April 20, 2006

Mr. Joseph E. Conen
Chairman, BWR Owners Group
DTE Energy - Fermi 2
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6400 N. Dixie Highway
Newport, MI 48166

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING THE BOILING WATER REACTOR OWNERS GROUP (BWROG) TOPICAL REPORT (TR) NEDO-33148, "SEPARATION OF LOSS OF OFFSITE POWER FROM LARGE BREAK LOCA [LOSS-OF-COOLANT ACCIDENT]" (TAC NO. MC3042)

Dear Mr. Conen:

By letter dated April 27, 2004, the BWROG submitted for Nuclear Regulatory Commission (NRC) staff review TR NEDO-33148, "Separation of Loss of Offsite Power From Large Break LOCA." The NRC staff has identified a number of items for which additional information is needed to continue its review. The NRC staff of the Probabilistic Risk Assessment Licensing (APLA) and the Electrical Engineering (EEEB) branches require responses to the enclosed RAI questions in order to continue the review. The two sets of RAIs are provided as Enclosures 1 and 2, respectively.

By letter dated December 2, 2005 (Agencywide Document Access and Management System Accession No. ML053330380) you were provided a set of RAIs from the APLA branch. Enclosure 1 of this letter supersedes in its entirety the questions transmitted to you in the December 2, 2005, letter. The December 2, 2005, RAIs are being withdrawn based on the BWROG’s stated intent to revise the subject TR to be a methodology document with respect to the risk assessment, rather than a generic risk assessment intended to be referenced by licensees with minimal need to do plant-specific analyses. This decision to change TR NEDO-33148, stated at a meeting between the NRC staff and members of the BWROG held at NRC Headquarters on February 14, 2006, obviates the NRC staff’s need for many of the December 2, 2005, RAI questions.

As agreed upon in a telephone call between Fred Emerson of your staff and myself, the BWROG will respond to the enclosed RAI questions by June 30, 2006. A revised schedule with target safety evaluation date will be established upon receipt of the revised TR and RAI responses. Please call me at 301-415-1774, if you have any questions on this issue.

Sincerely,

/RA/

Michelle C. Honcharik, Project Manager
Special Projects Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 691

Enclosures: 1) APLA RAI questions
2) EEEB RAI questions

cc w/encls: See next page

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Sincerely,

/RA/
Michelle C. Honcharik, Project Manager
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cc w/encls: See next page

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Accession No.: ML061030403 **NRR-088** ***No Substantial change from the Memorandum**

OFFICE	PSPB/PM	PSPB/LA	APLA/BC*	EEEB/BC*	PSPB/BC(A)
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REQUEST FOR ADDITIONAL INFORMATION

BOILING WATER REACTOR (BWR) OWNERS GROUP

TOPICAL REPORT (TR) NEDO-33148, "SEPARATION OF LOSS OF OFFSITE POWER FROM LARGE BREAK LOCA [LOSS-OF-COOLANT ACCIDENT]"

PROJECT NO. 691

PROBABILISTIC RISK ASSESSMENT LICENSING BRANCH A

All section, page, table, figure, or reference numbers in the questions below refer to items in TR NEDO-33148, unless specified otherwise.

Scope of the TR

1. In at least one place (e.g., Page 10) the TR refers to LOCAs up to "large recirculation loop pipe breaks." In other places (e.g., Section 6.0) it refers to 10-inch and larger breaks. Please clarify the break size above which an exemption from the loss-of-offsite power (LOOP) will be requested by licensees. Do all seven options presented in the TR assume the same break size?

Risk of LOOP with Large Break LOCA

2. The TR mentions References 2, 3, and 10 as the basis for the frequency of 1.0E-6 per year for the large break LOCA (LBLOCA) and LOOP combination. In addition, according to Figure C.4-1, the probability of LOOP given a LOCA is 1.0E-2. However, it is not clear how these two estimates are derived from the three references. Please explain how these two estimates have been derived and describe how a licensee would obtain plant-specific estimates of these two parameters.

3. NUREG/CR-6538 studied Generic Safety Issue (GSI)-171, "ESF [Engineered Safety Feature] Failure from LOOP Subsequent to a LOCA." Specifically, Section 8.5.1 of NUREG/CR-6538 identified two plant-specific design features that could impact the probability that offsite power will be lost given a LOCA: the electrical switchyard associated with a plant having undervoltage for a significant fraction of time, and the energization scheme implemented to power the safety loads after a LOCA. In addition, for those plants that transfer the source of power feeding the safety buses after reactor trip, a failure of this transfer could cause a loss of power to these buses. Please describe how these potential vulnerabilities are accounted for in the development of the conditional probability of LOOP as a result of a LBLOCA.

4. The TR states that "... The conditional loss of offsite power events (LOOP given LOCA and LOOP given transient) are modeled as grid centered events ..." The NRC staff notes that a consequential LOOP can also be due to plant-centered causes, such as failures in the switchyard. Please identify all the failure modes that could result in LOOP

and define whether each failure is a grid-centered or plant-centered event. How will the potential for plant-centered causes of consequential LOOP be considered in the risk assessment?

Guidance on Plant-Specific Risk Assessment

5. Please describe generally how a licensee would demonstrate that its probabilistic risk assessment (PRA) satisfies Regulatory Guide (RG) 1.174 "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," guidelines regarding sufficient scope, level of detail, and technical acceptability commensurate with this application.

6. Please describe generally what information a BWR licensee would submit to demonstrate that the five key principles stated in RG 1.174, Section 2 and RG 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications," Section B are met.

7. Page 2 of Figure C.4-1 models conditional LOOP events (LOOP given LOCA and LOOP given transient) as part of grid-centered events. According to this figure, a LBLOCA and LOOP are linked with an "AND" gate together with the recovery of offsite power within one hour. In other words, solving the top gate for grid-centered events would yield the following cutset (among other cutsets):

   LBLOCA * LOOP * NR-LOOP-1HR

   where NR-LOOP-1HR is the failure to recover offsite power within one hour. This cutset does not appear realistic because a consequential LOOP would occur shortly after a LBLOCA, so the time available for recovery of offsite power is very short, and probably cannot be credited.

   Please describe how a licensee would be expected to model recovery of the consequential LOOP given a LBLOCA in their risk assessments. Describe and justify the use of any recovery of offsite power.

8. Figures C.3-4 and C.4-1 present the LBLOCA event tree and fault tree for LOOP events, respectively. The event tree includes top events "TOP-LOSP2 (Offsite Power Available)" and "Recovery." The latter top event appears to be related to recovery of offsite power because the associated branches have the label "REC-LOSP-G6H." It appears that the LBLOCA event tree and fault tree for LOOP events are linked or combined in some way, but a description of the way they are linked was not found in the TR.

   Please describe in detail how a licensee would be expected to model the consequential LOOP event together with the LBLOCA event tree. The NRC staff notes that a consequential LOOP is likely to be delayed; i.e., not coincident with the LBLOCA. Please discuss in detail how a licensee would determine a plant-specific, best-estimate timing for the LOOP resulting from the LBLOCA, and how the delayed LOOP would be modeled in the PRA.

9. At the beginning of Section C.5, "Risk Calculation for Plant Changes," five steps to assess the impact on core damage frequency (CDF) and large early release frequency are presented. Please define the “base (unaltered case)," e.g., does it include the assumption that a LBLOCA and LOOP lead directly to core damage? Please provide more detail on each of the five steps.

10. Section C.6.2, "Sensitivity Analyses" does not address the generic probability of LOOP given a LOCA, nor the generic frequency of a LBLOCA and LOOP. Please describe how the licensee would be expected to develop this information on a plant-specific basis and to address the uncertainty in the frequency of a LBLOCA and in the conditional probability of LOOP given a LBLOCA?

Enabled Changes

11. Please describe how a licensee would assess the risk impact of adopting multiple options presented in the TR. To what extent, and in what manner, would the licensee evaluate the cumulative risk impact from changes made possible by an exemption to the regulations as requested in the TR?

3.1 Allow Emergency Diesel Generator Warm Up Prior to Loading

12. Section 3.1 states that fast starting of emergency diesel generators (EDGs) decreases their reliability and increases their unavailability. It states that a warm up of 30 to 60 seconds would increase reliability. It further states that many maintenance outages are focused on degradation associated with fast starts. Please provide the technical basis for the claim that 30 to 60 seconds warm up will increase reliability, including data that supports the statement that "many" EDG maintenance outages are attributable to diesel fast starts. Alternately, state how a licensee would determine the appropriate increases in reliability and availability for a plant-specific risk assessment.

3.2 Optimize the Loads Sequenced on to the EDGs

13. Section 3.2 states: "If the requirement for automatic loading of all LPCI [low pressure coolant injection] pumps or LPCS [low pressure core spray] pumps onto the diesel generators were eliminated, licensees would perform analyses to determine which equipment would be most beneficial to have automatically loaded." Please describe how a licensee could determine which loads would be beneficial and how it would evaluate the change in risk for a proposed change in EDG loading.

3.3 Start EDGs Only When Needed

14. Section 3.3 states that one of the safety benefits of revising the EDG start logic "... comes from the reduction of operator burden following accidents and transients." Please describe how a licensee would model this proposed change in their PRA model, or otherwise assess the risk of the proposed change in an acceptable manner.

15. Section 3.3 says that eliminating the anticipatory starting of the EDGs increases diesel availability and reliability, because spurious starts will be reduced. Provide data

regarding the number of spurious EDG starts that have occurred that are attributable to emergency core cooling system starting logic and justify the expected improvement in this frequency and provide justification for any improvement in EDG reliability assumed as the result of implementing this change. Alternately, state how a licensee would determine the appropriate increases in reliability and availability for a plant-specific risk assessment.

3.4 Simplified EDG Testing

16. Section 3.4 states: "There is an additional benefit that some of the tests could be simplified, which in turn could result in fewer operator distractions during plant operation." Please describe how a licensee would model the risk impact of simplified tests, including the impact of fewer operator distractions during plant operation.

3.5 Increased Motor-Operated Valve Stroke Times

17. Please describe how a licensee would determine which motor-operated valves (MOVs) to consider for this change, and how it would estimate the risk impact of increasing the selected MOV stroke times?

3.6 Automatically Start One Residual Heat Removal Loop in Suppression Pool Cooling Mode

18. Section 3.6 discusses the risk benefit from automatically starting one residual heat removal (RHR) loop in suppression pool cooling mode. In the event of a LOCA and failure of the RHR loop that is aligned for injection, the operator would have to align the other loop (e.g., the one aligned to start in suppression pool cooling mode) to inject.

    RG 1.174 includes seven elements that serve as guidelines for assessing the adequacy of defense-in-depth. These include:

    - A reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation.
    - Over-reliance on programmatic activities to compensate for weaknesses in plant design is avoided.
    - System redundancy, independence, and diversity are preserved commensurate with the expected frequency, consequences of challenges to the system, and uncertainties (e.g., no risk outliers).
    - Defenses against human errors are preserved.

    Please describe how adequate defense-in-depth is maintained for this proposed change. How would a licensee assess the risk associated with the resulting asymmetry in plant design and attendant impact on operator training complexity? How would a licensee assess the potential for RHR system water hammer if it was necessary to switch the suppression pool cooling loop to the injection mode during an accident?

<u>Miscellaneous Comments</u>

19. The TR contained a number of administrative and clerical errors, including:

a. Section C.4.5, first paragraph, refers to General Design Criteria (GDC) 16 vice GDC 17.

b. Section C.4.5 states "Figure C.4-3 shows the generic model logic for loss of offsite power events." However, Figure C.4-3 is entitled "Medium LOCA Conditional Core Damage Frequency [sic]." The correct reference appears to be Figure C.4-1, and it would appear that Figure C.4-3 should refer to "probability" vice "frequency."

c. Section 9.1 contains 17 PRA assumptions to be validated by plants referencing the TR. There are 18 assumptions listed in Section C.6.1. It appears that numbers 5 and 14 in Section C.6.1 were combined in the Section 9.1 list. It would be clearer if these lists were consistent.

d. Section 2.2, Page 6 cites References 3, 8, and 10 as the basis for the consequential LOOP probability used in the TR. Section 4.2, Page 16 cites References 2, 3, and 10.

e. Table C.6-1, Page C-66 discusses offsite power configurations. The "assessment" column states: "Section C.3.5 discusses this aspect of the generic model as it applies to other plant configurations." However, Section C.3.5 is “Simplified Level 2" and does not appear to address offsite power configurations.

f. Table C.6-1, Page C-67 discusses battery depletion time: "Section C.3 discusses the impact that different battery ratings have on the analysis." The NRC staff could not find this discussion in the TR.

g. Figure C.4-1 is very difficult to read.

h. Section C.4.5, "Offsite Power Configuration" states that "Figure C.4-3 shows the generic model logic for loss of offsite power events." It appears that the correct reference is Figure C.4-1.

20. The sensitivity study in Section C.6.2.4 shows that not inhibiting the automatic depressurization system (ADS) causes an increase in CDF for the "LPCI Does Not Start With On [sic] Offsite Power" case. This same case shows a CDF decrease if ADS inhibit is credited. However, Table C.6-1, on Page C-63, states for the ADS assumption: "The results show that this assumption does not impact the conclusions of this report." Please explain these results.

21. Section C.6.2 presents seven sensitivity analyses. Several apparent errors and a non-intuitive presentation format renders this section very difficult to understand. Please address the following if Section C.6.2 is to be retained:

a. All of the tables in Section C.6.2 use "CDF Decrease" as the metric; this is difficult to interpret as discussed in specific cases below. All of the tables have a column, "LPCI Does Not Start With On Offsite Power." Please provide a more descriptive heading.

b. Tables C.6.2.2 through C.6.2 4 have the same two row labels, which are apparently meant to define the base case and sensitivity case conditions. The latter two tables should have rows related to "Service Water Injection Source" and "ADS Actuation," respectively.

c. For the sensitivities involving "LPCI Does Not Start With On Offsite Power," Tables C.6.2.2, C.6.2.3, C.6.2.5, and C.6.2.7 appear to show an improvement in risk (a larger "CDF Decrease") as a result of model changes that would be expected to increase risk.

d. For sensitivities involving "Increased DG Reliability," Tables C.6.2.1, C.6.2.3, C.6.2.5, and C.6.2.7 appear to show an improvement in risk (a larger "CDF Decrease") as a result of model changes that would be expected to increase risk.

e. The results for Tables C.6.2.1 and C.6.2.2 are opposite for the two model changes shown; i.e., risk goes up for one change and down for the other as a result of the same sensitivity analysis.

REQUEST FOR ADDITIONAL INFORMATION

BOILING WATER REACTOR (BWR) OWNERS GROUP

TOPICAL REPORT (TR) NEDO-33148, "SEPARATION OF LOSS OF OFFSITE POWER FROM LARGE BREAK LOCA [LOSS-OF-COOLANT ACCIDENT]"

PROJECT NO. 691

ELECTRICAL ENGINEERING BRANCH

All section, page, table, figure, or reference numbers in the questions below refer to items in TR NEDO-33148, unless specified otherwise.

1. Section 1, Introduction, describes the scope of the TR to the coincident large break LOCA (LBLOCA) with a loss-of-offsite power (LOOP).

    a) The TR indicates that the capability of mitigating a LBLOCA will be removed from the design requirements for the onsite power system. Confirm that the capability to respond to a LBLOCA will remain if offsite power remains available.

    b) With only the offsite power system remaining to power the LBLOCA mitigating systems, describe the design and acceptance criteria for an operable offsite power system. Also, describe how you propose to modify the nuclear power plant technical specifications to ensure an adequate offsite power system will be available when needed.

2. Section 3.1, Allow Emergency Diesel Generator (EDG) Warm Up Prior to Loading, indicates that for small breaks, based on the time required to depressurize the reactor system, a diesel start and load time of less than 100 seconds would result in an acceptable peak cladding temperature (PCT).

    a) Confirm that for this scenario, the low pressure pumps would automatically load onto the EDG and the high pressure injection systems would not be required. If this is true, justify the deletion of the defense-in-depth caused by the elimination of the high pressure response.

    b) Provide the limiting size of the small or medium break LOCA (SBLOCA or MBLOCA) that would be acceptable if it took 100 seconds for the EDG to start and load. Also, describe the range of consequences associated with break sizes from the limiting SBLOCA up to the design basis break of the LBLOCA with a EDG start and load time of 100 seconds.

3. Section 3.2, Optimize the Loads on to the EDGs, indicates that a new automatic load sequence would replace some of the high capacity (emergency core cooling system (ECCS)) pumps such as low pressure core spray and low pressure core injection (LPCI)

with support equipment such as battery chargers, drywell coolers, and some equipment closed cooling loops.

Identify those plants that do not automatically load the safety-related battery chargers onto the EDG at present. Justify why the battery-chargers are not automatically loaded as soon as possible to keep its reflected load on the EDGs low compared to its current-limited rating that would be required if the battery chargers are manually loaded after two to eight hours.

4. Section 3.3, Start EDGs Only When Needed, proposes to eliminate the anticipatory LOCA start of the EDGs and only rely on the low voltage signals to start the EDGs.

   a) Confirm that it is the intent to only start the EDGs on undervoltage (with a fast start).

   b) Confirm that is your intent to not start the EDGs at all on "only" LOCA, not even using a "slow" start to bring the EDG up to speed for a controlled loading.

5. Describe the response of the plant to the full range of LOCAs between "a few seconds" delayed LOOP and "a few minutes" delayed LOOP.

6. Describe differences and the trade offs between starting and running the EDGs unloaded, a slow start and warmup scenario on:

   - Lubrication efficiency
   - Capability to accept load (any differences in the "Probability to Accept Load")
   - The elimination of the delayed "Failure to Start" probability

7. Section 3.4, Simplified EDG Testing, indicated the changes would result in a relaxation of acceptance criteria. It would appear that additional testing would be required to test for different LOCA break sizes and different loading responses depending on whether offsite power was available or not. Describe what testing acceptance criteria can be relaxed.

8. Some BWR EDGs are only capable of starting the large residual heat removal (RHR) loads at the beginning of the loading cycle where margin exists between EDG rating and load demand. Describe how this restriction will affect the proposed changes.

9. Describe what regulatory requirements are referenced in the statement "...loads that often have to be load shed under the current regulatory requirements." Clarify if this is an inference to the voltage and frequency limits that may be challenged using an undersized EDG.

10. Section 3.5, Increased MOV [motor-operated valve] Stroke Times, states separating a LBLOCA from LOOP will allow slower valve stroke times. Explain why the faster stroke times will not be required if the ECCSs are powered from offsite power.

11. Section 3.5 also states that thermal-hydraulic analysis has shown that adequate PCT can be maintained for a wide range of stroke time relaxations.

    a) It is not clear how stroke times for MOVs which can be powered by both the offsite power system and the onsite power system are being addressed in this section. Is the family of valves being considered restricted to only those systems which are not required to respond to the LBLOCA? Have stroke time relaxations been discussed in a separate TR or requested under a separate plant-specific change request that may provide further clarification?

    b) Section 3.5 notes that one MOV has experienced severe damage during a test under these conditions. Describe the damage and the relation to fast stroke times. Confirm that the damage was not caused by incorrectly set thermal overload relay or torque switch selection.

12. Clarify the statement in Section 3.5 that larger operators can add to EDG loading constraints. Explain why the existing (short-time) EDG ratings are challenged by the higher load of the existing fast acting MOVs.

13. In general, pump suction valves affect pump net positive suction pressure and pump discharge valves affect pump horsepower. Address the differences between the suction and discharge valves for the ECCS pumps.

    a) Confirm that the slower stroke times will not affect the starting or restarting loads seen by the EDG.

    b) Confirm the ECCS pumps will not have a problem with inadequate suction pressure.

14. Clarify the statement in Section 3.6, Automatically Start One RHR Loop in Suppression Pool Cooling Mode (SPC), that in order to make this change, a licensee would have to deterministically demonstrate that it could still mitigate the LBLOCA with offsite power available and a single active failure. The NRC staff believes this section can only apply to those plants that have two RHR pumps per division where it would be proposed to permanently re-align one of the two RHR pumps per division to the SPC mode. Otherwise, clarify why this has not already been demonstrated under the existing requirements.

15. Clarify the last paragraph of Section 3.6 to explain why the core damage frequency (CDF) due to loss of containment heat removal is higher than damaging the core (i.e. melting the core) from failure to reflooding the core because of loss of injection.

16. Section 3.7, Eliminate LPCI LOOP Select, states that "In the current LOCA analyses for Loop-Select plants, the logic is assumed to fail (i.e. select the broken loop) for all breaks less than or equal to 0.5 ft^2. This is well into the large break range, so elimination of this function will not affect other postulated accidents." Describe why other postulated events LESS than 0.5 ft^2 will not be a concern.

17. Section 4.3.1, Quantitative Impact of Optimizing EDG Loads, appears to attempt to provide a risk trade-off of manually loading two to four (or more) battery chargers before the batteries discharge to the point of inadequate direct current voltage against the elimination of core injection on a LBLOCA. Clarify why the consequences of a discharged battery are comparable to damaging the core and a deliberate loss of the primary fission barrier.

18. Section 4.3.4, Qualitative Risk Reductions, addresses three areas in the first paragraph: EDG Availability, EDG Reliability and Operator Action Reliability. The implication is that spurious starts reduces EDG availability and reliability. Describe how many false starts can be attributed solely to a false LOCA signal and what percentage of unavailability and unreliability can be attributed to that function.

19. If the existing LOCA logic is a significant contributor to spurious EDG starting and has a negative effect on EDG availability and EDG reliability, clarify why the existing deficient logic has not been corrected under the Maintenance Rule and describe your recommendation to revise the logic.

20. It appears that an arbitrarily assumed improvement of 10 percent in operator action reliability was used to justify the offset in the increase in CDF from the proposed changes. Clarify how an operator, action hours into the accident, can offset the immediately assumed damage to the core from failure to recover.

21. Appendix A, General Design Criterion (GDC) 35, Emergency Core Cooling, to Title 10 to the *Code of Federal Regulations* Part 50 is only one of six GDCs that require onsite power. The others are GDC 33, Reactor Coolant Makeup, GDC 34, Residual Heat Removal, GDC 38, Containment Heat Removal, GDC 41, Containment Atmosphere Cleanup and GDC 44, Cooling Water which also require onsite power. Address the effect that a slow start and delayed loading of the EDGs would also have on the response of these systems and address the total effect on CDF.