December 10, 2000

MEMORANDUM TO: ACRS Members

/RA/

FROM: Noel Dudley, Senior Staff Engineer
ACRS\ACNW

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS SUBCOMMITTEE MEETING ON MATERIALS AND METALLURGY REGARDING DG-1053, "CALCULATIONAL AND DOSIMETRY METHODS FOR DETERMINING PRESSURE VESSEL NEUTRON FLUENCE," NOVEMBER 16, 2000 - ROCKVILLE, MARYLAND

The minutes of the subject meeting, issued on November 17, 2000, have been certified as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc: Technical Support Branch
Operations Support Branch (3 copies)

cc via e-mail:
J. Larkins
J. Lyons
ACRS Fellows and Technical Staff
E. Barnard

Issued: November 17, 2000 ACRS-3229
CERTIFIED: December 8, 2000

CERTIFIED

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF SUBCOMMITTEE MEETING ON
MATERIALS AND METALLURGY
PROPOSED FINAL REGULATORY GUIDE FOR CALCULATIONAL AND DOSIMETRY
METHODS FOR DETERMINING PRESSURE VESSEL NEUTRON FLUENCE
NOVEMBER 16, 2000
ROCKVILLE, MARYLAND

The ACRS Subcommittee on Materials and Metallurgy met on November 16, 2000, to hold discussions with the NRC staff and its consultant concerning the proposed final regulatory guide DG-1053, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence." The entire meeting was open to public attendance. Mr. Noel Dudley was the cognizant ACRS staff engineer for this meeting. The meeting was convened at 8:35 a.m. and adjourned at 11:35 a.m.

ATTENDEES

ACRS

W. Shack, Chairman
T. Kress, Member
R. Seale, Member
N. Tsoulfanidis, ACRS Consultant
N. Dudley, ACRS Staff

NRC REPRESENTATIVES

N. Chokshi, RES
W. Jones, RES
S. Malik, RES
L. Lois, NRR
J. Carew, Brookhaven National Laboratory

INDUSTRY REPRESENTATIVES

J. Worsham, Framatome Technologies
K. Cozens, Nuclear Energy Institute

There were no written comments received from members of the public. Mr. James Worsham, III, Framatome Technologies, requested time to make an oral statement. Six members of the public attended the meeting. A list of meeting attendees is available in the ACRS office files.

INTRODUCTION

Dr. William Shack, Chairman of the Materials and Metallurgy Subcommittee, summarized the ACRS review of previous versions of the proposed final regulatory guide and asked Dr. Nilesh Chokshi, RES, to begin .

STAFF PRESENTATION

Introduction: Dr. Nilesh Chokshi, RES, explained that the proposed final regulatory guide was necessary to provide standardized methods and procedures for calculating neutron fluence and for using reactor vessel dosimetry measurements. He noted that the regulatory guide also provides an acceptable method for complying with regulations related to reactor pressure vessel integrity. Dr. Chokshi presented the status of the regulatory guide and outlined the staff's presentation.

Overview of DG-1053: Mr. William Jones, RES, presented the objectives of the regulatory guide. He explained that the regulatory guide was divided into sections concerning fluence calculation methods, dosimetry, and reporting requirements. The Subcommittee members and the staff discussed the following:

- why the regulatory guide was needed when other consensus standards provided guidance for calculating fluence and dosimetry monitoring,

- the impact of the regulatory guide on operating plants, and

- consistency between Regulatory Guide 1.99, "Radiation Embrittlement of Reactor Vessel Materials," and DG 1053 approximations of neutron attenuation across the reactor pressure vessel wall.

Proposed Final DG-1053: Dr. John Carew, Bookhaven National Laboratory, presented background information related to the development of DG-1053. He summarized the purpose and scope of DG-1053. He explained that the core geometry, material composition, and neutron source had to determined. Also, the core transport theory calculation of the neutron flux from the core to the vessel and cavity had to be developed. Dr. Carew described the discrete ordinates calculation methodology, the Monte Carlo calculation methodology, and the calculation methodology qualification procedure. He noted that licensees could use either the discrete ordinate or Monte Carlo methodology.

Dr. Carew explained that the fluence calculational methods provided best-estimate results, with an uncertainty of less 20 percent , for neutrons in the energy range from 15 MeV to 0.1 MeV. He described how the results were qualified using benchmarking and uncertainty analyses. He presented how the results of the calculational methods can be used as inputs to 10 CFR Part 50 Appendix G, "Fracture Toughness Requirements," and Regulatory Guide 1.99 for both PWR and BWR reactor vessel geometries. He noted that the results can also be used in developing vessel fluence reduction designs and life extension calculations.

The Subcommittee members, Dr. Carew, and the staff discussed attenuation of neutrons outside the reactor vessel, how the fluence source was averaged over the core, the use of mixed oxide fuel, and the uncertainties associated with the assumed fluence source. They discussed the basis for the uncertainty criteria of 20 percent and 30 percent used in the qualification procedure.

Dr. Crew outlined the development of DG-1053. He presented the staff's approach to resolving public comments and provided some examples. The Subcommittee members, Dr. Carew, and the

staff discussed who was on the team that evaluated the public comments, use of round robin exercises to validate the calculational methods, and revising the methodology as improved technologies and techniques are developed. They also discussed how the staff validated the use of the methodology for BWR reactor vessels.

NUREG-6115, "PWR and BWR Pressure Vessel Fluence Calculation Benchmark Problems and Solutions": Dr. Carew explained that the purpose of NUREG-6115 is to insure accurate fluence predictions, quantify uncertainty, standardize vessel fluence methods, and stream line the licensing process. Each licensee using the methodology in DG-1053 will have to complete the benchmark problem and demonstrate that the results of its calculational methodology are in agreement with the problem solution provided in NUREG-6115. He described the application of the benchmark problems, the problem definition, and the calculation inputs provided in NUREG-6115. Dr. Carew presented the axial geometry used for the PWR and BWR calculations, and explained the option of using either the discrete ordinates or the Monte Carlo calculation methodology. He provided graphs of the results from the two methodologies and demonstrated the similarity of these results.

The Subcommittee members, Dr. Carew, and the staff discussed the assumed octant geometry symmetry implied by modeling a 45° segment of the core, the computer time required to run the discrete ordinates and Monte Carlo calculations, the size of the mesh used in the discrete ordinates calculation, and neutron attenuation across the core. They also discussed how soon the new calculational methodologies will be adopted by licensees, what other embrittlement programs can benefit from the new methodologies, and in-vessel and ex-vessel dosimetry monitors.

Framatome Presentation: Mr. James Worsham, Framatome Technology, presented Framatome's involvement in the development of DG-1053. He noted that PWR Owners Groups, in the early 1990s, invested in cavity dosimetry, which was later determined by the staff to be inadequate to calculate vessel fluence. Consequently, Framatome reviewed the existing requirements for fluence calculations to support the industry contention that no changes to the existing calculational methodologies were necessary. Mr. Worsham stated that Framatome eventually agreed with the staff that the new calculational methodology presented in DG-1053 was necessary. He noted that the staff's estimates of the cost of the new methodologies were too low. Mr. Worsham raised the question of what benefits the industry would derive from using the new improved DG-1053 methodologies.

The Subcommittee members and Mr. Worsham discussed the NEI comment concerning the usability of the methodologies.

SUBCOMMITTEE DISCUSSION

The Subcommittee members and the staff discussed the following:

- possible reductions in the number and types of dosimetry monitors required due to the reduced uncertainty in the DG-1053 fluence calculation,

- possible modification of the reactor vessel wall attenuation factor assumed in Regulatory Guide 1.99 on the basis of a more accurate attenuation factor derived from the DG-1053 fluence calculation,

- other applications of the results from the DG-1053 calculational methodologies, and

- effects of different reactor coolant temperatures or fuel pin burnups on calculated results.

SUBCOMMITTEE COMMENTS, CONCERNS, AND RECOMMENDATIONS

Dr. Robert Seale noted that 30 years ago engineers and scientists decided to pursue two different calculational methodologies for determining neutron fluence. He was pleased to see that both the discrete ordinates and the Monte Carlo methodologies have overcome different limitations to produce consistent and accurate results.

Dr. Seale stated that DG-1053 is an example of primary research being undertaken years before any practical use had been identified and being completed in time to support significant NRC activities such as license renewal.

STAFF AND INDUSTRY COMMITMENTS

None.

SUBCOMMITTEE DECISIONS

The Subcommittee requested that the staff present information concerning the following items at the December 6-9, 2000 ACRS meeting.

- overview of DG-1053,
- overview of NUREG-6115,
- overview of the public comments including the pie chart depicting the type of comments,
- resolution of comment concerning the applicability of DG-1053 to BWR reactor vessels,
- resolution of comment concerning weighting factors for uncertainty estimates,
- comparison between the discrete ordinates and Monte Carlo methodology, and
- statement by Framatome.

FOLLOW-UP ACTIONS

None.

PRESENTATION SLIDES AND HANDOUTS PROVIDED DURING THE MEETING

The presentation slides and handouts used during the meeting are available in the ACRS office files or as attachments to the transcript.

BACKGROUND MATERIAL PROVIDED TO THE SUBCOMMITTEE:

1. Letter from J. Ernest Wilkins, Jr., Chairman, ACRS, to James M. Taylor, Executive Director for Operations, NRC, Subject: Proposed Draft Regulatory Guides DG-1023, "Evaluation of Reactor Pressure Vessels With Charpy Upper-Shelf Energy Less Than 50 FT-LB," and DG-1025, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," dated July 15, 1993.
2. Draft Regulatory Guide DG-1053, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," received October 23, 2000. [**Prepared for Internal Committee Use**]
3. Draft Regulatory Analysis for DG-1053, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," received October 23, 2000. [**Prepared for Internal Committee Use**]
4. Draft Summaries of Comments Received From Nuclear Energy Institute, Professor Alireza Haghighat, and Don't Waste Michigan concerning DG-1053, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," received October 23, 2000. [**Prepared for Internal Committee Use**]
5. Comments Received From Nuclear Energy Institute, Professor Alireza Haghighat, and Don't Waste Michigan concerning DG-1053, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," received October 23, 2000. [**Prepared for Internal Committee Use**]
6. U.S. Nuclear Regulatory Commission NUREG/CR-6115, "PWR and BWR Pressure Vessel Fluence Calculation Benchmark Problems and Solutions," completed May 20, 1997.

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NOTE: Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, One White Flint North, 11555 Rockville Pike, Rockville, MD 20852-2738, (301) 415-4737, or can be purchased from Ann Riley & Associates, LTD., 1025 Connecticut Ave., NW, Suite 1041, Washington, D.C. 20036, (202) 842-0034.

ACRS meeting agenda, meeting transcripts, and letter reports are available for downloading or viewing on the internet at http://www.nrc.gov/ACRSACNW.

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