February 14, 2003

MEMORANDUM TO: James E. Lyons, Director
New Reactor Licensing Project Office
Office of Nuclear Reactor Regulation

THRU: Marsha Gamberoni, Deputy Director ***/RA/***
New Reactor Licensing Project Office
Office of Nuclear Reactor Regulation

FROM: Belkys Sosa, ACR-700 Project Manager
New Reactor Licensing Project Office
Office of Nuclear Reactor Regulation

SUBJECT: TRIP REPORT FROM ACR REACTOR PHYSICS AND CANDU FUEL CHANNELS WORKSHOP AT CHALK RIVER LABORATORIES, ONTARIO, CANADA

On December 4-5, 2002, Anthony Attard, Ralph Caruso, Kenneth Heck, Walton Jensen, Mark Kowal, Samuel Miranda, Robert Pascarelli, Undine Shoop, Edmund Sullivan, Summer Sun, and Belkys Sosa of the Office of Nuclear Reactor Regulation (NRR) and David Bessette, Donald Carlson, Charles Greene, and Joseph Muscara of the Office of Nuclear Regulatory Research (RES) participated in a meeting with the Canadian Nuclear Safety Commission (CNSC) and Atomic Energy of Canada, Limited (AECL). The purpose of the meeting was to provide an introduction of CANDU fuel channels and discuss the Advanced CANDU Reactor (ACR) core physics as well as the Quality Assurance (QA) program for the ACR-700. Attached is the trip report from this activity.

cc: M. Cullingford, NRR
J. Dunn Lee, OIP
F. Eltawila, RES
J. Lieberman, OIP
K. Burke, OIP
T. Rothschild, OGC
T. Bergman, OEDO

Project No. 722

Attachment: As stated

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NAME	BSosa	MGamberoni
DATE	2/13/2003	2/13/2003

OFFICIAL RECORD COPY

Subject

ACR Reactor Physics, CANDU Fuel Channels Workshop, and Quality Assurance (QA)

Dates of Travel and Countries/Organization Visited

December 4-5, 2002
Chalk River Laboratories, Deep River, Ontario, Canada

Author, Title, and Agency Affiliation

Belkys Sosa
ACR-700 Project Manager
New Reactor Licensing Project Office (NRLPO)
Office of Nuclear Reactor Regulation

Other NRC participants:

- Anthony Attard, Division of Systems Safety and Analysis, Office of Nuclear Reactor Regulation
- Dave Bessette, Office of Nuclear Regulatory Research
- Donald Carlson, Office of Nuclear Regulatory Research
- Ralph Caruso, Division of Systems Safety and Analysis, Office of Nuclear Reactor Regulation
- Charles Greene, Office of Nuclear Regulatory Research
- Walton Jensen, Division of Systems Safety and Analysis, Office of Nuclear Reactor Regulation
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- Joseph Muscara, Office of Nuclear Regulatory Research
- Robert Pascarelli, New Reactor Licensing Project Office, Office of Nuclear Reactor Regulation
- Undine Shoop, Division of Systems Safety and Analysis, Office of Nuclear Reactor Regulation
- Edmund Sullivan, Division of Engineering, Office of Nuclear Reactor Regulation
- Summer Sun, Division of Systems Safety and Analysis, Office of Nuclear Reactor Regulation

Sensitivity

Distributed meeting materials are available to the public (ADAMS Accession # ML030160646). Portions of this meeting included proprietary information, which is not available for public release.

Background/Purpose

By letter dated June 19, 2002, Atomic Energy of Canada, Limited (AECL) requested that the U.S. Nuclear Regulatory Commission (NRC) begin a pre-application review of the Advanced CANDU Reactor (ACR-700) design. The ACR-700 is a 731 MWe, heavy-water-moderated, light-water-cooled, pressurized-water reactor design with an on-line refueling capability.

The pre-application activities for the ACR-700 include a series of technical presentations and tours of AECL test facilities. These activities facilitate the staff's review of the ACR-700 design and offer an opportunity to gather technical insight. This meeting supports the pre-application review process for the ACR-700 design.

Abstract: Summary of Pertinent Points/Issues

This meeting was the second in a series of technical workshops planned during the ACR pre-application phase. The main purpose of the meeting was to familiarize the staff with ACR core physics and fuel channels, as well as to discuss their quality assurance (QA) process. The design of the ACR Reactor Coolant System (RCS) pressure boundary is considered a technical area that will require focused attention from the staff. An assessment on the applicability of the ACR RCS components as a Class 1 pressure boundary system is expected during Phase 1 of the pre-application process. The Canadian Standard Association (CSA) requirements generally follow the requirements of the ASME Codes and supplements in those areas with specific application to the Canadian market. In order to facilitate the review process, AECL is planning to submit a comparison of the Canadian QA standard against U.S. standards approved by the staff for licensing applications.

Another important area identified by the staff as requiring extensive resources is the validation of analytical tools and analysis methods. AECL hopes to obtain the staff's approval of these analytical tools and computer models based on their acceptance in Canada. The Canadian Nuclear Safety Commission (CNSC) has extensive experience with operating CANDU reactors and validating computer codes used in CANDU safety analysis. The proposed international cooperation on new reactor designs, currently under commission review, could be beneficial to the NRC staff in the review of the ACR-700 design.

Discussion

The meetings were structured as a series of presentations and facilities tours. Separate workshops were conducted simultaneously each day, in order to focus the presentations to the staff's area of interest. The topics discussed were ACR Reactor Physics, CANDU Fuel Channel Design, and ACR Quality Assurance (QA) process. Canadian nuclear power utilities are regulated by the CNSC. The following representatives from CNSC were in attendance, Mr. Mandoli Walali, Mr. Malad Tolini, and Mr. Daniel McDougal.

The first day of the ACR Reactor Physics workshop consisted of presentations on the current analysis basis for CANDU reactor physics and qualification of the reactor physics toolset for current CANDU reactors. The presentations were followed by a tour of Zero Energy Deuterium Reactor (ZED-2), the critical reactor facility where many of the tests will be performed using full length fuel channels. On the second day, the physics workshop consisted of presentations on

the evolution of ACR physics from CANDU 6, the ACR physics toolset, an overview of ACR physics qualification process, and a presentation on ZED-2 measurements planned for ACR physics validation.

The CANDU Fuel Channels meeting included presentations on ACR fuel channel design, pressure tube-to-end fitting rolled joints, codes and standards applicable to fuel channels, and fuel channel surveillance and inspection. Following the presentations, the staff participated in tours of the fuel channel-related facilities including fuel channel inspection, rolled joint fabrication/testing and pressure tube scraping tool, and the Corrosion Test Loop (CTL-1). The second day of the meeting continued with overviews on fuel channel technology base, fitness for service and presentations on delayed hydride cracking and fracture, deformation, corrosion and hydrogen ingress, and a discussion on fuel channel anticipatory Research and Development (R&D) efforts.

The second half of the workshop on both days included scheduled AECL facility tours for both physics and fuel channel groups. On the first day, the staff toured the High Temperature (HT) Channels facility, Critical Heat Flux (CHF), moderator facility, Molten-Fuel Moderator-Interaction (MFMI) Test Facility, and containment. The second day included tours of the advanced CANDU fuel fabrication lab, and the National Research Universal (NRU) reactor.

The QA workshop was conducted in parallel both days to discuss the QA program as it relates to procurement, design, construction, and installation of the ACR-700. The participants agreed that AECL's certification submittal for ACR-700 would include a comparison matrix of Canadian QA standards against U.S. standards. Any differences would be reconciled and additional requirements would be identified and included in a supplemental QA program.

Other areas that were discussed include:

- The use of cold-worked Zirc-Niobium alloy (Zr-2.5wt%Nb) pressure tubes with rolled joints as a Class 1 pressure boundary, unique fuel design considerations, removable end fittings to refuel, and the role of the fueling machines.

- The elimination of the positive void coefficient of previous CANDU designs and the advances of the ACR design.

- The Advanced CANDU Fuel Fabrication Laboratory production of CANDU fuel from spent pressurized water reactor (PWR) fuel from the U.S. and prototype fuel assemblies using mixed-oxide (MOX) fuel from surplus weapons material.

- Procedure for submitting proprietary information to the NRC and associated requirements.

Pending Actions/Planned Next Steps for NRC

NRLPO is currently assessing the level of effort required by the staff and the benefits of the proposed international cooperation efforts on the ACR-700 pre-application phase and the impact on the schedule. The staff received a revised ACR-700 pre-application review plan from AECL on 18 December 2002.

The staff will proceed with the pre-application review interactions with AECL. These interactions are intended to provide details of the design features of the ACR-700 and the scope of the available and planned analysis and testing in support of the design. The next meeting is scheduled for March 2-7, 2003, at the NRC and will focus on ACR Safety Philosophy, Design Basis Accidents, and Acceptance Criteria.

A visit to the Thermal Hydraulics facility in Whiteshell, Manitoba, was suggested by AECL for early June 2003 as well as a visit to an operational CANDU 6 reactor in the first quarter in 2003. The staff supports the site visits as early as possible in the pre-application review phase.

Points for Commission Consideration/Items of Interest

The ACR-700 pre-application activities will accelerate once the NRC's plan for the pre-application review is developed and the schedule finalized. It is expected that numerous meetings similar in scope to this will take place with increasing frequency in order for the staff to understand the technology base of CANDU reactors and assess the unique ACR-700 design. AECL plans to submit their application for ACR Standard Design Certification in September 2004.

It is important to note that the staff has not reviewed ACR safety analysis computer codes and analytical methods. There exists an extensive research base created through decades of analysis, development, testing, and operation of CANDU reactors worldwide. AECL would like the commission to accept their codes based on their acceptance in Canada and other countries with possibly some limited confirmatory R&D efforts directed by the NRC. The proposed cooperation with the CNSC is expected to facilitate the staff's review and assessment of computer codes and analysis tools. This proposal is discussed in an International Cooperation on New Reactor Designs memorandum scheduled for review by the Commission in the early part of 2003. However, the expected level of effort for the ACR review will be substantially higher than the level of effort for the AP600/1000 and the ESBWR review. In addition to the ACR thermal hydraulic codes, the staff would have to focus their review on the ACR core design and fuel methods which was not necessary for the AP600/1000 and the ESBWR due to their use of existing fuel design. Direction from the Commission on the extent and depth of the staff's review of acceptable analytical methods reviewed, verified, and validated by other countries will be sought early in 2003, in order to support the pre-application phase schedule for the ACR-700 design.

Another item the staff will present to the Commission for consideration will be the use of Canadian Standard Association (CSA) design codes and standards to assess the unique features of the ACR-700 design. The CSA requirements generally follow the requirements of the ASME Codes and supplements where appropriate. In order to facilitate the review process, AECL is planning to submit a report comparing CSA N-286 to 10 CFR Part 50, Appendix B.

The issue of accepting the principle design features of the ACR RCS pressure boundary as a Class 1 pressure boundary design is expected to occupy the staff early in 2003. The use of Zr-2.5wt%Nb as a pressure boundary material for pressure tubes and pressure tube-to-end fitting rolled joints as part of the pressure boundary. The use of closure plugs, fuel channel removable closures, and fueling machines as components of a Class 1 pressure boundary

present a unique design consideration that may require an exception or deviation from current ASME codes and standards.

Attachments

None

On the Margins

None