Utility Resource Associates Corporation www.urac.com

Update...

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This Issue:

Reload Design and Safety Analysis Assessment

URA has performed independent assessments of several utilities' reload analysis and design processes and we have performed assessments for a number of utilities at the fuel vendors' core design offices.

These recent assessments have been similar to the earlier ones and have also included assessment by inspection for compliance to the recommendations of SOER 96-2 - Design and Operations Considerations for Reactor Cores. The URA assessment experience related to SOER implementation guidelines recommendations that have been addressed are:

Recommendation 1

- senior management establishment of expectations
- interplay of the various analytical models among utilities and fuel vendors, and the ability to accurately model and predict core performance
- potential consequences of mixed core designs (different fuel designs provided by the same vendor, or varying designs from different fuel vendors)

Recommendation 2

- definition and performance of interface requirements between the fuel vendor and the utility requirements and performance of levels of technical verification and review for critical parameters of the core design and reload analyses
- definition and control of design inputs and calculation methods
- incorporation of applicable industry operating experience into reload core designs and core performance monitoring program.
- evaluation of recognized deficiencies in core predictive capability during performance of core reload design.

Recommendation 3

- identification of monitoring to verify that design changes perform in an acceptable range.
- use of industry experience at other units with similar cores.

Recommendation 4

- support to reactor engineers in the use of on-line or off-line computer codes to analyze operating conditions
- and to make short term predictive calculations.

Recommendation 5

- use of experience with unintended changes such as axial flux shifts, control rod insertion anomalies, and reload analysis errors
- application of fundamental concepts
- use of core monitoring and prediction capabilities

URA has qualifications for assessment in other areas of these recommendations related to training, proper use of computer codes and methodology by design and operations groups, core operating limits including their bases, and reactivity management.

A new consideration is current NRC thinking per the NRC document "11th Annual Nuclear Regulatory Information Conference" dated March 4, 1999. Specifically, URA assessments will be viewed as self-assessments complementary to the NRC new reactor inspection and oversight program as described in NUREG-1649. Self-assessments will provide Nuclear Fuel departments with a contribution to being placed in the Utility Response (Green) band.

For further information, contact Pat Lacy at 301-294-1941 (pslacy@urac.com) or Kevin O'Sullivan at 301-294-8019 (ko'sullivan@urac.com) and see the accompanying related articles on "Using Trend Reports to Address SOER 96-2" and "Independent Technical Reviews."

- The integrated CPM-3/CORETRAN benchmark to eight

cycles of Prairie Island is now in progress, with completion scheduled for end of June.

- An Access97 database application was released to a utility company late last year. The database is used for managing fuel invoices, budgets, and inventories.

- The URA Associates Program has placed a licensing engineer at a PWR plant and a reload design and safety analysis engineer in a BWR fuels management group.

Using a Trends Report to Address Compliance with SOER 96-2

Recommendation 1 of SOER 96-2 advises that senior managers are to be aware of significant core design changes and the effects of those changes. Two requirements must be addressed to fulfill this recommendation.

First, the core engineers must be aware of these design changes and their effects. Core design changes can result from changes in energy requirements, operating strategy, or plant operating values due to equipment or procedure changes.

Second, the same engineers must present this information to senior management in a format that a technical or non-technical manager will be able to read and understand in a minimal amount of time.

URA has worked with utility companies to address these requirements via a Trends Report. The Trends Report evaluates the fuel design for an upcoming cycle relative to prior cycles to determine the anticipated change in key core performance parameters given the change in fuel design, operation, or plant parameters. The most important core performance parameters are discussed in the Executive Summary. More detail about these parameters and discussions of other key parameters are contained in the body of the report.

Each section of the report is dedicated to comparisons and trends of one specific physics parameter showing relevant data with an engineering discussion. For each physics parameter, the design variables and the operating parameters that most strongly influence that parameter are identified. The values for the parameter are then compared to previous cycles and the dependencies and expected changes are identified. Rationales are given for the calculated behavior based on the data presented and prior results.

A example of one of the key parameters is presented here to give a general idea of what a Trends Report contains for a PWR.

The design variables and operating parameters that are important to determine moderator temperature coefficient (MTC) are: 1) boron concentration; 2) core average exposure; 3) fresh fuel enrichment; and 4) fuel assembly design.

The MTC is primarily driven by boron concentration with the MTC becoming more positive as the boron concentration increases. The other parameters have smaller effects: The MTC will become more negative with increasing core average exposure and increasing feed enrichment. The fuel mechanical design affects MTC as the water (hydrogen) to uranium (H:U) ratio changes. MTC becomes more positive as the H:U ratio increases.

The Trends Report shows a table of predicted MTCs, boron concentrations, core average exposures, and average feed enrichment for several cycles. If the assembly design has changed in a way that changes the H:U ratio, the H:U ratios are also presented.

The trends are noted and a rationale for the behavior of the MTC is presented. When possible, the current values are explained with quantitative arguments using rules of thumb based on historical data or a scoping study based on a recent cycle. Any unusual behaviors are noted.

Finally, a conclusion is drawn about the MTC for the upcoming cycle. The conclusion specifically states whether or not the MTC for the cycle is reasonable and meets the trends and behavior expectations.

The report draws a conclusion about the reasonableness of the predicted core parameters and if the predicted parameters meet the trend and behavior expectations when compared to other cycles.

The most significant design and operating changes in the upcoming cycle are identified and compared to previous cycles. The parameters that may impact operation and need to be followed closely during the cycle are identified.

For further information, contact Kenneth Smolinske at 301-294-0124 or email at kmsmolinske@urac.com.

Design Reviews and Verification

URA has a long history of performing technical design reviews and independent verification of engineering analysis. These reviews have covered a broad range of nuclear engineering including core design/analysis, reload safety evaluations, criticality analysis, and radiological analysis. URA has performed this type of work under the client's QA program and/or under our own QA program.

As an independent consulting firm, URA functions effectively performing analysis reviews that are based on methodology from any of the five fuel vendors or independent in-house methodology. URA has familiarity and experience with the EPRI, Studsvik, and fuel vendor computer codes. In addition to review assignments from utility companies, URA's staff have been members of the NRC fuel vendor inspection teams at each of the five fuel vendor inspections.

URA has also performed technical reviews for emerging issues such as axial offset anomaly, U235 enrichment above 5 w%, and the introduction of different burnable absorbers in transition cycles.

URA continually provides support to clients for the verification of engineering calculation files. The utility organization is often faced with short term resource shortages and URA, via its broad base of experience, is able to quickly provide the needed resources and verification work.

For further information on Design Review and Verification support, please contact Rod Grow (301-294-0866) or email to rlgrow@urac.com.

Nuclear Fuel Databases

Managing fuel Purchase Orders, Work Orders and Invoices against current budgets with related daily inventory balances is one example of a database application that improves fuel management productivity. URA released recently a Microsoft Access97 database that integrates these functions with inventory tracking by site, U3O8 and SWU origin, quantity, and investment balance.

URA is working on other databases. One is for Core Design Trends. This database is an excellent storage and query media for PWR and BWR historical core design data versus core performance parameters. It also is used to generate reports and graphical displays. Other database applications that can save engineering labor include spent fuel isotopic inventories, fuel component tracking, fuel amortization, and data warehousing for license renewal and decommissioning submittals.

Using Access or SQL Server for these "specialty applications" provides a link to other databases (such as ORACLE and SYBAse) that are used in the company. Multi-unit operating companies that have reactor technical and financial data in relational databases can efficiently retrieve and use historical information, which is a significant process improvement especially if these companies plan to acquire other reactors.

An Access or SQL Server application makes it easy to share up-to-date information on the company intranet site, workgroup server, or the internet. For example, Access has a "Publish to the Web" feature to convert data or reports into HTML. These forms or reports can then serve as interactive database pages. This simple feature has many potential applications, such as showing the progress of fuel movement during a refueling outage, or posting MWHt or financial information to a company FTP site during monthly closings for plants that have multiple owners. The "Single Click hyperlinks" feature is also useful as it allows users to jump between Access and other applications or internal/external Web sites.

A related issue is the use of software on Local Area Networks. Whether fuel management files are in Unix or DOS formats, LANs improve productivity and provide a means to use the most current release of software at low unit cost through group licenses. Some of this efficiency is lost, however, through continued use of "old" QuickBasic or DOS programs that have incompatible file formats and outdated documentation.

URA provides service to update these "old" programs and file systems into a Microsoft relational database or Excel workbook. We recommend converting in stages to reduce project risk. The first stage gets the program to compile in Visual Basic or Digital Fortran. We execute test cases with client data and return a new Y2K compliant executable program with an Acceptance Test Report. Second is Visual Basic work on the user interface. Finally, key screens and reports are rewritten to use the new Windows look. The client or their IT support staff maintain and control the finished application, with no-cost telephone support from URA following project completion.

There is quick payback for the client that modernizes its core management, engineering, financial, and planning functions with Microsoft Office or BackOffice applications. For more information about our database work or to discuss how URA would address your needs, call Kevin O'Sullivan (301-294-8019) or email at ko'sullivan@urac.com.

CPM-3 and CORETRAN

URA hosted a CPM-3/CORETRAN Workshop late last year. The goal of the workshop was to familiarize utility reactor physics engineers with the EPRI lattice physics code, CPM-3, and the core simulation code, CORETRAN-01. CORETRAN-01 includes steady-state depletion, operational transient, and design basis transients capabilities.

Four EPRI contractors made presentations at the workshop, which was attended by representatives from US and international utility organizations. During the morning lectures, code capabilities and applications were summarized, theory presented, testing and validation results presented, and input requirements outlined. In the afternoon, hands-on sessions were used to demonstrate the codes' capabilities with various sample problems.

Ten high-performance PCs and one IBM RISC workstation were provided for use by the participants.

The hands-on sessions were very popular. Attendees were able to observe and modify the CPM-3 benchmark lattice physics PWR and BWR cases. CORETRAN core depletion demonstration problems were done the next day. On the third day, CORETRAN transient models were executed with a sample problem that demonstrated the cross-section generation by CORETRAN with the transient calculation performed using RETRAN-3D. Cross-section and core geometry data were passed directly from CORETRAN to the RETRAN-3D code.

Preprocessors were demonstrated and available for use with the sample problems. A graphical interface for CORETRAN allows input manipulation and generation, and graphical representation of results. The RETRAN preprocessor was used to demonstrate automated core mapping of neutronics channels to thermal-hydraulic channels for RETRAN-3D system transient calculations.

Both CPM-3 and CORETRAN-01 are in the late beta test stage and are to be formally released by EPRI in 1999. For more information about these code sets, please contact Don Hines (301-294-1330) or by email at ddhines@urac.com.

Consulting and Management Services

Utility Resource Associates, an engineering consulting firm located in Rockville, Maryland, offers a comprehensive range of technical and management services to the electric utility industry. Our team of engineers and physicists combine to bring expertise in nuclear engineering, reactor analysis, software development, training and project management.

- x Fuel Economics
  - v Fuel Cycle Cost Analysis and Accounting
  - v Procurement Planning
- x Reload Analysis
  - - Self Assessment Audits
  - v Core Design
  - v 10CFR50.59 Safety Evaluations
  - v Independent Design Verification Analysis
- x Nuclear Fuel Design & Fabrication
  - v Evaluation of Fuel Fabrication Process Specification
  - v Evaluation of Fuel Thermal/Mechanical Performance
- x Routine Reactor Analysis
  - v Core Follow, Monitoring & Performance Analysis
  - v Flux Measurement Interpretation
  - v Reactor Engineering & Operations Support
- x Safety Analysis
  - v Radiation & Shielding Analysis
  - v Spent Fuel Pool Criticality & Thermal Analysis
  - v Thermal Hydraulic & Transient Analysis
- x Technical & QA Reviews
  - v Fuel Fabrication Audits
  - v Quality Assurance Audits
- x Training & Education
  - v ACE Accreditation Assistance
  - v Staff Training
- x Staff Augmentation
  - v Engineering and Training
- x Fuel Management Relational Databases
  - v Core Design Trends
  - v License Renewal and Decommissiong Data

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