May 5, 2002

MEMORANDUM TO: Cornelius F. Holden, Section Chief
Electrical Engineering Section
Electrical and Instrumentation and Controls Branch
Division of Engineering

FROM: Mark P. Rubin, Section Chief**/Signed by M. Snodderly for**
Safety Program Section
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis

SUBJECT: RISK-INFORMED SECTION OF SAFETY EVALUATION PERTAINING TO DUANE ARNOLD ENERGY CENTER PROPOSED AMENDMENT FOR ONE-TIME ON-LINE SAFETY-RELATED BATTERY REPLACEMENT

Enclosed please find the Probabilistic Safety Assessment Branch's Risk-Informed Section of the Safety Evaluation pertaining to the Duane Arnold Energy Center's proposed license amendment for a one-time on-line safety-replacement battery replacement. The SPSB staff finds this proposal acceptable, since the licensee's documented risk impacts are within the guidelines of RG 1.177 and RG 1.174.

CONTACT: Millard Wohl, NRR/DSSA/SPSB
415-1181

May 5, 2002

MEMORANDUM TO: Cornelius F. Holden, Section Chief
Electrical Engineering Section
Electrical and Instrumentation and Controls Branch
Division of Engineering

FROM: Mark P. Rubin, Section Chief**/Signed by M. Snodderly for**
Safety Program Section
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis

SUBJECT: RISK-INFORMED SECTION OF SAFETY EVALUATION PERTAINING TO DUANE ARNOLD ENERGY CENTER PROPOSED AMENDMENT FOR ONE-TIME ON-LINE SAFETY-RELATED BATTERY REPLACEMENT

Enclosed please find the Probabilistic Safety Assessment Branch's Risk-Informed Section of the Safety Evaluation pertaining to the Duane Arnold Energy Center's proposed license amendment for a one-time on-line safety-replacement battery replacement. The SPSB staff finds this proposal acceptable, since the licensee's documented risk impacts are within the guidelines of RG 1.177 and RG 1.174.

CONTACT: Millard Wohl, NRR/DSSA/SPSB
415-1181

Accession#ML021340081 NRR-096
distribution: MWohl MRubin
G://SPSB/WOHL/DAEC Battery On-Line Change.wpd

OFFICE	SPSB	SC:SPSB
NAME	MWohl:nyc	MRubin
DATE	05/10/02	05/10/02

OFFICIAL RECORD COPY

PROBABILISTIC RISK ASSESSMENT INSIGHTS

TIER1

For the replacement of Division 1 and Division 2 batteries on a one-time basis at power, the licensee computed the total increase in annualized core damage frequency (Delta CDF) for both activities to be 9.6E-8/yr. The total increase in annualized large early release frequency (Delta LERF) was computed by the licensee to be 4.9E-9/yr. Both of these values are very small according to the guidelines of RG 1.174 (less than E-6 and less than E-7, respectively).

The licensee computed the Incremental Conditional Core Damage Probability (ICCDP) for two ten day on-line battery outage periods (Division 1 and Division 2) to be 9.6E-8 and 4.8E-9, respectively. These are well-within the RG 1.177 guideline values of 5E-7 and 5E-8, respectively.

The above values of Delta CDF, ICCDP, Delta LERF, and ICLERP are reasonable and acceptable to the staff. There is also an unquantified risk reduction due to non-replacement of the batteries at shutdown.

TIER 2

The licensee plans to implement several actions and conditions to support this 10 day for Division 1 and 10 day for Division 2 extended completion time (presently 8 hours). These take into account the Probabilistic Risk Assessment (PRA) analysis and minimize risk associated with the occurrence of a seismic event. They include:

(1) The existing safety-related battery charger associated with the replaced station battery is operable and connected to the DC bus in parallel with the temporary battery;
(2) An existing backup safety-related battery charger will be available to be connected to the DC bus if needed;
(3) The temporary and replacement batteries will be subjected to the applicable station battery surveillance tests before placing them into service;
(4) The plant is in a stable condition with no Required Actions in effect at the start of the battery replacement activity necessitating plant shutdown and no risk-significant, planned maintenance or testing activities which may impact AC or DC normal or emergency electrical distribution sources;
(5) Preparation of thorough planning to minimize the duration of the battery replacement project through good coordination of work activities;
(6) Conduct pre-job briefings to prevent worker error;
(7) Procedure refreshment for Operations personnel on AOP 302.1, “Loss of 125 VDC Power.”

During the actual conduct of the project, the licensee states that the work will be closely controlled and supervised in accordance with plant administrative procedures.

PRA QUALITY

The licensee developed Level 1 and Level 2 PRA models as part of the Individual Plant Examination (IPE) submitted to the NRC in November 1992 in response to Generic Letter 88-20. The Duane Arnold Energy Center (DAEC) has maintained these PRA models to conform to plant configuration and operating procedure changes subsequent to the original development, i.e., it is a "living PRA." The Individual Plant Examination for External Events (IPEEE) was submitted to the staff by the DAEC in November 1995. Subsequent to this submittal, a stand-alone, external events PRA model was developed to provide enhanced capability to assess risk from seismic and fire initiators. In 2001, both the internal event and external event PRA models were converted from the Reliability Engineering Building Block Environment for Computer Analysis (REBECA) PRA development and quantification platform to the Electric Power Research Institute's (EPRI's) Risk and Reliability Workstation Computer Aided Fault Tree Analysis (CAFTA). The licensee performed a rigorous comparison of REBECA and CAFTA cutsets to ensure that the conversion was performed appropriately. A revision to the Level 1 and Level 2 PRA models is currently being carried out by the licensee to incorporate various model enhancements and to update it for extended power uprate applications and conditions.

Because of its ongoing use as a licensee decision making tool, the licensee's PRA has been through a peer review as part of the BWR Owners' Group PRA certification program. The licensee states that the PRA review team concluded that all of the graded elements are of sufficient detail and quality to support a risk significance determination supported by deterministic insights. The review team also commented, according to the licensee, on DAEC's excellent PRA documentation and very consistent quality level across all elements of the certification.

The seismic portion of the external events PRA model was used by the licensee to calculate increase in core damage frequency for this requested change (one-time AOT from 8 hr. to 10 d. per Division) to the DAEC Technical Specifications. Since the external events model was created after performance of the PRA peer review, it was not included in the scope of the review. However, it contains modeling elements (system fault trees, component failure data, etc.) from the Level 1 PRA model, which were included in the review, and is judged by the licensee to be of sufficient quality and detail for use in this application. The seismic model employs a bounding approach to the quantification of core damage frequency, according to the licensee, and is therefore considered to overestimate actual risk from seismic events.

EXTERNAL EVENTS

The licensee's Individual Plant Examination for External Events (IPEEE) considers accidents in six categories:

-Seismic Events
-Fires
-High Winds and Tornadoes
-External Floods
-Transportation and Nearby Facility Hazards
-Other Plant-Unique External Events

1. Seismic

A PRA model was developed for the DAEC in 1997 which is explicitly designed for calculating the contribution to CDF from both seismic and fire events. This is known as the external events PRA model. The licensee states that the approach used in the development of the model for seismic events is consistent with guidance provided in the PRA Procedures Guide (NUREG/CR-2300).

The seismic-induced CDF analysis involves the construction and quantification of seismic event trees. A unique event tree is developed for each of nine seismic magnitude intervals. These event trees are supported by modified system fault trees. Results of the base seismic event tree quantification result in an estimate of core damage frequency for a full spectrum of earthquake intensities of 6.99E-7 per year.

2. Fire

In the PRA-based model for fires, the licensee assessed eighteen fire areas, including areas from the reactor building, the control building, and safety-related portions of the pump house. The estimated total core damage frequency from fires was estimated to be 3.1E-6 per year, which is approximately 20% of the total core damage frequency from internal and external events.

3. High Winds and Tornadoes

The extreme wind risk evaluation for the DAEC employs a bounding approach recommended in NUREG-1407, “Procedural and Submittal Guidance for the IPEEE for Severe Accident Vulnerabilities.”

The DAEC is located in the upper Midwest, a region of the country that has exhibited relatively high tornado activity. As such, Class I structures at the DAEC are designed to withstand the strongest tornado believed to be possible(i.e., 300 mph rotational wind speed and 60 mph translational wind speed.) Since safety-related trains and components are located within Class I structures, the probability of tornado-induced damage (considering both wind pressure and missile impact effects) to this equipment is very low. Other structures, including the turbine building where the temporary batteries will be located, are designed to a wind speed of 105 mph. Although higher speeds can be achieved by straight winds, the primary impact of straight winds on core damage frequency is from loss of offsite power. This is appropriately accounted for in the internal events PRA.

The total contribution to core damage frequency from extreme winds is conservatively estimated at 1.4E-7 per year. Use of a conservative bounding approach to quantification is consistent with NUREG-1407 methodology and minimized the necessary evaluation effort of the IPEEE analysis. The licensee estimates that if more realistic assumptions were used, the overall extreme wind risk contribution would be approximately an order of magnitude lower, which would place it at less than one percent of the total core damage frequency from internal and external events.

The 125 VDC batteries will be temporarily relocated from the Class I designed control building to the non-Class I turbine building. In this location, they will be somewhat more vulnerable to damage from extreme winds. However, the overall impact on core damage frequency is judged by the licensee to be very low for the following reasons:

– The annual exceedance probability for wind speeds greater than 105 mph is only 5.5E-3 per year.
– Division 1 and Division 2 battery replacement activities will be performed separately.
– Battery replacement activities will not be initiated under conditions of impending severe weather.

4. External Floods

Vulnerability to external flooding events was evaluated in the licensee's IPEEE using NUREG 1407 methodology. Per this methodology, if DAEC met the requirements of the 1975 Standard Review Plan, flooding could be screened from further analysis, which was found to be the case for DAEC. Therefore the estimated core damage frequency due to flood-related causes was assumed to be below 1E-6/yr.

The DAEC is located adjacent to the Cedar River in Eastern Iowa. The design flood level is 767', ten feet above ground level for most site buildings. Actual flood levels have never approached this height. Nonetheless, the site maintains contingency plans that are invoked when river water level is expected to rise above normal levels. These plans include installation of barriers at the doorways of buildings to prevent water intrusion into areas containing safety-related equipment.

The temporary 125 VDC batteries will be located in the turbine building on the same level (757') as the permanent batteries in the adjacent control building. Risk from external flooding is judged by the licensee to be the same with the batteries in either location because the two areas communicate with one another via a non-waterproof doorway.

5. Transportation and Nearby Facility Hazards

Vulnerability to transportation and nearby facility-related events was evaluated in the DAEC IPEEE using methodology contained in NUREG-1407. There are no nearby military or Industrial facilities within 5 miles of the DAEC. The area is rural, with only smaller retail establishments within this distance form the plant. For this reason no credible hazard to safe operation could be identified in relation to nearby facilities.

The IPEEE analysis also considered transportation accidents relating to aviation, ships/barges, railroad, and trucks. These classes of transportation hazard were considered for their impacts due to potential hazardous material releases and plant damage related to explosions or fires as well as their potential for impact damage. Transportation related hazards were judged to not be a significant contributor to risk for the DAEC.

Risk from transportation and nearby facility hazards is judged by the licensee to be unchanged by the proposed battery replacement activity.

6. Plant Unique External Events

In addition to the previous five categories assessed in the DAEC IPEEE, other external risks were screened for their potential impact on plant safety. A list of potential events to include in this category was compiled by the licensee from a variety of industry documents. Criteria used for screening events on the list included whether:

– the event was included in the definition of another event,
  the event could occur close enough to the plant to affect it,
– the event could result in worse consequences than analyzed events with similar frequencies and uncertainties,
– there is sufficient time to provide an adequate response to the event, and
– the event has damage potential similar to events for which the plant has been designed.

No events were identified in this process that were not already included under one of the previously considered external event categories. The proposed battery replacement activity is judged by the licensee not to change the conclusion of this review.

CONCLUSIONS

The staff concludes that the impact on plant risk of allowing the Duane Arnold Energy Center one-time on-line safety-related battery replacements for the Division 1 and Division 2 batteries is very small for both internal and external events. The staff thus recommends that the proposed one-time on-line replacements for the Division 1 and Division 2 batteries be allowed.

Principal contributor:
Millard Wohl