

June 25, 2002

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SUBJECT: FOREIGN TRIP REPORT - IAGE AND OPDE MEETINGS

Attached is our trip report for the visit to Paris, France to attend the Working Group on Integrity and Aging of Components and Structures (IAGE) metals subcommittee, main committee, cable aging task group, and OPDE meetings from May 11 through May 18, 2002. As discussed in the attachment, NRC participation on the IAGE committees and their activities provide vital information for our research programs, provide a forum for exchange of ideas, and provide opportunities for collaborative work. Examples of activities discussed during the current meetings include:

- (1) The piping data base project (OPDE) which will provide NRC with up-to-date input for developing LOCA frequency estimates;
- (2) The reactor pressure vessel benchmark problem using both deterministic and probabilistic evaluation. This will complement our activities related to development of a technical basis for risk-informing 10 CFR 50.61, the pressurized thermal shock (PTS) rule; and
- (3) Establishment of the Cable Task Group to discuss the status of research in each member country and identification of issues of common interest.

It is recommended that NRC participate in the OPDE and Cable Task Group Activities and continue its involvement with the IAGE Committees.

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NRC FOREIGN TRIP REPORT

Subject

IAGE and OPDE meeting information

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Dates of Travel and Countries/Organizations Visited

May 11 through May 18, 2002 - Meetings held at the OECD and NEA headquarters in Paris, France.

Sensitivity

Not applicable.

Background/Purpose

The purpose of the travel was to participate in the CSNI/IAGE meetings and the OECD meeting to kick-off the OPDE project. The CSNI/IAGE meetings included a two day metals subcommittee meeting, a one day meeting of the main committee, and a one day meeting to develop the charter for a cable aging task group within the IAGE metals subcommittee. The OPDE meeting was a single day meeting to initiate the piping database project. Activities sponsored by the IAGE committees provide vital support to several ongoing NRC research activities. In particular, the cable aging and piping database projects are integral components which are used to leverage existing NRC research programs. Dr. Chokshi is the chairman of the IAGE main committee and also chaired the cable aging meeting and served as the US representative on the task group. Dr. Tregoning is the US national coordinator for the OPDE project and also served as a US representative to the IAGE meetings.

Abstract

The four meetings held during the week covered a broad range of topics of particular interest to the NRC. The IAGE metals subgroup meeting primarily contained topic areas covering PTS, plant aging and service life management, NDE, thermal fatigue, and miscellaneous presentations. The miscellaneous presentations included information on the Hamaoka pipe rupture from JAERI and JAPEIC, the Brunsbüttel pipe rupture, and a steam generator tube rupture event in Korea. The US NRC (Chokshi and Tregoning) presented information on Davis Besse, LOCA frequency reevaluation efforts, and CRDM cracking.

The main committee meeting consisted of reports from the concrete, seismic, and metal subgroups. The main group evaluated several proposals and activities recommended by the subgroups. These proposals included development of a benchmark problem based on the NUPEC/NRC tests on containment pressure capacity at Sandia National Laboratory and development of a location and attribute listing of major shaker tables around the world. These were followed by discussions in topic areas of NDE/ISI, Aging, relevant IAEA and EC activities, and miscellaneous presentations. Miscellaneous presentations included US presentations on Davis Besse and LOCA frequency reevaluation. Also, BWR stub tube cracking at Hamaoka - Unit 1 was discussed and core shroud cracking at Fukushima Daini Unit -3 by JAPEIC. It was decided that material issues related to advanced reactors should be explored as a potential area for future interest. The next main committee meeting will devote a topic area to exploring international perspective on advanced reactors, examine commonality, and consider appropriate topics for international collaboration.

The cable aging task group meeting consisted of presentations from all participating countries on the status of their research projects, qualification practices, and their management philosophy and plan. Also, the IAEA summarized their sponsored work in this area. The US (Chokshi) presented the synopsis of technical issues and research needs which arose from the wire system and cable aging workshop held in Rockville in April 2002. These ideas will serve as the framework for the paper documenting technical issues and research needs. Additionally, this group nominated Jitendra Vora of the US NRC as the chairman, developed a preliminary schedule for completing the report, and outlined the major sections of the report.

The kick-off OPDE meeting to update the international piping failure data base was held on the final day. The US is participating in this effort through joint collaboration between the NRC and EPRI. Robert Tregoning of the NRC is the national coordinator for the US effort. The terms and conditions of the project were ratified after some final changes. The call for contributions will occur in early June 2002. At this time, funding is required for each country. It was decided that the US call for contributions will be made directly to our CSNI representative (Thadani). The project review group also ratified the selection of ERIN Engineering Inc as the clearinghouse for the database. The group decided the schedule and action items for the first year of the project. The first year will include completion and verification of recorded pipe failures between 1999 and 2001. After the first year, all participants will have access to the entire data base.

The meetings were successful. Information exchange between the NRC and the international nuclear community occurred for a board range of topics. Additionally, progress in several specific international projects (PROSIR, cable aging task group, and OPDE) was discussed. This included a reassessment of schedule and scope and the assignment of action items. NRC should continue its participation in the IAGE metals, concrete, and seismic subcommittees, main committee, and related activities such as the cable aging task group, and the OPDE project. The objectives of each of these bodies and/or projects parallel several current RES research initiatives. Therefore, NRC more effectively leverages existing research efforts. In addition, these groups provide a forum to obtain information about relevant reactor component failures, maintenance issues, and plant aging programs in other countries.

No policy issues were identified that need to be brought to management's or the Commission's attention.

Discussions

The IAGE metals subgroup meeting contained interesting information in several of the topic areas. The PTS session included a status report on the Probabilistic Structural Integrity of a PWR RPV (PROSIR) benchmark problem. The US is participating in this effort. A multi-step plan is proposed with the first step being a development of input parameters and solution of a deterministic PTS challenge to ensure consistency of results among all the analysts. This will be followed by a sequence of problems where the inputs and simulations are systematically randomized. Each analysis level represents an increase in modeling complexity. The US NRC presented current status and progress of the PTS reevaluation effort currently ongoing. The international community is closely watching this effort to determine how to proceed.

The plant aging and service life management topic areas provided insight into how some countries are addressing the issues which are raised by plant aging and license extension. Switzerland provided a presentation documenting their aging management philosophy. They've broken the functional areas of concern into mechanical, civil, and environmental categories and assigned expert teams to evaluate potential problems within each area for each system. Maintenance, ISI, and testing programs have been implemented which are commiserate with component/system importance.

Finland presented their program to minimize the potential for vessel cracking due to pressurized thermal shock of the Loviisa reactor. This reactor exhibited unusually high embrittlement, about twice the expected rate, within two years of start-up. This led to a comprehensive surveillance and mitigation program for PTS. Several steps have been taken. First, neutron fluence has been reduced to decrease the aging rate. Emergency core cooling water temperature has been increased and the high pressure injection system modified to reduce the thermal transient severity. More interestingly, the reactor was thermally annealed in 1995. The thermal annealing was successful in that most of the embrittlement-induced temperature shift was eliminated. Since this effort, the surveillance program has focused on determining the re-embrittlement rate. It's been found that the re-embrittlement rate is a strong function of the phosphorus content of the weld material. They reported that Phosphorus has a much greater role than copper during re-embrittlement since there is much less diluted copper remaining in the matrix.

Thermal fatigue of pipes continues to be a topic area of interest internationally. EdF appears particularly interested in this topic. There are two related projects within the metals subgroup on thermal fatigue: a thermal fatigue questionnaire and a postulated group project on the prediction of fatigue crack growth and initiation due to thermal fatigue. The thermal fatigue questionnaire was developed to provide a comprehensive assessment of international practice in this area. The questionnaire covers regulatory requirements and codes, practical experience and incidents, countermeasures related to thermal stratification, countermeasures related to mixing, research on thermal fatigue, and high cycle fatigue crack growth material properties. The US needs to provide their responses to the questionnaire. This will require interaction among the NRC, nuclear industry, and NRC contractors.

The failure mechanism of the Hamaoka event was outlined as follows. First, radiolysis generated hydrogen and oxygen in the reactor core which flowed into the RHR pipe with the main steam. The steam condensed while the hydrogen and oxygen accumulated in the top of the pipe at the elbow. The HPCI surveillance test caused high pressure fluctuations and high temperature steam to flow directly into the layer with the accumulated hydrogen and oxygen. Platinum from the water chemistry control adhered to the inner surface of the pipe. This could have facilitated the ignition of the gas. The hydrogen combustion led to rapid pressure rise and

pipe rupture. That section of the steam condensing system in the RHR system will be removed to prevent future hydrogen accumulation. Others locations will be evaluated to determine the potential for hydrogen accumulation. Facility modification may be pursued to mitigate the failure potential of any other locations.

The most interesting items from the main group meeting were the discussion of the synthesis report on aging and the presentation of Hamaoka control rod drive penetration cracking. The synthesis report on aging generally describes international activities within IAEA, the OECD, and the European Union (EU). While the document is primarily an generic overview of aging-related material damage mechanisms, predictive modeling of structures, qualified detection and surveillance methods, mitigation, plant documentation, and the knowledge base. The document concludes repair and replacement programs have been successful historically. The main concern is that decreasing national interest will reduce the infrastructure to combat aging problems. The document identifies the following needs in order to assure that the technical basis for continuing plant operation is maintained: methods and strategies for life management, computer-aided modeling of degradation, improvements in plant documentation, international user's groups, updated information retrieval systems, and more flexible quality assurance. Comments to this document are required by the end of May 2002.

Updated information concerning the Hamaoka CRDM housing cracking was provided. An Inconel 182 weld on a BWR stub tube caused a leak in early November. The licensee's final report indicated that the root cause was IGSCC. It attributed IGSCC to the level of dissolved oxygen (0.1 - 0.25 ppm during operation) and expected high residual stress in the weld. The countermeasures will include replacing the stub tube with Inconel 82 welding; utilized enhanced hydrogen water chemistry to reduce the oxygen level in the system, and attempting to optimize the leak detection system within the plant.

Additionally, it was discussed that the next meeting should include a task on material's issues associated with high temperature reactors. The idea is to assess potential material problems associated with advanced reactor operating environments, identify areas of common interest to the international community, and identify areas for potential joint research. Some topic areas to be discussed at the next meeting will include codes and standards, material performance, diagnostic procedures, and specific areas of concern. A potential format will be for each country to provide overview in these areas, and follow this with general discussion to determine potential areas for international collaboration. This initiative was purposed by the US.

The OPDE meeting was very successful. Ten countries are participating in the project: the US, Canada, Japan, Sweden, Korea, Spain, Switzerland, Finland, France, and Germany. The Czech Republic is also considering. The cost of operating the OPDE Project is currently estimated to be \$99,600 per year. It is agreed that all participants except Sweden will equally divide the cost of the project. Sweden is providing in-kind contributions (baseline data base) which have been valued at the yearly cost of each participant. Project costs in the years 2 and 3 of the project will remain at \$99,600. The yearly cost will also be divided equally among the participants. The following related documents were distributed: the draft quality assurance manual, the draft coding guidelines, and the OPDE Phase 1 - data validation/work scope definition. These documents will govern the data verification effort for the project and be utilized for quality assurance. The national coordinators for each country needed to review these documents and provide revision within two weeks from the meeting date.

The remainder of the meeting was a discussion of the tasks to be performed during the 1st year (Phase I) of the project. There is an initial trial period. During this time, the national coordinator

(NC) for each country will be supplied with their own pipe failure data that needs to be validated. Each country must then select a few events and complete or verify the data contained in the data base. This information is then sent to the clearinghouse (CH) for review. This trial period will end at the end of September, 2002. A second project meeting will then be held on Nov 18-19, 2002 at SKI, Sweden. During this meeting, the NC's will present the national reporting level requirements for that country on pipe failures, provide a progress report summary, and discuss results from the trial period. The next task will be to complete or verify all the data base records by the end of February, 2003. This will be followed by a meeting in May 2003 to plan Phase II and provide the updated data base to all participants. Continuing US participation is critical in light of LOCA reevaluation efforts tied to 10 CFR 50.46 revision.

Pending Actions/Planned Next Steps for NRC

NRC has several important action items. NRC will need to respond to the call for contributions for the OPDE project. The funding for this effort to NEA will be approximately \$10,000 and cover NRC's participation in the project from May 2002 to May 2003. Also, the US national coordinator for the OPDE effort (Tregoning) was assigned several action items to be completed over the next few months. Jitendra Vora was elected to be chairman of the wire and cable system aging task group. He is responsible for developing the schedule and content for a white paper detailing the current state of knowledge and future research priorities for wire and cable aging issues. This white paper is the principal deliverable for this task group over the next year. Nilesh Chokshi has several action items related to his chairmanship of the IAGE main committee. He also will coordinate the US response to the piping thermal fatigue questionnaire. The responses will require input from NRR and industry representatives. In consultation with others, he also will evaluate the US role in the thermal fatigue analysis round robin being sponsored by this group.

Points for Commission Consideration/Items of Interest

No commission action is required, however there was some information presented which may be of interest. Finland and Switzerland provided information on their plant aging management programs. The Swiss have implemented several Aging Surveillance Programs (ASP) in the areas of mechanical, civil, and electrical engineering. Finland provided information on thermal annealing recovery and reembrittlement that will augment Marble Hill experience-base. Also, the international community is beginning a program to evaluate pressurized thermal shock challenges using probabilistic fracture codes. This work follows along the lines of the current PTS reevaluation for possible 10 CFR 50.61 revision that RES is currently pursuing.

Attachments

Agendas for all four meetings are attached.

"On the Margins"

No additional information of probable interest to report.