzing motor current data in the frequency domain.

(5) Motor Electrical Parameters. Current, phase balance, and winding temperatures can provide indication of degradation to predict impending failure.

(6) Process and Equipment Parameters. Process and equipment parameter variations may impact condition monitoring results. Applicable process and equipment data should be collected in conjunction with the equipment condition monitoring data.

(7) As applicable and available, when doing walk downs of the equipment or during operator rounds and data collection, visual, auditory, olfactory, and tactile observations of equipment sounds, smells, discoloration, casing and bearing housing temperature changes or leaks can identify potential equipment problems that left unattended could lead to equipment failure.

3. REVISE THE CODE, OR CODE DISCUSSION

There are several methods to get Pump Condition Monitoring into the Code. One method is an outright revision to the code: most likely an Appendix. This method would mean that condition monitoring would require the publishing of the new code edition as well as acceptance of the local regulator. Another method is to produce a Code Case. The advantage of a Code Case is that it need not wait for a new Edition, although it would still need approval from the Regulator to use. Also, it need not be applied to all pumps in a program. A user can target this monitoring program as needed.

4. CONCLUSION

Pump Condition Monitoring is expected to improve the assessment of pump operational readiness through real-time, or near real-time, condition monitoring that will allow alternatives to the frequency of inservice testing requirements of ASME OM Code, Subsection ISTB or ISTF, for assessing the operational readiness of pumps in nuclear power plants.

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REFERENCES

[1] ASME OM Code