

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Tenth International Conference on Environmental Degradation of
Materials in Nuclear Power Systems—Nuclear Reactors
Project Number 20.01402.571, AI Number 01402.571.017

DATE/PLACE: August 5–9, 2001
Lake Tahoe, Nevada

AUTHOR: Gustavo A. Cragolino

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PERSONS PRESENT: The conference was attended by approximately 200 people. Joseph Mascara [Nuclear Regulatory Commission (NRC)] was also present.

BACKGROUND AND PURPOSE OF TRIP:

The purpose of the trip was to attend the conference to become more acquainted with new research advances and technical developments in the field of degradation of reactor materials related to environmental effects including fuel cladding, radiation damage and radiolysis, and present a paper in the session on Zircaloy cladding and waste containers.

SUMMARY OF PERTINENT POINTS:

The conference was well attended during all the 16 sessions. Two of them, one mainly devoted to pressurized water reactors (BWRs) and the other to boiling water reactors (BWRs) were conducted simultaneously everyday.

Sessions on PWR continued to be dominated by studies or reports on the intergranular stress corrosion cracks (IGSCC) of Alloy 600 in the form of reactor pressure vessel (RPV) head nozzle cracking, now extended to US reactors as well as stress corrosion cracking (SCC) of steam generating tubing promoted by primary water. SCC of Alloy 600 from the secondary side promoted by Pb contamination was also the subject of several presentations.

In the session on secondary side of PWR steam generator (SG) in which the invited speaker was Roger Staehle, there were several interesting papers on impurity enrichment in SG crevices in which is postulated the formation of aluminum silicate gel which turns unstable the Cr-rich passive film. A very interesting paper was presented on crack tip microstructures of Alloy 600 as well as experimental evaluations of tube support plate crevice chemistry although analysis of data seems affected by the limitations of the thermodynamic software (MULTIQ).

The sessions on primary side of PWR was initiated by an invited talk by Peter Scott (Framatome) in which the IGSCC of Alloy 600 was discussed in certain detail by offering experimental correlations rather than

attempting to discuss mechanistic interpretations. He emphasized too that the formation of acidic zeolites affects the stability of oxide films.

After an invited talk by Peter Andresen (GE Corporate R&D) on SCC in hot water systems, several papers on core shroud IGSCC, a problem currently prevailing in the core of BWRs, were presented followed by papers on irradiated assisted SCC (IASCC). In connection with this problem Steve Bruemmer (PNNL) made an excellent presentation on the current advances in the understanding of radiation damage and radiation induced segregation promoted by high doses of high energy neutrons on stainless steel core materials. Improved techniques have allowed the observation of very small defects in the nm range.

The subject of noble metal addition to the water of BWR to mitigate against IGSCC of core internals in the presence of H₂ injection was discussed through various papers that followed an invited presentation by Sam Hettiarachchi (GE Nuclear). Hettiarachchi reviewed the progress done in the application of the technique to many reactors in the US and some in Japan. Some of the papers presented in this session tried to offer some fundamental explanations in terms of electrochemical theory but the interpretations were limited by the lack of adequate kinetics data.

The session on Zircaloy cladding was initiated by the presentation of an overview by Friedrich Garzarolli (Siemens Nuclear) who described recent advances in the improvement in thermal treatments for Zircaloy cladding as well as the development and optimization of new Zr alloys as replacement of Zircaloy, mainly to reach high burnups. He also presented a paper describing the effect of high burnup on the corrosion of Zr fuel cladding alloys and the concurrent effect of hydride rim formation. Another paper presented by Shan (Framatome) presented modifications of the MATRO software to calculate corrosion and oxide film thickness for new Zr alloys cladding

L. Belovsky (ALIAS-SKODA) presented a paper in which impedance was used to study corrosion properties of Zr-based alloys, followed by a presentation from I. Muir (AECL-Chalk River Laboratories) in which surface analytical methods were used to study corrosion and hydrogen absorption of Zr-2.5Nb pressure tubes.

The author of this report presented a paper titled General and Localized Corrosion of Zircaloy under High-Level Radioactive Waste Disposal Conditions, in which the work conducted at CNWRA on the pitting corrosion of Zircaloy was reported. Mechanically polished specimens and specimens covered with hydrothermal grown oxide films were compared in terms of their resistance to pitting corrosion by measuring the repassivation potentials and conducting open circuit potentials tests in the present of reducible species such as Fe³⁺ cations and H₂O₂. The paper was well received and promote questions from the audience. It should be noted that in this conference all the questions and answers are collected and incorporated into the proceedings.

L. Young (GE Corporate R&D) presented a paper with the results of work in progress evaluating the SCC susceptibility of Alloy 22 and Ti-Grade in simulated saturated environments derived from J-13 Well Water using the KENO testing system. This system allows the simultaneous testing of multiple specimens under a variety of stress values, surface and heat treatment conditions in the same nominal environment. No SCC of Alloy 22 was detected after 4,000 hours of testing at stresses above the yield strength.

D.C. Agarwal (Krupp VDM Technology Corporation) provide a detailed discussion of the resistance to localized corrosion of Alloy 59 as compared to C-22, emphasizing the better stability of Alloy 59 under certain

thermal treatments. In his presentation , Agarwal indicated that Alloy 59 is being tested in LLNL as an alloy to be evaluated as an alternative material for WPs following an agreement of VDM with the DOE .

The final paper in this session devoted to Zr alloys fuel cladding and waste container materials was a paper presented by Bo Rosborg (Consultant to SKB) on the corrosion of Cu as a container material according to the current design adopted in the Swedish program. Details of the corrosion testing, evaluation, and some limited modeling was presented.

There were other sessions on radiation damage of RPV steels and IGSCC of welding materials for Ni-based alloys such as Alloys 182 and 82.

IMPRESSION/CONCLUSIONS:

Overall, it is considered that attendance was beneficial because the conference provided an opportunity to have updated information on corrosion problems prevailing in reactor power systems, and in particular the current operating experience and problems and failures of fuel cladding at high burnups. The information on WP and containers materials was limited, but this situation may change in future conferences. There was not a clear perception that the current situation regarding the nuclear industry in the country is going to change.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

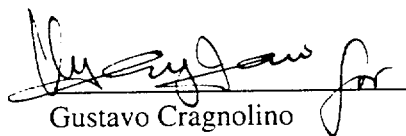
RECOMMENDATIONS:

Future attendance to these type of conferences that takes place every other year could be useful to keep track of the current developments in an industry characterized by high technology and sophisticated techniques as compared with other industries requiring corrosion services.

REFERENCES:

Proceedings of the conference which contains peer reviewed papers will be available as a CD ROM. Preprints of some papers of direct interest to our program as well as the program are available from the author of this report .

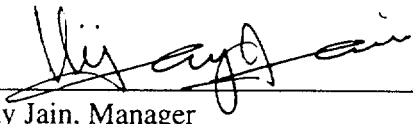
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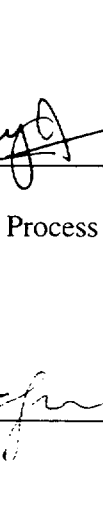
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