April 19, 2002
NG-02-0237

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station 0-P1-17
Washington, DC 20555-0001

Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License No: DPR-49

Response to Request for Additional Information (RAI) for Technical Specification Change Request TSCR-048 – "One-Time On-Line Safety-Related Battery Replacement"

Reference: NG-01-1412, "Technical Specification Change Request (TSCR-048): "One-Time On-Line Safety-Related Battery Replacement", dated December 19, 2001

File: A-117

Dear Sir(s):

On March 12, 2002 and April 11, 2002 conference calls were held with the NRC Staff regarding the reference amendment request to allow the on-line replacement of the Duane Arnold Energy Center (DAEC) safety-related station batteries. In order to complete their evaluation, the Staff requested additional information. A draft of the Request for Additional Information (RAI) had previously been provided to us electronically. The Attachment to this letter contains our understanding of the modified set of questions and responses based on the discussions held during the conference calls.

No new commitments are being made in this letter.

Please contact this office should you require additional information regarding this matter.

A001

This letter is true and accurate to the best of my knowledge and belief.

NUCLEAR MANAGEMENT COMPANY, LLC

By Gary Van Middlesworth
Gary Van Middlesworth
DAEC Site Vice-President

State of Iowa
(County) of Linn

Signed and sworn to before me on this 19 day of April, 2002,

by Gary Van Middlesworth

Kathryn Dunlap
Notary Public in and for the State of Iowa

July 24, 2002
Commission Expires

Attachment: DAEC Response to NRC Request for Additional Information Regarding Proposed Amendment for One-Time On-Line Safety-Related Battery Replacement

cc: C. Bleau (w/a)
R. Anderson (NMC) (w/o)
D. Hood (NRC-NRR) (w/a)
J. Dyer (Region III) (w/a)
D. McGhee (State of Iowa) (w/a)
NRC Resident Office (w/a)
Documaster

DAEC Response to NRC
Request for Additional Information
Regarding Proposed Amendment for
One-Time On-Line Safety-Related Battery Replacement

1. Describe testing on the back up battery with the temporary battery charger.

DAEC Response:

Prior to being placed in service, the backup battery will be tested in accordance with DAEC Technical Specifications (TS) surveillance tests. Specifically, the temporary battery cells will have been subjected to a modified performance discharge test (DAEC TS Surveillance Requirement (SR) 3.8.4.8) at the vendor's facility prior to shipment to DAEC. After the temporary battery is assembled at DAEC, cell parameters such as electrolyte level, float voltage and specific gravity will be verified (TS SR 3.8.6.1). Average electrolyte temperature of representative cells will be verified to be within limits (TS SR 3.8.6.3). Also the overall battery will be verified to be operable by verifying required terminal voltage, verifying no visible corrosion at terminals and connectors or verifying connection resistance is within limits, verifying cells, cell plates, and racks show no visual indication of physical damage (TS SR 3.8.4.1 thru 3.8.4.3).

2. Discuss what test will be done after installation of the new battery before connecting the battery to the DC bus.

DAEC Response:

In addition to the testing as described in item 1 above, the new battery will be given a full charge using the temporary battery charger before connection to the DC bus.

3. Provide details of the type and insulation of the cable between the temporary battery and the DC bus.

DAEC Response:

The cable will be safety-related, Class 1E, 350 MCM or equivalent, with 600 Volt insulation.

4. Describe the location of the temporary battery in the turbine room (i.e., proximity to high energy steam lines and orientation with respect to a blade failure scenario).

DAEC Response:

The temporary battery will not be in the immediate proximity of high-energy steam lines. It will be located about 35 feet away from the feedwater lines which include the feedwater regulating valves at that location. The most likely leak would be a packing leak on the valves that would be detected in a reasonable time by the operators and would not affect the temporary battery. The temporary battery will be located at the north end of the turbine building at ground elevation (757′ mean sea level (MSL)). The main turbine operating floor is located at elevation 780′ MSL. The battery will also be located perpendicular to the main turbine shaft so that turbine missiles should not be a concern.

5. We may need some discussion as to security arrangements to indicate the battery is protected.

DAEC Response:

The location where the temporary battery will be located is in the power block, so access is always controlled and limited. While the temporary battery is in place, augmented security measures will be in place. This will include erecting a rope barrier with signage.

6. It does not appear that the submittal states explicitly that the battery is class 1E.

DAEC Response:

The new permanent battery is procured as Class 1E, safety-related.

7. Please provide an estimate of Incremental Conditional Large Early Release Probability (ICLERP).

DAEC Response:

The value of Incremental Conditional Core Damage Frequency (ICCDP) provided in the change request submittal was calculated using the DAEC's Probabilistic Risk Assessment (PRA) model for external events. Accident sequences for this model terminate at core damage (Level 1) and are not carried through to containment failure (Level 2). As such, an explicit calculation of ICLERP is not possible with our current modeling capability. ICLERP can be estimated however, using accident class multipliers derived from the DAEC's Level 1 and Level 2 PRA models for internal events. An accident class is assigned to the endstate of each Level 1 sequence. The Core Damage Frequency (CDF) sum of all sequences within a particular class is the CDF for that class. The Level 2 model assesses the likelihood of core damage sequences also resulting in containment failure. So, accident classes from the Level 1 model also have a release frequency determined from the Level 2 model. The multipliers are calculated by dividing large early release frequency (LERF) by CDF for each accident class.

The base CDF for seismic events only is 6.99E-7 per year. When accident class multipliers are applied, the base LERF for seismic events is estimated as 2.7E-7 per year. When Division 1 batteries are being replaced, LERF for seismic events rises to 3.8E-7 per year. Using these values, the ICLERP for replacing the Division 1 batteries over a ten day period is 3.0E-9.

When Division 2 batteries are being replaced, LERF for seismic events is 3.4E-7 per year. Subtracting the base value from this value leads to an ICLERP for replacing the Division 2 batteries over a ten day period of 1.9E-9. The total estimated ICLERP for replacing both divisions over a twenty day period is 4.9E-9.

8. Please provide estimates of annualized delta core damage frequency (ΔCDF) and delta large early release frequency (ΔLERF).

DAEC Response:

Annualized ΔCDF is equal to instantaneous ΔCDF times the fraction of time within a year that the condition is in effect. For replacement of the Division 1 batteries, ΔCDF is 2.3E-6 per year. Since the replacement will take place over a ten day period, annualized ΔCDF is:

2.3E-6/yr x (10d / 365d) = 6.3E-8/yr

For replacement of the Division 2 batteries, ΔCDF is 1.2E-6 per year. This replacement activity will also take place over a ten day period. Annualized ΔCDF is therefore:

1.2E-6/yr x (10d / 365d) = 3.3E-8/yr

The total increase in annualized CDF for both activities is 9.6E-8/yr.

Similar to the method for ΔCDF, annualized ΔLERF is equal to instantaneous ΔLERF times the fraction of time within a year that the condition is in effect. For replacement of the Division 1 batteries, ΔLERF is 1.1E-7 per year. Since the replacement will take place over a ten day period, annualized ΔLERF is:

1.1E-7/yr x (10d / 365d) = 3.0E-9/yr

For replacement of the Division 2 batteries, ΔLERF is 0.7E-7 per year. This replacement activity will also take place over a ten day period. Annualized ΔLERF is therefore:

$$0.7E\text{-}7/yr \times (10d / 365d) = 1.9E\text{-}9/yr$$

The total increase in annualized LERF for both activities is 4.9E-9/yr.

Note that this request for increasing the allowed out-of-service time for 125 VDC batteries is a one time request. Therefore, these values for annualized ΔCDF and ΔLERF do not represent a permanent increase in risk values for the DAEC.

9. Explain why acceptance criteria of 1.0E-6 for ICCDP and 1.0E-7 for ICLERP are used rather than Regulatory Guide 1.177 criteria of 5.0E-7 for ICCDP and 5.0E-8 for ICLERP.

DAEC Response:

The acceptance criteria of 1.0E-6 for ICCDP and 1.0E-7 for ICLERP cited in this change request are from EPRI Technical Report TR-105396, "PSA Applications Guide" dated August 1995. This guide has been used by the DAEC on a number of occasions in the past for assessing acceptability of temporary plant configurations. It is recognized that standards for acceptance criteria are subject to change as the nuclear industry gains experience with use and application of PRA technology. Therefore, we wish to judge this request against the newer criteria cited in Regulatory Guide 1.177, which has been accepted by the NRC as indicative of changes that are generally acceptable.

According to Regulatory Guide 1.177, a temporary increase can be considered non-risk significant if it results in an ICCDP of less than 5.0E-7 and an ICLERP of less than 5.0E-8. Replacing both divisions of 125 VDC results in an ICCDP of 9.6E-8 and an ICLERP of 4.8E-09. Since both of these values are less than their respective criteria, the battery replacement activity may be considered to be non-risk significant.

10. Discuss the quality of your PRA, starting with origins, stating changes and quality internal/external reviews, and suitability as a tool in the present request.

DAEC Response:

Level 1 and Level 2 PRA models were developed as part of the Individual Plant Examination (IPE) submitted to the NRC in November 1992 in response to Generic Letter 88-20. The 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 for 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 EPRI's Risk & Reliability Workstation Computer Aided Fault Tree Analysis (CAFTA). A rigorous comparison of REBECA and CAFTA cutsets was performed to ensure the conversion was performed appropriately. A revision to the Level 1 and Level 2 PRA models is currently underway to incorporate various model enhancements and to update it for extended power uprate conditions.

The PRA was used for screening of components and development of reliability goals in accordance with the Maintenance Rule (i.e., 10 CFR 50.65). It was used for ranking importance of motor and air operated valves so that appropriate maintenance and testing requirements could be applied to these components (i.e., GL 89-10), and to support the DAEC's proposed risk informed In-service Inspection Program.

Because of its on-going use as a decision-making tool, the DAEC PRA has been through a peer review as part of the BWR Owners' Group PRA certification program. The peer 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 on the DAEC's excellent PRA documentation and very consistent level of quality across all elements of the certification.

The seismic portion of the external events PRA model was used to calculate increase in core damage frequency for this requested change to the DAEC Technical Specifications. Since the external events model was created after the time of our 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 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, and therefore is believed to overestimate actual risk from seismic events.

11. Discuss, quantitatively or qualitatively, impact of external events (seismic, fire, high winds, floods, and other) on the present request.

<u>DAEC Response:</u>

The 125 VDC batteries are being replaced in a manner which does not reduce the capability of the 125 VDC system to meet its load requirements for all events analyzed in the DAEC *internal* events PRA. The temporary batteries to be used during the Division 1 and Division 2 replacement activities are equivalent to the original batteries in every respect except that they will not be mounted in a seismically qualified configuration. As such, the replacement

activities are evaluated with respect to plant risk from earthquakes, which are categorized as an *external* event. In addition to earthquakes, results of other external events may be impacted by the fact that the temporary batteries will be located in the turbine building rather than in the control building. Implications for each of the external event types will be discussed with special emphasis on seismic events.

The DAEC Individual Plant Examination for External Events (IPEEE) considers accidents in six categories. These are:

- Seismic Events
- Fires
- High Winds and Tornadoes
- External Floods
- Transportation and Nearby Facility Hazards
- Other plant-unique external events

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 approach used in the development of the model for seismic events is consistent with guidance provided in the PRA Procedures Guide (NUREG/CR-2300) and consists of the following three major steps:

- Seismic hazard analysis
- Seismic capacity and fragility analyses
- Seismic induced core damage frequency analysis

A seismic hazard analysis involves defining the seismic hazard frequency curve, which provides estimated seismic event frequency as a function of seismic intensity. Earthquake hazard frequencies used in the DAEC Seismic PRA model are taken from the latest Lawrence Livermore National Laboratory work on seismic hazard estimates (NUREG-1488).

The seismic capacity and fragility analyses involve the identification of key components and their associated capability to withstand a seismic event. Seismic capacity is the seismic load level below which a component or structure will continue to properly perform its function. It may be defined in terms of stress, moment, or acceleration. For the DAEC Seismic Events Analysis, peak ground acceleration is used to represent seismic capacity because of the availability of applicable information in industry literature. For each component or component class, a certain peak ground acceleration is assigned corresponding to the earthquake level at which it is judged very unlikely that seismic motion induced failure of the component will occur. These are known as High Confidence Low Probability of Failure

(HCLPF) capacity values.

Seismic fragility is the conditional probability of component failure versus ground acceleration, where failure is defined as the response level at which components will no longer perform their intended function. In the DAEC Seismic Events Analysis, a single fragility curve is applied to all equipment considered in the model except for a few components identified in the IPEEE study as having unique seismic capacity issues. These include heat exchangers, switchyard equipment, and the main turbine lube oil tank. A fragility dependency curve is employed to model the increased likelihood of widespread equipment damage for higher intensity earthquakes.

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 system fault trees from the internal events PRA model, modified to incorporate seismic fragility data. Core damage sequences from the seismic model are assigned accident classes consistent with the base PRA accident sequence classification. The following general assumptions are used in the development and quantification of the seismic model:

- Hazard frequencies are based on earthquake intensity of the lower end of each seismic magnitude interval
- Fragility calculations are based on earthquake intensity of the upper end of each interval
- Only systems on the DAEC Safe Shutdown Equipment List are credited
- Credit is not given for recovery of offsite power lost due to a seismic event
- Credit is not given for recovery of equipment lost due to the seismic event
- Seismic induced ATWS sequences are not evaluated

Results of the base seismic event tree quantification are summarized in the following table. The estimate of core damage frequency contributions from all earthquake intensities is 6.99E-7 per year.

SEISMIC INTENSITY RANGE	INPUT FREQ (1/yr)	Conditional Core Damage Probability (CCDP)	SEISMIC INDUCED CDF
(0.01 - <0.05g)	3.00E-04	0.00E+00	0.00E+00
(0.05 - <0.12g)	1.50E-04	1.39E-04	2.08E-08
(0.12 - <0.20g)	4.80E-05	8.67E-04	4.16E-08
(0.20 - <0.30g)	1.30E-05	2.43E-03	3.15E-08
(0.30 - <0.50g)	5.40E-06	8.45E-03	4.56E-08
(0.50 - <0.70g)	1.40E-06	5.47E-02	7.65E-08
(0.70 - <0.90g)	6.00E-07	3.72E-01	2.23E-07
(0.90 - <1.0g)	2.30E-07	4.36E-01	1.00E-07
(>1.0g)	1.60E-07	1.00E+00	1.60E-07

Core damage frequency rises when batteries for the 125 VDC system are removed from service because loss of offsite power is a dominant contributor to core damage in the seismic PRA model. The Division 1 or Division 2 125 VDC distribution panel loses all power following a loss of offsite power event if its respective battery is not available. Results of the seismic model quantification with Division 1 and Division 2 batteries out of service are reported in the technical specification change request for this battery replacement activity.

Fire

EPRI's Fire-Induced Vulnerability Evaluation (FIVE) methodology was used to analyze fire risk for the DAEC IPEEE. This methodology involves a streamlined conservative assessment utilizing look-up tables and questionnaires as well as existing plant analyses such as the DAEC Appendix R Fire Hazard Analysis. In 1997, a more comprehensive assessment was performed resulting in the development of a PRA based model for fires. The approach used in this evaluation consists of the following major steps:

- Fire ignition frequency analysis
- Fire growth and damage analyses
- Fire induced core damage frequency analysis

Eighteen fire areas are assessed including areas from the reactor building, the turbine building, the control building, and safety-related portions of the pump house. The total core damage frequency from fires is estimated to be 3.1E-6 per year, which is approximately 20% of the total core damage frequency from internal and external events.

The temporary batteries will be located in the north end of the turbine building on ground level (757'). This fire area includes the main feedwater pumps as well as cables that support operation of various Division 1 safety-related components. The risk impact of locating 125 VDC batteries in this area is very low due to the availability of offsite AC power to the 125 VDC distribution panels via battery chargers. When offsite power is available, the 125 VDC distribution panels remain energized even when their respective batteries fail due to a postulated fire in the turbine building. Since a loss of offsite power coincident with an all engulfing fire in the turbine building north end is not likely, the conditional CDF for this event with the batteries located there remains essentially unchanged.

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." This methodology involves the following steps:

- Comparison of the plant tornado design basis with the 1975 Standard Review Plan
- Development of an extreme wind hazard curve
- Analysis of structure and component fragilities
- Quantification of accident sequences

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 minimum 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 hazard 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. If more realistic assumptions were used, it is estimated that 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 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
- The battery replacement activities will not be initiated under conditions of impending severe weather

External Floods

Vulnerability to external flooding events was evaluated in the DAEC IPEEE using methodology contained in NUREG-1407. Per the methodology, if DAEC met the requirements of the 1975 Standard Review Plan, flooding could be screened from further analysis. This was found to be the case for the 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 the 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 to be the same with the batteries in either location because the two areas communicate with one another via a non-waterproof doorway.

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 from 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 to be unchanged by the proposed battery replacement activity.

Plant Unique External Events

In addition to the previous five categories assessed in the DAEC IPEEE, other external hazards were screened for their potential impact on plant safety. A list of potential events to include in this category was compiled 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 to not change the conclusion of this review.