June 25, 2009

Mr. Richard L. Anderson
Vice President, Duane Arnold Energy Center
FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION, INCLUDING A REVISION TO RAI 3.H, REGARDING SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR THE DUANE ARNOLD ENERGY CENTER (TAC NO. MD9770).

REFERENCE: Letter from Mr. Charles Eccleston to Mr. Richard Anderson, Vice President, Duane Arnold Energy Center, titled "Request for Additional Information Regarding Severe Accident Mitigation Alternatives for Duane Arnold Energy Center (TAC NO. MD9770)", dated May 26, 2009.

Dear Mr. Anderson:

In a letter dated May 26, 2009, the U.S. Nuclear Regulatory Commission (NRC) staff issued a request for additional information (RAI) regarding the severe accident mitigation alternatives (SAMA) analysis submitted by FPL Energy Duane Arnold, LLC, for license renewal of the Duane Arnold Energy Center (DAEC). The NRC has revised and is re-issuing this SAMA RAI. The revised RAI is included in the Enclosure to this letter. The NRC has revised this RAI, specifically RAI 3.h, to remove reference to NRC Generic Issue (GI)-199, as the applicability of this GI and its results are still under review by the agency. The revised RAI was discussed with Mr. Herb Giorgio of your staff on June 11, 2009, and supersedes the May 26, 2009 version. Please note that no other changes, beyond those made to RAI 3.h, were made to the RAI. Please also note that the May 26, 2009, letter and RAI have been removed from public access in the NRC's Agencywide Documents Access and Management System (ADAMS).

In order to maintain the environmental review schedule, we request that you provide all SAMA RAI responses, including your response to revised RAI 3.h, according to the original schedule of July 17, 2009. If you have any questions, please contact me at 301-415-8537 or by e-mail at charles.eccleston@nrc.gov.

Sincerely,

/RA/

Charles Eccleston, Project Manager
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-331

Enclosure:
As stated

cc w/encl: See next page

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Letter to R. Anderson from C. Eccleston, dated June 25, 2009

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REQUEST FOR ADDITIONAL INFORMATION
REGARDING THE ANALYSIS OF SEVERE ACCIDENT MITIGATION ALTERNATIVES
FOR DUANE ARNOLD ENERGY CENTER (DAEC)

1. Provide the following information regarding the Probabilistic Risk Assessment (PRA) models used for the Severe Accident Mitigation Alternative (SAMA) analysis:

   a. Anticipated transient without scram (ATWS) events are stated to contribute 29 percent of the core damage frequency (CDF). This amounts to approximately 3E-06 per year and seems very high. Discuss why ATWS makes such a significant contribution to CDF.

   b. Provide a breakdown of the internal event CDF by initiating event down to those that contribute 1 percent or more to the total CDF (including internal floods). Provide the contribution from station blackout events if not separately provided in this listing.

   c. Table 3.1.1.1-1 lists dominant contributors to CDF based on a risk reduction worth (RRW) importance analysis of the CDF cutsets. A number of types of basic events appear to be missing from this list, such as initiating events and common cause failures. Describe the development of this listing and provide the complete importance analysis listing down to a RRW of 1.005.

   d. The third most important contributor to CDF listed in Table 3.1.1.1-1 is PDI1947 with a RRW of 1.053. Table 5.1.2 indicates that this event is addressed by SAMA 165, however, Table 6-1 indicates that a plant modification not reflected in the PRA would reduce this event's RRW and therefore this SAMA is not applicable. Justify using a PRA for SAMA identification and evaluation that does not reflect the current plant design with regard to a failure that contributes over 5 percent of the CDF. Identify any other design changes that are not reflected in the PRA, and provide an assessment of the impact of the design changes on the importance analysis, the results of the SAMA identification process, and the results of the cost-benefit analysis.

   e. With regard to Revisions 3 (also called 3A) and 3B of the DAEC PRA:

      i. The table on page F-15 indicates a CDF of 3.3E-05 per year and a date of March 1995 for Rev. 3A, and a CDF of 1.5E-05 per year and a date of August 1995 for Rev. 3B. Other dates are given for these revisions on page F-14. Confirm the CDF and the dates for these two PRA revisions.

      ii. The identification of DAEC PRA model changes since the individual plant examination (IPE) submittal combines the changes for Rev. 3A and Rev. 3B. Provide a separate listing of the major changes in Rev. 3A (that contribute to the net increase in CDF) and the major changes in Rev 3B (that contribute to the net decrease in CDF).

   f. The nature of some of the PRA model changes identified in Section 3.1.1.2 is not clear from the information provided. Provide clarification of the following items:

i. Rev. 4 – Automatic depressurization system (ADS) Suppression added as a means for vapor suppression – Explain how ADS provides vapor suppression, which normally means condensing steam released to the drywell to limit containment pressure.

ii. Rev. 4 – Allowance for failure of decay heat removal upon success of high pressure coolant injection/reactor core isolation cooling for small loss of coolant accidents – Explain what is meant by allowance.

iii. Rev. 4 – Sequences for loss of offsite power (LOOP) events with stuck-open relief valve categorized as LOOP to inadvertent open release valve – Clarify this statement.

iv. Rev. 4 – Revision of event trees for human error probabilities or containment heat removal – Explain how event trees are used for human error probabilities (HEPs) and containment heat removal (CHR).

v. Rev. 4 – Incorporated initiating event frequencies for transients and manual shutdown – Explain how transients and manual shutdown were previously represented.

vi. Rev. 5 – Incorporated changes with smaller impacts as a result of boiling water reactor owners group (BWROG) certification comments – Identify which of the Revision 4 and 5 changes were in response to the BWROG comments.

g. Table 3.1.1.1-1 gives a risk reduction worth (RRW) of 1.053 for PDI1947 and 1.005 for PDI2046. From the descriptions provided, these events appear to involve the same instrument but in different loops of the residual heat removal service water. Explain why the RRW values are so different.

h. None of the listed changes incorporated in the DAEC PRA explicitly include updating the component failure rates to reflect DAEC plant-specific data. Clarify if and when this was done.

i. Provide a description of the Level 1 and 2 PRA update process, the quality control of PRA model changes, and the independent review and approval of the PRA model update documentation. Include a discussion of the results of any independent reviews that have taken place of the Level 1 and/or the Level 2 models other than that by the BWROG.

j. Confirm that the BWROG review scope included internal flooding as well as the Level 2 model, and that PRA Rev. 3B was the version that was reviewed.

2. Provide the following information relative to the Level 2 PRA analysis:

a. It is stated that no major changes have been made to the Level 2 PRA model since the IPE submittal. Since the IPE Level 2 model was based on the state of knowledge in the 1991-1992 time frames, discuss the impact of the current state of knowledge regarding BWR accident progression and containment failure mechanisms on the DAEC Level 2 model and the evaluation of SAMAs using this model. Include a discussion of how implementation of the severe accident management program (including emergency procedure and severe accident

guidelines) and the B.5.b security enhancements would impact the results of the Level 2 analysis and the identification and evaluation of SAMAs.

b. Table 3.4.4-1 gives general emergency declaration times which, when compared with the release times from scram of Table 3.4.3-2, indicate that for 3 of the 4 "late" release categories the release begins well before 6 hours after declaration of a general emergency and are therefore "early" releases using the definition of early from the IPE. It is also noted that a number of the release fractions in Table 3.4.3-2 (M/L, M/I, L/I, L/E, LL/I) do not meet the definitions for release magnitude of the IPE. (The IPE is referenced here because the ER does not define the criteria used to classify releases in terms of release timing and magnitude). Discuss the source category definitions with respect to timing and magnitude of release, the assignment of containment event tree endpoints to release categories, the development of the release fractions, the selection and definition of representative sequences, material access authorization program code version utilized for source term analysis, and the impact of the above apparent source term category disparities on the SAMA results.

3. Provide the following information regarding the treatment of external events in the SAMA analysis:

a. Section 3.1.2 lists external event CDF values for PRA revisions 3B through 5C. Clarify whether any changes were made to the external events models in these revisions, or whether these values only reflect the changes to the internal event models for these revisions. Describe the external event model changes, if any.

b. Provide more information on the development of the current seismic PRA beyond that provided in Section 3.1.2.2.1. Include a discussion of: the nature of the seismically induced core damage sequences, the treatment of loss of offsite power and its recovery, the determination of the fragilities utilized in the model for equipment and structures, the human error probabilities employed, the major conservatisms and/or non-conservatisms in the model, and the results of any reviews of the model (peer, independent/consultant, or other). Include discussion of failure of the turbine lube oil tank and potential fire as discussed extensively in the staff SER on the DAEC IPEEE.

c. The NRC staff safety evaluation report (SER) on the individual plant examination of external events (IPEEE) (p. 13) discussed rerouting of certain cables so that they would not pass through the cable spreading room, and indicated that this was nearing completion at the time of the IPEEE submittal. Confirm that this has been completed.

d. Provide more information on the development of the current fire PRA beyond that provided in Section 3.1.2.1.1. Include a discussion of: the source and validity of fire ignition frequencies relative to the concerns about these values raised in the technical evaluation report (TER) for the DAEC IPEEE, the fire growth and suppression analysis including codes employed and major assumptions, assumptions regarding fire barrier effectiveness, conservatisms and non-conservatisms in the model, and the results of any reviews of the model (peer, independent/consultant, or other).

e. Provide the CDF and description of the dominant fire and seismic core damage sequences as indicated by the current external events PRA.

f. If possible, provide the results of the CDF importance analysis for the combined internal and external events. If this is not possible, provide the results for the external events model.

g. The ER does not discuss how external events were considered in evaluating SAMA benefits. From the results provided in Section 4 (and from an October 10, 2008 e-mail from FPL), it is apparent that a multiplier of 1.57 was applied to the estimated benefits for internal events in order to account for additional benefits in external events. Confirm the use of a multiplier and provide a discussion on development of the multiplier. Justify why an external events multiplier was used instead of propagating the impact of SAMA related changes through both the internal and external events models (since DAEC is stated to have an external events PRA).

h. The NRC has developed an estimate of the DAEC seismic CDF (based on the NUREG-1488 seismic hazard curve) that is significantly higher than the value reported in the seismic IPEEE. It suggests that the DAEC external event multiplier used in the SAMA analysis may be too low. If the larger seismic CDF value is used, the external events multiplier would be approximately 2.3 versus the value of 1.57 used in the SAMA assessment. Provide an assessment of the impact on SAMA results (baseline and baseline with uncertainty) if an external events multiplier of 2.3 is used. This assessment can be limited to internal event SAMAs that could have significant benefits in external events.

4. Provide the following information relative to the Level 3 PRA analysis:

a. Provide additional information on how the population growth rates and the transient population data were developed, including: the source of the transient population estimate and how the growth rate estimates were applied.

b. Confirm that all three recently discovered problems in SECPOP2000 have been accounted for in preparing the MACCS2 input for DAEC, i.e., a formatting problem in input block text files, an error in formatting the economic database used by SECPOP2000, and gaps in the economic database file. (The ER description appears to address only two of these items).

c. The DAEC core inventory provided in Table 3.4.3-1 is stated to be end-of-cycle values for DAEC. Confirm that this core inventory reflects the expected fuel management/ burnup during the license renewal period.

d. It is stated that releases were modeled as being from the off-gas stack or the top of the reactor building depending on the accident sequence release location. Indicate the type of sequences associated with releases from each location, and relate this to the relevant source term category.

e. Crop production parameters (e.g., fraction of farmland devoted to grains, vegetables, etc.) are stated to have come from the 1997 National Census of Agriculture. Discuss why

Information on regional crops was not based on the more up-to-date 2002 Census of Agriculture, and any important differences between these two sources.

f. Clarify the source/location of the precipitation data used in the MACCS2 input.

5. Provide the following information with regard to the selection and screening of Phase I SAMA candidates:

a. No SAMA items were added to the plant-specific list of SAMAs as a result of the review of important human actions, on the basis that DAEC plant procedures and training meet industry standards. The CDF contribution from failure of important operator actions could possibly be reduced by providing additional alarms or automating certain actions. For each of the important operator actions on page F-24, identify potential means of improving operator response, and provide an assessment of the costs and benefits of these improvements.

b. The NRC SER for the DAEC IPE identifies nine potential improvements and evaluations. Seven of these are included in the Phase I list of SAMAs. Describe the resolution of the other two items, i.e., prioritize injection systems for use in degraded core conditions and evaluate the benefits of resetting the ADS timer instead of immediately locking out the automatic initiation of ADS. If not already implemented, discuss why these two items were not included in the Phase I SAMA list.

c. In Table 5.1-2 these are several basic events (e.g., CB8490, 1G031, 1A311) that are addressed only by generic SAMAs. Explain why there is nothing unique about these failures or the DAEC design that might be better addressed by a DAEC-specific SAMA.

d. Although Table 5.5-1 includes SAMAs for external events based on generic insights and improvements identified in the IPEEE, all of which have been implemented, the current plant-specific fire and seismic risk results do not appear to have been systematically reviewed for the purpose of identifying potential SAMAs specific to external events.

i. For each of the major fire risk contributors at DAEC, provide an evaluation demonstrating that there are no viable SAMA candidates that would further reduce the fire risk.

ii. For each of the major seismic risk contributors at DAEC, provide an evaluation demonstrating that there are no viable SAMA candidates that would further reduce the seismic risk.

e. The source for SAMA 156 (Provide an alternate source of water for the RHRSW/ESW pit) is stated to be “Expert Panel”. This source is not discussed in the ER. Describe the “Expert Panel”, the source of this SAMA, and if any other SAMAs were identified and discarded by this panel.

f. Provide further information on the basis for the disposition of the following SAMAs in Table 6-1:

i. SAMA 57 – The disposition column indicates that the screen wash system is a reliable

system and that firewater and well water are available as a backup for maintaining level in safety-related pump pit. Nevertheless failures in the river water system are high on the list of important events. Justify why enhancements to the system do not warrant further consideration, given the system importance.

ii. SAMA 126 – The SAMAs that are cited in the disposition column are not related to flood propagation prevention, which is the focus of this SAMA. Confirm whether the internal flooding analysis indicates that any flood barriers are important and whether upgrading these barriers could be cost-beneficial.

iii. SAMA 134 – The SAMAs that are cited in the disposition column are not related to upgrading fire barriers, which is the focus of this SAMA. Confirm whether the fire analysis indicates that any fire barriers are important and whether upgrading these barriers could be cost-beneficial.

iv. SAMA 135 - The SAMAs that are cited in the disposition column are not related to reducing fire-induced spurious actuations, which is the focus of this SAMA. Confirm whether the fire analysis indicates that spurious actuations are important.

v. SAMAs 1 and 3 – The disposition column indicates that these SAMAs were implemented through severe accident management guidelines (SAMG). Explain how the SAMG meets the intent of this SAMA (i.e., provide additional DC battery capacity, and add additional battery charger).

vi. SAMA 9 – Describe the alternate mitigation strategy cited and how it meets the intent of this SAMA (i.e., reduce DC dependence between high-pressure injection system and ADS).

vii. SAMA 34 – Explain how the procedures that are in place meet the intent of this SAMA (i.e., improve reliability of ADS components). viii. SAMA 38 - Explain how the procedures that are in place meet the intent of this SAMA (i.e., improve low pressure injection capability).

ix. SAMA 48 – The disposition column indicates that this SAMA (remove low pressure coolant injection loop select logic) is being addressed by a current licensing action. Cite the specific licensing action and indicate its status.

x. SAMA 59 and 60 – Describe the alternate mitigation strategies cited and how they meet the intent of these SAMAs (i.e., creating ability for emergency connection of existing or new sources to feedwater and condensate system, or installing an independent diesel for condensate storage tank makeup pumps).

xi. SAMA 118 – Explain how the procedures that are in place meet the intent of this SAMA (i.e., add an independent boron injection system), considering that SAMA 119 addresses the use of alternative systems for injection.

xii. SAMA 136 – Describe the alternate mitigation strategy cited and how it meets the intent of this SAMA (i.e., to implement alternate shutdown methods if the control room becomes uninhabitable).

xiii. SAMAs 158 and 159 – These SAMAs specifically address issues associated with maintenance and fires in the switchgear rooms and the river water system. Confirm whether the maintenance and risk management program cited in the disposition specifically covers these systems.

6. Provide the following information with regard to the Phase II cost-benefit evaluations:

a. In Table 7.1.3-1 the benefit for SAMA 41 (Provide capability for alternate injection via the reactor water clean up) was indicated to be determined by considering it to be viable only for steam breaks. Confirm whether this SAMA would also be beneficial for either short term or long term transients.

b. In Table 7.1.3-1 the benefit for SAMA 55 (Implement modifications to allow manual alignment of the fire water system to RHR heat exchangers) was indicated to be determined by assuming that the RHR Service Water system did not fail. Confirm that this included not failing due to loss of electric power.

c. Table 7.1.3-1 indicates for SAMA 117 that elimination of all standby liquid control (SLC) injection failures reduces CDF by 6.6 percent, while Table 5.1-1 indicates that failure of the operator to inject SLC early contributes almost 10 percent of CDF. Explain the reason for this difference.

d. For SAMA 164 (Improve the reliability of the RWS control system) Table 7.1.3-1 identifies the SAMA case as RWS02 versus BASE02. Presumably the benefit of this SAMA was determined after another SAMA (SAMA 158?) was assumed to have been implemented. Clarify why a revised base case was needed for this SAMA. Describe the assumptions in this evaluation, including what this SAMA involves, and provide the detailed assumptions and results for the revised base case.

e. Provide an expanded discussion of the use of the lower bound cost estimates of $30K and $100K for procedures and hardware changes, respectively, and what the expert panel cost estimates include, such as, inflation, contingencies, replacement power.

f. Provide more detail on the SAMA design and the basis for the stated cost for the following SAMAs: 12, 35, 41, 52, 55, 56, 75, 78,139 and 163.

g. Provide dollar estimates instead of “>MAB” for the following SAMAs, since their benefit using a higher external event multiplier with uncertainties could exceed the maximum attainable benefit (MAB) reported in the ER: 10, 15, 17, 27, 28, 49, 120, 123, and 139.

h. On Page F-9 it is stated that a member of Design Engineering reviewed the cost estimates to assure adequate accuracy. Specify which cost estimates were reviewed in this manner.

i. Provide the percent change in offsite economic cost risk (OECR) for each SAMA so that the benefits presented can be confirmed.

7. Provide the following information with regard to the sensitivity and uncertainty analyses:

   a. On page F-91 it is stated that "Unless otherwise noted, it is assumed in these sensitivity analyses that sufficient margin exists in the maximum benefit estimation that the Phase I screening would not have to be repeated in the sensitivity analysis." This assumption does not appear to be appropriate. Specifically, if the benefits were increased by a factor of 2.5 (to account for uncertainties) the maximum benefit would be increased to $5.65 million and several of the 13 Phase I SAMAs that were screened out based on excessive costs might have screened in (e.g., SAMAs 80 and 104). Provide an assessment of the impact of uncertainties on the Phase I screening.

   b. In Section 8.2, Uncertainty, SAMAs 12 and 78 are stated to be cost beneficial. This does not appear to be the case in Table 8.2-1. Clarify this discrepancy.

8. For certain SAMAs considered in the Environmental Report, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, provide an evaluation of the following SAMAs:

   a. Use a portable diesel driven pump for low pressure injection through existing systems.

   b. Use a portable diesel driven pump to provide makeup to the RHRSW/ESW pit.

   c. Use a portable DC power supply to maintain DC power availability for SBO sequences.

   d. Improve the reliability of cross-ties between the RHR system and the RHR service water (RHRSW), the fire systems or other systems that could be used for alternate low pressure injection.

   e. Create a procedure to maximize control rod drive flow to provide early and/or late injection.