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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO ON-SITE AUDIT OF TACO-3 FUEL PERFORMANCE CODE

DUKE POWER COMPANY

OCONEE, McGUIRE, AND CATAWBA NULCEAR STATIONS

DOCKET NOS. 50-269, 50-270, 50-287, 50-369, 50-370, 50-413, AND 50-414

1.0 INTRODUCTION

In letters dated May 4 and August 24, 1994, Duke Power Company (DPC or the licensee) requested that NRC review and approve the transfer of the fuel performance code TACO-3 from B&W Fuel Company to DPC for reload licensing applications. The transfer includes the approved Topical Report BAW-10162P-A, "TACO3-Fuel Pin Thermal Analysis Computer Code" and a related approved Topical Report BAW-10183-P, "Fuel Rod Gas Pressure Criterion."

Previously, the NRC staff has approved the use of the TACO-2 code for DPC. The TACO-3 code is an improved version of the TACO-2 code. Duke Power will apply TACO-3 as part of its reload methodology for reload analyses at Oconee, McGuire, and Catawba. This report summarizes the on-site review and audit of the transfer program which was undertaken by DPC to develop the capability to independently perform the TACO-3 code for reloads.

In order to evaluate the capability of DPC to properly utilize the computer code and methods for reload core design, the NRC staff and its consultant from Pacific Northwest Laboratories conducted an on-site audit at DPC headquarters in Charlotte, North Carolina, from March 7 through 10, 1995. The audit team's evaluation follows.

2.0 EVALUATION

2.1 Code Description

The TACO-3 code was originally developed by B&W Fuel Company based on an earlier approved TACO-2 code. The TACO-3 code was approved by the NRC for licensing calculations in 1989 (BAW-10162P-A). Duke Power intends to use TACO-3 for the reload analyses that include (1) linear heat rate to melt, (2) cladding strain, (3) fuel rod pressure, and (4) verification of B&W LOCA initialization.

In order to estimate rod and assembly powers, and axial power shapes for input to TACO-3 analyses, DPC will also apply an NRC-approved physics code SIMULATE (DPC-NE-1004A) for reload analyses.

2.2 Code Verification

Duke Power has performed benchmarking calculations with TACO-3 for each of the licensing analyses. Duke Power intends to use TACO-3 to verify that the results obtained are identical to those calculated by B&W in order to verify the code.

The procedure used by DPC to verify a code obtained from an outside source is documented in "Nuclear Engineering Group, NE-103, Workplace process for Documentation of Safety-related Analyses." The audit team has reviewed the results of benchmarking calculations, and found that the code is consistent with the B&W TACO-3 source code. In addition, DPC has a process of periodically checking all computer codes to verify that they do not change from the original source codes.

The team reviewed the DPC code verification process, and concluded that the TACO-3 benchmarking results ensure that the code is consistent with the B&W source code, and therefore, the code verification is acceptable.

2.3 Code Applications

As mentioned earlier, DPC will use TACO-3 to analyze linear heat rate to melt, cladding strain, fuel rod pressure, and B&W LOCA initial condition verification for reload applications. Duke Power reload methodology for applying TACO-3 including code input is documented in (1) DPC-NE-2008P, Duke Power Company Fuel Mechanical Reload Analysis Methodology Using TACO-3, (2) DPC-1553, 26-00-0083, MK-BW Axial Power Shapes for TACO-3, and (3) DPC-1553, 26-00-0082, Generic MK-BW TACO-3 Analyses. These documents are consistent with the approved B&W methodology described in BAW-10162P-A and BAW-10183-P. The team reviewed these documents and concluded that the DPC reload methodology is consistent with the approved B&W methodology with some minor differences described in the following paragraphs.

2.3.1 Steady-state Axial Powers

For steady-state operation, DPC uses the approved physics code SIMULATE to determine the axial power shapes based on two assumptions: (1) core average axial power is similar to peak assembly axial power, and (2) the axial power shape remains the same between cycles for the same fuel design. The team has examined the SIMULATE analyses and confirmed that the assumptions are in general valid for the cycles evaluated. However, there are conditions such as significant design changes or operational modifications that may invalidate these assumptions. Thus, the team recommended that DPC re-evaluate the axial power shapes if either of the above two assumptions are no longer valid.

2.3.2 Transient Axial Powers

For transient conditions, DPC also uses SIMULATE code to determine the axial power shapes. In order to maximize transient axial power, DPC will run the SIMULATE code several times with conservative control rod movement and xenon transients to determine axial power peaking for each assembly. In addition, DPC will re-examine the transient axial power using the above methodology when certain significant changes are made. The team reviewed the Duke Power transient methodology, and concluded that the transient axial power is conservative and thus acceptable. However, the team noticed that changes in transient power could result in changes in steady-state power. Therefore, the team recommended that DPC re-evaluate the steady-state axial power shapes when the transient axial power shapes are altered.

2.4 Computer Facility

Duke Power reload design calculations will be run on IBM RISC System 6000 workstation. There are a total of 11 workstations, and one of them is designated as the workstation of the TACO-3 source code. The rest of the workstations can execute the TACO-3 program through networking.

The source code workstation has a backup system that includes optical diskettes and tapes to prevent accidental loss. The audit team found that there is only one key person who can get access to the TACO-3 software for maintenance purposes. Although DPC explained that was for security reasons, we were concerned that the software accessibility being limited to one key person could be rather undesirable in case of the loss of the key person. The team thus recommended that the key personnel responsible for software security and protection should be limited, but not to only one person.

Should any source code changes be made by B&W, DPC will obtain a new version from B&W and update the entire source code. The source code changes are controlled by the internal documents, "Nuclear Policy Manual, Nuclear System Directive: 800. Computer Control," and "Engineering Directives Manual, EDM-101: Engineering Calculations/Analyses." Duke Power has a third document in draft form (Nuclear Engineering Group, NE-114, Workplace Procedure for Documentation of Software And Data Quality Assurance Plans) which governs the use and maintenance of computer software such as TACO-3. This third document is currently pending an internal review and approval. The team pointed out that any source code update should be verified with B&W that the new version has been accepted by the NRC.

The team has reviewed computer facility and related source code software manuals, and found them adequate and thus acceptable.

2.5 Training

The DPC training program is documented in "Nuclear General Office, Training, Quality Improvement Project," and "Nuclear Engineering Division, NE-107, Workplace Procedure for Nuclear Engineering Division Training." Duke Power held many meetings with B&W to train its technical engineers. Duke Power also requires its technical engineers to have on-job-training to demonstrate proficiency. In addition, DPC has an agreement with B&W to obtain technical support, if necessary.

Training records showed that several engineers had received training and demonstrated adequate proficiency in executing the TACO-3 code. However, there is currently only one engineer who is capable of certifying the TACO-3 calculations and results.

Duke Power indicated that it will train more engineers to certify the TACO-3 calculations once the NRC approves the TACO-3 transfer. However, the team was concerned that the certifying process may not be completed for the coming reload applications. It is desirable that all TACO-3 calculations can be checked and certified by more than one person. Therefore, the team recommended that DPC should expedite the certifying process in order to have more qualified engineers for TACO-3 reload licensing applications.

Notwithstanding this concern, the audit team has reviewed the DPC training procedures and manuals, and found them adequate and thus acceptable.

2.6 Quality Assurance

The DPC quality assurance (QA) program for acquiring external softwares is documented in (1) Nuclear Policy Manual, Nuclear System Directive: 800, Computer Control, (2) Engineering Directives Manual, EDM-101: Engineering Calculations/Analyses, (3) Nuclear Engineering Group, NE-103, Workplace Procedure for Documentation of Safety-related Analyses, (4) Nuclear Engineering Group, NE-110, Workplace Procedure for Applying Externally Licensed Methodologies Within Nuclear Engineering, and (5) Nuclear Engineering Group, NE-114, Workplace Procedure for Documentation of Software And Data Quality Assurance Plans. As indicated earlier, the fifth document describing the source code software maintenance is currently in draft form for internal review and approval.

For each reload application including the TACO-3 calculations, DPC has qualified engineers assigned to be responsible for neutronic, mechanical, and thermal-hydraulic analyses. These engineers are required to strictly follow all the available QA procedures. For TACO-3, the calculation is performed according to a certified procedure documented in report DPC-NE-2008P, "Duke Power Company Fuel Mechanical Reload Analysis Methodology Using TACO-3." Then the calculation is certified, approved, and documented in a cycle-specific calculation file for each plant. The calculation file can be verified against the operating results, or examined by an internal audit.

Duke Power has an internal audit requirement which is performed by the Quality Verification Department. Although the internal audit for TACO-3 may be infrequent, the audit can serve the purpose of maintaining good quality of work. The team reviewed the licensee's QA manuals and procedures that govern the software applications. The team concluded that the DPC QA program is acceptable.

3.0 CONCLUSIONS

The NRC on-site audit team covered the scope of the licensee's reload methodologies, computer software acquisition and verification, computer facility, training, and quality assurance program. The audit team also evaluated DPC's independent capability on code qualification, code benchmarking, and code applications for the TACO-3 computer code. Based on the results of this audit and the previous successful transfer of the TACO-2 code to DPC, the audit team concluded that DPC has demonstrated the technical capability to perform the TACO-3 analyses for reload licensing applications, and therefore the transfer of TACO-3 code from B&W to DPC is acceptable.

In addition, the audit team recommended the following improvements:

1. Duke Power re-evaluate the axial power shapes if either of the following assumptions are no longer valid: (1) core average axial power is similar to assembly axial power, and (2) the axial power does not change between cycles. (Section 2.3.1)

2. Duke Power re-evaluate the steady-state axial power shapes when the transient axial power shapes are changed. (Section 2.3.2)

3. Key personnel responsible for the TACO-3 software security and maintenance should be limited, but not to only one person. (Section 2.4)

4. Any TACO-3 source code update should be verified with B&W that the new version has been accepted by the NRC. (Section 2.4)

5. Duke Power's internal certifying process for TACO-3 calculations should be expedited in order to have more qualified engineers for reload licensing applications. (Section 2.5)

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