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Subject of this Document: Report of vists to CEN/SCK, Mol, Belgium, and CBNM, Geel, Belgium, September 20-21, 1979. Summary of Conferences on "Accuracies in Correlation between Property Change and Exposure Data from Reactor Pressure Vessel Steel Irradiations" at Julich, September 24-27, 1979 and the Third ASTM-EURATOM Symposium on Reactor Dosimetry at Ispra, October 1-5, 1979.

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Responsible NRC Individual and NRC Office or Division: C. Z. Serpan, Chief, Metallurgy and Materials Research Branch, Division of Reactor Safety Research

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INTERIM REPORT

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ORNL

FOREIGN TRIP REPORT

ORNL/FTR-761

DATE: November 6, 1979

SUBJECT: Report of Foreign Travel of Friedemann W. Stallmann, Computing Consultant, Division of Reactor Safety Research

TO: Herman Postma

FROM: F. W. Stallmann

PURPOSE: To attend and present a paper at the IAEA Specialists' Meeting on accuracies in correlation between property change and exposure data from reactor pressure vessel steel irradiations. To attend and present several papers at the ASTM-EURATOM Symposium on Reactor Dosimetry, review papers and chair a workshop there. To visit the CEN/SCK facility at Mol and the CBNM facility at Geel, Belgium, to assess and coordinate their activities with our LWR-PV program.

SITES VISTED:		
9/20/1979	CEN/SCK, Mol Belgium	J. Debrue G. & S. DeLeeuw
9/21/1979	EURATOM, Geel, Belgium	W. Bambynek, J. Van Audenhove
9/24-27/1979	KFA, Jülich, FRG	W. D. Schneider, D. Pachur
10/1-5/1979	EURATOM, Ispra, Italy	R. Dierckx

ABSTRACT: The traveler visited the CEN/SCK and CBNM sites in Belgium. Both installations are involved in research of advanced neutron dosimetry methods and members of CEN/SCK are actively participating in our LWR-PV program at ORNL. Information was obtained which is needed for evaluation and uncertainty analysis of the dosimetry used in our PCA and PSF irradiations. The traveler attended and presented a paper at the IAEA Specialists' Meeting on accuracies in correlation between property change and exposure data from reactor pressure vessel steel irradiations in Jülich, FRG. The purpose of this meeting was an exchange of information between dosimeters and metallurgists in order to facilitate the cooperation between the two in light water reactor pressure vessel surveillance. This exchange of information is particularly important for the NRC-LWR-PV surveillance program which is a joint effort of several U. S. and European laboratories, and to

ABSTRACT: (CONT'D) which ORNL is a major contributor. A large number of participants in this program were present at the conference. The traveler attended also the Third ASTM-EURATOM Symposium on Reactor Dosimetry in Ispra, Italy. Contribution of ORNL to the NRC-LWR-PV surveillance program and the NRC-HSST program were presented at several workshops in this symposium. Mr. W. Zijp, from Petten, Holland, and the traveler were reviewer-chairman for the workshop on Adjustment Codes, Uncertainties, and Input Needs. As a result of this workshop, several participants agreed to set up input data sets for adjustment codes to be used for intercomparison and validation of these codes. The traveler chaired also an informal meeting of the ASTM E10.05.01 Task Group on Uncertainty Analysis in order to exchange information with European researchers and to initiate cooperation with European installations which have similar goals.

Report of Travel to Western Europe

September 18 - October 29, 1979

Site Visit at CEN/SCK, Mol, Belgium

Several researchers in this installation are actively participating in the dosimetry for the NRC-LWR-PV surveillance program. A tour through the laboratories included the BRI reactor, which provides the benchmark field for the calibration of dosimeters, and the counting and spectroscopy facilities. The discussion with the researchers present centered around the following topics:

1. Active $^{6}Li(n,\alpha)t$ neutron spectroscopy has been performed at the PCA-PV facility of ORNL by G. DeLeeuw-Gierts and S. DeLeeuw from CEN/SCK. Results of these measurements will be combined with other dosimetry measurements for the validation of neutron transport calculations. For this purpose the raw data, response functions and estimates of uncertainties for the ^{6}Li spectroscopy need to be transmitted to ORNL. Details of this exchange of information were discussed and agreed upon.

2. The $^{93}Nb(n,n')^{93}Nb^{m}$ reaction is widely used in European countries for pressure vessel surveillance and will be used also in the PSF and BSR metallurgical experiments at ORNL. This reaction ideally suited for these purposes, but its nuclear constants are not sufficiently well known and counting is difficult. H. Tourwé, at CEN/SCK and co-workers, are the leading researchers in this field and the applications of their methods and results to the experiments including uncertainty analysis was discussed.

3. Methods have been developed and tested at CEN/SCK and CBNM, Geel, to determine the damage in quartz crystals induced by irradiation. The parameter which is easiest to measure is the swelling and the resulting decrease in density. The use of quartz damage monitors for pressure vessel surveillance would be advantageous since the damage response function of quartz is similar to that of steel. Quartz damage monitors will be used in the PSF metallurgical experiment and the results will be used to validate damage models and to determine whether quartz monitors can be used routinely for surveillance applications.

Site Visit at CBNM, Geel, Belgium

This installation has one of the leading European facilities for making foil detectors and gamma-ray standards for calibration of counting equipment. Such detectors are used extensively in the dosimetry for the PCA, PSF and BSR irradiations at ORNL. Discussion with researchers at this installation centered around uncertainty analysis and possible calibration and standardization. The director, W. Bambynek, expressed interest in the activities of the ASTM E10.05.01 Task Group on Uncertainty Analysis and indicated a willingness for exchange of information.

The IAEA Specialists' Meeting

The purpose of this meeting was an exchange of information between dosimeters and metallurgists in order to facilitate the cooperation between the two, particularly in the area of light water reactor pressure vessel surveillance. Attendance was by invitation only, with 53 participants representing 15 countries and the IAEA.

Several participants reported on experiments for irradiation of steel in Belgium, France, Germany and the U. S. Among the problems discussed on the metallurgical side were:

1. The relevance of various test results like NDT-shift, upper shelf energy, tensile strength to fracture toughness

2. Uncertainties involved in determining NDT-shift from Charpy tests

3. Dependency of material changes on neutron flux-fluence spectrum, chemical composition, temperature

4. Proper choices of exposure units (flux $\geq$ 1 MeV, dpa etc.)

On the dosimetry side the following problems were discussed.

1. Determination of exposure units from foil dosimetry through unfolding codes

2. Use of damage monitors (gamin, tungsten)

I presented a paper outlining the design considerations and expected results of the ORR-PV metallurgical experiment at ORNL.

D. Pachur explained in private discussion his recent results in annealing of radiation induced defects in steel. In these experiments annealing temperatures for different types of defects can be determined and correlation between specific types of defects and specific changes in material properties can be established.

Third ASTM-EURATOM Symposium

This biennial symposium was attended by about 130 researchers from many countries. Most of the papers were assigned to one of 8 workshops covering

1. Metallurgy and dosimetry interface
2. Fusion
3. LWR pressure vessel surveillance in practice
4. Fast reactor and research reactor characterization
5. Adjustment codes
6. Fuel dosimetry
7. Benchmarks
8. Dosimetry techniques

W. Zijp and myself were reviewer and chairman for workshop 5. The increased use of statistical methods including covariances in adjustment (unfolding) codes was noted. Mr. Zijp proposed to establish a testing procedure for adjustment codes using as input data results from some dosimetry experiment including all the uncertainties. Several participants agreed to cooperate in this effort.

My interest was also in workshops 1, 2, 5, and 8 since these topics are related to my work in ORNL's LWR program. I co-authored 4 papers which were discussed at the appropriate workshops. These papers are related to the work performed in FY-79 at ORNL and are listed below.

1. "Neutron Spectral Characterization of the NRC-HSST Experiments" F. W. Stallmann and F. B. K. Kam
2. "Status Report on the Activities of the ASTM E10.05.01 Task Group on Uncertainty Analysis", F. B. K. Kam and F. W. Stallmann
3. "The Core Power of the Pool Critical Assembly Light Water Reactor Benchmark", F. B. K. Kam et al
4. "Neutron Spectral Characterization of the PCA-PV Benchmark Facility" F. W. Stallmann, A. Fabry and F. B. K. Kam

An informal meeting of the ASTM E10.05.01 Task Group on Uncertainty Analysis was held in connection with the symposium; it was chaired by F. B. K. Kam and myself. Nine participants from European countries attended the meeting and showed interest in the activities of the Task Group and expressed willingness to share information concerning similar efforts at European organizations

Conclusions

My impressions gained from the trip is that there are many promising developments at European installations to improve the dosimetry in LWR-PV surveillance work. These methods are at present applicable to test reactors and much more research is needed to obtain comparable improvement in commercial power reactors. The correlation between dosimetry and irradiation damage need also further work. The LWR-PV surveillance program at ORNL will have a decisive impact on these problems. The contacts and exchange of information with European workers in this field will prove most valuable for the better understanding of mutual problems and clearer definition of future goals.

APPENDIX

FULL ITINERARY:

9/18-19/1979	Travel from Knoxville Tennessee to Brussels, Belgium
9/20/1979	CEN/SCK, Mol, Belgium
9/21/1979	CBNM, Geel, Belgium
9/22-23/1979	Weekend and travel to Jülich, FRG
9/24-27/1979	KFA, Jülich, FRG
9/28-30/1979	Weekend and travel to Ispra, Italy
10/1-5/1979	JRC, Ispra, Italy
10/6-28/1979	Vacation
10/29/1979	Travel from Frankfurt, FRG to Knoxville, Tennessee

PERSONS CONTACTED:

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R. Dierckx, CCR, Ispra, Italy

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