Sandia National Laboratories
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subject: *FY12 Q3 Milestones*

1. Explore Opportunities to obtain field aged materials for predictive model validation

Sandia National Laboratories has spent numerous years performing laboratory accelerated aging experiments on various cable insulation types sourced from different cable manufacturers. These experiments have led to the creation of the SCRAPS database, and have ultimately afforded the ability to make lifetime predictions at varying environmental conditions (e.g., thermal and/or radiation). Unfortunately, the major downfall in our work has been validating these predictive models with measured tensile data from field returned specimens (cables which have aged naturally in nuclear power plants).

As part of our goals for Q3 of FY12, we set out to obtain field aged materials to aid in model validation. We are happy to report that we have received cables from three different sources: 1) the High Flux Isotope Reactor at Oak Ridge National Laboratory (HFIR at ORNL), 2) Comision Nacional de Energia Atomica (CNEA in Argentina), and 3) the Zion Nuclear Power Station.

1.1 Description of As Received Cables:

1.1.1 Cables from HFIR at ORNL

We received ~50 ft of varying colored low voltage Anaconda Durasheeth cables that are ~45 years old. Based on conversations with the lead electrician out at HFIR, the environmental conditions which the cables were exposed to were ~27 °C (80 °F) with ~70% RH (no gamma irradiation exposure). At this time, we have already prepared specimens to be tensile tested to determine how much tensile strength is remaining for the varying insulations. To better understand the current “health” of the received cables, we have also prepared specimens to further age (thermally) which will help us predict how much life is remaining in these particular cables (measured by reduction in elongation at break, where “end-of-life” is defined as 50% absolute).

1.1.2 Cable from CNEA

We received a 1.5 m section of a silicon rubber cable (both jacket and low voltage cables are the same material type) which has 34 conductors and is ~30 years old. This particular cable was exposed to both gamma radiation and elevated temperatures—further details will be obtain from the TPOC at CNEA—Jorge Zorrilla. We have prepared tensile samples to measure elongation at break and will perform further aging (gamma irradiation and elevated temperatures; ~30 Gy/hr at 100 °C) to determine how much life the cable retains.

1.1.3 Cable from Zion Nuclear Power Station

We received ~0.4 m of a 480 V black cable (appearing to be an Okonite EPR) that is ~30+ years in age. Unfortunately, we do not know the environmental conditions to which this cable was exposed to, other than that it was part of a circuit which resulted in a power failure due to water diffusing through the jacket. The lines were run underground in a PVC conduit. Due to the size of the cable, our intent is to separate the insulation from the jacket and prepare tensile slab specimens for elongation at break measurements to aid in identifying how much life remains. Unfortunately, not knowing the full pedigree/history of the cable will limit our ability to appropriately place a data point on our EPR prediction curve.

2. Examine and Identify the NPP areas of concern for cables as a means to determine what experiments must/should be performed next

As a means to provide the most relevant data in support of the LWRS program, it is critical that we answer the right questions. More explicitly, what are the real environmental conditions that cables are exposed to, both normal and harsh situations? To aid in this understanding, we held a cable aging summit here at SNL at the end of Q2 and Q3 of FY12. As a result, EPRI is developing a survey to send out to the utilities to capture this critical information. Face-to-face discussions with Gary Toman and Andrew Mantey (both from EPRI) indicate the most harsh conditions cables are exposed to are ~50 °C and between 1 to 5 Mrad over 40 years. Comparatively, Toman and Mantey suggest that most of the low voltage cables are in benign conditions, i.e. 27 °C with no radiation or moisture exposure. The survey data and resulting EPRI publication will formally document this information and will ultimately help us better tailor our active cable aging studies.

3. Continue to Assist in the EMDA Program on Cable Aging

We have and are actively providing feedback to the NRC/LWRS Program on the EMDA document through technical editing of the manuscript and discussion via teleconferences. The current action item is to provide our final feedback on rev. 2 of the document to the NRC by July 21, 2012.

4. Continue to collect and analyze aging data initiated in Q2

We currently have cable insulations (Eaton Dekoron EPR, Brand-Rex XLPO, and Eaton Dekoron XLPO) aging at 12, 38, 165, 280 Gy/hr at 27 °C. To this date, we have only seen the "end-of-life" (elongation at break tensile property reduced to <50%) for samples aged at 280 Gy/hr and 165 Gy/hr. Some of the data collected and analyzed are shown on the following pages.

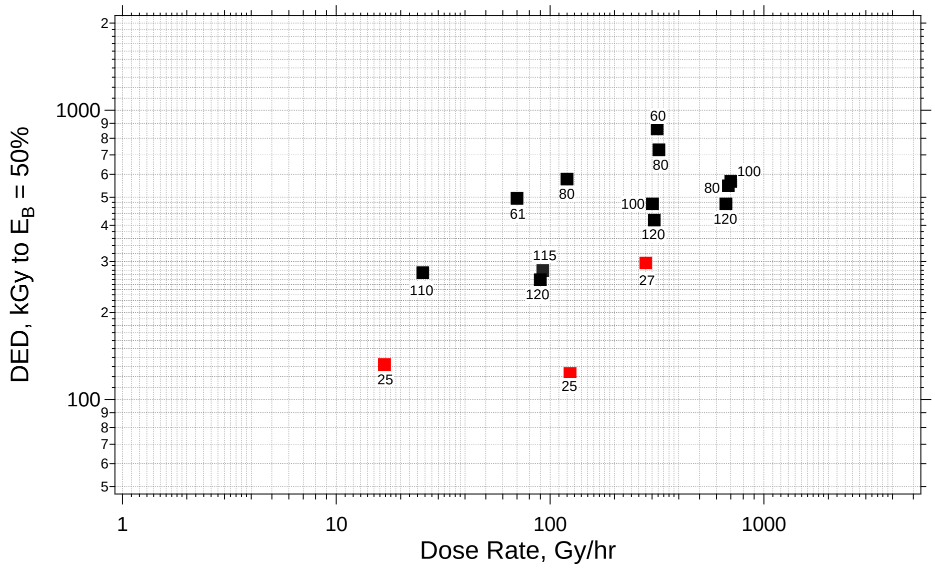

Figure 1. Dose-to-equivalent damage required for Brand-Rex XLPO to achieve 50% (absolute) elongation at break measured at varying temperatures and dose rates. The numbers next to the data points indicate the temperature the experiment was performed at. The points shown in red suggest that this particular cable insulation exhibits "inverse temperature" effects. The data point highlighted in red measured at 27 °C and 280 Gy/hr was measured this year.

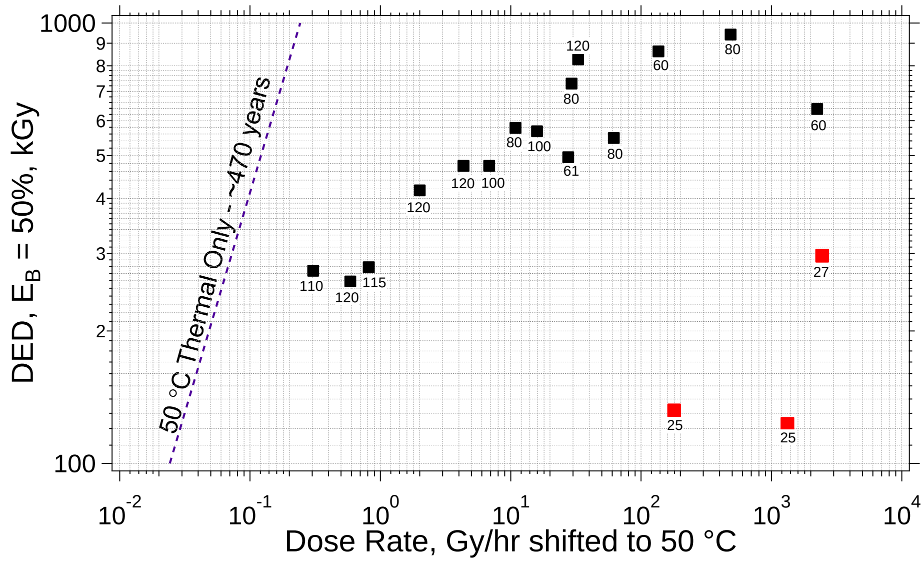

Figure 2. Dose-to-equivalent damage required for Brand-Rex XLPO to achieve 50% (absolute) elongation at break measured at varying temperatures as a function of a shifted dose rate (assuming the activation energy, *Ea*, is 76 kJ/mol). The numbers next to the data points indicate the temperature the experiment was performed at. The points shown in red suggest that this particular cable insulation exhibits "inverse temperature" effects.

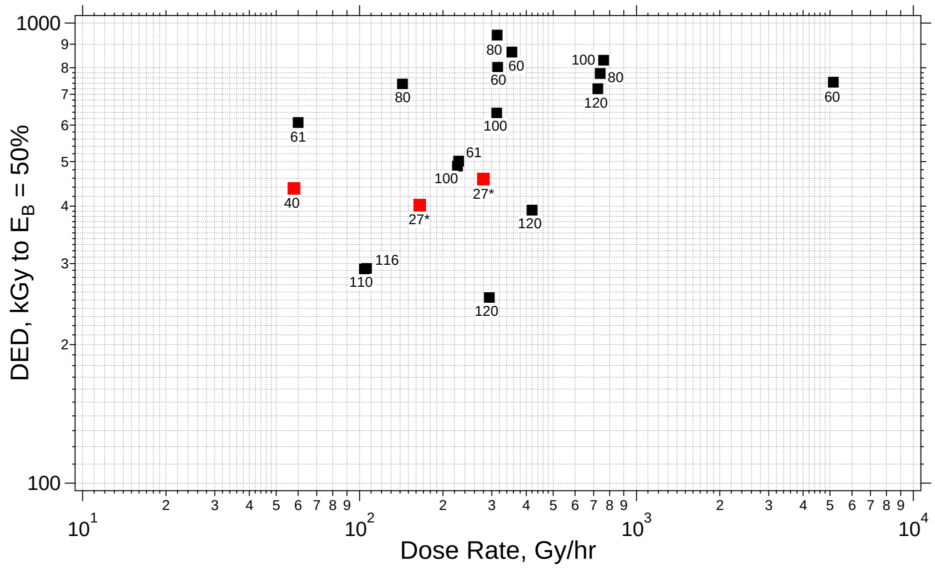

Figure 3. Dose-to-equivalent damage required for Eaton Dekoron EPR to achieve 50% (absolute) elongation at break measured at varying temperatures and dose rates. The numbers next to the data points indicate the temperature the experiment was performed at. The points shown in red suggest that this particular cable insulation exhibits "inverse temperature" effects. The data points highlighted in red measured at 27 °C and 280/165 Gy/hr were measured this year.

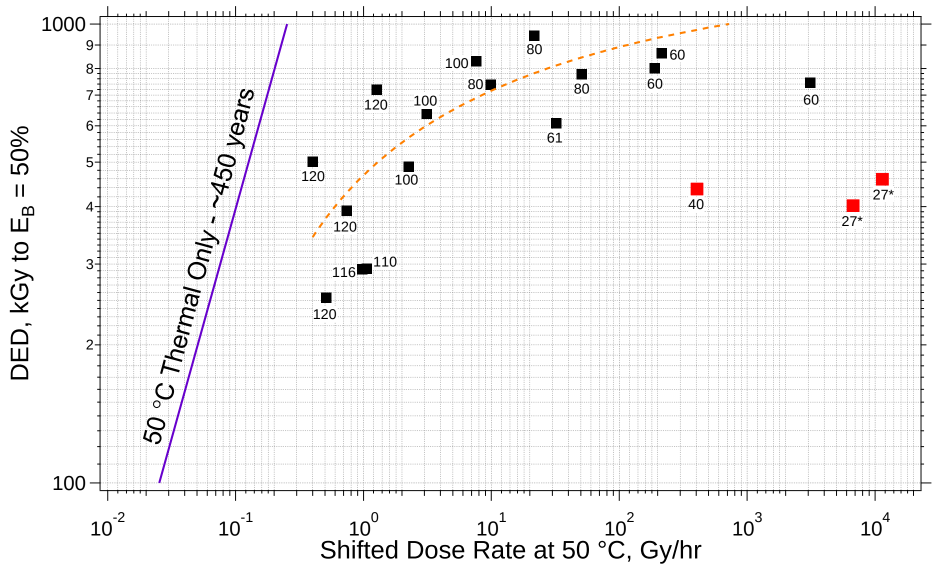

Figure 4. Dose-to-equivalent damage required for Eaton Dekoron EPR to achieve 50% (absolute) elongation at break measured at varying temperatures as a function of a shifted dose rate (assuming the activation energy, *Ea*, is 106 kJ/mol). The numbers next to the data points indicate the temperature the experiment was performed at. The points shown in red suggest that this particular cable insulation exhibits "inverse temperature" effects.