July 30, 2012

MEMORADUM TO: Michele G. Evans, Director
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Richard P. Correia, Director ***/RA/***
Division of Risk Analysis
Office of Nuclear Regulatory Research

SUBJECT: TRANSMITTAL OF FINAL BROWNS FERRY NUCLEAR PLANT UNITS 1, 2, AND 3 ACCIDENT SEQUENCE PRECURSOR ANALYSIS

This memorandum provides the final results of an accident sequence precursor (ASP) analysis of an operational event that occurred at Browns Ferry Nuclear Plant, Units 1, 2, and 3, on April 27, 2011. The analysis has a conditional core damage probability (CCDP) of less than 1×10^{-4}, which means that it is a lower risk event. Therefore, the NRC is not requesting a formal review from the licensee as described in the U.S. Nuclear Regulatory Commission (NRC) Regulatory Issue Summary 2006-24, "Revised Review and Transmittal Process for Accident Sequence Precursor Analyses".

The ASP Program continues to systematically review licensee event reports (LERs) and all other event reporting information (e.g., inspection reports) for potential precursors and to analyze those events that have the potential to be precursors. Most of the precursors that occurred in fiscal year (FY) 2011 have been analyzed using the Significance Determination Process, and have been accepted as official ASP Program results. These analyses do not require further review by the Office of Nuclear Reactor Regulation (NRR), the applicable Region(s), and licensees. In addition, a formal ASP analysis package does not need to be transmitted to the licensee. The complete summary of FY 2011 ASP events will be provided in the upcoming Commission paper on the status of the ASP Program and standardized plant analysis risk models, which is scheduled to be issued in October 2012.

Transmittal to Licensees Requested. We are requesting NRR to send the enclosed final ASP analysis to the Browns Ferry licensee. A model for the transmittal letter can be found in the Agencywide Documents Access and Management System (ADAMS) at Accession No. ML062710403. The ASP analysis will be made available to the public after the NRC has transmitted the analysis to the licensee. Please inform us when the ASP analysis has been sent to the licensee.

CONTACT: Sandra Herrick, RES/DRA
301-251-7607

Final ASP Analysis Summary. A brief summary of the final ASP analysis, including the results, is provided below.

Loss of Normal Offsite Power Due to Switchyard Damage Caused by a Tornado (April 2011) at Browns Ferry Nuclear Plant. This event is documented in LERs 259/11-001, -002, -003, -005 and Inspection Reports 05000259/2011003 and -004.

Event Summary. On April 27, 2011, at 4:36 p.m., severe weather in the Tennessee Valley Service Area caused grid instability and loss of all 500 kilovolts (kV) offsite power sources, which resulted in automatic scrams of all three units. All three units were in Mode 1 at the time of the event. All scram systems were actuated, and all required systems started and functioned successfully with the exception of an indeterminate position indication for the Unit 3 inboard Main Steam Isolation Valve B. All onsite safe shutdown equipment was available with the exception of the Emergency Diesel Generator (EDG) 3B, which was unavailable due to planned maintenance. All three units immediately entered Mode 3 (Hot Shutdown) with their respective 4 kV shutdown boards supplied by seven out of eight of the onsite EDGs. On May 2, at approximate 8:50 p.m., the Notice of Unusual Event was terminated following restoration of qualified offsite power sources to all eight 4 kV shutdown boards.

In addition to the loss of offsite power event on April 27, two loss of shutdown cooling (SDC) events occurred on April 28 (Units 1 and 2) and May 2 (Unit 1).

Summary of Analysis Results. This operational event resulted in CCDP of 1×10^{-5} for Units 1, 2, and 3. The detailed ASP analysis can be found in the enclosure. The most likely core damage sequence for all three units involved the failure of emergency power and its recovery; followed by operators failing to depressurize the reactor; and the failure of extended operation of emergency core cooling systems. In general, the risk insights are consistent with loss of offsite power (LOOP) events at other boiling-water reactors analyzed by the ASP Program.

A sensitivity analysis was performed to determine the risk impact for the EDG failures that led to two loss of SDC events. The result of this analysis represented the incremental risk at shutdown, due to EDG failures during the long duration of LOOP event. The CCDP for the representative loss of SDC case was calculated to be 2×10^{-7}. The most likely core damage sequence for the loss of SDC events includes postulated failures of the low-pressure coolant injection and core spray system; followed by the failure of alternate heat removal and the residual heat removal system; and the failure of operators to recover SDC in 12 hours.

Risk Insights. The dominant risk for this 5-day LOOP event is in the first 24 hours after offsite power was lost (i.e., the risk from the loss of SDC events during the final 96 hours of the LOOP was minimal compared to the CCDP of the at-power LOOP). The risk of the at-power LOOP event was heavily mitigated by the availability of the alternate 161 kV offsite power source. The dominant equipment failure contributor to risk of this event was the postulated common-cause failure of the raw service water strainers. Failure of these strainers would lead to loss of cooling to the EDGs and a subsequent station blackout. During this scenario, operators would have approximately 4 hours (the battery depletion time of the station batteries) to align the alternate 161 kV offsite power source or recover an EDG to one of the eight shutdown boards. If the operators failed to restore emergency power, the reactor core isolation cooling pump would fail due the depletion of the station batteries and subsequent core damage would occur.

Sensitive Information. The detailed ASP analysis has been reviewed in accordance with current guidance of sensitive unclassified non-safeguards information, and it has been determined that it may be released to the public.

Enclosure:
As stated

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ADAMS Accession No.: ML12180A056

OFFICE	RES/DRA/PRB	Tech Editor	RES/DRA/PRB	RES/DRA
NAME	S. Herrick*	QTE (via email)	G. DeMoss	R. Correia
DATE	07/09/12	07/02/12	7/27/12	7/30/12

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