UNITED STATES
NUCLEAR REGULATORY COMMISSION
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October 31, 1996

MEMORANDUM TO: Keith R. Wichman, Acting Chief
Materials and Chemical Engineering Branch
Division of Engineering

FROM: Edmund J. Sullivan, Chief
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Materials and Chemical Engineering Branch
Division of Engineering

10/31/96

SUBJECT: FOREIGN TRIP REPORT

From September 24-27, 1996, I attended the 14th International Conference on NDE in the Nuclear and Pressure Vessel Industries in Stockholm, Sweden. I presented a paper on the steam generator rulemaking that I coauthored with Emmett Murphy. This conference included an overview tour of the Forsmark Nuclear Power Station on September 27. On October 1, 1996, I met in Dijon, France, with representatives of DSIN to discuss developments in the area of steam generator internals degradation. The following summarizes the information acquired during this trip.

## 14TH INTERNATIONAL CONFERENCE ON NDE

### Plenary Session

Performance demonstration (PD) was the most emphasized issue of this conference. In addition, issues related to NDE technological developments and results, steam generator tube inspection, and risk-based inservice inspection were also discussed. There were three speakers at the Plenary Session, S. Crutzen, K. Iida, and F. Ammirato, representing the European, Japanese, and American NDE communities, respectively.

Serge Crutzen discussed the Joint Research Council (JRC) European Commission position on PD. He indicated that the European qualification methodology embraces either ASME Appendix VIII type PD or the use of partial trials and technical justification, thereby avoiding total reliance on costly mockups. The practical trials may be either blind or non-blind. As with Appendix VIII, equipment and procedures are qualified separately from personnel. Pilot studies have indicated that technical justification is a difficult task and that for successful qualification the defects used need to produce fully consistent response to the actual defects being simulated.

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Professor Iida indicated that in Japan qualification is being performed through specimens with notches. At present there are no plans to introduce personnel skill demonstrations with real flaws. The Japanese regard ASME Appendix VIII as problematic, costly, in worst cases damaging, not an adequate reflection of inspector skills, and biased toward the need for expensive equipment in both the nuclear and non-nuclear industries (implying that the NDE standards for both industries and the same).

Frank Ammirato of EPRI discussed PD from the point of view of its benefits, including PD as an alternative to prescriptive procedures and as a method of justifying inspection intervals, repair options, and replacement schedules.

Performance Demonstration Issues

J. Deschamps of BCCN/DSIN presented a paper on the French safety authority view on PD. EdF has issued its own PD methodology in a draft RSEM Code (French ISI rules). The author noted concerns with use of partial trials and technical justification, the lack of a clear separation between development and qualification phases, and with similarity of NDE systems used for qualification versus those used in the field. DSIN is working with EdF to resolve its concerns with the draft RSEM Code. A rule on PD will be issued in 1997. The RSEM Code will form some part of the requirements depending upon resolution of issues with EdF.

S. Crutzen presented a paper discussing the potential for using realistic defects for training and practice leading up to qualification on real defects, if required by the regulatory authorities. He indicated that in his view, training only on real flaws represents a limited number (due to availability) of particular cases and that such training does not lead to high inspector capability. (The EPRI - Performance Demonstration Initiative experience would suggest that practice on real defects is needed to meet Appendix VIII requirements.)

G. Light discussed work done at SwRI to produce, by a weld solidification process (WSP), flaws that have similar acoustic response to IGSCC. He indicated that they believe the process can produce flaws that will satisfy Appendix VIII requirements. Photomicrographs of real IGSCC and WSP flaws were displayed for comparison. It was noted that the branching in the WSP flaws may be less extensive and that the acoustic response does not appear to cover the same range as for real IGSCC flaws. Lars Skanberg of SKi, the Swedish regulatory authority, commented that from a regulatory point of view it is essential to justify the applicability of defect simulations such as this.

P. Lemaitre of JRC presented a paper on ENIQ, the European Network for Inspector Qualification. The objective of the ENIQ program is to coordinate and manage resources for qualification of NDE techniques and procedures and to support the development of international codes and standards. This program has been discussed in previous trip reports. Lemaitre reported, however, that ENIQ now includes a task involving cooperation with Eastern and Central European countries to promote ENIQ's views on inservice inspection. There is also a new task in the ENIQ program on risk-based inspection (RBI). This is a newly launched task. They intend to start by gathering information, identifying missing information, and, if determined necessary, establishing a program to develop a European approach toward RBI.

J. Novat of BCCN/DSIN presented a paper on his personal views on the ENIQ methodology and the on-going ENIQ pilot study. He indicated that the qualification approach is valid only if the (pilot) simulation bounds the qualification. While there has been a good deal of discussion of the resource limitations involved in making test blocks with real flaws, the real difficulty with the ENIQ approach is not in the cost of the blocks but in rigorously following all the "logical steps", including valid technical justification when realistic (vs. real) flaws are used. Relying on the skill of the personnel can lead to undermining the qualification process if all the steps are not followed. ENIQ is in basic agreement with the positions of the European regulatory authorities, but the major difficulty in implementation may be with following all the "logical steps" involved.

P. Lemaitre discussed the on-going ENIQ pilot study. He indicated that the concerns expressed by Mr. Novat were being addressed in the pilot study. This study is being conducted to test the feasibility of the JRC European methodology and explore how to apply it. Phase 1 is a "simple" exercise being conducted by JRC. Phase 2 will involve industrial vendors. The test specimens are 300 to 700 mm diameter pipes with 12 to 30 mm wall thickness. The flaws to be studies in Phase 1 are IGSCC and fatigue cracks. Mr. Lemaitre noted that the procedures are defined and the test pieces have been ordered. Lessons learned include 1) the importance of specifying all the necessary information in advance, 2) the importance of separating the equipment and procedure qualification from the personnel qualification, 3) performing open trials for the equipment and procedures resulting in better understanding of both, and 4) the importance of similarity of test pieces and the actual components to facilitate technical justification.

U. Sandberg of Forsmarks Kraftgrupp discussed the Swedish utilities' experience working to new requirements on PD. New requirements for inspection of nuclear components were introduced in Sweden in January 1995. The PD requirements are required to

be fully implemented in 1998. The requirements apply to the reactor vessel and to what was called Grade A and B piping. The implementation of the requirements must be monitored by a third party. SKi has approved third party monitoring by the new Swedish NDT Qualification Center. The Grade A and B piping has been ranked by a risk index method. Problem areas and lessons learned from implementation to date include: 1) inspection procedures need to be more prescriptive (although it is recognized that this involves the risk of the procedures becoming lab rather than field oriented), 2) long test specimen delivery time and the need for practice specimens early, 3) validation of defects is almost non-existent, 4) the parties involved are not accustomed to technical justifications (TJ) and for the high priority inspections, very little TJ is available, 5) qualification requirements do not always coincide with the safety case - information needed for structural analysis is not always available, and 6) qualification has started with the most difficult cases and this should have been avoided.

Steam Generators

Jack Lareau of ABB Combustion Engineering presented a paper on UT of steam generator (SG) tubing using a lamb wave probe (LWP) technique to detect cracking at expansion transitions. With this method the sound beam is introduced into the tube about 1 inch above the expansion transition. The lamb waves are not believed to be affected by geometry changes, such as dents and the expansion transition, as with ECT techniques. The LWP is believed to have a lower detection threshold, lower false positive rate, and better resolution of ligaments than ECT probes. The author indicated that the LWP may be used in the future as a resolution tool based on RPC or Plus Point screening. After the presentation I indicated to the author that clients using this approach would avoid regulatory challenge if they discuss it with the NRC prior to use during SG inspections.

C. Broure of Hoogovens Technical Services (in the Netherlands) discussed UT inspection techniques based on the rotating mirror concept. Inspection speeds of 1 meter per minute can be achieved with this technique. Based on tests with outside diameter and inside diameter stress corrosion cracking, the author reported: 1) detection thresholds of 10% wall thickness in straight SG tube sections and 20% in U-bend SG tube sections, 2) high correct defect detection, 3) no false calls, 4) relative invulnerability to magnetite and tube pilgering, and 5) poor depth sizing capability, especially in U-bends, and general overestimation of defect lengths.

M. Bieth of JRC summarized PISC III round robin test results on SG tube inspections. These results have been summarized in previous trip reports and are also reported in detail in the

draft PISC III Action 5 report. JRC is working on resolving comments on the draft report and anticipates issuing the final report by the end of the calendar year.

Risk-Based inspection

S. Walker of the EPRI NDE Center presented a paper on the application of damage mechanism-specific NDE methods in support of risk-based inspections. During the question and answer session this approach was criticized by both J. Novat of DSIN and S. Crutzen of JRC because its implementation depends on known mechanisms and it would be unlikely that new mechanisms will be picked up by the ISI. They indicated that it is important to add other flaw types and that safety requires more general inspection assurance.

Advanced UT and ECT Techniques

A number of papers were presented in this area. As with recent developments in inspection of SG tubes, the emphases were on probes and signal processing (designed to increase the signal to noise ratio for the application of interest) and automated data analysis. The conference proceedings will contain descriptions of these developments and it is expected to be issued by the end of the year.

In discussions during coffee breaks, authors indicated that future directions of advanced techniques may include increased machine analysis of data with corresponding decrease in human analysis involved in decision making. These types of developments will be of great interest to the regulators. Notwithstanding this potential trend in decreased reliance on human factors, Glen Light of SwRI presented an interesting paper on auralization of ultrasonic data to aide inspection engineers in flaw detection. This approach converts ultrasonic signals into audible signals. Based upon the premise that the human ear is sensitive to noise and can detect slight differences in the audible background, SwRI is working to determine whether aural UT used with conventional UT can increase inspection reliability. The presentation included some actual demonstration via prerecorded tapes.

SUMMARY OF MEETING WITH DSIN

In a meeting in April 1996 in Rockville, DSIN representatives presented information on four tube support plate (TSP) degradation mechanisms discovered in 1995 in steam generators (SG) similar to Westinghouse model 51 SGs. The first two mechanisms dealt with 1) degradation of the top tube support plate (TSP), TSP number 8, at Fessenheim 2 caused by chemical cleaning and 2) ligament cracking of TSPs near a seismic stop. In the meeting on October 1, DSIN representatives indicated that

there was basically nothing new to present on these two mechanisms. The population of SGs affected by these two mechanisms is understood and the repairs to address these problems have been made (i.e., plugging and stabilizing tubes).

The third mechanism dealt with evolving tube support plate eddy-current testing (ECT) signals from the 1994 to the 1995 inspections at Gravelines 2. Video inspection of TSP 8 in 1995 confirmed a wastage type degradation of TSP ligaments. SGs at the other three Gravelines units were also believed to be affected. Since the meeting in April, visual inspection of the eighth TSP has confirmed the presence of wastage at Gravelines 3 and 4. EdF has concluded based on the nature and pattern of the wastage that the wastage is due to erosion-corrosion. The SGs at Gravelines 1 were replaced in 1994; prior to the replacement review of ECT records indicated a large number of tubes were potentially affected. However, video inspection of the eighth TSPs at Gravelines 1 indicated no wastage of ligaments. The ECT indications from this unit are believed now to be due to deposits. Scrapings of deposits on this TSP were taken to attempt to determine the difference in this regard between unit 1 and the other units. These deposits are presently being analyzed.

The fourth mechanism dealt with damage to the flow distribution plate (FDP) at Gravelines 4. Degradation of the FDPs of the three SGs was believed to exist based upon review of ECT records. However, during the outage at Gravelines 4 in May 1996, no damage of the FDPs was seen. The ECT signals are now believed to have been caused by deposits that were evident during the video inspection. DSIN representatives indicated that the third and fourth degradation mechanisms may be related to the ammoniac water chemistry at the Gravelines units which is not used at other nuclear plants in France.

During the meeting in April 1996, DSIN representatives also discussed a problem with dropping of the SG wrapper at Blayais 3. It was reported that the wrappers on SGs 1 and 2 had dropped and that temporary repair of the SG 1 wrapper had been made. The repair was considered temporary because the initial fatigue analysis did not show that the repair was good until the end of life. The fatigue analysis has recently been refined and it now shows that the repairs can be considered permanent. DSIN is reviewing the analysis. A modified repair design has been developed that is similar to the design used on SG 1 but it eliminates the threaded connections that were the limiting aspect of the design used on SG 1. This modified design is being used on SG 2.

Wrapper dropping is being monitored in all the SGs of the 51B, 51B1, 68/19 and 47/22 designs. The monitoring is being undertaken through on line (metrologic) instrumentation and through visual inspections during outages. If the on line monitoring were to indicate dropping in excess of certain criteria, the plant would have to be shut down. To date no other SGs have shown the problem.

In addition to the wrapper dropping problem, cracking of the wrapper above the original upper support was discovered at Blayais 3. The cause of this cracking is as of yet not understood. DSIN is asking EdF to aggressively pursue determining the root cause of the wrapper drop and wrapper cracking problems because of the safety significance of a wrapper drop.

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