April 17, 2002

MEMORANDUM TO: Lakshminaras Raghavan, Chief
Section 1
Project Directorate III
Division of Licensing Project Management

FROM: Kamal A. Manoly, Chief ***/RA/***
Civil & Engineering Mechanics Section
Mechanical & Civil Engineering Branch
Division of Engineering

SUBJECT: RESPONSE TO TASK INTERFACE AGREEMENT (TIA 2001-15) FOR D.C. COOK, UNITS 1 AND 2 (TAC NO. MB3603 AND MB3604)

In a memorandum dated December 19, 2001, Region III requested NRR (TIA 2001-15) to review licensee's Transient Mass Distribution (TMD) and structural calculations to verify that the D.C. Cook Unit 1 and 2 containment structures meet their design basis requirements. Specifically, Region III requested NRR staff to determine if the licensee utilized appropriate methodologies, assumptions, and input in concluding that containment structures comply with design basis requirements. EMEB staff performed a design audit at the licensee's office on January 8-10, 2002, to review structural calculations and other documentation to verify conformance with the design basis requirements for various concrete slabs and walls within the containment structure. Based on its review of the design records, the staff has identified two findings:

(1) In the calculations for ice condenser end walls, and the missile shield, the licensee used yield strength values for steel rebar obtained from CMTRs. These values are, respectively 19% and 26% higher than the code required minimum guaranteed design basis yield strength of 40 ksi. The staff has, in principle, not accepted the use of material CMTR properties (e.g; yield strength) in lieu of nominal specified code properties.

(2) In the computer analysis for the Unit 1 and 2 Fan-Accumulator room walls, the licensee used a computer program, *SOLVIA,* that has not been reviewed by the staff in other applications.

The staff recommends the following actions:

(1) The licensee should provide adequate justification for using material CMTR yield strength values for rebar in the ice condenser end walls and the missile shield.

(2) The licensee should confirm that the construction deficiency that led to the installation of grade 40 rebar in certain concrete components in place of grade 60 rebar as specified in the original design records is only limited to the missile shield. The licensee should discuss the actions taken to ascertain that the identified discrepancy was an isolated incident.

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(3) The licensee should provide documentation for the validation of the computer program, *SOLVIA.*

Details of the staff's assessment are provided in Attachment 1.

Docket No. 50-315/316

Attachment: As stated

cc: JStang
SBajwa

(3) The licensee should provide documentation for the validation of the computer program, *SOLVIA.*

Details of the staff's assessment are provided in Attachment 1.

Docket No. 50-315/316

Attachment: As stated

cc: JStang
SBajwa

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ADAMS ACCESSION NUMBER: ML021070317

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DATE	4/11/2002	4/17/2002

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Attachment 1

Staff Assessment Relating to Task Interface Agreement (TIA 2001-15)
Evaluation of D.C. Cook Containment Structure
Conformance to Design Basis requirements

I. Background

In a memorandum dated December 19, 2001, Region III requested NRR (TIA 2001-15) to review licensee's Transient Mass Distribution (TMD) and structural calculations to verify that the D.C. Cook Unit 1 and 2 containment structures meet their design basis requirements. Specifically, Region III requested NRR staff to determine if the licensee utilized appropriate methodologies, assumptions, and input in concluding that containment structures comply with design basis requirements. In particular, Region III requested NRR to verify the following six attributes in the calculation:

1. Concrete strength utilized in structural calculations;
2. Reinforcing steel material strength used in structural calculations;
3. Unit 2 design input that licensee obtained subsequent to June 11, 2001, meeting are consistent or conservative with respect to the value utilized in the TMD and structural calculations;
4. If utilized, was the use of dynamic increase factor (DIF) adequately justified by the licensee;
5. If utilized, did the licensee properly apply yield line theory analysis in structural calculations; and
6. Methodology and assumptions utilized by the licensee to perform transient mass distribution analysis and structural calculations was consistent with licensing basis code requirements.

The Plant Systems Branch (SPLB) is responsible for review of TMD analysis identified in attributes # 3 and # 6. The Mechanical and Civil Engineering Branch (EMEB) is responsible for reviewing calculations related to the containment structure. EMEB staff performed a design audit at the licensee's office on January 8-10, 2002, to review structural calculations and other documentation to verify their conformance with the design basis requirements for various concrete slabs and walls within the containment structure. The calculation for Fan-Accumulator room walls was reviewed at the NRC headquarter office. A complete list of structural calculations and design documents that were reviewed in response to TIA 2001-15, is provided in Attachment 2. Due to the large volume of structural calculations and design documents, the audit focused on sampling of pertinent records to address the attributes identified by Region III in the TIA.

Based on its review of the design records, the staff identified specific findings (below) relating to attributes # 1, 2, 4, 5 and 6. For each of the calculation attributes, the staff has also included its recommended follow up action for Region III consideration.

II. Calculation Attributes Review Summary

II.1 Attribute # 1 - Concrete strength utilized in structural calculation

The licensee utilized as-built concrete strength of 4424 psi based on 28 days concrete cylinder strength. The staff had reviewed the licensee's justification for the as-built concrete strength earlier during the review of the operability evaluation and considered the use of 28 days strength acceptable for the reconstituted design basis calculations. However, in the computer analysis for Fan-Accumulator room walls (Calculation SD-010412-001, Rev. 1), the licensee used concrete strengths of 4468 psi for Unit 1 and 4424 psi for Unit 2. For the calculation of shear stress in Fan-Accumulator room walls, the licensee used concrete strength of 4450 psi for Unit 1 and 4478 psi for Unit 2 (calc. SD-01016-001).

Finding:

The licensee did not use a consistent value for concrete strength, f_c', in its reevaluation of the Fan-Accumulator room walls in Units 1 and 2. The concrete strength values used are higher than 4424 psi that the staff has accepted earlier during its review of the operability determination.

Recommended Action:

None. The maximum concrete strength, f_c', used in the calculations is about 1% higher than the 4424 psi value. This difference is judged to have no tangible effect on the calculation of allowable wall shear stress since the ACI code allowable shear stress varies with the square root of the concrete strength, f_c'.

II.2 Attribute # 2 - Reinforcing Steel Material Strength

During the design audit, the licensee stated that only two containment structures, ice condenser end walls and missile shield, have utilized certified mill test reports (CMTRs) for determining the yield strength of reinforcing steel (rebar). CMTRs are required from the supplier to certify that the rebar meets the code required minimum guaranteed design basis yield strength of 40 ksi. Typically, CMTRs for each heat contain only one test value of the rebar yield strength, and therefore, inherent statistical variability (coefficient of variation) in the rebar strength can not be accounted for. The licensee, in section 5.5.3 of its reconstituted engineering specification, ES-CIVIL-0432-QCN, Rev. 1, stated that the rebar yield strength based on the CMTRs can be used for the design basis calculations. The licensee has also revised the UFSAR to reflect this change to the original design basis criteria. The licensee, without adequate justification, has used rebar yield strength that is 19% and 26% higher than the code required minimum guaranteed design basis yield strength of 40 ksi in the ice condenser end walls (calculation SD-010307-003, Rev. 1) and the missile shield (calculation SD-010307-001, Rev. 1) respectively. Additional details are provided in Attachment 2.

The licensee's design of the missile shield was initially based on the assumption of using Grade 60 rebar, while the rebar that was actually used in the construction was that of Grade 40. In its reconstituted design basis calculations, the licensee did not provide adequate justification for using higher yield strength based on CMTRs in lieu of the code specified value of 40 ksi. The licensee referenced Crystal River unit 3 UFSAR and the staff's SER as a basis for its

justification to use CMTRs in the reconstituted design basis calculations. The Crystal River SER approved the FSAR amendment on the basis that the maximum stress in shield wall reinforcement is 40,400 psi, which exceeds the minimum required yield strength of 40,000 psi by an insignificant 1%. The Crystal River SER does not endorse the use of rebar yield strength as high as 26% greater than the guaranteed minimum design basis yield strength, nor does it support the D.C. Cook licensee's basis for its UFSAR design change that allows the use of test rebar yield strength for all future design calculations.

Finding:

In the calculations for ice condenser end walls and the missile shield, the licensee, without adequate justification used CMTRs values for rebar yield strength that are respectively, 19% and 26% higher than the code required minimum guaranteed design basis yield strength of 40 ksi.

Recommended Action:

(1) The licensee should provide adequate justification for using material CMTR yield strength values for rebar in the reevaluation of the ice condenser end walls (calculation SD-010307-003, Rev. 1) and the missile shield (calculation SD-010307-001, Rev. 1).

(2) The licensee should confirm that the discrepancy that led to the use of Grade 40 rebars in place of Grade 60 rebars does not extend beyond the condition identified in the missile shield.

II.3 Attribute # 4 - Justification of DIF

The licensee indicated that it did not use of any dynamic increase factors (DIF) in the structural calculations. The staff's audit findings are consistent with the licensee's assertion.

Recommended Action : None

II.4 Attribute # 5 **-** If utilized, did the licensee properly apply yield line theory analysis in structural calculations:

The licensee did not indicate, and the staff didn't identify during the sampling audit, the use of yield line theory analysis in the structural calculation of Fan-Accumulator room walls (SD-010412-001, Rev. 1). The staff notes, however, that the use of yield line theory is technically acceptable if properly implemented and is also referenced in the design basis documents.

Recommended Action: None

II.5 Attribute # 6 - Methodology and Assumptions consistent with Code requirements

Based on a sampling review of the voluminous calculations and design documents, the staff noted that, with the exception of the calculations for the missile shield, ice condenser end walls,

and fan-accumulator room walls, the licensee's calculation methodology and assumptions appear to be reasonable and consistent with the licensing basis code requirements.

Finding:

In the computer analysis for the Unit 1 and 2 Fan-Accumulator room walls (Calculation SD-010412-001, Rev. 1), the licensee used a computer program, *SOLVIA,* that is unfamiliar to the staff.

Recommended Action:

The licensee should discuss in reasonable detail the available documentation for the validation of the computer program *SOLVIA*.

Attachment 2

D.C. Cook Nuclear Power Plant
Detailed Audit findings Relating to Reinforcing Steel

I. Revision of Reinforcing steel yield strength

The licensee stated that only two containment structures, ice condenser end walls and missile shield have utilized certified mill test reports (CMTRs) to establish a reinforcing steel (rebar) yield strength to use for the reevaluation of affected concrete components. CMTRs are required from the supplier to certify that the rebar meets the code required minimum guaranteed 40 ksi design basis yield strength. The licensee, in section 5.5.3 of its engineering specification, ES-CIVIL-0432-QCN, Rev. 1, approved the use of tested rebar yield strength for the design basis calculations and revised the UFSAR to reflect this change.

(a) Ice Condenser End Walls (Calculation SD-010307-003, Rev. 1, page 81)

The licensee indicated in this calculation that, in order to qualify the design of ice condenser end walls for calculated TMD pressure, it was necessary to use test CMTR values for the rebar yield strength. The CMTRs for the rebar material in the ice condenser end walls are provided in attachment 1 to Calculation SD-010307-003, Rev.1. In Attachment 1 of the calculation, the licensee identified #11 size rebar marked “5319” as the critical bars for design evaluation. These rebar were fabricated from three different heats of steel. The heats are identified as D-7051, C-2093, and C-32919. Typically, CMTRs for each heat contain only one test value of the rebar yield strength ignoring inherent statistical variability. The licensee used the yield strength of 47.7 ksi (19 % higher than the design basis yield strength of 40 ksi) that was reported for heat # C-32919.

The licensee’s reinforcing steel procurement specification No. DCC CE 107 QCS, Rev. 3, dated March 26, 1969, was reviewed by the staff. The requirements in this specification are that (1) the buyer (licensee) shall be provided with CMTRs for each heat of steel by the supplier in accordance with ASTM A-615-68 specification, and (2) in addition, the buyer will have independent tests performed to confirm compliance with ASTM A-615-68 for tensile, yield point, and percent elongation for each heat. For this confirmatory (“check”) test, the buyer required in the procurement specification that the rebar supplier furnish six specimens from each heat to the licensee’s job site testing laboratory at Bridgman, Michigan. The procurement specification states that the fabricator will be informed when the test results are known.

During the inspection, the licensee provided certified test results as discussed above that were performed by Calumet Steel (the supplier) to certify that the rebar meets the minimum guaranteed yield strength of 40 ksi. However, documentation of the “check” tests performed by the licensee’s laboratory was not available.

The use of limited test data (total of three, one from each heat) although adequate for demonstrating that the rebar meets the original licensing basis minimum design strength of 40 ksi, is not justified to support a higher yield strength (47.7 ksi) in support of the revision of licensing basis and, is therefore, not acceptable.

(b) Missile Shield (Calculation SD-010307-001, Rev.1, dated 6/26/01)

The licensee indicated that the maximum acceptable LOCA pressure would have to be reduced from 50 psi to 42.37 psi in order to qualify the missle shield with the as-built 40 ksi rebar installed. In lieu of reducing the maximum LOCA pressure, the licensee opted to use CMTR test value for the rebar yield strength to qualify the design of the missile shield for the calculated TMD pressure of 50 psi. The licensee used the rebar yield strength of 50.6 ksi that is 26 % higher than the design basis yield strength of 40 ksi. Based on the rebar test strength of 50.6 ksi, the licensee concluded that the capacity of the missile shield for LOCA pressure is 53.6 psi, which is greater than the calculated TMD pressure of 50 psi.

Attachment # 6 to the missile shield calculation provides rebar yield strength test data. The Actual CMTRs are not provided; rather a summary of the yield strength from each heat is included in the attachment. The missile shield design utilized # 5, #8, and #11 size rebar. Each size rebar comes from a different heat of steel. For each heat, only one yield strength test value is provided. The licensee used rebar yield strength of 50.6 ksi to determine the moment capacity of the missile shield. The staff does not consider the use of very limited test data to support higher yield strength values for the installed rebars to be an adequate justification for revising the licensing basis and, is therefore, unacceptable.

II. Discussion of Florida Power Crystal River Unit 3

The licensee provided the following excerpts from the Crystal River UFSAR and the associated staff SER on an issue that the licensee considered relevant to the construction deficiency discussed in this report audit. The licensee, in its 50.59 evaluation, relied on these documents to justify the licensing basis change in the D.C. Cook UFSAR and the use of rebar test yield strength, that is as high as 26% greater than the minimum required design basis strength of 40 ksi, in the reconstituted licensing basis calculations.

(a) Excerpt from Crystal River Unit 3 UFSAR**,** (revision 26, chapter 5, page 49 of 89, section 5.2.6 on Interior Structures)

“The secondary shield wall is designed to15.0 psi differential pressure, in accordance with ACI 318-71. For 17.5 psi peak differential pressure as reported in section 14.2.2.5.11, the stress in the rebar is approximately 40400 psi, which is slightly higher than the guaranteed minimum yield strength of the material specified (Grade 40). Based on 70,000 psi minimum ultimate strength of grade 40 rebar, in order to have rebar failure, the maximum differential pressure can be as high as 30.3 psi”

(b) Excerpt from Crystal River 3 SER (UCR NO: 99-UFSAR-0850-03, Page 505)

“The secondary shield wall was designed for a differential pressure of 15 psi with capability to 17.5 psi taking the reinforcing steel to yield. The secondary shield wall was designed in

accordance with ACI 318-71 which was consistent with using the latest available codes at the time of its design."

III. Staff Assessment

In the staff's view, the above excerpts do not set a precedent that the NRC has approved the use of CMTR test rebar yield strength for design basis calculations. The SER essentially accepts the Crystal River licensee's justification and concurs with its assessment that the stress in the shield wall reinforcement is slightly above the rebar minimum yield stress of 40,400 psi by only 1% which was considered insignificant. These excerpts do not provide the basis for using test rebar yield strength as high as 26% greater than the guaranteed minimum design basis yield strength that was used in two of the D.C. Cook's design basis calculations. Furthermore, the Crystal River SER does not endorse an UFSAR design change that will allow the use of test rebar yield strength for all future design calculations.

Attachment 3

D.C. Cook Nuclear Power Plant Audit
Documents Reviewed

1. Engineering specification, ES-CIVIL-0432-QCN, Rev. 1
2. Ice Condenser End Walls (Calculation SD-010307-003, Rev. 1, page 81)
3. Missile Shield (Calculation SD-010307-001, Rev. 1, dated 6/26/01)
4. Unit 1 Ice Condenser Slab at 640' (Calculation SD-010411-001, Rev. 1, 8/1/01)
5. Load and load combination (Calculation SD-000713-001, Rev. 1, 8/2/01)
6. Unit 1 Ice condenser slab-concrete slab and beams detailed analysis (Calculation SD-990909-002, Rev. 1)
7. Ice condenser slab - sub-floor steel frames (Calculation SD-000314-003)
8. Ice condenser slab-supporting steel columns (Calculation SD-000403-001)
9. Design basis analysis of Unit 1 and 2 Fan-Accumulator room walls (Calculation SD-010412-001, Rev. 1)
10. Excerpt from Crystal River Unit 3 UFSAR, (Rev. 26, chapter 5, page 49 of 89, section 5.2.6 on Interior Structures)
11. Excerpt from Crystal River Unit 3 SER (UCR NO: 99-UFSAR-0850-03, Page 505)