UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

ENCLOSURE 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING ENVIRONMENTAL QUALIFICATION OF

MOBIL GREASES FOR LIMITORQUE ACTUATORS

COMMONWEALTH EDISON

DRESDEN STATION UNITS 2 AND 3

DOCKET NOS. 50-237/249 AND

QUAD CITIES STATION UNITS 1 AND 2

DOCKET NOS. 50-254/265

## 1.0 INTRODUCTION

During the NRC Diagnostic Evaluation Team inspection at the Dresden Station in August 1987 one item identified was the use of unqualified Mobil greases in Limitorque actuators for drywell motor-operated valves (MOVs). The Limitorque vendor manual states that Exxon Nebula EP 0 and EP 1 for actuator main gear box and Exxon Beacon 325 for actuator limit switch box are the only approved lubricants for MOVs inside the containment (drywell).

By letter dated January 22, 1988, the licensee committed to providing an Environmental Qualification (EQ) Test Report to support the use of Mobilux EP0, EP1 and EP2 greases for the main gear box of Limitorque actuators at Dresden and Quad Cities Nuclear Power Stations.

## 2.0 EVALUATION

The EQ Test Report, "Nuclear Environmental Qualification Test Program on Mobil Greases for Limitorque actuators" (Wyle Laboratories), dated September 15, 1989, evaluated the acceptability of using Mobilux EP0, EP1, and EP2 greases for the main gear box and Mobilgrease 28 for the limit switch box of Limitorque actuators at Dresden and Quad Cities Nuclear Power Generating Stations. The test program consisted of the following:

- Baseline functional tests: penetration tests (ASTM D-217); dropping point tests (ASTM D-566); and infrared analysis
- Normal radiation exposure ($2.2 \times 10^6$ Rads)
- Thermal aging

  EP0 at 250°F for 100 days
  EP1, EP2 and Mobilgrease 28 at 250°F for 300 days

- Accident radiation exposure ($1.1 \times 10^7$ Rads)

- Post-aging functional test

  Same as baseline functional test

- Cycle aging

  After thermal aging, radiation and ASTM tests, EPO, EP1, EP2 and Mobilgrease 28 tested in Limitorque actuators to simulate at least 120 full stroke and return cycles

- Accident simulation

  After cycle aging, actuators were tested in an environmental chamber for the 70 minute Design Basis Accident requirement (30 minutes at 349°F and 40 minutes at 287°F).

- Post-accident functional test

  Same as baseline functional test

The baseline functional tests determined that the EPO grease in its as-received condition did not meet the National Lubricating Grease Institute consistency requirements. Therefore, a new batch of EPO grease was provided by Mobil and was subjected to the test program described above with the exception that the thermal aging duration was 100 days at 250°F. The new batch of EPO grease was limited to a 100 day thermal aging because of the time lost in the test program to replace the deficient original EPO grease. The qualification of the EP1 and EP2 with a 300 day at 250°F accelerated aging test was extended for the qualification of EPO by similarity analysis. Mobilux EPO, EP1, and EP2 multiservice extreme pressure grease is compounded with an unleaded lithium 12 - hydrostearate soap base and a combination of mineral oils. All three greases are identical in composition, with exception of the relative amounts of base oil and soap thickener. During the qualifications test program the three greases were periodically reevaluated by infrared (IR) scans and penetration testing. The IR scans which show changes in chemical composition such as oxidation, indicated equivalent levels of degradation following exposure to identical environmental conditions which produce thermal and radiation-induced stresses. The licensee concluded that testing performed on EP1 and EP2 can be extended for the qualification of EPO.

The greases qualified life evaluated by the licensee is 38.6 years at 150°F service temperature based on the "10-Degree Rule". The "10-Degree Rule" is an approximate relationship which describes the rate of temprature-dependent reaction. The "10-Degree Rule" states that for each 10-Degree (°C or °K) rise in temperature the specific reaction rate doubles or the life is reduced by one-half. Since the greases service temperature is 150°F (65.6°C) and it is thermally aged at 250°F (121.1°C) in the qualification program, the temperature difference of 55.6°C results in a 38.6 year qualified life by applying the "10-Degree Rule".

Aging is usually applied to thermal aging in the form of the Arrhenius model, which relates the qualification life to absolute temperature change and activation energy. However, in the absence of the activation energy for greases for use in the theoretically based Arrhenius model, the empirical "10-Degree Rule" was used by the licensee to establish the greases qualified life. The licensee provided several references documenting and supporting the "10-Degree Rule".

Of more significance than qualification life of grease is the performance evaluation of Limitorque actuators lubricated with thermally aged and irradiated greases (cycle aging in the environmental qualification program). Mobilux EP0, EP1 and EP2 were inserted into the main gear cases of three Limitorque actuators, one type of grease per actuator, and Mobilgrease 28 in the limit switch gear cases of all three actuators. Each actuator was tested to simulate 120 full cycles and the stroke time and maximum motor current during the closing and opening stroke was recorded. Throughout the cycle aging the stroke times were constant and only minor variations in the motor currents were observed. It was concluded that valve operability was not significantly changed during the cycle aging test. Current lubrication maintenance and surveillance requirements at the Dresden/Quad Cities Nuclear Stations specify periodic cycling of the valve actuators (not less than twice a year except in a few cases valve actuators are cycled only during every outage). Therefore, valve operability, which includes grease performance, will be tested and verified periodically during plant life.

In addition to valve performance, the current lubrication maintenance and surveillance requirements at the Dresden/Quad Cities Nuclear Stations specifies a lubrication inspection of Limitorque actuators every other refueling outage or approximately every three years. This maintenance surveillance interval will ensure that the consistency, quality, and quantity of grease are adequate for proper operation of the operators.

## 3.0 CONCLUSION

We have reviewed and evaluated the licensee's submittal dated October 11, 1989 regarding the qualification of Mobil greases for Limitorque actuators for the Dresden Station Units 2 and 3 and the Quad Cities Station Units 1 and 2 and conclude that the use of Mobil greases are acceptable. Specifically, we find the following acceptable:

- The use of Mobilux EP0, EP1 and EP2 in Limitorque actuator main gear boxes in place Exxon Nebula EP0 and EP1 which are qualified for use inside containment,

- The use of Mobil grease 28 in Limitorque actuator limit switch gear box in place of Exxon Beacon 325 which is qualified for use inside containment,

- The maintenance and surveillance valve performance on Limitorque actuators every other refueling outage or approximately every three years to ensure the consistency, quality, and quantity of grease,

- The cycling of valve actuators, not less than twice a year (except in a few cases where these actuators are cycled during each outage) to ensure adequate valve performance.

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Dated: