U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Brookhaven National Laboratories (BNL)

<u>Information Sheet</u>: Red Oil Hazard Risk Analysis, Felix E. Gonzalez *(NRC/RES/DRA)*

Background

In SECY-04-0182, the NRC staff reported to the Commission on the status of risk-informed regulation in the Office of Nuclear Material Safety and Safeguards (NMSS). The SECY proposed the trial use of a guidance document, "Risk-Informed Decision-Making for Nuclear Material and Waste Applications" (RIDM), to assist staff in risk informing. The Staff Requirements Memorandum to SECY-04-0182 approved this proposed use with caveats and directed specific changes to be made to the document. The document (with the changes and caveats from the Commission incorporated) was issued for trial use on May 11, 2005.

Since issuance, the guidance in the RIDM document has been used to provide risk insights in specific regulatory areas within NMSS. NRC has been using the RIDM methodology in reviewing the license application of the Mixed Oxide Fuel Fabrication Facility (MOX FFF).

During the Construction Authorization Request stage of NRC's review, concern was expressed about the effectiveness of the process safety features to prevent and mitigate the formation and consequences of a red oil excursion (ROE). For the License Application and Integrated Safety Analysis, the licensee updated the design of the facility to improve safety regarding the red oil hazard.

Red oil is formed when an organic constituent reacts with nitric acid in specific conditions of temperature, concentration, and residence time. Previous studies have shown that red oil decomposition is exothermic and could generate a relatively large amount of gas. Therefore, a risk exists of runaway reaction(s) and over pressurization.

Approach

Brookhaven National Laboratories (BNL) was given the task of conducting a risk-analysis study on the red oil hazard of the MOX FFF. This study included consideration of all processes that are vulnerable to ROEs. A qualitative assessment of the possibility of red oil reactions was carried out for the various units composing the Aqueous Polishing Unit. To supplement the qualitative analyses, a quantitative evaluation, which used failure modes and effects analyses consisting of event trees and fault trees, was carried out to gain further insights into possible combinations of failures that could lead to ROEs.

The analysis was performed using probabilistic risk analysis techniques. These techniques can be considered as risk-informing the qualitative analysis to help NRC staff focus attention on areas of higher risk significance.

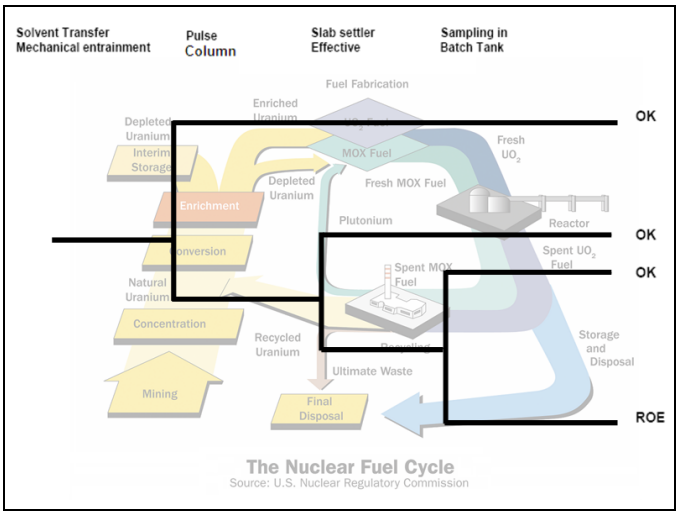

Figure 1. Simplified Event Tree with the Nuclear Fuel Cycle in the Background. The event tree shows the conditions for a possible ROE given certain failures in the equipment. These equipment failures can cause that the organic is transferred to equipment that have the conditions necessary for red oil formation and potentially a ROE.

Program Management

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