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Predictive Maintenance Program for Motor Operated Valves at Angra I Nuclear Power Plant

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SUMMARY

A Motor Operated Valves (MOV) predictive maintenance program is performed every year at Angra I Nuclear Power Plant and it pursues the idea of enhancing plant safety and reliability through early fault detection and diagnosis of equipment degradation prior to equipment failure. At the last annual predictive maintenance activities, several Limitorque motor operated valves were checked. The data analysis was performed and final diagnosis indicated that some valves should be upgrading, that is, the torque switch, limit switch and spring pack should be changed.

This paper will show in details the predictive maintenance activities developed, the results obtained during the data analysis, diagnosis activities and a new monitoring and diagnosis program for MOV to be introduced at Angra I Power Plant in a near future.

INTRODUCTION

Angra I Nuclear Power Plant is a PWR; two loops 626 MWe and was the first Brazilian initiative on the nuclear electric field. The purpose of the Predictive Maintenance Program at Angra I is to enhance plant safety and reliability through early detection and diagnosis of equipment degradation prior to equipment failure[1]. In particular motor operated valves shall receive special focus inside the Predictive Maintenance Program. Diagnosis testing to evaluate the operating status of valves is a method that has been used as standard in the nuclear power plants considering their exact requirements in terms of safety and availability.

Nonintrusive diagnosis methods have provided the ability to detect malfunctions in plant components during normal plant operation[2]. Early fault detection could avoid catastrophic failures and reduces the costs associated with such failures. One of most important diagnostic application in nuclear power plan is that related to the motor operated valves. The diagnosis of motor-operated valve degradation has been performed using analysis of the motor power, torque and valve stem thrust signatures and control switches associated with the actuator[2,3]. The NRC Generic Letter 89-10 provides guidelines for the test and evaluation of safety-related MOV's in nuclear power plants[3].

Angra I nuclear power plant has been performed every year a MOV predictive maintenance program, following the basic guidelines of NRC Generic Letter. In this paper this program is described, specifically for those activities related with MOV's during the annual refueling outage P8[4].

DESCRIPTION OF MOV DIAGNOSE ROUTINE

The maintenance routine program for the motor operated valves at Angra I nuclear power plant, is applicable for the gate, globe, butterfly and diaphragm MOV's type. Most valves checked are gate types. The electrical and the mechanical data are recorded during the actuation of the valve fitted with an actuator. The control system of the electric motor is performed in-situ and not from Motor Control Center (MCC). The system, showed in Figure 1, is divided into three parts: data acquisition, data storage and signal analyzer. The valve parameters are measured during valve operation condition open-to-close and close-to-open and the conditioned signals are stored in a computer hard disk. These parameters are the current and voltage from the three lines, stem thrust, torque, spring pack displacement and the control switches associated with the actuator (torque switch, limit switch with direction open, limit switch with direction close and bypass). These parameters and their associated channels are described in Table 1.

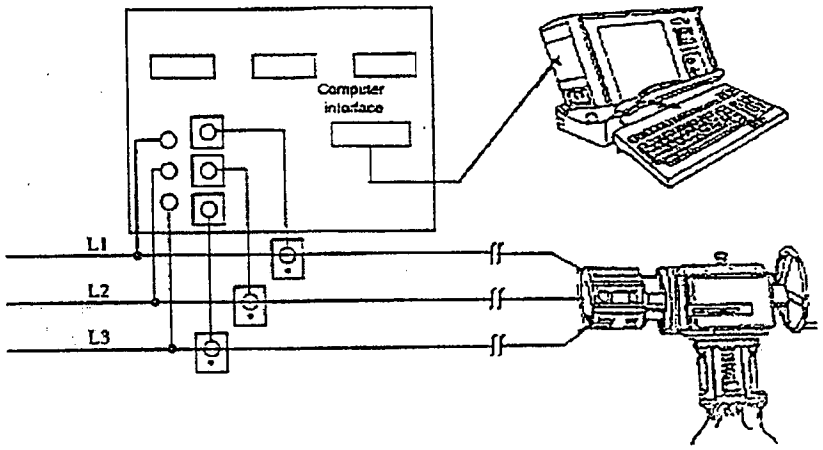

Figure 1: Schematic diagram of measurement system [2]

Table 1. Sequence of channel and associated parameters

Channel	Parameter
1	Voltage Line
2	Voltage Line
3	Voltage Line
4	Voltage Line
5	Current Line
6	Current Line
7	Torque Switch
8	Limit Switch (direction open)
9	Bypass Switch
10	Active Motor Power
11	Spring Pack Displacement
12	Stem Thrust
13	Torque

The motor power is calculated using the three motor currents and the three motor voltage traces.

The MOV Tag No. 8804-B, gate type with Limitorque actuator SMB-1 model is taken as an example to show some results. This valve is located at the nuclear power plant cooling water system.

Figure 2 shows the signatures "as left" during opening and closing cycles.

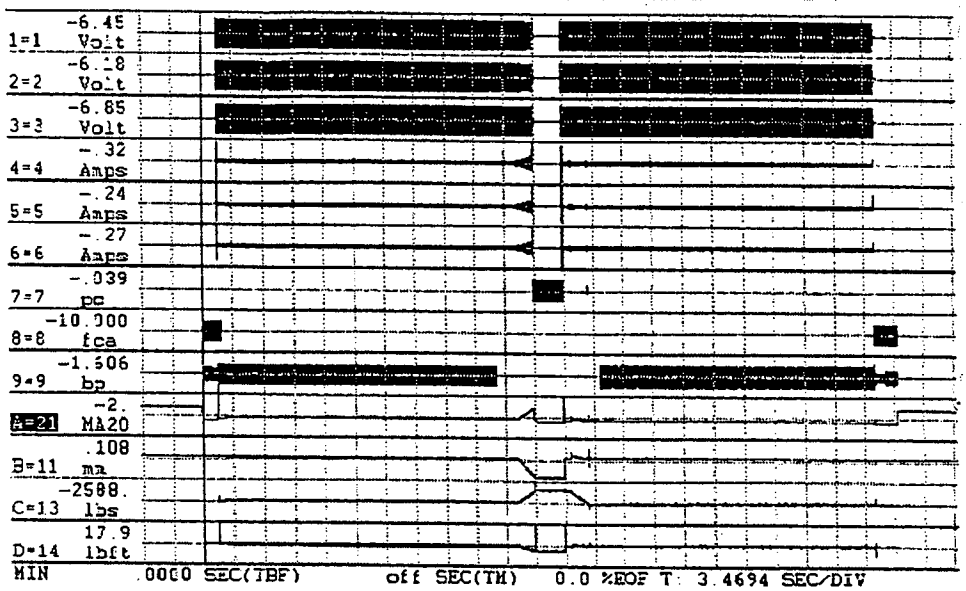

Figure 2: Signatures during close-to-open and open-to-close cycles.

The trace magnitude and characteristic of the parameters are evaluated qualitatively and quantitatively. Careful evaluation of the recordings can reveal some effects, which may adversely affect the operability of the valves and their actuators, or could reveal signs of irregularity. If the evaluated parameters are outside of their tolerance limit, it is possible that changes occurred in the settings of the limit switches and in the actuator and appropriate corrective actions should be taken.

The plots in Figure 2 were obtained after calibration and corrective actions in the MOV.

Beside this diagnostic of the MOV's generally performed during the annual refueling outage, the chemical analysis of the grease is also made during normal operation of the plant.

FUTURE MOV PREDICTIVE MAINTENANCE PROGRAM AT ANGRA I NPP

The monitoring and diagnosis group from IPEN/CNEN-SP is developing a wavelet based MOV monitoring system to be used at Angra I and Angra II nuclear power plants[5]. This system uses the measured parameters from motor current control center to obtain the active motor power and the multiresolution wavelet analysis technique is applied for signal analysis improvement.

This project offers a valve diagnosis concept, which allows the online MOV performance monitoring from the plant's motor control center (MCC). This is a safe and reliable method to demonstrate MOV performance during plant operation and it is therefore right in line with the requirements of the NRC generic Letter No. 89-10.

This diagnosis concept also allows trend measurements of the sensitive MOV parameters as part of a predictive valve maintenance and life extension program.

In conclusion, the early detection of abnormal conditions of MOV's reduces the risk forced outages, avoids unnecessary valve inspection and provides a better-recommended preventive and corrective action program.

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