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Authors:	F.B.K. Kam, I. Remec
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OAK RIDGE NATIONAL LABORATORY
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OAK RIDGE NATIONAL LABORATORY
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POST OFFICE BOX 2008, OAK RIDGE, TENNESSEE 37831-6285

ORNL FOREIGN TRIP REPORT

ORNL/FTR-5970

DATE: October 18, 1996

SUBJECT: Report of Foreign Travel of F.B.K. Kam, Consultant; and Igor Remec, Research Staff Member I, Computational Physics & Engineering

TO: C.E. Oliver

FROM: F. B. K. Kam and I. Remec

PURPOSE: The primary purpose of this trip was to monitor the USNRC contract with the Russian Research Center, Kurchatov Institute (RRC-KI) relating to the status and results of the Reactor Vessel Dosimetry Benchmarks for Commercial VVER-440 Plants. A secondary purpose was to co-chair a workshop on the Dosimetry Aspects of Annealed Vessels and present two papers at the Ninth International Symposium on Reactor Dosimetry.

Sites Visited:

9/2-6/96	Palace of Culture	Prague, Czech Republic (CZ)
9/9-11/96	Skoda	Plzen, CZ
9/12-13/96	Nuclear Research Institute	Rez, CZ

Abstract:

F.B.K. Kam co-chaired with Dr. A. Kryukov of RRC-KI the workshop on the Dosimetry Aspects of Annealed Vessels. The issues addressed at the workshop dealt with the long irradiation time, the complicated power-time history, the lack of neutron fluence monitors, and neutron spectrum. The procedure of taking templates and scrapings from the inner surface of the RPV was proposed. The method of niobium extraction from the steel scrapings and using the $^{93}Nb(n,n')^{93m}Nb$ reaction to obtain the flux and fluence values for annealed RPVs was put forward. However, this technique is relatively expensive. Dr Zaritsky of RRC-KI said that using modern methods to characterize the dosimetry of the surveillance programs in VVER-1000 reactors indicated that the preliminary results were very different from the design values and from previous evaluations, and the reevaluation of the surveillance test results may be needed.

At the Ninth International Symposium on Reactor Dosimetry I. Remec presented a paper entitled "Oak Ridge National Laboratory Embrittlement Data Base and Dosimetry Evaluation Program" and a poster entitled "Simultaneous Neutron and Gamma Spectrum Adjustment." The poster was declared by the International Program Committee the best in Poster Session A "Techniques." The Ninth International Symposium on Reactor Dosimetry was of excellent technical value. The majority of papers and discussions addressed dosimetry analysis, transport calculations, radiation damage correlations, pressure vessel annealing etc. and were of direct interest for the work in the NRC sponsored "Embrittlement Data Base and Dosimetry Evaluation Program."

The travelers participated in the meeting of the Reactor Vessel Dosimetry Benchmark for Commercial VVER-440 Plants at Plzen, September 9-11, 1996 and at Rez, September 12-13, 1996. The USNRC has a contract with RRC-KI which will provide experimental benchmark data for the verification of current calculational models to predict pressure vessel (PV) fluences in the VVER-440 nuclear power plants. Several of the older VVER-440 reactors are not equipped with surveillance capsules. RRC-KI will provide three topical reports and a final report of the three benchmark mockups for users of existing operating VVER-440 reactors. All results of the program to date are given in Appendix D.

REPORT OF FOREIGN TRAVEL

INTRODUCTION

The purpose of this trip was two fold: 1 - F. B. K. Kam was invited to co-chair a workshop on the Dosimetry Aspects of Annealed Vessels and I. Remec was invited to present two papers at the Ninth International Symposium on Reactor Dosimetry; and 2 - the travelers participated in a meeting of the Reactor Vessel Dosimetry Benchmarks for Commercial VVER-440 Plants to discuss in detail the various aspects of the USNRC dosimetry benchmark contract with the RRC-KI. The participants in the contract were from the Nuclear Research Institute (NRI) and Skoda, Czech Republic, the Institute of Nuclear Research and Nuclear Energy (INRNE), Bulgaria, and RRC-KI, Russia. The end result of this contract will be three topical reports detailing the specifications, calculational and experimental results, and uncertainties of the three benchmarks (Mockup 1, Mockup 2, and Mockup 3) for a VVER-440 nuclear power plant (NPP). A final report will be written to document the final results of the three mockups, the conformity of the benchmarks to an actual VVER-440 NPP, and recommendations to users in validating their calculational methods.

SUMMARY OF DISCUSSIONS

NINTH INTERNATIONAL SYMPOSIUM ON REACTOR DOSIMETRY

Approximately 150 participants from 17 nations attended the conference. The list of the Sessions and Workshops is given in the Appendix B.

The poster by I. Remec, entitled "Simultaneous Neutron and Gamma Spectrum Adjustment" was declared the best poster in Poster Session A "Techniques " (see Appendix E) by the International Program Committee. The poster presented an extension of the spectrum adjustment procedure to allow simultaneous neutron and gamma spectrum adjustment. The feasibility of this technique was demonstrated in the analysis of Oak Ridge High Flux Isotope Reactor dosimetry experiments. Conditions in which gamma rays may contribute considerably to radiation damage in steels were discussed. Beryllium helium accumulation fluence monitors (HAFMs) were found to be good monitors in gamma fields of intensities high enough to contribute to steel embrittlement. The use of ^{237}Np, ^{238}U and ^{9}Be HAFM as gamma dosimeters was proposed for high-dose irradiations in high-energy, high-intensity gamma fields.

I. Remec also presented the paper entitled "Oak Ridge National Laboratory Embrittlement Data Base and Dosimetry Evaluation Program," prepared by J. V. Pace III, I. Remec, J. A. Wang and J.E. White, in the oral session D "Damage Correlation and Exposure Parameters." The paper presented an overview of the U.S. Nuclear Regulatory Commission sponsored program, carried out at ORNL, with the objective to develop, maintain, and upgrade computerized data bases, calculational procedures, and standards relating to reactor pressure vessel (RPV) fluence spectra determinations and embrittlement assessments.

In the following some interesting presentations and discussions from the symposium are summarized.

In the session "Damage Correlation and Exposure Parameters" D. E. Alexander (Argonne National Laboratory, U.S.) presented a paper entitled "The Role of Gamma Rays and Freely-Migrating Defects in Reactor Pressure Vessel Embrittlement," which discussed the role of gamma-rays in embrittlement prediction. Lively discussion that followed showed that this subject is of great interest to the community. Due to the lack of time the discussion was continued later in the workshop "Radiation Damage," where about one hour was spent on debating the importance of gamma rays in the PV embrittlement prediction.

In the same session A. Alberman (CEA Saclay, France) presented an interesting paper entitled "Neutron Spectrum Effects and Damage Analysis in Pressure Vessel Steels Irradiations," in which he discussed the results of the ESTEREL program. The program, which started in 1989 and was completed in 1995, was designed to derive experimental correlation between steel embrittlement determined by Charly-V tests and neutron fluence. Irradiations were carried out in the SILOE and OSIRIS test reactors. Their conclusions that appear to be the most interesting are: (a) in terms of damage analysis, $\Phi_{E>0.1MeV}$ was proved totally irrelevant, $\Phi_{E>1MeV}$ was proved to be the most appropriate exposure parameter, and displacements per atom (dpa) did not bring any better correlation; (b) no spectrum effect on embrittlement in the range met in a PWR (vessel internal surface, vessel 1/4 thickness, and capsules) has to be taken into account. I. Remec finds these conclusions surprising and in disagreement with the current practice in U.S. If experimental data can be obtained from EDF and CEA, he also feels that it would be very informative to re-analyze them.

In the session "Benchmarks," H. A. Abderrahim (SCK/CEN, Belgium) presented a paper entitled "WINES: Water Inelastic Neutron Scattering Experimental Study." The authors performed an experiment to study the fast neutron transport through thick layers of water. The goal of the experiment was to provide data for validation of neutron transport codes and nuclear cross-section libraries used for LWR surveillance dosimetry analyses. The neutron source was a ^{235}U (enriched to 93%) fission plate, clad in aluminum and inserted in the neutron beam emerging from the BR1 reactor. Neutrons from the fission plate enter a large water tank in which fission dosimeters and fission chambers were placed at different distances from the plate, to measure the reaction rates. The calculations were performed with DORT (discrete ordinates) and TRIPOLI (Monte Carlo) codes and a variety of transport cross-section libraries (based on ENDF/B-IV and ENDF/B-VI). It was found that the calculated-to-measured reaction-rate ratios decreased dramatically at larger (e.g. 25 cm and more) thicknesses of water. Based on preliminary results it was argued that the inelastic scattering in water is not represented adequately in the existing cross-section libraries. In the discussion the traveler (I. Remec) pointed out the need to take into account the photo fissions in the reaction rate calculations. He suggested that most of the observed discrepancies arise from photo fissions (which were not taken into account in the analysis) rather than from deficiencies in the inelastic scattering cross-sections for water.

In the "Nuclear Data" session K. Kobayashi (Research Reactor Institute, Kyoto University, Japan) presented the paper "Revision of JENDL-3 Dosimetry File;" the main 30 dosimetry cross sections and their covariances were revised and replaced. The validation was performed through integral tests which were carried out with available standard/reference neutron fields. Generally good agreement of experimental and measured average cross-sessions was obtained with the exception of $^{55}Mn(n,2n)$, $^{58}Fe(n,\gamma)$ and $^{64}Zn(n,p)$ reactions, where large discrepancies (approximately 30%) were observed. S. A. Badikov (Institute of Physics and Power Engineering, Obminsk, Russia) presented the paper "Status of Russian Dosimetry File." The RDF file contains 33 cross-section and their covariances. Evaluations were carried out at the Russian Nuclear Data Center. The cross sections and covariances are given in the ENDF/B-6 format (Files 3, 30, 33) and will be distributed with a code for covariance information transformation. Both dosimetry files could be of interest for the U.S. users, since they include more recent evaluations than ENDF/B-6.

The workshop on "Dosimetry Aspects of Annealed Vessels" was chaired by F.B.K. Kam and Dr. A. Kryukov (RRC-KI). The list of attendees is given in Appendix C. Specific issues addressed in the workshop were:

1. the long irradiation time;
2. the complicated power-time history; and
3. the lack of neutron fluence monitors.

The procedure of taking templates and scrapings from the inner surface of the RPV was proposed. The method of niobium extraction from the steel scrapings and using the $^{93}Nb(n,n')^{93m}Nb$ reaction to obtain the flux and fluence values for annealed RPVs was recommended.

The AMES (Ageing Materials Evaluation Studies) project proposal for the investigation of irradiation variables in RPV steels was suggested. The material aspects of this project were discussed in the Radiation Damage Workshop co-chaired by M. Brumovsky and A. Lowe. It was proposed that cooperation between eastern and western research organizations to investigate the influences of irradiation parameters on radiation embrittlement of RPV (PWR and VVER) would be beneficial to everyone. The materials program was to investigate the effects of irradiation temperature, flux level, spectrum, and irradiation time. The overall program combines material and dosimetry specialists.

Modern methods to characterize the dosimetry of the surveillance programs were discussed. Dr. S. Zaritsky presented the results of the new fluence evaluations in the surveillance capsules of the VVER-1000 reactors where the capsules are located in the region of high neutron flux gradients. The results obtained were very different from the design values and from previous evaluations. The results are only preliminary due to the complexity of the task. However, he indicated that the reevaluation of the surveillance test results may be needed for all VVER-1000 units. He proposed the following steps:

-experimental modeling and measurements of the radiation environment for the VVER-1000 surveillance capsules at the mock-up (LR-0 reactor) to validate the calculational methods and data;

-experimental investigations of the temperature and neutron fields in the surveillance capsules of operating NPP VVER-1000s;
-use of more sophisticated calculational methods and codes (e.g. Monte Carlo);
-more accurate calculations taking into account the irradiation history and control rods movements;
-use of the $^{93}Nb(n,n')^{93m}Nb$ monitor as a reference reaction in the fluence evaluation in the surveillance capsules.

In the workshop "LWR Surveillance," chaired by S. Anderson (Nuclear Engineering Consultant, U.S.) and C. Garat (Framatome, France), considerable attention was given to the uncertainties of the dosimetry measurements and transport calculations. The workshop participants agreed that the uncertainties of the measured activities are generally in the range 5-10%, and the uncertainties of the fast flux in the capsules and in the pressure vessels, obtained from the transport calculations, are approximately 15-20%.

In the workshop "Adjustment, libs. and uncertainties," chaired by B. Bohmer (FZ Rossendorf e. v., Germany) and J. J. Wagschal (Racah Institute of Physics, Jerusalem, Israel) the discussion of neutron spectrum adjustment procedures stressed the advantage of the adjustment over the other procedures used to analyze dosimetry results. Adjustment not only provides the best-estimate values of the irradiation parameters, but also reduces their uncertainties. As a major obstacle for more widespread use of spectrum adjustment methods, the generation of the covariance matrix of the calculated spectrum was identified. The traveler (I. Remec) concluded that contributions towards the solution of this problem are needed within the reactor dosimetry community.

Another recommendation that was repeated several times was that the iron displacement cross-section in the ASTM standards should be updated with ENDF/B-VI data.

An unresolved issue appears to be the disagreement between the calculations and measurements of the gamma fields; as reported by several participants the measurements are approximately 2 times higher than the calculations.

The Ninth International Symposium on Reactor Dosimetry was of excellent technical value, and this series is expected to remain the most important in the field of reactor dosimetry. The majority of papers and discussions at the workshops were of direct interest for the work in the NRC sponsored "Embrittlement Data Base and Dosimetry Evaluation Program."

Mr. B. Osmera from Nuclear Research Institute (NRI) Rez, Czech Republic, invited I. Remec to visit NRI Rez and tour the Light Water Zero Power Reactor (LR-0). The visit was made after the end of the conference, on Friday afternoon, September 6. LR-0 is an experimental reactor with maximum power of 5kW, dedicated to investigations of the neutronic characteristics of VVER type reactor lattices and shielding. The core consists of shortened (1250 mm active-length) VVER-1000 or VVER-440 fuel assemblies with ^{235}U enrichments 1.6-4.4 %. At the LR-0 reactor the VVER-440 and VVER-1000 mock-up experiments were performed. In these experiments the neutron spectra at the PV surveillance capsule location, inner surface of the PV, 1/3 thickness and 2/3 thickness of the PV, and at the outer surface of the PV were measured. Measured spectra can be used to check

the calculational procedures and cross-section libraries used to calculate the neutron spectra at the PVs of VVERs. The preparation of the benchmark based on VVER-440 mockup experiments was discussed in the second meeting and is described in this trip report. B. Janski and M. Marek, both from NRI Rez, also showed and explained the assemblies used to produce the reference neutron fields, based on ^{252}Cf sources, used in NRI Rez.

I. Remec was invited to participate in two informal meetings organized by A. Haghighat and B. Petrovic (both of Penn State University, U.S.), held on Tuesday, September 3, and Thursday, September 5, 1996, after the conference sessions. At the first meeting "Neutron Fluence Estimation in VVERs", representatives from NRI Rez and Skoda (Czech Republic) were presented. The second meeting "Formation of PTS (Particle Transport Simulation) Group," had more participants (from Argentina, Germany, Mexico, Czech Republic, and Finland). The organizers (A. Haghighat and B. Petrovic) were trying to identify areas in which they could provide technical assistance to other countries in the field of PV neutron fluence determination. I. Remec gathered from the discussion that little response from other countries is to be expected on this initiative.

REACTOR VESSEL DOSIMETRY BENCHMARK FOR COMMERCIAL VVER-440 PLANTS

This project covers six major tasks:

1. Benchmarks Specifications;
2. Calculational Model Definition;
3. Transport Calculations;
4. Sensitivity Analysis;
5. Experimental Data and Comparison with Calculations; and
6. Documentation of three topical reports and one final report.

There are three benchmark configurations; mockup 1, mockup 2, and mockup 3. The format and specifications for mockup 1 were discussed in a previous meeting. All required data are to be included in order that one can perform transport calculations without additional information. Fuel element parameters (fuel diameter, density, and thickness of cladding), axial reflectors details in the upper and lower components of the fuel assemblies, basket and barrel details, material composition and densities, and geometry were included in topical report 1. The travelers indicated that the source distribution, axial profile of the fuel, and an Institute report number are not specified. S. Zaritsky provided the axial profile to the participants and it will be added to the report later. The other two items were added to the topical report (UJV 10746-R) during our meetings in Rez, September 12-13, 1996.

The calculational model definition was modified to take into account the upper and lower reflectors in homogenized form. The cosine axial source distribution with averaged extrapolated length of 14.1 cm was adopted, and the experimental axial-source distribution was distributed to all participants on diskette. This diskette has not been checked by the travelers.

Calculations were performed using the S_nP_m multigroup approximation. Skoda performed a 2-D calculation, RRC-KI performed a 3-D synthesis calculation, and INRNE used their own code, ASINT, to synthesize their results. The BUGLE-93 cross section library was used by all three participants. The task was to compare each of the methods and codes. Skoda calculated the pin-to-pin source distribution using the MOBY DICK code for use by the participants. A more sophisticated pin-to-pin source distribution was calculated by V. Krysi of Skoda to distribute to the participants at the meeting. In addition to BUGLE-93, Skoda and INRNE used the BGL-440 cross sections generated from the VITAMIN-B6 using VVER-440 spectra. INRNE also used the cross section set FLUNG to calculate the fluence above 0.5 MeV and 1.0 MeV. In all the calculations, the fission spectrum in BUGLE-93 was used. The calculations were normalized at each experimental point by the integral of the spectra from 100 keV to 10 MeV. The group fluxes and fluences above specified energies were calculated behind the barrel, in front of the PV, 1/3 thickness into the PV, 2/3 thickness into the PV. and behind the PV.

Sensitivity analyses were performed by Skoda and INRNE to investigate the following effects:

1. insertion of the displacing tank and experimental tube parameters (dimension effects);
2. the water gap thickness (± 2mm);
3. the air gap thickness between the LR-0 vessel and the PV model (65+ 10 mm);
4. the water gap thickness between core and basket;
5. the thickness of the steel of out-of-core components (± 2 mm);
6. the source distribution; pin-to-pin vs. assemble-to-assembly;
7. the use of different data libraries; and
8. the scattering anisotropy; P_3 vs. P_5.

Calculations were compared with preliminary experimental data in the 47 energy group structure of BUGLE-93. Preliminary results show good agreement between Skoda and RRC-KI. The results of INRNE are being compared with those of other participants. The experimental and calculational source distributions have been compared by Skoda and the results are reported in topical report 1. It is anticipated that the data format needed for comparisons will be formalized at the next meeting. The results of the comparisons are given in the first three reports in Appendix D.

The next meeting of the participants is scheduled during the first week of December 1996. A tentative copy of the agenda for this meeting is listed in Appendix F.

Appendix A

ITINERARY

I. Remec

8/30-9/1	Travel from Oak Ridge, Tennessee, to Prague, Czech Republic
9/2-6	Ninth International Symposium on Reactor Dosimetry, Prague, CZ
9/6	Visit to Nuclear Research Institute, Rez and return to Prague
9/7-8	Weekend
9/9-11	Travel to Plzen, Czech Republic, first session of the meeting on "Reactor Vessel Dosimetry Benchmark for Commercial VVER-440 Plants", held in hotel Skoda, Plzen
9/10-11	Reactor Vessel Dosimetry Benchmark Meetings in Plzen, CZ
9/12-13	Reactor Vessel Dosimetry Benchmark Meetings in Rez, CZ
9/14-21	Vacation; travel to and vacation in Ljubljana and Nova Gorica, Slovenia
9/22	Travel from Nova Gorica to Trieste, Italy, and to Oak Ridge, Tennessee
	(Note: all expenses of I. Remec for the period 9/14-22 were at no cost to ORNL and NRC)

F.B.K. Kam

8/30-9/1	Travel from Oak Ridge, TN to Prague, Czech Republic
9/2-6	Ninth International Symposium on Reactor Dosimetry, Prague, CZ
9/7-8	Weekend in Prague, CZ (NOTE: all expenses of F. B. K. Kam's stay in Prague, 9/1-7/96 were at no cost to ORNL and NRC)
9/9-11	Reactor Vessel Dosimetry Benchmark Meetings in Plzen, CZ
9/12-13	Reactor Vessel Dosimetry Benchmark Meetings in Rez, CZ
9/14	Travel from Prague, CZ to Oak Ridge, TN

List of Sessions and Workshops at the 9th International Symposiumon Reactor Dosimetry

Date	Session Title	EWGRD Ch.	ASTM Ch.
Sep.02-06	General Chairman	P. D' hondt	
Sep.02-06	Symposium Chairman	B.Ošmera	F.H. Ruddy
Sep.02	Opening	P.D'hondt B.Ošmera	F.H. Ruddy
Sep.02	Key Note	B. Ošmera	F.H. Ruddy
Sep.02	Oral Sess.A1:RPV Surveillance & PLIM	S.Zaritski	R.Gold
Sep.02	Oral Sess.A2:RPV Surveillance & PLIM	F.Hegedüs	J.R.Worsham III
Sep.02	Post. Sess.A: Techniques	J.Hógel	P.J.Griffin
Sep.03	Oral Sess.B: Benchmarks	K.Illeva	J.Kimura
Sep.03	Oral Sess.C: Nuclear Data	E.Zsolnay	K.Kobayashi
Sep.03	Post. Sess.A continued: Techniques	M. Hort	P.J.Griffin
Sep.04	Oral Sess.D: Damage Correlation & Exposure Param.	M.Brumovský	A.L.Lowe
Sep.05	Oral Sess.E: Characterization of Environments (Exp + Cal)	H.Ait. Abderrahim	D.W.Vehar
Sep.05	Post.Sess.A/B:Surveillance,Bench.&Nucl.Data	B.Böhmer	E.P.Lippincott
Sep.05	Oral Ses. F: Dosimetry of Research Reactors and Irrad. Exper.	A.Alberman	M.H.Sparks
Sep.05	Closing	P.D'hondt B. Ošmera	F.H. Ruddy

Workshop Number	Date	Workshop Title	EWGRD Ch.	ASTM Ch.
		Workshop General Chairman	H.Nolthenius	M.Sparks
1	Sep.03	Benchmark	S.Zaritsky	J.Adams
2	Sep.04	Quality Assurance	E.Zsolnay	J.W.Rodgers
3	Sep.05	Fussion	F.Hegedüs	Y.Ikeda
4	Sep.03	Adjustment,libs and unc.	B. Böhmer	J.J.Wagschal
5	Sep.04	Mixed field dos.	H.Ait Abderrahim	C. Heimbach
6	Sep.05	Annealed vessels	A.M.Kryukov	F.Kam
7	Sep.03	LWR Surveillance	C.Garat	S.Anderson
8	Sep.04	Radiation Damage	M.Brumovský	A.Lowe
9	Sep.05	Test and Research Reactors	D. Beretz	M.Flanders

APPENDIX B

Agenda for the Workshop on Dosimetry Aspects of Annealed Vessels

September 5, 1996

1. Dosimetry and retrodosimetry aspects of templates analysis (before and after annealing, and without annealing)

2. Investigation of irradiation variables in reactor pressure vessel steels

3. Thermometry and dosimetry of surveillance assemblies of VVER-1000

4. The experiment on the working NPP

5. Benchmark formulation

6. Problem areas and future efforts

APPENDIX B

Agenda of the Reactor Vessel Dosimetry Benchmark for Commercial VVER-440 Plants Meeting

Plzen, CZ: September 9-11, 1996
Rez, CZ: September 12-13, 1996

1. Mock-ups specifications
2. Calculational models definitions for the Mock-ups.
3. Discussion of the preliminary results of the deterministic (DOT) calculations, Mock-up No. 1
4. Status of the source definition and calculations
5. Monte Carlo calculations - model definition, results or the checking of the Mock-up No. 1 calculational model in RRC KI.
6. Status of the experimental data re-evaluation
7. Comparison of the preliminary results of the Mock-up No. 1 deterministic calculations with the BUGLE-93 group cross sections library
8. Comparison of the preliminary results obtained with different cross section data libraries (BUGLE-93, BGL 440, FLUNG)
9. Discussion of the preliminary sensitivity results of Mock-up No. 1 (scattering anisotropy, source definition, fission spectrum, water gap thickness, air gap thickness, steel layers thicknesses, etc).
10. Recommendations and requirements for the final calculations and analysis - Mock-up No. 1.
11. Recommendations and requirements for the calculations and analysis - Mock-ups No. 2 and 3.
12. Definition of the formats of the calculational and experimental data presentation, and the intercomparison schemes for the final report.

APPENDIX C

ATTENDEES

Workshop on Dosimetry Aspects of Annealed Vessels
September 5, 1996

Name	Organization	Country
A. M. Kryukov	RRC-KI	Russia
F. B. K. Kam	ORNL	USA
A. Ballesteros	Tecnatom	Spain
W. Voorbraak	ECN	Holland
V. Vikhrov	RRC-KI	Russia
V. Tsofin	OKB Gidropress	Russia
V. Komolov		Russia
S. M. Shadrintsev		Russia
V. Stary		Czech Republic
M. Brumovsky	NRI	Czech Republic
B. Osmera	NRI	Czech Republic
A. Lowe		USA
M. C. Vicente		Spain
P. D'Hondt	SCKCEN	Belgium
R. de Wouters	Tractebel	Belgium
G. Hehn		Germany
J. Hogel	Skoda	Czech Republic
K. Ilieva	INRNE	Bulgaria
V. Valenta	Skoda	Czech Republic
T. Petrova	INRNE	Bulgaria
T. Apostolov	INRNE	Bulgaria
P. Platonov	RRC-KI	Russia
S. Zaritsky	RRC-KI	Russia
A. Alberman	Sarclay	France
F. Ruddy	Westinghouse	USA

APPENDIX C

ATTENDEES

Reactor Vessel Dosimetry Benchmarks for Commercial VVER-440 Plants

Name	Organization	E-mail
B. Ošmera	NRI Řež	jir@nri.cz
J. Mikuš	NRI Řež	jir@nri.cz
J. Kyncl	NRI Řež	jir@nri.cz
F. Kam	ORNL Oak Ridge	fbk@ornl.gov
I. Remec	ORNL Oak Ridge	i7r@ornl.gov; remeci@ornl.gov
T. Apostolov	INRNE Sofia	tapostol@bgearn.acad.bg
K.D. Ilieva	INRNE Sofia	krilieva@bgearn.acad.bg
S.I. Belousov	INRNE Sofia	belousov@bgearn.acad.bg
S.M. Zaritsky	RRC KI Moscow	zaritsky@atis.kiae.su
M.I. Gurevich	RRC KI Moscow	zaritsky@atis.kiae.su
E.B. Brodkin	RRC KI Moscow	zaritsky@atis.kiae.su
A.L. Egorov	RRC KI Moscow	zaritsky@atis.kiae.su
V. Valenta	ŠKODA	vvalenta@jad.In.skoda.cz
J. Hógel	ŠKODA	jhogel@jad.In.skoda.cz
M. Hort	ŠKODA	mhort@jad.In.skoda.cz
J. Hep	ŠKODA	jhep@jad.In.skoda.cz
V. Smutný	ŠKODA	vsmutny@jad.In.skoda.cz
V. Krýsl	ŠKODA	vkrysl@jad.In.skoda.cz

APPENDIX D

LIST OF INFORMATION RECEIVED

1. J. Mikus and B. Osmera, "Design, Geometry and Material Composition of VVER-440 Mockup in LR-0 Experimental Reactor," Topical Report 1, UJV 10746R, Nuclear Research Institute, Rez, Czech Republic, August 1966

2. A. Koneena et al., "Calculational Results of Skoda for Mockup No. 1 and Sensitivity Calculations," Skoda Report AE 8464 Dok, Plzen, Czech Republic, April 4, 1995

3. K. Ilieva and S. Belousov, "Reactor Pressure Vessel Dosimetry Engineering Benchmarks for VVER-440 Reactor Type," INRNE, Sofia, Bulgaria, September 1996

4. The Detail Sketch of the upper and Lower Components of the Fuel Assembly and the Lower Support Structure of LR-0

5. The Two-Dimensional Source Distribution in the Core of Mock-up No. 1 and Comparison with the Experimental Data Hard Copy and Diskette Distributed with Topical Report No. 1.

6. Calculational Results of RRC-KI for Mock-up No. 1 and Their Comparison with Preliminary Experimental Data

7. Book of Abstracts, 9th International Symposium on Reactor Dosimetry.

8. Papers of the 9th International Symposium on Reactor Dosimetry.

9 th International Symposium
on
REACTOR DOSIMETRY

The International Programme Committee appreciated
the poster presentated by

I. Remec

Simultaneous Neutron and Gama Spectrum Adjustment

as the best one in the Poster Session A

Appendix F

Agenda
of the Reactor Vessel Dosimetry Benchmark for Commercial VVER-440 Plants Meeting

Řež, December 2 - 7, 1996

1. Mock-ups specifications
   a) Mock-up No. 2
      B. Ošmera, J. Mikuš (NRI)
   b) Mock-up No. 3
      B. Ošmera, J. Mikuš (NRI)
   c) Specifications checking by the MCU code
      M. Gurevich (RRC KI), J. Mikuš (NRI)
2. Calculational models definitions and refinements
   V. Krysl, V. Smutný (Škoda)
   E. Brodkin, A. Egorov, M. Gurevich, S. Zaritsky (RRC KI)
   K. Ilieva, S. Belousov (INRNE)
   F. Kyncl (NRI)
3. Results of experimental data evaluations
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      B. Ošmera (NRI), M. Hort (Škoda)
   b) In-core pin-to-pin and axial power distributions
      J. Mikuš, B. Ošmera (NRI)
4. Status of the source calculations, comparison with the experimental results.
   V. Krysl (Škoda), J. Mikuš (NRI)
5. Comparison of the standard synthesis, ASYNT and TORT calculations, comparison with the experimental data - analysis of the necessity of 3D TORT calculations
   a) Mock-up No. 1
   b) Mock-up No. 2
      E. Brodkin, A. Egorov (RRC KI)
      S. Belousov (INRNE)

6. Discussion of the Monte Carlo calculations.

J. Kyncl, B. Ošmera (NRI)

M. Gurevich, S. Zaritsky (RRC KI)

7. Comparison and analysis of the base calculational results and experiments for Mock-ups 2 and 3.

V. Smutný, V. Valenta, M. Hort, J. Hep (Škoda)

B. Ošmera (NRI)

S. Belousov, K. Ilieva (INRNE)

E. Brodkin, A. Egorov, S. Zaritsky (RRC KI)

8. Conformity analysis

V. Smutný, V. Valenta, J. Hep (Škoda)

B. Ošmera (NRI)

S. Belousov, K. Ilieva (INRNE)

E. Brodkin, A. Egorov, S. Zaritsky (RRC KI)

Recommended participants

RRC KI:	S. Zaritsky, A. Egorov, E. Brodkin, M. Gurevich
INRNE:	K. Ilieva, S. Belousov, T. Apostolov
Škoda:	V. Valenta, V. Smutný, V. Krysl, J. Hep, M. Hort, A. Konečná
NRI:	B. Ošmera, J. Mikuš, J. Kyncl
ORNL:	F.B.K. Kam, I. Remec

Time schedule:

Mo, Dec. 02:	Arrivals to Řež
	Topics 1 and 2
Tu, Dec. 03:	Topics 3, 4
We, Dec. 04:	Topics 5, 6
Thu, Dec. 05:	Topics 7, 8
Fri, Dec. 06:	Memorandum
Sat, Dec. 07:	Departures

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