

TECHNICAL NOTE RADIATION TESTING OF MOV LONG LIFE

Background: To be suitable for safety related motor operated valves, MOV Long Life had to undergo a number of tests under a variety of upset conditions. Testing included accelerated thermal aging, irradiation and exposure to water and/or steam. This testing can also be applicable when MOV Long Life is being considered for other applications at nuclear power plants. The test data indicated that MOV Long Life is equivalent or better than a number of products now being used for bearings, couplings, gears, and slides. Summaries of the nuclear specific testing are given below.

1. EPRI

The Electric Power Research Institute (EPRI) issued report 1003483, "Comparative Analysis of Nebula and MOV Long Life Greases for Limitorque Main Gearbox Applications". This report is dated December 2002.

It addressed the need for a replacement for the obsolete and discontinued Exxon Nebula® EP grease. The work was undertaken to qualify MOV Long Life by comparison with Nebula in thermal and radiation exposures simulating service, main steam line break (MSLB) and loss of coolant accident (LOCA) conditions. Testing was done under Herguth Laboratories 10 CFR50, Appendix B, Quality Assurance Program. This included;

- Oven aging at 150°C for 300 hours,
- Gamma irradiation to 220 Mrad, and
- Thin film air and thin film steam exposure at 150°C.

Analytical tests were penetration, weight loss, dropping point, infrared (FTIR) traces, differential scanning calorimetry (DSC), rheometer studies and pin on disc (POD).

EPRI Penetration Measurements (60 strokes)			
	New Grease	Aged Grease	Aged and 220 Mrad
MOV Long Life	329	341	399

It concludes that MOV Long Life is superior to Nebula in essentially all key performance respects. Further, that because MOV Long Life is compatible with Nebula that no problems are expected when adding it to actuators in service. Mixtures also tended to perform as well as or better than pure Nebula. As a result MOV Long Life was considered an acceptable replacement for Nebula in both mild and harsh environments

The full report also included a copy of COG-JP-01-009 and is available from EPRI. The Project Manager was Ed McKinney at 704 717-6431 or go to www.epri.com.

2. COG

The Candu Owners Group has issued report COG-JP-01-009 “Qualification of MOV Long Life Grease for Limitorque Main Gearbox Application”.

This report summarizes technical literature on lubrication requirements for the Limitorque main gearbox, discusses published test data and, based on that identifies MOV Long Life Grade 1 as the potential replacement for the Exxon Nebula EP1 grease. To verify this recommendation for the CANDU stations the report provides test results on Nebula EP1 and MOV Long Life samples subjected to the following sequences of stresses in simulation of a worst-case service condition;

- Oven aging at 130°C for 660 hours;
- Gamma irradiation to 70 Mrad; and
- Loss of Coolant Accident (LOCA) steam exposure including 6 hours exposure to 171°C and 105kPa steam.

COG Penetration Measurements (60 strokes)				
	New Grease	5 Year Aged Grease	5 Year Aged and 70 Mrad	5 Year Aged, 70 Mrad and LOCA
MOV Long Life	326	318	326	309

It concluded that MOV Long Life was suitable for Limitorque gearboxes used in nuclear service. In addition, this report verifies compatibility between new MOV Long Life and aged Nebula. This was done to assess the impact of when MOV Long Life is used for the “top-up” of gearboxes filled with Nebula.

Chemical and physical testing on the greases included ASTM D-1403 penetration, Brookfield R/S-CPS dynamic rheological tests, ASTM D-974 modified total base number, ASTM D-2266 four ball wear, appearance, evaporation loss, ASTM D-2265-94a dropping points, FTIR, and ASTM D-1831 roll stability. The report also has a review of other test data but this was limited to just utility sources.

The full report is available from COG in exchange for “Buy-in Fees”. Contact Henry Chan at 416 595-1888 x105 or e-mail: <mailto:henry.chan@candu.org>. It is also included with the above EPRI report.

3. Exelon

Exelon (then ComEd) issued Technical Support Laboratory Report on the “Evaluation of Cor-Tek MOV Long Life and MOV Plus Greases Following Radiation Exposure”. This is Dresden station report A2000-178S dated August 25, 2000. Actual dosage for two samples ranged from 205.51 to 206.20 Mrad using a Cobalt 60 gamma source. Note ‘Cor-Tek’ was an earlier distributor now replaced by Forsythe.

Penetration showed a slight 7&8% increase that was expected and attributed to cleavage of hydrocarbon chemical bonds. The values were still within acceptable post accident properties. The dropping point changes of 5&7% after irradiation were also considered acceptable because the values were still much higher than for the currently used product and remained well above the reported accident conditions.

EXELON Penetration Measurements (60 strokes)		
	New Grease	200 Mrad
MOV Long Life	338/338	363/364

Testing by Exelon also included infrared analysis, odor and appearance. There were no significant changes in the spectrum that might indicate degradation and no signs of oxidation of the oil or other significant shifts in the spectra. Plus there was no change in the odor and only a yellowing of the greases after exposure.

The conclusions were that MOV Long Life showed improvements over the presently used greases in its ability to maintain consistency at elevated temperatures, better oil retention, better EP stability, lower scuffing and better tolerance of moisture. In addition, that it will continue to lubricate even after severe radiation exposure.

4. Other

The grease manufacturer had irradiated nine different calcium sulphonate thickened greases to 20 Mrad using gamma radiation at a 0.1 Mrad/h dose rate. This included greases different suppliers. All the calcium sulphonate greases did at least as well as the currently accepted greases. They also conducted many Shell Role Stability tests with heat and water (EQ) showing that the calcium sulphonate thickener was superior.

In addition, the Candu Owners Group had tested at Atomic Energy of Canada Limited two different MOV calcium sulphonate thickened greases. These were MOV Plus and MOV Syn and they were tested on actual stems. To give a 5 year service life aging was at 120°C (248°F) for 8 weeks and then it was irradiated to 10 Mrad. MOV Plus was one of the few greases to meet the 5 year life and give performance within the 9% bounds. In other testing at AECL they included MOV Syn and 5 years aging with 85 Mrad. The calcium sulphonate greases did better than Exxon Nebula but not as well in all tests with some of the more heavily EP additised greases. However, the need for such zinc based and chlorinated compounds can be considered a disadvantage.

Summary: MOV Long Life has been tested under nuclear power plant conditions including radiation levels up to 220 Mrad. Even under severe conditions the degradation was generally less than previously used products and within acceptable bounds.

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