**MONTHLY PROGRESS REPORTS
AND
FINAL REPORT
October-December 1994**

**USE OF INTERNATIONAL DATA SETS TO EVALUATE
AND VALIDATE PATHWAY ASSESSMENT MODELS
APPLICABLE TO EXPOSURE AND DOSE
RECONSTRUCTION AT DOE FACILITIES**

Subcontract to:

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SENES Oak Ridge Inc.
Center for Risk Analysis
Oak Ridge, Tennessee 37830**

Subcontract No. B-218797

April 1, 1995

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MASTER

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BACKGROUND

BACKGROUND

In April 1988, the US and the former-USSR signed a Memorandum of Cooperation (MOC) for Civilian Nuclear Reactor Safety; this MOC was a direct result of the accident at the Chernobyl Nuclear Power Plant Unit 4 and the following efforts by the two countries to implement a joint program to improve the safety of nuclear power plants and to understand the implications of environmental releases. A Joint Coordinating Committee for Civilian Nuclear Reactor Safety (JCCCNRS) was formed to implement the MOC. The JCCCNRS established many working groups; most of these were the responsibility of the Nuclear Regulatory Commission, as far as the US participation was concerned. The lone exception was Working Group 7 on Environmental Transport and Health Effects, for which the US participation was the responsibility of the US Department of Energy (DOE). The purpose of Working Group 7 was succinctly stated to be, "To develop jointly methods to project rapidly the health effects of any future nuclear reactor accident." To implement the work DOE then formed two subworking groups: 7.1 to address Environmental Transport and 7.2 to address Health Effects. Thus, the DOE-funded Chernobyl Studies Project began.

This project, "Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities," grew out of several activities being conducted by the Principal Investigator Dr. F. Owen Hoffman. One activity was originally part of the Chernobyl Studies Project and began as Task 7.1D, "Internal Dose From Direct Contamination of Terrestrial Food Sources." The objective of Task 7.1D was to (1) establish a collaborative US-USSR effort to improve and validate our methods of forecasting doses and dose commitments from the direct contamination of food sources, and (2) perform experiments and validation studies to improve our ability to predict rapidly and accurately the long-term internal dose from the contamination of agricultural soil. The latter was to include the consideration of remedial measures to block contamination of food grown on contaminated soil.

At early times following an accident, the direct contamination of pasture and food stuffs, particularly leafy vegetation and grain, can be of great importance. This situation has been modeled extensively by scientists in the US, the former-USSR, and many other countries. However, models employed then to predict the deposition, retention and transport of radionuclides in terrestrial environments employed concepts and data bases that were more than a decade old. The extent to which these models have been tested with independent data sets was limited. The data gathered in the former-USSR (and elsewhere throughout the Northern Hemisphere) offered a unique opportunity to test model predictions of wet and dry deposition, agricultural foodchain bioaccumulation, and short- and long-term retention,

redistribution, and resuspension of radionuclides from a variety of natural and artificial surfaces.

The current objective of this project is to evaluate and validate pathway-assessment models applicable to exposure and dose reconstruction at DOE facilities through use of international data sets. This project incorporates the activity of Task 7.1D into a multinational effort to evaluate models and data used for the prediction of radionuclide transfer through agricultural and aquatic systems to humans. It also includes participation in two multinational studies, BIOMOVs (BIOSpheric Model Validation Study) with the Swedish National Institute for Radiation Protection and VAMP (VALidation of Model Predictions) with the International Atomic Energy Agency, that address testing the performance of models of radionuclide transport through foodchains.

In early Fiscal Year 1994, at the recommendation of DOE Headquarters with concurrence from the Working Group 7 Leader,* this project and any future work will be considered separately from the Chernobyl Studies Project. This is due to the nature and scope of this project being much broader than the original objective of Task 7.1D. Also, at the request of DOE Headquarters, the Working Group Leader will continue to provide oversight for this project. It is expected that the transfer of information from these international model-validation studies to dose-reconstruction activities being performed at DOE facilities will be facilitated by a separate project and that the essential activities of former Task 7.1D will be folded within the broader umbrella of the BIOMOVs and VAMP Projects.

As the DOE and other US organizations move further into environmental restoration and similar activities that require the use of models to predict risk or to determine cleanup criteria, the validity of such models becomes crucial. At the present time BIOMOVs and VAMP are the only model-validation studies that have significant stature, and it is strongly recommended that DOE aggressively support US participation in these validation studies.

NOTE: *During Fiscal Year 1993, the work being conducted under the auspices of Working Sub-Groups 7.1 and 7.2 was substantially changed, and many tasks were completed. Thus, the two Sub-Groups were combined into a single Group 7.

The subcontract with SENES Oak Ridge, Inc. ended on December 31, 1994. The period of performance for the subcontract was August 27, 1993 to December 31, 1994. This report contains monthly progress reports (October—December 1994) and the final report for this project and subcontract.

BUDGET

EH Monthly Summary

International Data Sets: Summary of Financial Status

Budget Category: HA-01-17

(1,000 Dollars)

Month Ending: February 1995

DOE Project Number	LLNL Project Number	Project Title	FY 1995 Budget*	FY 1995 Total Cost To Date**	Percent Spent	Remaining Balance	Variance Linear Rate***
	6288-13	Use of International Data Sets to Evaluate * and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities	84.0	83.6	100%	0.4	0
		Subcontract to: Owen Hoffman (SENES Oak Ridge Inc.)	68.2	68.0	100%	0.2	0
		Lynn Anspaugh / Sheilah Hendrickson LLNL					
LLNL TOTALS			\$84.0	\$83.6	100%	\$0.4	0

*Final Invoice approximately 2-3 months after
Contract end date of December 31, 1994*

* Includes FY 1994 carryover - No new FY 1995 funds - Subcontract terminates 12/31/94

** Includes commitments (Liens, Subcontract, IUTs, ICOs, etc.)

*** Amount in parenthesis () indicates total cost to date is under the cumulative linear spending rate

3/30/95

EH Monthly Detailed Summary
Use of International Data Sets: Summary of Financial Status
(1,000 Dollars)

Project: Use of International Data Sets to Evaluate and Validate Pathway Assessment

LLNL No: 6288-13

Models Applicable to Exposure and Dose Reconstruction at DOE Facilities

DOE No: 93-ES-966 and 93-ES-1337

[Owen Hoffman—SENES Oak Ridge Inc.] (Lynn Anspaugh / Sheilah Hendrickson)

Cost Item	Months												Year-to-Date
	1994			1995									
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Labor Costs/Salary/Benefit/Org Chg	27.2	9.6	0.0	0.0	0.0								36.8
Travel	2.4	2.6	1.1	0.0	0.0								6.1
Procurement and Expenses*	-1.1	-0.3	61.2	0.0	18.4								78.2
Technical Information Department	0.0	0.0	0.2	0.0	0.0								0.2
Facility/Service/Distributed Charges	13.9	4.9	0.0	0.0	0.0								18.8
LLNL Overhead***	-0.1	0.0	4.0	0.0	1.2								5.1
TOTAL	42.3	16.8	66.5	0.0	19.6								145.2
Actual to-date SENES+LLNL Total	-1.1	-0.3	65.4	0.0	19.6								83.6
Liens/Preliens Subcontract \$415 K	68.2	68.2	7.0	7.0	0.0								
Budget	81.8	81.8	81.8	81.8	81.8								
Funds Available	82.9	83.2	17.8	17.8	-1.8								
* Includes management procurement charges for all purchases, costs incurred from IUTs, ICOs, subcontracts													
** Division; Program; Laboratory; General & Administrative (G & A); Laboratory Directed Research Development (LDRD)													

TOTAL = Combination of actual LLNL charges and estimated monthly costs from SENES

Actual to-date SENES+LLNL Total = Actual invoices paid to SENES + LLNL costs

Liens/Preliens = Subcontract award minus actual invoices submitted from SENES

Final Invoice approximately 2—3 months after Contract end date of December 31, 1994

3/28/95

OCTOBER 1994

EH-40 Monthly Report

October 1-November 4, 1994

Project Title: Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities

DOE Project Number: 94-ES-966 **LLNL Project Number:** 6288-13
93-ES-1337

Principal Investigator: F. Owen Hoffman

M&O Contractor: Lawrence Livermore National Laboratory
(Lynn Anspaugh/Sheilah Hendrickson)

Contract to:

Subcontract B218797 with SENES Oak Ridge, Inc.

I. Project Objective

As stated in subcontract B218797, the purpose of this work is to evaluate and validate pathway assessment models applicable to exposure and dose reconstruction at Department of Energy facilities through use of international data sets.

This work has centered on involvement in two international model testing programs, BIOMOVs II and IAEA/VAMP; development of appropriate high-quality data sets for model testing using site-specific data obtained in various countries; and use of these data sets to test both process-level and multiple pathways environmental transport models.

II. Current Project Status/Monthly Progress

Administrative

The 5th BIOMOVs II Workshop was held October 24-28 at the International Atomic Energy Agency in Vienna. The 6th and Final Research Coordination Meeting of IAEA/VAMP was held the following week, October 31-November 4, also in Vienna. Highlights of these meetings are discussed in the following sections and in the trip report.

Of the major test exercises discussed in the following sections, two test exercises are at or nearing completion (VAMP Scenarios CB and S), three are ready for serious use and detailed analysis of results (BIOMOVs II Scenarios W, CP, and R), and five more are under development. Of these last five, three test scenarios are essentially ready for release to modelers; with minimal adaptation, they would be suitable for use specifically with dose reconstruction models.

The appropriate next steps in these projects are (1) to complete the final reports on the VAMP exercises, (2) to complete the BIOMOVs II exercises and prepare final reports on them, and (3) to carry out the new test exercises as their development is completed. The new scenarios are designed to address specific situations not addressed in previous test exercises (e.g., the effects of post-contamination countermeasures, surface water contamination, and additional radionuclides). Renewed funding will be necessary to see the present projects through to completion and to ensure that additional test exercises both meet the Government's anticipated needs for appropriate model testing opportunities and make use of properly validated, high-quality data sets. In addition, for the Government to achieve the best possible use from model testing activities, it is highly desirable for the data sets (input data and test or output data, together with complete documentation) to be properly archived. This will enable present and future researchers and modelers to have access to suitable data sets for testing a wide variety of models. Additional funding is also necessary if archival of the data sets is to occur in a timely fashion and while the data sets are still complete.

Technical accomplishments

1. At the final plenary session of the 6th and Final Research Co-ordination Meeting, Owen Hoffman gave a presentation describing the results and conclusions from both Scenario CB and Scenario S.

A number of conclusions were drawn from the Scenario CB exercise:

- 1) Most models tended to overestimate the body burdens of Cs-137.
- 2) The experience of the modeler is as important as the nature of the model.
- 3) Testing is necessary at several steps within a pathway, otherwise compensatory error may not be identified.
- 4) Models should be amenable to alterations in structure to address site specific conditions.

- 5) Because user judgment is always necessary, critical assessments should be performed by more than a single group.

Additional conclusions were drawn from the Scenario S exercise:

- 1) Very accurate estimates were made for non-traditional pathways (i.e., fish, berries, big game, mushrooms). A major reason for this is the abundance of pre-Chernobyl data on radionuclides in northern climates.
- 2) User experience is still a factor in determining the accuracy of results.
- 3) Uncertainty estimates are highly dependent on judgment and thus differ among investigators.
- 4) Compensatory error is still evident.

The major finding from completion of the two test exercises is that **model testing against independent data sets exposed the importance of the model user in determining the accuracy of the model prediction.** Blind testing of model predictions identified the most important reasons for mispredictions to be the following:

- 1) user inexperience (e.g., an inability to assess the "face validity" of results);
- 2) insufficient understanding of important site-specific pathways and processes;
- 3) differences in interpretation of imperfect input data; and
- 4) use of generic parameter values which did not fit site-specific situations.

Factors which may affect model performance include the flexibility of the model (both in parameter values and in model structure) for site-specific assessment, the availability of site-specific data to quantify key model parameters, the presence of compensatory error in the model, and the possibility that apparent accuracy may in some cases be due to the averaging of distinctly different processes across an entire region. Suggestions for future model testing exercises include the use of additional sites and radionuclides, testing for exposure of members of critical groups or specific population subgroups, consideration of the representativeness of Chernobyl fallout data to other situations, and testing of models at the process level.

- 2) The final report for Scenario CB of the IAEA/VAMP Multiple Pathways Assessment Working Group is in press. Pre-publication copies were distributed at the Vienna meeting.
- 3) The initial draft report for Scenario S, together with participants' individual evaluations, was distributed to participants at the VAMP 6th Research Coordination Meeting in Vienna. Remaining problem areas in the report were addressed in the discussions. A revised version of the complete report will be completed by February 15 for publication by the IAEA.

Scenario S was the most comprehensive test to date of multiple pathways exposure assessment models, and uncertainty estimates were required on both the test data and the model predictions. Scenario S was the first test to include contributions to the human diet from natural and seminatural ecosystems and to consider the importance of human consumption of freshwater fish. In this situation, contaminants accidentally released to the atmosphere were transferred to humans via consumption of fish. Several important findings were obtained from this test exercise: (1) differences in the dietary uptake and whole body concentrations of Cs-137 occur due to differences in gender and age; (2) different pathways dominated the exposure of individuals at different times following the contaminant release; and (3) changes in dominant pathways with time were affected by soil composition and hence soil fixation of Cs-137. These findings are supported by a comparison of test data (normalized for total deposition) between Scenarios CB and S.

- 4) Results of a model intercomparison exercise performed at SENES Oak Ridge using data from Scenarios CB and S were presented at the BIOMOVs II and IAEA/VAMP meetings in Vienna, with specific emphasis on the effect of the user on the outcome of model predictions. The presentation included predictions obtained by a single user with several assessment models potentially used for dose reconstruction calculations in the United States: NCRP, AIRDOS-EPA, SS-57 (IAEA Safety Series 57), RESRAD, and PATHWAY. The first four, which have been discussed in previous monthly reports, are quasi-steady state models. PATHWAY, a dynamic model, was recently encoded at SENES from published model descriptions.

Use of the data sets from VAMP for this intercomparison exercise has permitted comparison of our model results both with the test data (observations) and with predictions made by other modelers (participants in the VAMP exercises). The results indicate that the variability among model predictions is reduced when models are run by a single individual using a consistent interpretation of the input data for all models. Differences among model results may in many cases

be due more to choice of parameter values (e.g., generic vs. site-specific) than to actual differences in model structure. The results for the U.S. models also show that bias in the model predictions is usually toward the conservative side. This is expected for screening models such as NCRP and SS-57, but was also found with models such as AIRDOS-EPA, which was designed to give a best estimate. The extent of conservatism in the model predictions is not extreme and was usually less than one order of magnitude.

- 5) Three new Multiple Pathways scenarios were distributed and discussed at the Vienna meeting: Scenario H (Hanford), which describes an I-131 release in 1963; Scenario I (Ipup River), which is based on data from the Bryansk region of Russia following the Chernobyl accident and which is the first multiple pathways scenario to consider the effects of countermeasures; and Scenario T (Techa River), which uses data from historic releases of radioactive contamination into the Techa River in Russia. Discussion centered on whether to release the scenarios in their present form or to adapt one or more of them for testing of dose reconstruction models. The IAEA was encouraged to make use of these scenarios as soon as possible while momentum is high, rather than waiting until 1996 when a new model testing program is expected to be initiated.
- 6) Initial comparison and evaluation of model predictions for the BIOMOVs II Post Chernobyl scenarios was carried out prior to the October meeting in Vienna. Model predictions have been received for all three scenarios: Scenario W (Wash-off), Scenario CP (Cooling Pond), and Scenario R (Resuspension). SENES staff submitted model predictions for each scenario. More detailed discussion of the modeling results is included in the draft Progress Report 5 of BIOMOVs II, given as an attachment to this report.

The model predictions were compared with the test data (observations), but in anticipation of submissions by additional modelers, the test data were released only to modelers who had submitted predictions. The scenarios have been submitted as a set to *Health Physics*, and additional predictions for the scenarios are expected from modelers both inside and outside the BIOMOVs II community.

Secondary deadlines have been made for additional model predictions. BIOMOVs II participants have been asked to submit all calculations or revised calculations by 15 January 1995. The deadline for submissions from readers of *Health Physics* will be approximately one year after publication. BIOMOVs II technical reports describing each model testing exercise and its results will be prepared before BIOMOVs II ends in 1996.

- 7) Two new scenarios were discussed in the BIOMOVs II Post Chernobyl Data Working Group; these are actually extensions of the W and CP scenarios. Scenario FP (Flood Plain) was distributed in draft form. This scenario describes the wash-off of contaminated soil into the Pripyat River (Ukraine) during a flood in 1991. The proposed extension of Scenario CP will provide an opportunity to compare dose and risk assessments for three possible remediation plans (no remediation, filling of the cooling pond with dirt, and drainage of the cooling pond) and for a possible accident (breaking of the dam). Primary emphasis will be given to placing the new exercises in settings where there is the best demonstration of scientific interest.

Activities in progress

- 1) A trip report for the Vienna meetings is in preparation.
- 2) Model predictions (both model intercomparisons and comparisons of predictions with test data) are being compiled for distribution to the participants in the Post Chernobyl Data Working Group of BIOMOVs II. Test data will be released only to modelers who submitted predictions. Modelers have been asked to submit any additional or revised predictions by January 15, 1995. A decision has not yet been made concerning the need for an interim working group meeting.
- 3) The section of the Scenario S report dealing with dose calculations is being revised to permit adequate explanation of the methodology used for dose estimation. Additional revision of the report will be done based on comments received from working group participants. Documentation of the test data is expected in December. A deadline of January 15 was given for comments on the report and revised write-ups from individual participants (modelers' own descriptions of their models and modeling results). A revised version of the complete report will be completed by February 15; further review of the document prior to publication will be at the discretion of the IAEA.
- 4) Results of the model comparison exercise using data from IAEA/VAMP are being prepared for submission to the open literature. This exercise has involved use by a single modeler of five different codes (NCRP, AIRDOS-EPA, SS-57, RESRAD, and PATHWAY) with two separate data sets. The material being prepared will include presentation of the individual performances of the models as compared both with the test data (observations) and with predictions made by other modelers (participants in the VAMP exercise).

Travel--The 5th BIOMOVs II Workshop was held October 24-28 at the International Atomic Energy Agency in Vienna. The 6th Research Coordination Meeting of IAEA/VAMP was held the following week, October 31-November 4, also in Vienna. The trip report is in preparation.

III. Significant Problems/Issues/Concerns

Not applicable this month.

IV. Assistance Required of EH-40 Staff

Not applicable this month.

Foreign Trip Report Summary

F. Owen Hoffman, Kathleen M. Thiessen, and Shyam K. Nair

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Subcontract No. B218797

November 8, 1994

Date of Trip: October 17 - November 4 (Owen Hoffman)
October 24 - November 4 (Shyam Nair, Kathleen Thiessen)

Trip Destination: International Atomic Energy Agency, Vienna, Austria

Purpose of Trip: The purpose of this travel was threefold: (1) to participate in and chair a meeting for the revision of IAEA Safety Series 57 (Owen Hoffman), (2) to participate in (Shyam Nair and Kathleen Thiessen) and chair (Owen Hoffman) a working group for the BIOMOVs II Workshop involving model testing and improvement, and (3) to participate in (Shyam Nair and Kathleen Thiessen) and chair (Owen Hoffman) a working group for the VAMP Workshop involving model validation and testing.

Abstract

The purpose of the first meeting was to finalize a document to replace IAEA Safety Series 57 with a new document on "Dose Assessment Methods for the Purpose of Limiting Radioactive Releases." The primary purpose of the document was to provide a simplified version of Safety Series 57 that can be used by third-world and other countries to calculate screening dose rates for the purpose of limiting discharges of radionuclides to the environment. The draft document was revised, and with minor and editorial changes to most of the chapters of the document, it should be ready for publication in early 1995.

The second meeting was the Fifth Workshop of BIOMOVs II (BIOSpheric Model Validation Study - Phase II), held at the IAEA Headquarters in Vienna, Austria. In the "Post Chernobyl Data" working group, chaired by Owen Hoffman, model predictions were presented for three scenarios previously developed from Ukrainian and Russian data sets. The scenarios tested involved several important processes of environmental contamination including contamination of surface water by runoff from contaminated soils (Scenario W), contamination of aquatic ecosystems due to aerial deposition of contamination (Scenario CP), and resuspension of contaminated soil into air (Scenario R). Model predictions were compared with each other and with actual measurements. Reasons for differences in predictions and deviation from measurements were discussed, and goals for the remainder of the BIOMOVs II program were established to provide for timely completion and document preparation. Shyam Nair presented predictions for the washoff and resuspension scenarios, and a set of predictions for Scenario CP was contributed by other representatives of SENES Oak Ridge. Presentation of different modeling approaches, incorporating different assumptions, levels of process detail, and ranges of parameter values, along with comparison of predictions with actual measurements, provided a unique opportunity for the scientists to understand the relative importance of various processes and parameters defining the systems. Based on this feedback, the modelers can now make appropriate adjustments to their models to improve their predictive capabilities.

The third meeting was the Sixth and Final Research Coordination Meeting of the IAEA/VAMP (Validation of environmental Model Predictions) program. Four working groups (aquatic, terrestrial, urban, and multiple pathways) met in parallel sessions throughout the week to discuss model predictions for scenarios developed in earlier VAMP meetings and to prepare drafts of final working group reports. The multiple pathways working group distributed pre-publication copies of the final report for Scenario CB (Central Bohemia), and discussed the remaining incomplete areas in the final report for Scenario S (Southern Finland). In the final plenary session, Owen Hoffman summarized the key findings and accomplishments of the multiple pathways group. Shyam Nair attended and helped draft sections of the final document for the "rivers"-subgroup of the aquatic group; he also presented predictions for one of the scenarios from the urban working group.

Foreign Trip Report

F. Owen Hoffman
Kathleen M. Thiessen
Shyam K. Nair

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The purpose of this travel was threefold: (1) to participate in and chair a meeting for the revision of IAEA Safety Series 57 (Owen Hoffman; October 17 - October 21), (2) to participate in (Shyam Nair and Kathleen Thiessen) and chair a working group for (Owen Hoffman) the BIOMOVs II Workshop involving model testing and improvement (October 24 - October 28), and (3) to participate in (Shyam Nair and Kathleen Thiessen) and chair a working group for (Owen Hoffman) the VAMP Workshop involving model validation and testing (October 31 - November 4). The itinerary of each participant is presented in Appendix A.

Two additional members of the SENES team also attended the meetings. B. Gordon Blaylock, funded by the IAEA and the Centers for Disease Control and Prevention, attended all three meetings. A. Iulian Apostolaei, funded by the IAEA as a representative of Romania, attended BIOMOVs II and VAMP. Summaries of the activities that they were involved in are included in this trip report as a courtesy to the Department of Energy.

I. IAEA Safety Series 57

Appendix B provides the agenda for the meeting. The meeting was chaired by Owen Hoffman, who was also involved with the original IAEA Safety Series 57 and has been instrumental in producing the updated document. Dr. Charles W. Miller of the Radiation Studies Branch, Centers for Disease Control and Prevention, Atlanta, Georgia was chairman of the chapter on atmospheric releases to the environment. He also worked with Dr. Yasuo Onishi from Battelle Pacific Northwest Laboratories, Richland, Washington, on the surface water modeling chapter. Dr. B. Gordon Blaylock of SENES Oak Ridge and Dr. Martin J. Frissel of the Netherlands were chairmen of the chapters on dosimetry and the transfer coefficients in the terrestrial and aquatic environments, respectively.

In the revised Safety Series 57, the emphasis is on a document for use by under-developed countries. The purpose of the report is to provide a screening methodology for individuals who do not have access to computers, and who are required to provide estimates of the effects of releases of radionuclides from facilities such as hospitals. Methodologies were developed that use a minimum number of calculations for a reasonably accurate evaluation of the releases of radionuclides from facilities. Therefore, in the equations used, several parameters are lumped into one, and the equations are simplified. This document should not be misconstrued as a replacement for IAEA Safety Series 57, but it is a self-contained screening methodology which can be used by under-developed countries.

Chapter 8, dealing with the conclusions of the Safety Series 57, was completely rewritten for the current report. The chapter on the dispersion of radionuclides in aquatic ecosystems was simplified and is being completed. The release of radionuclides into sewer systems and the possible routes of exposure are being investigated by Jane Simmonds of the National Radiological Protection Board, United Kingdom, to determine whether such a section should be included in the report. Plans are for the report to be in the hands of the editor by early 1995.

II. 5th Workshop of BIOMOVs II (October 24 - October 28, 1994)

Appendix C presents the agenda for the workshop. Workshop activities centered around six working groups involving complementary studies, reference biospheres, post-Chernobyl data, special radionuclides (^{14}C and ^3H), uranium mill tailings, and uncertainty and validation.

A. Post-Chernobyl Data Working Group

Owen Hoffman, Kathleen Thiessen, Gordon Blaylock, and Shyam Nair participated in the post-Chernobyl working group meeting, which was chaired by Owen. On the agenda for discussion were three scenarios: Scenario W involved washoff of ^{137}Cs and ^{90}Sr from an experimental plot by runoff from artificially induced rainfall and washoff of the same radionuclides from another plot by snowmelt; Scenario CP involved the contamination of the ecosystem defined by the Chernobyl cooling pond; and Scenario R involved the resuspension of radionuclides in Ukrainian regions impacted by Chernobyl fallout.

Model predictions have been received for all three scenarios; the scenarios and the modeling results are described in more detail in the following sections. The scenarios have been submitted as a set to *Health Physics*, and additional predictions for the scenarios are expected from modelers both inside and outside the BIOMOVs II community. The model predictions described below were compared with the test data (observations), but in anticipation of submissions by additional modelers, the test data were not released to anyone who had not submitted predictions.

In addition to the three scenarios described below (Scenarios W, CP, and R), plans were presented for additional scenarios which are actually extensions of the W and CP scenarios. Scenario FP (Flood Plain) was distributed in draft form. This scenario describes the washoff of contaminated soil into the Pripyat River (Ukraine) during a flood in 1991. The proposed extension of Scenario CP will provide an opportunity to compare dose and risk assessments for three possible remediation plans (no remediation, filling of the cooling pond with dirt, and drainage of the cooling pond) and for a possible accident (breaking of the dam).

The decision was made for the Post Chernobyl Data Working Group to concentrate its efforts on concluding the existing scenarios and to evaluate the best opportunities for development of the extensions of the scenarios. Primary emphasis will be given to placing the new exercises in settings where there is the best demonstration of scientific interest.

Scenario W: Wash-Off of ^{90}Sr and ^{137}Cs from Two Experimental Plots Established in the Vicinity of the Chernobyl Reactor.

Runoff from contaminated land is one of the main sources of contamination to surface water. The Chernobyl accident has provided a unique opportunity to develop a data base suitable for testing the predictive capability of mathematical models to assess radionuclide wash-off into rivers and lakes from soils contaminated by the deposition of fuel particles.

Phase I of the wash-off scenario examines the wash-off of ^{90}Sr and ^{137}Cs from two experimental plots established in the vicinity of the Chernobyl reactor. These scenarios were developed by Alexei V. Konoplev, A. A. Bulgakov, and

Owen Hoffman on the basis of experiments carried out by scientists from the Institute of Experimental Meteorology, SPA "Typhoon," Obninsk. Konoplev was a participant at the workshop.

The first scenario (Scenario HR) consisted of spraying a 625-m² experimental plot twice with artificial rainfall. Concentrations of ¹³⁷Cs and ⁹⁰Sr in the top 10 cm of soil and their distributions in exchangeable and nonexchangeable forms were measured prior to the experiments. Runoff generated during the two experiments and during the next 24 hours was collected, and amounts of dissolved and suspended forms of ¹³⁷Cs and ⁹⁰Sr in the runoff water and the volumes of rainfall and runoff were measured. The modelers were asked to predict the vertical distributions of ¹³⁷Cs and ⁹⁰Sr concentrations in exchangeable and nonexchangeable forms prior to the experiments in the top 10 cm of the soil as the prediction midpoint. As prediction endpoints, they were asked to predict the concentrations (in exchangeable and nonexchangeable forms) and amounts of ¹³⁷Cs and ⁹⁰Sr in the runoff water from each experiment and 24 hours after the experiment. All predictions were to be supported with estimates of the 95% confidence intervals.

Five modelers participated using different models and assumptions. They included Shyam Nair, Gennady Lyashenko (Cybernetics Centre, UAAS, Ukraine), Bela Kanyar (National Research Institute for Radiobiology and Radiohygiene, Budapest, Hungary), Wolfgang Raskob (KfK, Germany), and Alexander Popov (Russia). All, except Raskob, used detailed speciation chemistry and transport processes in their models. Raskob provided order-of-magnitude estimates using hand-calculations and a K_d -based approach. Raskob and Lyashenko did not make midpoint predictions because their models did not include vertical transport. Kanyar did not provide 95% confidence intervals. Only Nair and Popov made predictions for midpoints, endpoints, and confidence intervals.

Observed values of midpoints and endpoints were disclosed for the benefit of modelers. However, they were not released to the general audience because of the expectation that other modelers will perform calculations. Shyam Nair's model provided the closest agreement with the measurements for the prediction midpoints, while other models fared better with the endpoints. The next step of

the Phase I efforts involves making model structure/parameter adjustments to reconcile the differences. The main reasons for disagreement between Shyam Nair's model predictions and endpoints were believed to be the low values assumed for suspended solids in the runoff water and for depth of runoff in the topsoil. After adjustment for these parameter values, this model is expected to provide better predictions for the endpoints.

There was only one response (A. Popov) to the second scenario (Scenario SM) involving washoff of contaminants by snowmelt. Since Shyam Nair and other participants intend to complete predictions for this scenario, the measured endpoint values were not discussed.

Scenario CP: Assessment of the Consequences of the Radioactive Contamination of the Chernobyl NPP Cooling Pond.

The objective of Scenario CP is to test models for radioactive contamination of aquatic ecosystems; the scenario is based on data from the Chernobyl Nuclear Power Plant cooling pond. The input data include characteristics of the cooling pond ecosystem and estimates of amounts of ^{137}Cs in the Chernobyl cooling pond (30 May 1986). The scenario consists of two stages of calculations. The first stage required calculations of ^{137}Cs concentrations in different media for which measurements exist and against which model predictions can be tested. The second stage required calculations for dose and risk estimates which can only be predicted, not tested.

A cooling pond is a suitable model for studying the dynamic processes of radionuclide migration and accumulation in closed aquatic systems. Dynamic processes worthy of detailed investigations include (1) ^{137}Cs accumulation in different trophic levels, (2) the accumulation and removal of ^{137}Cs from the flesh of fish, and (3) the dependence on size of the accumulation of ^{137}Cs by various species of fish. In addition, the cooling pond has a unique temperature distribution structure.

Owen Hoffman is one of the authors of the scenario. The rest of the developers and authors of the scenario include scientists from the Institute of Experimental Meteorology, SPA "Typhoon," Obninsk, Russia; the Institute of Evolution

Morphology and Ecology of Animals, Russian Academy of Sciences, Moscow, Russia; the Chernobyl Ministry of Ukraine, Kiev, Ukraine; and the Institute of Nuclear Research, Ukrainian Academy of Sciences, Kiev, Ukraine. The chief contributor to the scenario, Dr. I. I. Kryshev, was present at the workshop.

Results for Stage 1 were submitted by Rudie Heling (KEMA Nederland BV) and Dan Galeriu (IAP-RL, Romania). The predictions were compared to the test data (observations), but the test data were not released to anyone but the modelers. Revisions to these predictions are expected, along with predictions from additional modelers. One set of predictions for Stage 2 was submitted by Gordon Blaylock and Ying Feng (SENES Oak Ridge). Stage 2 was designed for model intercomparison only, so there are no test data for this stage. Revised results from these modelers are expected, along with additional sets of predictions from other modelers.

Scenario R: Atmospheric Resuspension of Radionuclides in Ukrainian Regions Impacted by Chernobyl Fallout.

Resuspension is the process by which surface deposits of radioactive particles are re-entrained into the air by mechanisms such as wind action and mechanical disturbances enhanced by human activity. The resuspension of particulates deposited following the large, unintentional releases of radioactivity from Unit 4 of the Chernobyl Nuclear Power Station in 1986 has been studied extensively for the past 6 years. These data form the basis for this scenario. The data in the scenario reflect the heterogeneity of exposure to resuspended material and permit the examination of three different exposure situations. The prediction endpoints included calculations of annual average and seasonal concentrations of ^{137}Cs at selected locations (one in each city) in three different cities (Kiev, Pripyat, and Poleskoe) and calculations of resuspension rates and factors for the city of Zapolie from 1986 to 1992. All predictions were to include uncertainty estimates in terms of the 95% limits about the mean. The primary developer of the scenario, Dr. E. Garger of the Institute of Radioecology UAAS, Kiev, Ukraine, was a participant at the BIOMOVs II meeting.

Three modelers performed calculations: C. W. Miller from the Centers for Disease Control and Prevention, Atlanta; Dan Galeriu from Chalk River Nuclear Laboratories, Ontario, Canada; and Shyam Nair. The predictions were compared with the actual observations. Shyam Nair's results provided the best match with the observations in terms of both trends and values.

B. Other Activities of the BIOMOVs II Workshop

Gordon Blaylock, Iulian Apostoaei, and Shyam Nair also participated in other working group meetings. In the working group session for Post Chernobyl Data, Dr. Alexei Konoplev of SPA "Typhoon" from Obninsk, Russia, discussed the mass exchange rate of ^{90}Sr from the floodplain of the Pripyat River which occurred in 1991. The increase in the mass exchange rate for ^{90}Sr was apparently caused by the ice jam which formed on the floodplain. This is not an unusual condition in the area, but it was the first time such an ice jam had occurred since the Chernobyl Accident. A new BIOMOVs scenario (FP) was introduced whose purpose was to model the remobilization of ^{137}Cs and ^{90}Sr from the Pripyat floodplain during 1991.

Iulian Apostoaei took part in the "modeler interpretation" subgroup of the Uncertainty and Validation working group. This subgroup studied the effect of user interpretation. All users were asked to use one and the same model on different scenarios. The scenarios were based on contamination of Bremen (Germany) from Chernobyl fallout and contamination of Hanford (USA) from historical releases of radioiodine. He also attended several sessions of the Model Complexity working group. This group studied the effect of model structure on the uncertainty in predictions. Modelers were asked to use models with different structures to perform calculations for a given scenario. To eliminate user knowledge of specific conditions at a given site, a hypothetical scenario was used.

Shyam Nair participated in the working group dealing with uncertainties and validation. He was particularly interested in the subgroup "Use of Lysimeter Data" because the data collected by this group through lysimeter experiments at Nirex Corp. in the United Kingdom would be useful for the modeling of groundwater flow in the unsaturated zone. He also expressed an interest to get involved in the future activities of this subgroup by participating in the model

validation exercises using actual lysimeter data. He also agreed to perform model simulations and to provide results to the "Effects of Model Complexity" subgroup for their model comparison and uncertainty analysis studies.

Plenary sessions included presentations from all six working groups and discussions of past, present, and future activities of BIOMOVs II. Iulian Apostoaei was invited to present his work on effects of various parameters such as user experience and model complexity on the accuracy of model predictions. This work was based on data sets from VAMP and it used models that are extensively used in the US for screening, regulatory, and dose reconstruction applications.

III. Sixth and Final RCM of the IAEA/VAMP

Appendix D presents the agenda for this meeting. Workshop activities centered around four working groups: aquatic, terrestrial, urban, and multiple pathways. The aquatic group was further subdivided into "lakes" and "rivers" subgroups. Owen Hoffman chaired the multiple pathways group and Kathleen Thiessen provided the technical expertise to analyze, compare, and present predictions from different modelers who participated in the multiple pathways exercises. Gordon Blaylock and Shyam Nair participated in the "rivers" subgroup of the aquatic group. Iulian Apostoaei participated in the terrestrial group. Shyam Nair also participated in the urban group.

Multiple Pathways Assessment Working Group:

The Multiple Pathways Assessment Working Group of IAEA/VAMP has completed two test exercises: Scenario CB (Central Bohemia, Czech Republic) and Scenario S (Southern Finland). The final report for Scenario CB is now in press, and a pre-publication version was distributed to VAMP RCM participants. The first complete draft of the final report for Scenario S was distributed for comment and discussion, primarily among working group participants.

Scenario S was the most comprehensive test to date of multiple pathways exposure assessment models, and uncertainty estimates were required on both the test data and the model predictions. Scenario S was the first test to include contributions to

the human diet from natural and seminatural ecosystems and to consider the importance of human consumption of freshwater fish. In this scenario, contaminants accidentally released to the atmosphere were transferred to humans via consumption of fish. Several important findings were obtained from this test exercise: (1) differences in the dietary uptake and whole body concentrations of ^{137}Cs occur due to differences in gender and age; (2) different pathways dominated the exposure of individuals at different times following the contaminant release; and (3) changes in dominant pathways with time were affected by soil composition and hence soil fixation of ^{137}Cs . These findings are supported by comparison of test data (normalized for total deposition) between Scenarios CB and S; for instance, comparison of the distributions of the human whole body concentrations of ^{137}Cs shows distinct differences between the two populations for 1990, as well as showing the existence of a critical subpopulation in the Finnish group (Fig. 1).

Discussion of the draft report identified several areas in need of further attention before a final report can be issued. In particular, the documentation of the test data will be completed and reviewed, and the section on estimation of doses to humans will be revised in light of more adequate estimates from the originators of the test data.

Three new scenarios were distributed and discussed: Scenario H (Hanford), which describes an I-131 release in 1963; Scenario I (Iput River), which is based on data from the Bryansk region of Russia following the Chernobyl accident and which is the first multiple pathways scenario to consider the effects of countermeasures; and Scenario T (Techa River), which uses data from historic releases of radioactive contamination into the Techa River in Russia. Discussion centered on whether to release the scenarios in their present form or adapt one or more of them for testing of dose reconstruction models. The IAEA was encouraged to make use of these scenarios as soon as possible while momentum is high, rather than waiting until 1996 when a new model testing program is expected to be initiated.

At the final plenary session of the RCM, Owen Hoffman gave a presentation describing the results and conclusions from both Scenario CB and Scenario S.

Fig. 1. Comparison of distributions of whole body concentrations for adults (males and females) in Central Bohemia (CB) and southern Finland (S) for 1990. Shown are (A) the observations and (B) the observations normalized for total deposition. Confidence limits on the normalized observations represent only the uncertainty in the total deposition. Observations for CB are for the fourth quarter of 1990; observations for S are for December 31, 1990.

A number of conclusions were drawn from the Scenario CB exercise:

1. Most models tended to overestimate the body burdens of Cs-137.
2. The experience of the modeler is as important as the nature of the model.
3. Testing is necessary at several steps within a pathway, otherwise compensatory error may not be identified.
4. Models should be amenable to alterations in structure to address site specific conditions.
5. Because user judgment is always necessary, critical assessments should be performed by more than a single group.

Additional conclusions were drawn from the Scenario S exercise:

1. Very accurate estimates were made for non-traditional pathways (i.e., fish, berries, big game, mushrooms). A major reason for this is the abundance of pre-Chernobyl data on radionuclides in northern climates.
2. User experience is still a factor in determining the accuracy of results.
3. Uncertainty estimates are highly dependent on judgment and thus differ among investigators.
4. Compensatory error is still evident.

The major finding from completion of the two test exercises is that **model testing against independent data sets exposed the importance of the model user in determining the accuracy of the model prediction.** Blind testing of model predictions identified the most important reasons for mispredictions to be the following:

1. user inexperience (e.g., an inability to assess the "face validity" of results);
2. insufficient understanding of important site-specific pathways and processes;
3. differences in interpretation of imperfect input data; and
4. use of generic parameter values which did not fit site-specific situations.

Factors which may affect model performance include the flexibility of the model (both in parameter values and in model structure) for site-specific assessment, the availability of site-specific data to quantify key model parameters, the presence of compensatory error in the model, and the possibility that, in some cases, apparent accuracy may be due to the averaging of distinctly different processes across an entire region. Suggestions for future model testing exercises include the use of additional sites and radionuclides, testing for exposure of members of critical groups or specific population subgroups, consideration of the representativeness of Chernobyl fallout data to other situations, and testing of models at the process level.

Aquatic Pathways Working Group:

The Aquatic Pathways Working Group was divided into two subgroups. The lake scenario which examined the transport and accumulation of radionuclides from the Chernobyl fallout in small lakes in Sweden and Norway was the initial scenario for the aquatic working group. Later a decision was made to split the aquatic working group into the lake and river subgroups. Gordon Blaylock and Shyam Nair attended the working sessions of the river subgroup. The river task had two scenarios: the release of radionuclides from the Chernobyl accident to the Dnieper River, and the release of radionuclides from the Oak Ridge National Laboratory to the Clinch and Tennessee Rivers. The accumulation of radionuclides in different compartments was to be predicted, along with the potential dose to individuals who used the river systems.

The lake scenario is nearing completion, but the size of the document has grown considerably and may present a problem in publication. The river scenario has also grown to an untenable size and is in need of reorganization as well as completion of the scenarios. Three groups had provided predictions for the Clinch River scenario; however, they were not complete. The document is currently in need of a considerable amount of work and is not ready for the editors. As a result, Mark Zheleznyak, Institute of Mathematical Machines, and Systems, Kiev, Ukraine, and Gordon Blaylock of SENES Oak Ridge, Tennessee, USA, have been requested to travel to Vienna in February, 1995, to aid in the completion of the document.

Gordon Blaylock was also made responsible to consolidate sections from different contributors in preparation for the final documentation of the activities of this group. This document will be available for release to the public during the IAEA Symposium in 1995 (International Symposium on Environmental Impact of Radioactive Releases).

Shyam Nair reviewed the modeling section of the document and provided suggestions to improve the overall quality of the document.

Urban Working Group:

Shyam Nair participated in this group as a modeler. Two problems were defined, one involving a resuspension scenario in an urban environment located in Goiania, Brazil; and the other involving external radiation exposure from groundshine from the deposition of ^{137}Cs and ^{134}Cs from the Chernobyl accident fallout at a location 50 km west-south-west from the nuclear power plant. For the resuspension scenario, modelers were asked to predict concentrations and deposition rates of ^{137}Cs at two heights in a 180-m^2 contaminated plot behind a house located in front of a contaminated street. For the external radiation scenario, the modelers were asked to provide best estimates of the mean external dose to several population groups classified by age differences. Modelers for both problems were required to provide estimates of uncertainty associated with their predictions.

Four modelers provided predictions for the first problem: Shyam Nair; Charles W. Miller from the Centers for Disease Control and Prevention, Atlanta; K. Nicholson from AEA Technology, UK; and John Garland from AEA Technology, UK. The predictions were compared with each other and with actual test data. Shyam Nair will be responsible for preparing a technical document summarizing the results for this problem. Six modelers provided predictions for the second problem involving the calculation of external doses to different population groups. These predictions were compared with each other and with actual test data, and reasons for differences in model predictions were discussed.

Terrestrial Working Group:

Iulian Apostoaei attended the sessions of this working group, where the primary focus was the forest ecosystem. Most of the forest system models are still generic in nature because they lack the experimental data to parameterize the models. Theoretical and experimental research on subcompartments of the system were also presented. Iulian Apostoaei also participated in the “fruit-tree modeling” subgroup, where he proposed a model for the transfer of mobile elements and reviewed existing data for fruit-tree ecosystems.

Appendix A

Itinerary

Date	Activity	Contact
10/14-15/94	Depart Oak Ridge, TN, USA, and arrive in Vienna, Austria (Owen Hoffman)	
10/17-21/94	Meeting for the Revision of IAEA Safety Series 57	M. Crick
10/21-22/94	Depart Oak Ridge, TN, USA, and arrive in Vienna, Austria (Kathleen Thiessen, Shyam Nair)	
10/24-28/94	Meeting of 5th BIOMOVs II Workshop	S. Hossain G. Linsley
10/31-11/04/94	Meeting of the Sixth and Final Research Coordination Meeting of IAEA/VAMP	S. Hossain G. Linsley M. Crick
11/05/94	Return to Oak Ridge, TN, USA	

Appendix B

Agenda and List of Participants

for

Revision of IAEA Safety Series 57

INTERNATIONAL ATOMIC ENERGY AGENCY

Department of Nuclear Energy and Safety
Division of Nuclear Safety

1994-10-14

NOTIFICATION OF AN AGENCY-SPONSORED MEETING

Title & Dates of meeting AG-794 on Dose Assessment Methods for the Purpose of Limiting Radioactive Releases, Vienna 17-21 October 1994

IAEA Scientific Officer Mr M.J. Crick, A2736, Ext.: 2729 e-mail: CRICK@NEPO1.IAEA.ORG.AT

Secretary Ms. C. Vilaplana, A2735, Ext.: 2732 e-mail: VILAPLAN@NEPO1.IAEA.ORG.AT

Place of meeting Vienna International Centre

Conference Room A19, Ext.: 1381

Working Groups Meeting Rooms: C0739, Ext.: 1348
C0741, Ext.: 1358

COUNTRY / ORGANIZATION	PARTICIPANTS	ADDRESS ABROAD	PERIOD
AUSTRIA	Dr. M. Tschurlovits	Atom Institute of Austrian Univ. Schuettelstrasse 115 A-1020 Vienna Tel: 725136	17-21 October 1994
	Dr. Martin Gerzabek	Austrian Research Centre Seibersdorf A-2444 Seibersdorf Tel: 022 54 80 3521 Fax: 022 54 803 653	17-21 October 1994

BELGIUM	Mr. Nicolas Lewyckij	SCK/CEN Boeretang 200 B-2400 Mol Tel. 32 14 332 818	17-21 October 1994
CANADA	Mr. David Rowen	Atomic Energy of Canada Limited Chalk River Laboratories Chalk River Ontario, K0J1J0 Tel. (613) 584-3311 Fax. (613) 584-4024	17-21 October 1994
CZECH REPUBLIC	Dr. Ivan Bucina	Centre of Radiation Hygiene Institute of Public Health Srobarova 48 100 42 Prague 10 Tel. 42 2 673 10578/84 or 675 10283/89	17-21 October 1994
	Ms. Irene Malátová	Centre of Radiation Hygiene Institute of Public Health Srobarova 48 100 42 Prague 10 Tel. 42 2 673 10578/84 or 675 10283/89	17-21 October 1994
	Ms. Jana Vidláková	Centre of Radiation Hygiene Institute of Public Health Srobarova 48 100 42 Prague 10 Tel. 42 2 673 10578/84 or 675 10283/89	17-21 October 1994
FRANCE	Mr. Pascal Santucci	CEA/IPSNDPEI/SERGID BP 6 92265 Fontenay-aux-Roses Tel. 33-1-4654 8898 Fax. 33-1-47351423	17-21 October 1994
	Mr. Rémy Casimir	CEA/IPSND/DPHD/SEGR BP 6 92265 Fontenay-aux-Roses Cédex, FRANCE Tel. 33-1-46548285 Fax. 33-1-46548829	17-21 October 1994

GERMANY	Dr. G. Proehl	Institut für Strahlenschutz Neuherberg, Postfach 1129 D-85758 Oberschleissheim	17-21 October 1994
HUNGARY	Dr. Béla Kanyár	National Research Institute for Radiobiology and Radiohygiene Budapest 22, Pentz Karoly u. 5 P.O. Box 101, Budapest, H-1775 Tel: (1) 226 6531 Fax: (1) 226 6531	17-21 October 1994
INDIA	Mr. Sundaram	Bhabha Atomic Research Centre Health Physics Division Trombay Bombay 400 085	17-21 October 1994
ITALY	Dr. Luigi Monte	ENEA-PAS Divisione Chimica Ambientale ENEA CRE Casaccia Via P. Anguillarese, 301 00060 Roma Tel: 39 630 48 46 45 Fax: 39 630 48 66 78	17-21 October 1994
THE NETHERLANDS	Dr. Martin J. Frissel	Torenlaan 3 6866 BS Heelsum Tel: 3373 12248 Fax: 30 291 604	17-21 October 1994
	Mr. J. Grijsa	ECN Petten Business Unit Nuclear Energy P.O. Box 1 1755 ZG Petten Tel: 0031 2246 4618 Fax: 0031 2246 3490	17-21 October 1994
SPAIN	Dr. C. Torres	CIEMAT Instituto Prima Avda. Complutense, 22 28040 Madrid Fax: 134 66006	17-21 October 1994

SWEDEN	Dr Ulla Bergstrom	Studsvik EcoSafe AB Environmental Services S-611 82, Nykoping Tel. 46 155 22 1000 Fax. 46 155 2630 70	17-21 October 1994
UNITED KINGDOM	Ms. J Simmonds	National Radiological Protection Board Chilton, Didcot Oxon OX ORQ Tel: 44 (235) 833891	17-21 October 1994
	Mr T. Parker	British Nuclear Fuels plc Sellafield Seascale, Cumbria CA 20 1 PG	17-21 October 1994
USA	Dr Charles W Miller	Radiation Studies Branch Centers for Disease Control and Prevention, MS-F35 4770 Buford Highway NE Atlanta, GA 30341-3724 Tel: 404 488 7040 Fax: 404 488 7044	17-21 October 1994
	Dr F O Hoffman	SENEC Oak Ridge, Inc 677 Emory Valley Road Suite C, Oak Ridge Tennessee 37830 Tel: (615) 483-6111 Fax (615) 481-0060	17-21 October 1994
	Dr Y. Onishi	BATTELLE Pacific Northwest Laboratories Battelle Boulevard P.O. Box 999 Richland, Washington 99352 Tel: (509) 3768302 Fax: (509) 376 5368 or 376 4428	17-21 October 1994

	<i>Mr G. Blaylock</i>	<i>SENES Oak Ridge, Inc 677 Emory Valley Road Suite C, Oak Ridge Tennessee 37830 Tel: (615) 483-6111 Fax: (615) 481-0060</i>	<i>17-21 October 1994</i>
	OBSERVER	ADDRESS	PERIOD
	<i>Mr Alexei Marinets</i>	<i>Atom institute of Austrian Univ Schuettelstrasse 115 A-1020 Vienna Tel: 725136</i>	<i>17-21 October 1994</i>

Appendix C
Agenda and List of Participants
for the
5th Workshop of BIOMOVs II

BIOMOVs II 5th Workshop

At the International Atomic Energy Agency,
Vienna International Centre (VIC),
Wagramerstrasse 5, PO Box 100,
A-1400 Vienna

24 - 28 October 1994

Provisional Agenda*

Monday 24 October

- 8.30 - 10.00 Time to come through IAEA security and to register arrival with Secretariat. The Plenary meetings will be in conference Room I, 2nd floor, building C.
- 10.00 - 10.30 **PLENARY**
- Welcome and administrative announcements.
Status of BIOMOVs II. General objectives for the week.
- 10.30 - 12.30 **Presentations on Working Group Activities:**
(In several cases these will be more detailed than at previous workshops. This is because significant detailed progress has been made and useful interactions between groups are anticipated.)
- Complementary Studies
 - Reference Biospheres
 - Post Chernobyl Data
 - Special Radionuclides (C-14, and Tritium)
- 12.30 - 13.30 **LUNCH**
- 13.30 - 15.00* **Presentations on Working Group Activities:**
- Uranium Mill Tailings
 - Uncertainties and Validation
 - Natural Analogues Scenario (NATAN)
 - Use of Lysimeter Data
 - Model Complexity
 - Modeller Interpretation
- 15.30 - 17.30 **WORKING GROUP SESSIONS**
- Uncertainties and Validation, Modeller Interpretation, NATAN scenario
Lysimeter scenarios, Follow up of Quantitative Comparison Methods.
 - Post-Chernobyl Data, Wash-off Scenario
- 17.30 Reception at the VIC hosted by the BIOMOVs II sponsors.

*Except for Monday morning and Friday afternoon, we suggest half hour coffee/tea breaks from 10.30 - 11.00 and 15.00 - 15.30.

Tuesday 25 October

- 9.00 - 9.15 **PLENARY**
Announcements, eg for Working Group Sessions
- 9.15 - 12.30 **WORKING GROUP SESSIONS**
- Special Radionuclides, Tritium
 - Complementary Studies
- 12.30 - 13.30 **LUNCH**
- - - - -

- 13.30 - 17.30 WORKING GROUP SESSIONS
- Uranium Mill Tailings
 - Post-Chernobyl Data, Cooling Pond Scenario
 - Special Radionuclides, C-14

Social Evening

Wednesday 26 October

(To be held at Hotel Regina, Rooseveltplatz 15, A-1096 Vienna, since VIC is closed.)

- 9.00 - 12.30 WORKING GROUP SESSIONS
- Reference Biospheres
 - Post Chernobyl Data, Resuspension Scenario

- 13.30 - 17.30 WORKING GROUP SESSIONS
- Special Radionuclides, Tritium
 - Complementary Studies
 - Post Chernobyl Data, (cont)

Thursday 27 October

9.00 - 9.15 PLENARY
Administrative announcements.

- 9.30 - 12.30 WORKING GROUP SESSIONS
- Post Chernobyl Data (cont)
 - Reference Biospheres

12.30 - 13.30 LUNCH

- 13.30 - 17.30 WORKING GROUP SESSIONS
- Uranium Mill Tailings
 - Uncertainties and Validation, Effects of Model Complexity

Friday 28 October

9.00 - 9.15 PLENARY
Administrative announcements.

9.15 - 11.30 Presentations from Working Groups on Progress and Planned Actions, linked to discussion from floor, including discussion of links with other projects, publication of BIOMOVs work etc.

11.30 - 12.30 Coordinating Committee Meeting
Closure of main Workshop

12.30 - 13.30 LUNCH

13.30 - 17.00 Opportunity for active participants, Secretariat and Steering Committee to discuss detailed work programmes and to document arrangements.

Please note this is still a provisional agenda. Also, rooms will be available for separate work in small groups additional to the main Working Group sessions.

BIOMOVS II 5TH WORKSHOP

List of Attendees

Iulian Apostoaie	Senes Oak Ridge
Rao Avadhanula	AECL
Ian Barraclough	NRPB
Runo Barrdahl	SSI
Peter Barry	PJ BARRY
Yves Belot	IPSN
Ulla Bergstrom	Studsvik
Glen Bird	AECL
Gordon Blaylock	Senes Oak Ridge
Martin Broderick	NIREX
Adrian Butler	Imperial College
Henri Camus	IPSN
David Cancio	CIEMAT
Larry Chamney	AECL
Philippe Ciffroy	EdF
Jean Louis Daroussin	Cogema
Philip Davis	AECL
Constantin Dovlette	RIERE, Romania
James Droppo	PNL
Ove Edlund	Studsvik
Mike Egan	AEA technology
Mark Elert	KEMATA
Cecile Ferry	IPSN
Vitold Filostovic	Inst. of Physics, Lithuania
Martin Frissel	IUR
Nandor Fulop	NRIRR, Hungary
Dan Galeriu	IAPRL, Romania
Evgenii Garger	Inst. of Radioecology, Ukraine
Jane Gerado	IAEA
Nandor Glavatszkih	NRIRR, Hungary
Helen Grogan	H. Grogan
Eberhardt Henrich	BMGSK
Owen Hoffman	SENEs Oak Ridge
Gert Hoppe	Brenk Systemplanung
Gunnar Johansson	SSI
John Kessler	EPRI
Gerald Kirchner	BREMEN Univ.
Richard Klos	PSI
A Kononovich	Res. Inst. for NPP, Russia
Alexei Konoplev	Ukrainian, Acad. of Sciences
Branko Kontic	Josef Stefan Inst, Slovenia
Ivan Kryshev	Inst. of Exp. Meteorology, Russia
Richard Little	Intera, UK

BIOMOV5 II 5TH WORKSHOP

List of Attendees

Alexander Kryshev
Vladimir Lutkovsky
Gennady Lyashenko
Paul Martin

Charles Miller
Leif Moberg
Anna Mortimer
Shyam Nair
Robert Neel
Sverker Nilsson
Frank Pelz
Ring Peterson
Wolfgang Raskob
Cathy Read
Thomas Riesen
Pascal Santucci
Tatiana Sazykina
William Schell
Inmaculada Simon
Graham Smith
Yvonne Stiglund
Siegfried Strack
Tomoyuki Takahashi
Kathy Thiesson
Patsy Thompson
Orihiko Togawa
Lazlo Toro
Carlos Torres
Ulf Tveten
Paul Ujit de Haag
Catherine Valentin-Ranc
Frits van Dorp
Barbara Watkins
David Webbe-Wood
Roger Wilmot
Theo Zeevaert
Charley Yu
Don Lush
Allan Ashworth
Jean Koch
Siegfried Strack

Inst. of Exp. Meteorology, Russia
Ukrainian Hydrometeorological Inst.
Cybernetics Centre, UAAS, Ukraine
Env. Res. Inst. of the Supervising Scientist,
Australia
CDC, USA
SSI, Sweden
Intera, UK
Senes Oak Ridge
US NRC, USA
SKB, Sweden
WISMUT, Germany
AECL, Canada
KfK, Germany
LG Mouchel, UK
PSI, Switzerland
CEA-IPSN, France
Inst. Exp. Meteorology, Russia
Univ. Pittsburg, USA
CIEMAT/IMA, Spain
Intera, UK
Studsvik, Sweden
KfK, Germany
JAERI, Japan
SENEs Oak Ridge, USA
AECB, Canada
RISO Nat. Lab, Denmark
Rad. Hygined Lab, Romania
CIEMAT/IMA, Spain
Inst. for Energiteknikk, Norway
RIVM, Netherlands
ANDRA, France
Nagra, Switzerland
Intera, UK
MAFF, UK
Gallson Ass. UK
SCK-CEN, Belgium
Argonne, USA
BEAK, Canada
HM Insp. of Pollution, UK
Israel,
KfK, Germany

Appendix D
Agenda and List of Participants
for the
Sixth and Final Research Coordination Meeting
of
the IAEA/VAMP

PROVISIONAL PROGRAMME, 6th VAMP RCM, 31 Oct.-4 Nov. 1994

Day	Aquatic WG Meeting Rooms C0737/C0739	Terrestrial WG Meeting Room. V	Urban WG Meeting Room C0755	Multiple Pathways WG Meeting Room I
Monday Oct. 31	9:30 a.m. : WELCOME PLENARY SESSION (Outline of plans of Working Groups) Meeting Room I			
	Sub-group meetings Lakes - Mtg. Rm. C0737 Rivers - Mtg. Rm. C0739	Working Group Meeting (see separate programme)	No meeting	Review of overall WG progress Working Group - Scenario S report: main text
	6:00 p.m. - Reception			
Tuesday Nov. 1	Sub-group meetings	Special Session on Radionuclide behaviour in forest ecosystems - emphasis on modelling - paper presentations (see separate programme)	No meeting	Working Group - Scenario S report: Appendices on: a) input and observed data b) individual evaluations
Wednesday Nov. 2	Sub-group meetings	Working Groups a) Forest modelling b) Fruit tree transfer modelling	Working Group - results of 4th Questionnaire - resuspension, overall dose problem - recommendations	Working Group - Future Scenarios I, H and T
	5:00 p.m. - IUR Meeting - Meeting Room I			
Thursday Nov. 3	FINAL VAMP PLENARY - Meeting Room I Working Group Reports Conclusions Plans for future - new international study: ideas for topics; 1995 Symposium (VAMP input)			
	Working Group - Conclusions and recommendations	Working Group - Conclusions and recommendations	Working Group - Conclusions and recommendations	Working Group - Conclusions and recommendations
Friday Nov. 4	Sub-group meetings	Working Group Meeting (as necessary)	Working Group Meeting (as necessary)	Working Groups (as necessary)

VAMP Terrestrial Working Group

Monday, 31 October 1994

Chairman - A. Aarkrog (Denmark)

1. Information on ongoing IAEA projects related to radioecology

Revision of Safety Series 57

"Generic Models and Parameters for Assessing
the Environmental Transfer of Radionuclides
from Routine Releases"

M. Crick

Progress in the Coordinated Research Programme on Radionuclide Transfer from Air,
Soil and Fresh Water to the Foodchain of Man in Tropical and Subtropical
Environments

M. Frissel

2. Topical presentation

Sources of environmental radioactive contamination in the countries of former USSR

A. Aarkrog

3. Review of Working Group Progress

G. Linsley

4. Discussion of Working Group Conclusions

NOTIFICATION OF AN AGENCY-SPONSORED MEETING

Title of meeting: 6th and Final RCM of the IAEA/EC CRP on Validation of Models for Radionuclide Transfer in the Terrestrial, Urban and Aquatic Environments (VAMP)

Dates of meeting: 31 October - 4 November 1994 Scientific Secretaries: Mr. G. Linsley, A2656 Ext.2666
Mr. S. Hossain, A2662 Ext. 2668
Ms. K-L. Sjoebloom, A2661Ext. 2667
Mr. M.J. Crick, A2736 Ext. 2729

Secretary: Ms. Nerri Barrios, A2655, Ext. 2702

Conference Clerks: Mr. Dudley Pieries
Ms. Carol El Wadi

Places of meeting: Conference Room I (2nd Flr. C-Bldg.), Ext. 4611
Conference Room V (7th Flr. C-Bldg.), Ext. 1351
Room C0755, Ext. 1367
Room C0737, Ext. 1347
Room C0739, Ext. 1348

List of Participants

NAME	ADDRESS, TEL., FAX, TELEX	PERIOD
<hr/>		
AUSTRIA		
Mr. Martin H. Gerzabek	Austrian Research Centre Seibersdorf A-2444 Seibersdorf Tel: 02254 7 80 3521 or 3600 Fax: 02254 7 80 3653 Tlx: 14-353 fzs a	1 - 4 Nov.
Mr. Eberhardt Henrich	Bundesministerium für Gesundheit, Sport und Konsumentenschutz Radetzkystr. 2 A-1031 Vienna Tel: 43 1 71172 4453 Fax: 43 1 7122331 Tlx: 136114	31 Oct.-4 Nov.
Mr. Alexei Marinets	Atomintstitute Schüttelstr. 115 A-1020 Vienna Tel: 72701 283 Fax: 7289220 EM: marinets @ati.ac.at	31 Oct. - 4 Nov.

Mr. Franz Josef Maringer	Bundesforschungs-und-Prüfzentrum Arsenal Faradagasse 3 P.O. Box 8 A-1031 Vienna Tel: 43 1 79747 536 Fax: 43 1 79747 592 Tlx: 136677 EM: maringer@ygig44.una.ac.at	31 Oct.-4 Nov.
Mr. Franz Schönhofer	BALUF (Federal Inst. for Food Control and Research) Kinderspitalgasse 15 A-1090 Vienna Tel: 40491 520 Fax: 40491 540	31 Oct.- 4 Nov.
Ms. Friderike Strebl	Austrian Research Centre Seibersdorf A-2444 Seibersdorf Tel: 02254 7880 3551 Fax: 02254 7880 3653 Tlx: 14-353 fzs a	31 Oct. - 4 Nov.
Mr. Manfred Tschurlovits	Atominstitut Schüttelstr. 115 A-1020 Vienna Tel: 21701 282 Fax: 21892 20 EM: TSCHURLOVITS@ati.ac.at	31 Oct. - 4 Nov.
Mr. Günter Winkler	(address same as above) Tel: 72701 2883 Fax: 7289220 EM: WINKLER@ati.ac.at	31 Oct. - 4 Nov.

BELARUS

Mr. A. Dvornik	Laboratory of Forest Radiology Forest Institute 71 Proletarskya St. 246654 Gomel Tel: 0232 53 73 73; 0232 53 83 41 Fax: 0232 53 68 12	31 Oct.- 4 Nov.
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BELGIUM

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Mr. Jean Marie Lambotte	SPRI Cité Adm., de l'Etat Quartier Vésale N-2/3.24 B-1010 Brussels	31 Oct. - 4 Nov.
Mr. Yves Thiry	Radioecology Laboratory Radiation Protection Research Unit CEN/SCK Boeretang 200 B-2400 Mol Tel: 32 14 33 21 11 Fax: 32 14 32 03 72	31 Oct. - 4 Nov.
Mr. Theo Zeevaert	SCK/CEN Boeretang 200 B-2400 Mol Tel: 32 14 33 28 68 Fax: 32 14 32 10 56 Tlx: 31922 EM: ZEEVAERT@bmlsckll	31 Oct. - 4 Nov.
Mr. C. M. Vandecasteele	SCK/CEN Radioecology Laboratory Radiation Protection Research Unit Boeretang 200 B-2400 Mol Tel: 32 14 33 21 11 Ext. 5244 or 5240 Fax: 32 14 32 03 72 or 32 14 32 10 56 EM: VDCASTEL@BMLSCK11	31 Oct. - 4 Nov.
CANADA		
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Mr. Larry Chamney	Atomic Energy Control Board Radiation & Environmental Protection Division (REPD) Ottawa, Ontario K1P 5S9 Tel: 1 (613) 995 1639 Fax: 1 (613) 995 5086	31 Oct. - 4 Nov.
Mr. Kok Ping Ho	(same as above) Tel: (613) 995 2908 Fax: (613) 995 5086	31 Oct. - 4 Nov.

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CZECH REPUBLIC		
Mr. Petr Beneš	Czech Technical University in Prague Dept. of Nuclear Chemistry 115 19 Praha 1 Břehová 7 Tel: + 42 2 2317626 Fax: + 42 2 2320861	31 Oct. - 4 Nov.
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Ms. Dana Drábová	(same as above)	31 Oct. - 4 Nov.
Mr. Jan Horyna	Czechoslovak Atomic Energy Commission Slezská 9, 120299 Praha 2 Tel: 42 2 2152458 Fax: 42 2 2152467 Tlx: 121107 CKAEC	31 Oct. - 4 Nov.
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Ms. Irena Malátová	Center of Radiation Hygiene - NIPH Šrobárova 48 100 42 Prague 10 Tel: + 42 2 67311452 or 67313089 Fax: + 42 2 67311410	31 Oct. - 4 Nov.
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Mr. Dušan Vopálka	(same as above)	31 Oct. - 4 Nov.

CHINA, PEOPLE'S REPUBLIC OF

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DENMARK

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FINLAND

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FRANCE

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Mr. Jean-Marie Quinault	CEA/IPSN DPEI/SERE, Bt 159 CE/Cadarache 13108 Saint Paul lez Durance Cedex Tel: (33) 42 25 76 64 Fax: (33) 42 25 49 48	31 Oct. - 4 Nov.
Ms. Jacqueline Garnier-Laplace	IPSN/DPEI/SERE CE/Cadarache Bt. 159 13108 St. Paul lez Durance Tel: (33) 42 25 37 33 Fax: (33) 42 25 49 48	31 Oct. - 4 Nov.
Gilles Gontier	(address same as above) Tel: (33) 42 25 41 06	31 Oct. - 4 Nov.
GERMANY		
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Mr. Ulrich Fielitz	Dr. Ulrich Fielitz Umweltanalysen Am Herberhäuser Weinberge 23 D-37075 Göttingen Tel: 49 551 21350 Fax: 49 551 25661	31 Oct. - 4 Nov.
Mr. Hilmar Förstel	Forschungszentrum KFA Jülich Radioagronomie P.O. Box 1913 D-52425 Jülich Tel: + 49 2461 61 3241 Fax: +49 2461 61 2518	31 Oct. - 4 Nov.
Mr. Harry Koehler	P. I. Wissen und Technik Rablstr. 16 D-81669 Munich	31 Oct. - 4 Nov.
Mr. Gerhard Pröhl	GSF-Institut für Strahlenschutz Postfach 1129 D-85758 Neuherberg Tel: + 49 31 87 2889 Fax: + 49 3187 3363	31 Oct. - 4 Nov.

Mr. Peter Jacob	GSF-Forschungszentrum für Umwelt und Gesundheit, GmbH Neuherberg Postfach 1129 D-85758 Oberschleißheim Tel: +49 (089) 3187 4008 Fax: +49 (089) 3187 3363 Tlx: 523125 stral d	2 - 4 Nov.
Mr. Heinz Müller	GSF Institut für Strahlenschutz Postfach 1129 D-85758 Neuherberg Tel: + 49 89 3187 2283 Fax: + 49 89 3187 3363	31 Oct. - 4 Nov.
Mr. Werner Rühm	Bundesamt für Strahlenschutz Institut für Strahlenhygiene Ingolstädter Landstraße 1 85764 Oberschleißheim Tel: + 44 89 31603 393 Fax: + 44 89 31603 111 EM: Ruehm@Bfs.de	31 Oct. - 4 Nov.
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HUNGARY

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Mr. Béla Kanyár	National Research Institute for Radiobiology and Radiohygiene Budapest 22 Pentz Karoly u.5 Budapest, H-1775 Tel: (1) 226 6531 Fax: (1) 226 6531 Tlx: 225103 EM: h5211kan@ella.hu	31 Oct. - 4 Nov.
Mr. Peter Zombori	KFKI Atomic Energy Research Institute P.O. Box 49 H-1525 Budapest Tel: (36) 1 1699 499 Fax: (36) 1 1696 567 Tlx: 224722 kfk i h	31 Oct. - 4 Nov.

IRELAND

Ms. Barbara Rafferty	Radiological Protection Institute of Ireland 3 Clonskeagh Square Clonskeagh Road Dublin 14 Tel: 353 1 6609511 Ext. 3607 Fax: 353 1 6680187 Telex 30610	31 Oct. - 4 Nov.
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ISRAEL

Mr. Jean Koch	Israel Atomic Energy Commission Soreq Nuclear Research Center 81800 Yavne Tel: 972 8 434388 Fax: 972 8 434315 Tlx: 381455	31 Oct. - 4 Nov.
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ITALY

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NORWAY

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POLAND

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Mr. Pawel Krajewski	Central Laboratory for Radiological Protection Department of Radiation Hygiene ul. Konwaliowa 7 03-194 Warsaw Tel: 110195 Fax: 111616 Tlx: 812381 CLOR PL	31 Oct. - 4 Nov.

ROMANIA

Mr. Iulian Apostoaei	c/o SENES Oak Ridge, Inc. 677 Emory Valley Road Suite C, Oak Ridge TN 37830 Tel: (615) 483 6111 Fax: (615) 481 0600	31 Oct. - 4 Nov.
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RUSSIAN FEDERATION

Mr. M. Balonov	Inst. of Radiation Hygiene Ministry of Public Health Mira Str. 8, 197101 St. Petersburg Tel: 7 (812) 233 4843 Fax: (812) 314 3360	31 Oct. - 4 Nov.
Mr. S.V. Fessenko	Russian Inst. of Agricultural Radiology 249020, Kievskaya Str. Obninsk Kaluga Region Tel: 08439 2 12 32 Fax: 7 095 255 22 25	31 Oct. - 4 Nov.
Mr. Alexei Konoplev	SPA "Typhoon" Intitute of Experimental Meteorology 82, Lenin St., Obninsk Kaluga Region Tel: 007 08439 718896 Fax: 007 095 2552225 EM: typhoon@adonis.iasnet.com	31 Oct. - 4 Nov.

Mr. Ivan Kryshev	SPA "Typhoon" Intitute of Experimental Meteorology 82, Lenin St., Obninsk Kaluga Region Tel: 7 (08439)71289 Fax: 7 (095) 2552225 Tlx: 412 633 INFOR SU	31 Oct. - 4 Nov.
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Ms. Tatiana Sazykina	"SPA Typhoon" Intitute of Experimental Meteorology 82, Lenin St., Obninsk Kaluga Region Tel: 7 (08439) 71289 Fax: 7-095-2552225 Tlx: 412633 INFOR SU EM: typhoon @ adonis.ias.msk.su	31 Oct. - 4 Nov.
Mrs. Vera Smorehkova	State Committe for Social Protection Staraya 8/5 CIS 103132 Moscow	31 Oct. - 4 Nov.
Mr. V. Sourkont	International Cooperation Dept. of Emercom Moscow	31 Oct. - 4 Nov.
Mr. F. A. Tikhomirov	Radioecology Laboratory Soil Sciences Faculty Moscow State University Leninskie gory, 119899 Moscow Tel: Fax: 7 095 939 0989	31 Oct. - 4 Nov.
Mr. Ivan B. Tokin	St. Petersburg State University Faculty of Applied Mathematics Dept. of Math. Biology Libary Sq. 2 St. Petersburg 198904 Tel: 8 12 108 3897 Fax: 7 812 428 6649 7 812 314 3360	31 Oct. - 4 Nov.
Mr. Vassilly Voznjak	State Committee for Social Protection 8/5 CIS, 103132 Moscow	31 Oct. - 4 Nov.

SLOVAK REPUBLIC

Mr. Ondrej Slávik	Nuclear Power Plant Research Institute Okružná 5 918 64 Trnava Tel: 42 805 91264 or 42 805 21301 Ext. 2672 Fax: 42 805 91264	31 Oct. - 4 Nov.
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SPAIN

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SWEDEN

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Ms. Ulla Bergström	Studsvik Eco & Safety AB 61182 Nyköping Tel: 46 155 221652 Fax: 46 155 221616	31 Oct. - 4 Nov.
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Mr. Lars Håkanson	Inst. of Earth Sciences Uppsala University Norbyv. 18B 75236 Uppsala Tel: 018 183897 Fax: 018 1855 5920	31 Oct. - 4 Nov.
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Ms. Lynn Marie Hubbard	Swedish Radiation Protection Institute Statens Strålskyddsinstitut Miljölab S-17116 Stockholm Tel: 46 8 729 7100 Fax: 46 8 729 7108	31 Oct. - 4 Nov.
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Mr. R. Thomas Palo	Swedish University of Agricultural Sciences The Faculty of Forestry Department of Ecology S-90183 Umeå Tel: Fax: 46 90 16 68 17	31 Oct. - 4 Nov.
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SWITZERLAND

Mr. Thomas Riesen	Paul Scherrer Institute Div. of Radiation Hygiene Würenlingen and Villigen CH-5232 Villigen PSI Tel: 056 99 21 11 Fax: 056 99 23 09	31 Oct. - 4 Nov.
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UNITED KINGDOM

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Mr. P. J. Coughtrey	L.G. Mouchel & Partners West Hall Parvis Road W. Byfleet Surrey, KT14 6EZ Tel: 0932 336633 Fax: 0932 336630	2 - 4 Nov.
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Mr. Nick Mitchell	(same as above)	31 Oct. - 4 Nov.
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Mr. George Shaw	Imperial College at Silwood Park Centre for Analytical Research in Environment Ascot, Berkshire SL5 7TE Tel: 344 294277 or 344 294293 Fax: 344 24931	31 Oct. - 4 Nov.
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Mr. Zitouni Ould-Dada	(same as above)	31 Oct.- 4 Nov.
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UKRAINE

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Mr. Vladimir Lutkovsky	Ukrainian Hydrometeorological Inst. Nauka Ave. 37 Kiev 252028 Tel: 7 (044) 265 1130 Fax: 7 (044) 265 5363	31 Oct. - 4 Nov.
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Mr. Gennady Polikarpov	Institute of Southern Biology Prospect Nihomova 2 335000 Sevastopol	31 Oct. - 4 Nov.
Mr. Boris Prister	Ministry for Chernobyl Affairs 2 Lesi Ukrainki CIS 252002 Kiev	31 Oct. - 4 Nov.
Mr. Oleg V. Voitcekhovitch	Ukrainian Hydrometeorological Institute Kiev 252028, Nauka Av. 37 Tel: 7 (044) 265 11 30 Fax: 7 (044) 265 53 63	31 Oct. - 4 Nov.
Mr. Mark Zheleznyak	Institute of Mathematical Machine and Systems Glushkova 42, Kiev 252207 Tel: 7 044 266 5583 Fax: 7 044 266 4091	31 Oct. - 4 Nov.

USA

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Mr. F. O. Hoffman	(same as above)	31 Oct. - 4 Nov.
Ms. Kathleen M. Thiessen	(same as above)	31 Oct. - 4 Nov.
Mr. Shyam K. Nair	(same as above)	31 Oct. - 4 Nov.
Mr. Bruce A. Napier	Battelle, Pacific Northwest Laboratories P. O. Box 999 Richland, WA 99352 Tel: 509 375 3896 Fax: 509 375 2019 EM: BA_NAPIER@PNL.GOV	31 Oct. - 4 Nov.
Mr. William L. Robison	Lawrence Livermore National Laboratory Health and Ecological Assessment Div. P. O Box 808, L-453 Livermore, CA 94551-9900 Tel: (510) 422 3884 Fax: (510) 423 6785	31 Oct. - 4 Nov.
Mr. William R. Schell	University of Pittsburgh Graduate School of Public Health -EOH 260 Kappa Drive Pittsburgh, PA 15238 U. S. A. Tel: 412 967 6532 Fax: 412 624 1020	31 Oct. - 4 Nov.
Mr. Dennis L. Strenge	Battelle Pacific Northwest Laboratories P. O. Box 999, K3-54 Richland, WA 99352 Tel: 509/375 6944 Fax: 509/375 2019	31 Oct. - 4 Nov.
Mr. W. Thiessen	Oak Ridge	31 Oct. - 4 Nov.
Mr. Charley Yu	Argonne National Laboratory Building 900 9700 South Cass Avenue Argonne, IL 60439 Tel: (708) 252-5589 Fax: (708) 252 4624 EM: yu@smtplink.eid.anl.gov	31 Oct. - 4 Nov.

EUROPEAN COMMISSION

Mr. G. Desmet	European Commission DG XII De Wet Straat 200 B-1049 Brussels	31 Oct. - 4 Nov.
Mr. G. N. Kelly	European Commission XII/F/6 (ARTS 3/53) 200, rue de la Loi B-1049 Brussels Tel: 32 2 295 6484 Fax: 32 2 296 6256	31 Oct. - 4 Nov.

INTERNATIONAL UNION OF RADIOECOLOGY

Mr. Jan Bonnijns	IUR, Savel 16 B-2480 Balen	31 Oct. - 4 Nov.
Mr. Martin Frissel	IUR Torenlaan, 3 NL-6866 BS Heelsum Tel: 31 8373 12248 Fax: 31 8373 12248	31 Oct - 4 Nov.
Mr. Rene Kirchmann	IUR 5 rue Cardinal Cardijn B-4680 Oupeye Tel: 32 41 642564 Fax: 32 41 481090	31 Oct. - 4 Nov.
Mr. Felix Luyks	IUR Dereymaekerlaan 28 B-3080 Oupeye	31 Oct. - 4 Nov.

OTHERS

Mr. John I. Richards	IAEA Seibersdorf	
Mr. Wolfgang Baresch	Margaretenguertel 126-134/5/5 A-1050 Vienna	31 Oct. - 4 Nov.

Appendix E

List of Literature Obtained During the Foreign Trip

- Barry, P. J. "The Irrigation Pathway - BIOMOVs B2 Scenario Revisited." Draft Manuscript.
- Barry, P. J. "Model Validation Techniques." Draft Manuscript.
- Benes, P., and R. Poliak. 1990. "Factors Affecting Interaction of Radiostrontium with River Sediments." *Journal of Radioanalytical and Nuclear Chemistry* 141(1): 75-90.
- Benes, P., and M. Cerník. 1992. "Kinetics of Radionuclide Interaction with Suspended Solids in Modeling: II. Effect of Concentration of the Solids and Temperature." *Journal of Radioanalytical and Nuclear Chemistry* 159(2): 187-200.
- Benes, P., K. Stamberg, and R. Stegmann. 1993. "Study of the Kinetics of the Interaction of Cs-137 and Sr-85 with Soils Using Batch Method: Methodical Problems." Draft Manuscript.
- Benes, P., M. Cerník, and O. Slávik. 1994. "Modelling of Migration of ^{137}Cs Accidentally Released into a Small River." *J. Environ. Radioactivity* 22: 279-293.
- BIOMOVs. 1994. "An Interim Report on Reference Biospheres for Radioactive Waste Disposal." BIOMOVs II: Technical Report No. 2.
- BIOMOVs. 1994. "Wash-off ^{90}Sr and ^{137}Cs from Pripyat River's Flood-plain as a consequence of the Ice Jam Event and Radiation Doses formation for the population of Kiev Region as result of this hydrological event." BIOMOVs Scenario FP, Stage 1. Draft.
- Bredehoeft, J. D., and L. F. Konikow. 1993. "Ground-Water Models: Validate or Invalidate." *Ground Water* 31(2): 178-179.
- Dvornik, A. M., and T. A. Zhuchenko. "Predictive Model of Pine Wood Radiation Contamination (Forest Life)." Draft Manuscript.
- Fesenko, S. V., R. M. Alexakhin, S. I. Spiridonov, and N. I. Sanzharova. "Dynamics of ^{137}Cs concentration in agricultural products in areas of Russia subjected to contamination after the accident at the Chernobyl Nuclear Power Plant." Draft Manuscript.
- Helton, J.C. 1993. "Uncertainty and sensitivity analysis techniques for use in performance assessment for radioactive waste disposal." *Reliability Engineering and System Safety* 42: 327-367.

Imazuka, Y., and R. Klos. 1994. "The Application of Probabilistic Modelling Techniques in Switzerland." PSI/NAGRA.

International Atomic Energy Agency (IAEA). Sediments and Pollution in Waterways: General Considerations. 1984. IAEA-TECDOC-302.

IAEA. Assessing the radiological impacts of past nuclear activities and events. 1984. IAEA-TECDOC-755.

IAEA. Modelling of resuspension, seasonality and losses during food processing: First report of the VAMP Terrestrial Working Group. 1992. IAEA-TECDOC-647.

IAEA. VAMP: Progress Report No. 5. 1993. International Atomic Energy Agency and Commission of the European Communities.

IAEA. Modelling the deposition of airborne radionuclides into the urban environment: First report of the VAMP Urban Working Group. 1994. IAEA-TECDOC-760.

IAEA. "Validation of Models Using Chernobyl Fallout Data from the Central Bohemia Region of the Czech Republic-Scenario CB: First Report of the VAMP Multiple Pathways Assessment Working Group." IAEA-TECDOC-DRAFT. 1994.

IAEA. "Validation of Models Using Chernobyl Fallout Data from the Central Bohemia Region of the Czech Republic-Scenario S: Second Report of the VAMP Multiple Pathways Assessment Working Group." IAEA-TECDOC-DRAFT. 1994.

McGee, Dr. E. J., and Prof. V. Dritchko. 1994. "Report on the Radioecology of Peatlands Congress, State Agrarian University, Pushkin, St. Petersburg, Russia, June 7-11 1994." *I.U.R. Newsletter* 15: 1-16.

Murray, A.S., A. Johnston, P. Martin, G. Hancock, R. Marten, and J. Pfitzner. 1993. "Transport of naturally occurring radionuclides by a seasonal tropical river, northern Australia." *Journal of Hydrology* 150: 19-39.

Remez, Dr. V. P., and Dr. S. K. Novikova. "'Fezhel'" Type Sorbents Highly Selective to Cesium Isotopes." Draft Manuscript.

Sanzharova, N. I., S. V. Fesenko, R. M. Alexakhin, et.al. 1994. "Changes in forms of ^{137}Cs and its availability for plants as dependent on properties of fallout after the Chernobyl nuclear power plant accident." *The Science of the Total Environment* 154: 9-22.

- Schell, W.R., and I. Linkov. "A Dynamic Model for Evaluating Radionuclide Distribution in Forests from Nuclear Accidents." Draft Manuscript.
- Tikhomirov, F. A., and A. I. Shcheglov. 1994. "Main investigation results on the forest radioecology in the Kyshtym and Chernobyl accident zones." *The Science of the Total Environment* (in press).
- Tkalich, P. V., M. J. Zheleznyak, G. B. Lyashenko, and A. V. Marinets. 1994. "Rivtox-Computer Code to Simulate Radionuclides Transport in Rivers." *Computational Methods in Water Resources* X: 1173-1180.
- Zheleznyak, M. J., P. V. Tkalich, G. B. Lyashenko, and A. V. Marinets. 1993. "Aquatic Dispersion Models - First Approaches to Integration into the CEC Decision Support System Based on Post-Chernobyl Experience." *Radiation Protection Dosimetry* 50(2-4): 235-241.
- Zheleznyak, M. J., Yu. I. Kuzmenko, P. V. Tkalich, et al. 1994. "Modelling of Radionuclide Transport in the Set of River Reservoirs." *Computational Methods in Water Resources* X: 1189-1196.

List of VAMP Reports - published and planned

1. Validation of Environmental Model Predictions (VAMP)
- glossary brochure explaining the VAMP programme
Status: published 1993
2. Modelling of resuspension, seasonality and losses during food processing.
First report of VAMP Terrestrial Working Group, IAEA TECDOC-647
Status: published 1992
3. Assessing the radiological impact of past nuclear activities and events, IAEA
TECDOC -755
Status: published 1994.
4. Modelling of interception/retention of particles on plant surfaces and of
radionuclide transfer in semi-natural ecosystems.

Second report of the VAMP Terrestrial Working Group, IAEA TECDOC _____
Status: to be completed.
5. Validation of models using Chernobyl fallout data from the Central Bohemia
region of the Czech Republic - Scenario CB.

First report of the VAMP Multiple Pathways Assessment Working Group,
IAEA TECDOC _____.
Status: nearly completed; to be submitted for publication in near future.
6. Validation of models using Chernobyl fallout data from Southern Finland
- Scenario S.
Second report of the VAMP Multiple Pathways Assessment Working Group,
IAEA TECDOC _____.
Status: to be completed.
7. Scenarios for model testing - scenarios I and H
Third report of the VAMP Multiple Pathways Assessment Working Group,
Informal report.
Status: to be completed.

8. Modelling of radionuclide transfer into lakes.
First report of the VAMP Aquatic Working Group
IAEA TECDOC _____
Status: to be completed
9. Modelling of radionuclide transfer into rivers and reservoirs.
Second report of the VAMP Aquatic Working Group
IAEA TECDOC _____
Status: to be completed.
10. Modelling the deposition of airborne radionuclides into the urban environment.
First report of the VAMP Urban Working Group, IAEA TECDOC-760
Status: published 1994.
11. Modelling for external and inhalation dose assessment in urban areas.
Second report of the VAMP Urban Working Group, IAEA TECDOC _____
Status: to be completed.
12. Modelling weathering, decontamination and the movement of radionuclides into sewage systems in urban environments.
Third report of the VAMP Urban Working Group, IAEA TECDOC _____
Status: to be completed.
13. Modelling resuspension and assessing total dose in urban environments.
Fourth report of the VAMP Urban Working Group, IAEA TECDOC _____
Status: to be completed.

NOVEMBER 1994

EH-40 Monthly Report
November 5-30, 1994

Project Title: Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities

DOE Project Number: 94-ES-966 **LLNL Project Number:** 6288-13
93-ES-1337

Principal Investigator: F. Owen Hoffman
M&O Contractor: Lawrence Livermore National Laboratory
(Lynn Anspaugh/Sheilah Hendrickson)

Contract to:
Subcontract B218797 with SENES Oak Ridge, Inc.

I. Project Objective

As stated in subcontract B218797, the purpose of this work is to evaluate and validate pathway assessment models applicable to exposure and dose reconstruction at Department of Energy facilities through use of international data sets.

This work has centered on involvement in two international model testing programs, BIOMOVs II and IAEA/VAMP; development of appropriate high-quality data sets for model testing using site-specific data obtained in various countries; and use of these data sets to test both process-level and multiple pathways environmental transport models.

II. Current Project Status/Monthly Progress

Administrative

Most activities under this subcontract are being brought to a stopping place because the allotted funds are nearly exhausted. Some projects which are close to completion will not be finished, due to lack of continuing funding.

Technical accomplishments

(1) A trip report was submitted for the recent Vienna meetings of BIOMOVs II and IAEA/VAMP.

(2) Model predictions (both model intercomparisons and comparisons of predictions with test data) were compiled and sent to the BIOMOVs II secretariat for distribution to the participants in the Post Chernobyl Data Working Group of BIOMOVs II. Test data have been released only to modelers who submitted predictions. Modelers have been asked to submit any additional or revised predictions by January 15, 1995.

Activities in progress

(1) The section of the Scenario S report dealing with dose calculations is being revised to permit adequate explanation of the methodology used for dose estimation. Additional revision of the report will be done based on comments received from working group participants. Documentation of the test data is expected in December. A deadline of January 15 was given for comments on the report and revised write-ups from individual participants (modelers' own descriptions of their models and modeling results). A revised version of the complete report will be completed by February 15; further review of the document prior to publication will be at the discretion of the IAEA.

(2) Results of the model comparison exercise using data from IAEA/VAMP are being prepared for submission to the open literature. This exercise has involved use by a single modeler of five different codes (NCRP, AIRDOS-EPA, SS-57, RESRAD, and PATHWAY) with two separate data sets. The material being prepared will include presentation of the individual performances of the models as compared both with the test data (observations) and with predictions made by other modelers (participants in the VAMP exercise).

Travel--Not applicable this month.

III. Significant Problems/Issues/Concerns

Not applicable this month.

IV. Assistance Required of EH-40 Staff

Not applicable this month.

VAMP-MP NEWSLETTER

Issue No. 5, International Atomic Energy Agency, November 1994.

VAMP-MP is the Multiple Pathways Assessment Working Group of the IAEA/CEC Co-ordinated Research Programme on Validation of Environmental Model Predictions.

SIXTH AND LAST VAMP RCM VIENNA

31 OCTOBER - 4 NOVEMBER 1994

The sixth and last RCM of the VAMP programme was held from 31 October to 4 November 1994 in Vienna. The VAMP Multiple Pathways Assessment Working Group (VAMP-MP) was busy in completing the remaining work of the group. The main task in this respect was the finalization of the Scenario S report.

CONTROVERSY ON SCENARIO S DOSE CALCULATIONS

During the discussion of the main text of the S report, controversy arose concerning the definition of "dose" with respect to the dose assessment task of Scenario S. The footnote on page 1 of DESCRIPTION OF TEST SCENARIO S provides the following definition:

"The term 'dose' refers to the sum of the effective dose equivalent from external exposure in a given period and the committed effective dose equivalent from radionuclides taken into the body in the same period."

Thus for the internal dose, both from ingestion and inhalation, it is the committed effective dose equivalent considering 50 year period after intake; whereas for the external it is the effective dose equivalent for the given period only. Although most of the participants have used the above definition, they are requested to check their dose calculations once again and submit them by 6 December 1994.

Please also note that for dose calculations and statistical distribution of body content:

"... the 'test persons' are adults 20 years old in 1986".

Although this has been specified in the text of scenario description, the set of forms for the submission of predictions for dose and distribution of body content has the caption "man". Please

ignore this caption and consider average adults including both men and women in this respect.

The independent dose estimates of STUK will also be checked for the consistent use of the above dose definition.

FINALIZATION OF THE SCENARIO S REPORT

The Scenario S will be finalized following the schedule given below:

- Revised dose assessments (participants)
6 December 1994
- Documentation of test data (STUK)
6 December 1994
- Final revised individual evaluation
(participants) 15 January 1995
- Small Consultants' Meeting in Vienna
(STUK/ SENES) 20-24 February 1995
- Complete Scenario S report to participants
(Secretariat) 28 February 1995
- Comments from participants
31 March 1995
- Send for publication April 1995

Further information about the VAMP-MP Working Group can be obtained from its Secretariat:

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DECEMBER 1994

EH-40 Monthly Report
December 1-31, 1994

Project Title: Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities

DOE Project Number: 94-ES-966 **LLNL Project Number:** 6288-13
93-ES-1337

Principal Investigator: F. Owen Hoffman
M&O Contractor: Lawrence Livermore National Laboratory
(Lynn Anspaugh/Sheilah Hendrickson)

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As stated in subcontract B218797, the purpose of this work is to evaluate and validate pathway assessment models applicable to exposure and dose reconstruction at Department of Energy facilities through use of international data sets.

This work has centered on involvement in two international model testing programs, BIOMOVs II and IAEA/VAMP; development of appropriate high-quality data sets for model testing using site-specific data obtained in various countries; and use of these data sets to test both process-level and multiple pathways environmental transport models.

II. Current Project Status/Monthly Progress

Administrative

Most activities under this subcontract have been brought to a stopping place because the contract period has ended.

Technical accomplishments and activities still in progress

1. Dr. Owen Hoffman gave an invited presentation at the Annual Conference and Exposition of the Society for Risk Analysis (see attached excerpt from the conference program). Dr. Hoffman's talk was entitled "The Use of Chernobyl Data to Test Predictions and Uncertainty Estimates from Exposure Assessment Models." He received very positive response regarding the importance of the

work and the implications for both DOE and EPA models, in analysis of both chemical risks and radiation risks. It is recognized that this project is the only U.S. study in which the credibility of model predictions is being tested.

2. The questions about ingestion dose estimates for Scenario S have been resolved. The section of the Scenario S report dealing with dose calculations is being revised accordingly. Additional revision of the entire report is being completed based on comments received from working group participants. Dr. Kathleen Thiessen of SENES Oak Ridge has been asked to return to Vienna in February, at IAEA expense, to assist in the finalization of this report.
3. Results of the model comparison exercise using data from IAEA/VAMP are nearly ready for submission to the open literature. This exercise has involved use by a single modeler of five different codes (NCRP, AIRDOS-EPA, SS-57, RESRAD, and PATHWAY) with two separate data sets. The material includes a presentation of the individual performances of the models as compared both with the test data (observations) and with predictions made by other modelers (participants in the VAMP exercise).
4. A draft TECDOC was prepared for the Urban Working Group of IAEA/VAMP. This paper summarizes the results from a modeling problem dealing with resuspension of contaminated soil in an urban area. Comments are being solicited on the draft, which will then be submitted to the IAEA for publication.
5. The final report of the Rivers and Reservoirs Scenario of the IAEA/VAMP Aquatic Working Group is in progress. Dr. Gordon Blaylock of SENES Oak Ridge has been asked to return to Vienna in February, at IAEA expense, to assist in the finalization of this report.
6. The three Post Chernobyl Scenarios of BIOMOVs II will be published in *Health Physics* following completion of the review/revision process, which is proceeding satisfactorily.

Travel--Not applicable this month.

III. Significant Problems/Issues/Concerns

Not applicable this month.

IV. Assistance Required of EH-40 Staff

Not applicable this month.

Society for Risk Analysis
Annual Conference and Exposition
Baltimore, Maryland

Preliminary Program
December 4-7, 1994
Hyatt Regency at the Inner Harbor

Sunday, December 4, 1994

Workshop A	9 AM-5 PM
Workshop B	9 AM-5 PM
Workshop C	9 AM-5 PM
Workshop D	9 AM-1 PM
Workshop E	9 AM-5 PM

Council Meeting	Noon-5 PM
Baltimore City Tour	Departs 1:30 PM
Registration	4-7 PM
Welcome Reception	5-7 PM
Dinner Cruise/Tour	Boards 6:30 PM

Coffee will be served in the exhibit area each day at 10:00-10:30 AM and from 3:00-3:30 PM each day except Wednesday.

Luncheons will take place each day in the ballroom from Noon-1:30 PM.

Monday, December 5, 1994

New Member Breakfast	7:30 AM
Registration	8 AM-4 PM
Exhibits	Noon-6 PM

8:30-10 AM Plenary Session: Risks Along the Regulatory Super Highway; Lynn Goldman, US EPA

10:30 AM-Noon	A1	Technical Findings in Ecological Risk Assessment
10:30 AM-12:15 PM	B1	The Perception of Risk: New Insight
10:30 AM-Noon	C1	Risk Management and Decision Making
10:30 AM-Noon	S6	Probabilistic Approaches to Environmental Health Risk Analysis Variability and Uncertainty
10:30 AM-Noon	E1	Student Papers-Awards
10:30 AM-Noon	F1	Risk Characterization - Part 1

Monday Continued

1:30-3 PM	A2	Bioavailability From Soil and Groundwater
1:30-3 PM	S2	Divergent Risk Perceptions and Evaluations of Yucca Mountain
1:30-3 PM	S4	The Delaney Clause: Its Virtues, Its Vices, and Alternatives
1:30-3 PM	S7	Probabilistic Approaches to Environmental Health Risk Analysis-Distributions of Contaminants and Implications for Exposure Assessment
1:30-3 PM	S10	Holistic Risk Assessment: An Emerging Strategy for Environmental Decisions
1:30-3 PM	F2	Site Evaluation: Generic Issues

3:30-5 PM	S1	Ethics and Value Judgements in Environmental Risk Decision Making
3:30-6:30 PM	S3	US EPA Risk Communication Research Roundtable - Part 1 Communicating About Scientific Uncertainty and Part 2 Defining Practitioner Needs
3:30-5 PM	S5	Geographical Dimensions of Risk Analysis and Management
3:30-5 PM	S8	Probabilistic Approaches to Environmental Health Risk Analysis - Applications and Case Studies
3:30-5 PM	E2	Risk Analysis for Public Policy Decisions
3:30-5 PM	S11	Determination, Communication, and Value of Uncertainty Analysis in Environmental Management

Pre-town Meeting **5 PM**

Insomniac Tour **Departs 7PM**

Tuesday, December 6, 1994

Chapters and Sections Breakfast	7 AM
Registration	8 AM-4 PM
Exhibits	Noon-6 PM

8:30 AM-Noon	S12	Risk Assessment in Agriculture and Food Safety - Parts 1&2
8:30-10 AM	S14	Organizational Perspectives on Risk Communication and Pollution Prevention

Tuesday Continued

8:30-10 AM	C2	Residential/Occupational Exposure
8:30-10 AM	S16	Probabilistic Approaches to Environmental Health Risk Analysis – Part 1
8:30-10 AM	E3	Risk and Decision Making
8:30-10 AM	F3	Risk Ranking
10:30 AM-Noon	B2	Intervention Strategies: The Issues and The Players – Part 1
10:30 AM-Noon	C3	Quantitative Analysis of Uncertainty in Engineered Systems
10:30 AM-Noon	S17	Probabilistic Approaches to Environmental Health Risk Analysis – Part 2
10:30 AM-Noon	S20	Dioxin Risk Assessments: Characterizing the Uncertainties
10:30 AM-Noon	F4	Risk Characterization – Part 2
1:30-5 PM	S13	Risk Assessment in Agriculture and Food Safety – Parts 3&4
1:30-3 PM	B3	Intervention Strategies: The Issues and the Players – Part 2
1:30-3 PM	C4	Data and Experts
1:30-3 PM	S18	Probabilistic Approaches to Environmental Health Risk Analysis – Part 3
1:30-3 PM	E4	Dose Response Analysis
1:30-5 PM	S22	New Developments in Wildlife Food Web Exposure Modeling – Parts 1&2
3:30-5:30 PM	B4	Scientific Uncertainty and Its Influence on The Public
3:30-5:30 PM	S15	The Biological Effects of Low Level Exposures to Chemicals and Radiation: Advances in Understandings of Toxicological Mechanisms
3:30-5 PM	S19	Probabilistic Approaches to Environmental Health Risk Analysis – Part 4
3:30-5:30 PM	S21	Predicting Blood Lead Levels: Models and Applications
Council Meeting		7-9 PM

Wednesday, December 7, 1994

International Attendee Breakfast		7 AM
Registration		8 AM-Noon
Exhibits		9 AM-Noon
8:30-10 AM	A3	Food Safety
8:30-10 AM	B5	Issues of Trust and Public Reliance on Risk Communication Channels
8:30-10 AM	C5	RCRA and Superfund
8:30-10 AM	D1	Exposure From Consumer Products
8:30-10 AM	S23	Dermal Exposure
8:30-Noon	S25	Benchmark Dose Approach: Development, Application and Challenges – Parts 1&2
10:30 AM-Noon	A4	Strategies for Ecological Assessment
10:30 AM-Noon	B6	Education and Evaluation of Risk Communication Programs
10:30 AM-Noon	C6	Safety and Reliability in Engineering Applications
10:30 AM-Noon	D2	Monte Carlo Simulation in Exposure Assessment
10:30 AM-Noon	E5	Site Evaluations: Specific Issues
1:30-3 PM	A5	Legal and Regulatory Issues
1:30-3 PM	B7	Risk Management in the Public Sector
1:30-3 PM	C7	Bringing Economics to Risk Analysis
1:30-3 PM	D3	Indirect/Multimedia Exposure
1:30-3 PM	S24	Risk Assessment in the Context of Environmental Justice
1:30-3 PM	F5	Uncertainties in Environmental Health Risk Analysis

Tuesday Afternoon Sessions

Track A

1:30-3:00 PM

S13 Risk Assessment in Agriculture and Food Safety - Part 3

Organized by: A. Hogue & A. Ahl

S13.01 Risk Assessment Strategies in a Federal Agency with a Wide Range of Risk Responsibilities. *A. S. Ahl; USDA/APHIS, Washington, DC*

S13.02 Hazard Analysis Critical Control Point (HACCP) Applications in Plant Quarantine. *R. L. Griffin; US Department of Agriculture, Washington, DC*

S13.03 Plant Pest Risk Assessment at Agriculture and Agri-Food Canada. *A. E. Stahevitch; Agriculture and Agri-Food Canada*

S13.04 The Port of El Paso Risk Assessment. *C. E. Miller and R. L. Griffin; US Department of Agriculture, Washington, DC*

3:30-5:00 PM

S13 Risk Assessment in Agriculture and Food Safety - Part 4

Organized by: A. Hogue & A. Ahl

S13.05 Assessment of the Likelihood of Introducing Bluetongue Disease Through the Importation of Cattle. *R. S. Morley and S. A. Renwick; Agriculture and Agri-Food Canada*

S13.06 Quantitative Assessment of the Risk of Disease Transmission by Bovine Embryo Transfer. *P. Suttmoller and A. E. Wrathall; Pan American Health Consultants*

S13.07 Indirect Biological and Economic Impacts of Tropical Bont Tick Eradication. *S. A. Ferenc; University of Florida*

Track B

1:30-3:00 PM

B3 Intervention Strategies: The Issues and The Players - Part 2

B3.09 Reversing the Direction of Risk Communication: Bringing Stakeholders Into the Risk Equation at a Contaminated Site. *S. McCracken, M. MacDonell, L. Haroun and J. Peterson; U.S. Department of Energy, Missouri, and Argonne National Laboratory*

B3.10 Oak Ridge Reservation in the 21st Century: Participatory Planning for Future Uses. *R. K. White and M. R. English; Martin Marietta Energy Systems, Inc. and University of Tennessee*

B3.11 Future Uses of Department of Energy Sites: A Vortex of Issues and a Myriad of Players. *W. Metz, R. Harris and J. Sparhawk; Argonne National Laboratory, US Department of Energy, Washington, DC and HAZWRAP*

3:30-5:30 PM

B4 Scientific Uncertainty and Its Influence on The Public

B4.12 Resolving Uncertainty in Scientific Evidence for Environmental Trials. *L. A. Reynolds and S. E. Hrudevy; University of British Columbia and University of Alberta, Canada*

B4.13 Unconfounding Content and Structure in the Mental Models Approach for Risk Communication Design. *C. J. Atman and A. Bostrom; University of Pittsburgh and Georgia Institute of Technology*

B4.14 Probability, Direct Inference, and a Conceptual Gulf in Risk Communication. *V. R. Walker; Hofstra University School of Law*

B4.15 Scientific Uncertainty and Its Influence on the Public Communication Process: NATO Advanced Research Workshop Update. *V. Sublet, V. Covello, M. Lum and T. Tinker; University of Cincinnati, University of California at Berkeley and Agency for Toxic Substances and Disease Registry*

Track C

1:30-3:00 PM

C4 Data and Experts

C4.13 Results from Expert Elicitation of Climate Scientists. *M. G. Morgan and D. Keith; Carnegie Mellon*

C4.14 An Equivalent-Damage Index for Assessing Comparative Risk Among Greenhouse-Gas Emissions. *J. K. Hammitt, A. K. Jain and D. J. Wuebbles; Harvard School of Public Health and Lawrence Livermore National Laboratory*

C4.15 The Use of Chernobyl Data to Test Predictions and Uncertainty Estimates From Exposure Assessment Models. *F. O. Hoffman; SENES Oak Ridge, Inc.*

C4.16 Quantification of Over-Confidence Bias in the Expected Value of Information. *J. K. Hammitt and A. I. Shlyakhter; Harvard School of Public Health*

3:30-5:30 PM

S15 Extended Session - The Biological Effects of Low Level Exposures to Chemicals and Radiation: Advances in Understandings of Toxicological Mechanisms

Organized by: E. J. Calabrese

S15.01 BELLE - A Paradigm Shift? *R. Cook; Dow Corning Corporation*

S15.02 Title not available at time of printing. *B. Butterworth; CIIT*

S15.03 Alcohol Consumption and Risk of Myocardial Infarction. *J. M. Gaziano; Brigham & Women's Hospital*

S15.04 A Brief History and Critique of the Low Dose Effects Paradigm. *L. Sagan; Electric Power Research Institute*

S15.05 Human Responses to Low level Exposures. *R. Cook; Dow Corning Corporation*

AUGUST 1993 TO
DECEMBER 1994

EH-40 Final Report
August 1993 to December 1994

Project Title: Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities

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Contract to:
Subcontract B218797 with SENES Oak Ridge, Inc.

1.0. Project Objective

As stated in subcontract B218797, the purpose of this work is to evaluate and validate pathway assessment models applicable to exposure and dose reconstruction at Department of Energy facilities, through use of international data sets.

This work centered around (1) involvement in two international model testing programs, BIOMOVs II and IAEA/VAMP; (2) development of appropriate high-quality data sets for model testing using site-specific data obtained in various countries; and (3) use of these data sets to test both process-level and multiple pathways environmental transport models.

BIOMOVs II (BIOSpheric Model Validation Study, Phase II) is managed by the Atomic Energy Control Board of Canada, the Atomic Energy of Canada Limited, Centro de Investigaciones Energeticas Medioambientales y Tecnologicas of Spain, Empresa Nacional de Residuos Radiactivos S.A. of Spain, and the Swedish Radiation Protection Institute. The VAMP (Validation of Environmental Model Predictions) Programme is sponsored by the International Atomic Energy Agency.

The principal investigator, Dr. F. Owen Hoffman, serves as chairman for both the Post Chernobyl Data Working Group of BIOMOVs II and the Multiple Pathways Assessment Working Group of VAMP.

2.0. Technical Accomplishments

The tasks completed under this subcontract are described below, together with other tasks which are still in progress. Recommendations for further work are given in Section 3.0 of this report; reports and papers resulting from or describing this work are listed in Section 4.0, and meeting participation and presentations are listed in Section 5.0. Brief summaries of the model testing scenarios developed during this work are provided in Section 6.0.

2.1. Multiple Pathways Assessment Working Group of VAMP

Two major multiple pathways test exercises are complete or nearing completion (Scenarios CB and S). Three new scenarios are essentially ready for release to modelers; with minimal adaptation, they would be suitable for use specifically with dose reconstruction models.

2.1.1. Scenario CB (Central Bohemia, Czech Republic)

This scenario used data from Chernobyl fallout collected in the Czech Republic. The starting points of the scenario were measured concentrations of Cs-137 in air and soil in 1986. The scenario's midpoint and endpoints were time-dependent quantities of Cs-137 in various types of food and fodder, time-dependent concentrations of Cs-137 in the whole body for adult humans, and estimates of doses to adult humans from external and internal radiation exposure. Predictions were made for the years 1986-1989.

Model predictions for the time variation of Cs-137 concentrations in humans are shown in Figure 1 for selected models and modelers. The overestimates in the model predictions are due primarily to overestimates of Cs-137 concentrations in foodstuffs and amounts of foods consumed; the best results were obtained by modelers familiar with the region.

Following disclosure of the test data, modelers were given an opportunity to improve their models. Revised predictions for the same modelers are shown in Figure 2. Changes to models were based on improved understanding of the processes being modeled (e.g., metabolic transfer of Cs-137 into meat and milk), as well as corrections to errors in the codes or parameter values.

A number of conclusions were drawn from the Scenario CB exercise:

- 1) Most models tended to overestimate the body burdens of Cs-137.
- 2) The experience of the modeler is as important as the nature of the model.
- 3) Testing is necessary at several steps within a pathway, otherwise compensatory error may not be identified.
- 4) Models should be amenable to alterations in structure to address site specific conditions.
- 5) Because user judgment is always necessary, critical assessments should be performed by more than a single group.

The final report for Scenario CB is in press as an IAEA technical report.

2.1.2. Scenario S (Southern Finland)

This scenario used data from Chernobyl fallout collected in southern Finland. The starting points of the scenario were measured concentrations of Cs-137 in air and soil in 1986. The scenario's midpoint and endpoints were time-dependent quantities of Cs-137 in various types of food and fodder; time-dependent concentrations of Cs-137 in the whole body for men, women, and children; and estimates of doses to adult humans from external and internal radiation exposure. Predictions were made for the years 1986-1990; uncertainty estimates were required on both the test data and the model predictions.

Scenario S was the most comprehensive test to date of multiple pathways exposure assessment models; it was the first test to include contributions to the human diet from natural and seminatural ecosystems and to consider the importance of human consumption of freshwater fish. In this situation, contaminants accidentally released to the atmosphere were transferred to humans via consumption of fish. Examples of model predictions for Cs-137 concentrations in fish and mushrooms are shown in Figures 3 and 4, respectively. Predicted Cs-137 concentrations in adult males are shown in Figure 5 for all models and modelers.

Several important findings were obtained from this test exercise: (1) differences in the dietary uptake and whole body concentrations of Cs-137 occur due to differences in gender and age; (2) different pathways dominated the exposure of individuals at

different times following the contaminant release; and (3) changes in dominant pathways with time were affected by soil composition and hence soil fixation of Cs-137. These findings are supported by a comparison of test data (normalized for total deposition) between Scenarios CB and S.

Conclusions drawn from the Scenario S exercise include the following:

- 1) Very accurate estimates were made for non-traditional pathways (i.e., fish, berries, big game, mushrooms). A major reason for this is the abundance of pre-Chernobyl data on radionuclides in northern climates.
- 2) User experience is still a factor in determining the accuracy of results.
- 3) Uncertainty estimates are highly dependent on judgment and thus differ among investigators.
- 4) Compensatory error is still evident.

The final report for Scenario S is in nearly complete. The anticipated date for submission of the report to the IAEA for publication is April 1995.

2.1.3. Conclusions from the CB and S test exercises

The major finding from completion of the two test exercises is that model testing against independent data sets exposed the importance of the model user in determining the accuracy of the model prediction. Blind testing of model predictions identified the most important reasons for mispredictions:

- 1) user inexperience (e.g., an inability to assess the "face validity" of results);
- 2) insufficient understanding of important site-specific pathways and processes;
- 3) differences in interpretation of imperfect input data; and
- 4) use of generic parameter values that did not fit site-specific situations.

Factors that may affect model performance include the flexibility of the model (both in parameter values and in model structure) for site-specific assessment; the availability of site-specific data to quantify key model parameters; the presence of compensatory error in the model; and the possibility that apparent accuracy in some

cases may be due to the averaging of distinctly different processes across an entire region. Based on these two exercises, suggestions for future model testing exercises include the use of additional sites and radionuclides; testing for exposure of members of critical groups or specific population subgroups; consideration of the representativeness of Chernobyl fallout data to other situations; and testing of models at the process level.

2.1.4. Comparison of test data between Scenarios CB and S

The use of two independent test scenarios by the same working group provided an opportunity to compare not only improvements in modeling capabilities between the first and second exercises, but also the behavior of the contaminant concentrations in two very different locations over a period of several years.

Comparisons between Central Bohemia and southern Finland were made for milk, beef, pork, and human whole body concentrations. The observed data were normalized to the total deposition (Figures 6-9). The figures also show the cumulative time-integrated concentrations normalized for total deposition. After 5 years, the differences between the time-integrated, normalized concentrations in two regions are reduced to within a factor of 2 to 3.

The differences in the normalized observations for the early measurements (approximately the first year) demonstrate the dependence of the observations on the characteristics of the initial deposition, e.g., wet- vs. dry-deposition and distance from contaminant source. For the later years, concentrations in foodstuffs are influenced greatly by the soil properties, while the concentrations in humans are influenced by the food types consumed by the population. Cesium-137 persists longer in the Finnish soil than in the soils of Central Bohemia, resulting in persistently higher concentrations of Cs-137 in milk, beef, and pork. However, concentrations in all three foods are declining with increasing time, with the exception of pork for Scenario S. Here the differences are due to the differences in the diets of pigs in the two regions. In Central Bohemia, pigs are fed primarily on milk products such as whey, and the concentrations of Cs-137 in pork follow the same trends as for milk. In Finland, however, the pigs eat mostly grains. Concentration of Cs-137 in feed grains such as barley and oats have not declined, and hence the pork concentrations are also level.

The normalized concentrations of Cs-137 in humans are not greatly different for the two locations (Figure 9). Concentrations after 5 years are slightly higher for southern Finland. The major difference is probably the diets in the two regions,

with Finland having a much higher proportion of seminatural food sources, such as fish and mushrooms, containing persistent high levels of contamination. In addition, the Finnish population sample is more nearly random than is the Czech sample.

Distributions of the whole body concentrations of adults for Scenarios CB and S were compared for 1987 and 1990 (Figures 10-11). When these data are normalized for total deposition (bottom graphs), essentially no difference is seen between CB and S for 1987 (Figure 10). For 1990, however, there is no overlap at all, with the Finnish data showing both higher normalized concentrations and greater variability among concentrations (Figure 11).

Results of the comparison of test data between Scenarios CB and S are being prepared for submission to the open literature.

2.1.5. Model intercomparison using data from Scenarios CB and S

A model intercomparison exercise was performed at SENES Oak Ridge using data from Scenarios CB and S, with specific emphasis on the effect of the user on the outcome of model predictions. Predictions were obtained by a single modeler with several assessment models which could potentially be used for dose reconstruction calculations in the United States. Results are described below for four quasi-steady state models: AIRDOS-EPA, the screening methodologies of NCRP and IAEA Safety Series 57 (SS-57), and RESRAD. Calculations made very recently with the dynamic model PATHWAY are included in several of the figures.

The four quasi-steady state models use very similar equations. The main difference between them is in the construction of the source term. For NCRP, AIRDOS-EPA, and SS-57, the source term is represented by a constant air concentration (Bq/m^3) in the area of interest. The radionuclide is deposited onto the soil and vegetation and then is transported through the environmental pathways. Conversely, the source term for RESRAD is described as a uniformly contaminated zone below ground (Bq/kg dry soil) that is the starting point for all pathways. The actual source terms for the CB and S Scenarios are far more complex, but can be described as a contaminated cloud for 1986 and a soil reservoir for the next years.

In order to have the same input for all the models, the total deposition was used as the starting point. The measured air concentration for the first year was used to calculate the doses due to inhalation and to cloud immersion. The amount deposited was assumed to form the soil reservoir for the next years. Obviously, the

real system was not an equilibrium situation. However, one level of equilibrium was considered for the first year and a second level for the succeeding years. The first level of equilibrium consisted of a constant air concentration and a constant soil contamination (superficial deposition for the NCRP, AIRDOS-EPA, and SS-57 models, and a 3-cm thickness of soil for the RESRAD model). The second level of equilibrium consisted only of soil contamination (superficial deposition for NCRP, AIRDOS-EPA, and SS-57, and a 6-cm thickness of soil for RESRAD). These assumptions permitted a provisional simulation of the dynamic aspect of the processes involved.

For the calculations, three endpoints were considered which are intermediary steps in dose assessment: the concentrations of Cs-137 in milk, beef, and pork. The comparisons between the calculations done by SENES Oak Ridge and the predictions produced by the models in the CB and S exercises are shown in Figures 12-17. The observed values (test data) are included as references. (The names of the models used by SENES Oak Ridge are shown in each figure in bold, italic characters.) RESRAD was used during the S test exercise by the developer of the model, Dr. C. Yu of Argonne National Laboratory. His predictions are labeled RESRAD; those produced by SENES Oak Ridge are labeled RESRAD-A. The models used by SENES did not make distinctions between beef and pork. Predictions for a general "meat" category were used in the graphs for both beef and pork. The uncertainties in these predictions were derived by propagation of only the error associated with total deposition. Additional uncertainty would be expected if the variability of the model parameters were to be taken into account.

The upper graph in each figure shows the cumulative time-integrated concentrations for milk $[(\text{Bq} \cdot \text{month})/\text{L}]$ and for beef and pork $[(\text{Bq} \cdot \text{month})/\text{kg}]$. The time-integrated concentrations were preferred because the quasi-steady state models can produce only yearly averaged values. The integrations shown were done over a 3-year period for CB and a 5-year period for S. The integrated values over the 3- or 5-year period are strongly influenced by the contribution of the first year.

Predictions by the steady-state models are dominated by the total deposition. For this reason, the time-integrated values were normalized to the total deposition (Bq/m^2 ; lower graphs in Figures 12-17). Most of the model users from the CB and S exercises provided estimates of the total deposition which they used for their own predictions; the integrated values for their predictions have been normalized to their predicted total deposition. Predictions from the models used by SENES Oak Ridge were normalized to the measured deposition, as were predictions from modelers who did not provide their own estimates of total deposition.

In all cases, the NCRP, AIRDOS-EPA, and SS-57 models overestimated by a factor of 2 to 20. This is expected, because these models were designed to give conservative estimates, that is, not to underestimate. Results obtained with RESRAD-A were much closer to the observed values, producing reasonable underestimates for milk and beef but giving an overestimate for pork. Apparently, RESRAD was designed for the pasture-milk-beef pathway, rather than for the pork pathway. However, predictions for the S region obtained by SENES are comparable to the predictions produced by the developer of the model during the S exercise.

Calculations for the ingestion dose and the total dose are shown in Figures 18-21. The authors of the scenarios provided estimates of the doses from local measurements obtained over a 3-year period for CB and a 5-year period for S; calculations by SENES Oak Ridge were done for similar periods.

The ingestion dose is determined primarily by the concentration in milk and meat predicted by each model. RESRAD-A performed acceptably for the CB region (only a slight underestimation), for which it accurately reproduced the time-integrated concentrations for milk and meat. In contrast, RESRAD-A underestimated the ingestion dose for S region by a factor of 3. This result comes from a previous underestimate for the milk and meat endpoints. The other three models showed a large overprediction for both scenarios. The NCRP model gave the largest overestimate, while the estimates for AIRDOS-EPA and SS-57, which used the same mathematical description of the processes, were very close together.

RESRAD gave excellent predictions of the total dose, but this result contains the compensatory effect of the underestimate for the ingestion dose and an overestimate for the ground exposure dose. Similar behavior can be seen in the calculations made with RESRAD-A for both the CB and S regions, as well as in the calculations provided by the model developer in the Scenario S exercise. AIRDOS-EPA, SS-57, and NCRP overestimated the total dose by a factor of 6 to 7 for CB and by a factor of 3 to 4 for S. Once again, the conservative character of these models is evident.

Use of the data sets from VAMP for this intercomparison exercise has permitted comparison of results obtained with these models both with the test data (observations) and with predictions made by other modelers (participants in the VAMP exercises). The results indicate that the variability among model predictions is reduced when models are run by a single individual using a consistent interpretation of the input data for all models. Differences among model results in many cases may be due more to choice of parameter values (e.g., generic vs. site-specific) than to actual differences in model structure. The results for the U.S. models also show that bias in the model predictions is usually toward the

conservative side. This is expected for screening models such as NCRP and SS-57, but is also found with models such as AIRDOS-EPA, which is designed to give a best estimate. The extent of conservatism in the model predictions is not extreme and was usually less than one order of magnitude.

An additional benefit of this exercise is that we now have an operational version of the dynamic model PATHWAY. An operational version of PATHWAY was not available from Colorado State University (the developers); therefore we reprogrammed the model based on the equations and parameter values described in the open literature. To verify the SENES Oak Ridge version of the model, we have run the code for selected test examples provided in the original documentation for PATHWAY. The SENES version of PATHWAY has produced results similar if not identical to those produced by the Colorado State version. Further tests with the PATHWAY methodology will be made outside the scope of this project, due to the loss of continued funding for this project.

The results of the model intercomparison exercise, including the addition of calculations with the dynamic model PATHWAY, are being written up for publication. We anticipate submitting the manuscript to *Health Physics* in February 1995.

2.1.6. Development of additional multiple pathways scenarios

Three new multiple pathways scenarios have been developed and distributed as part of the VAMP program: Scenario H (Hanford), which describes an I-131 release in the U.S. in 1963; Scenario I (Ipup River), which is based on data from the Bryansk region of Russia following the Chernobyl accident and which is the first multiple pathways scenario to consider the effects of countermeasures; and Scenario T (Techa River), which uses data from historic releases of radioactive contamination into the Techa River in Russia. These scenarios will be used in future model validation programs sponsored by the IAEA. One or more of them may be revised for use specifically with dose reconstruction models.

2.2. Other involvement in VAMP

In addition to the work with the Multiple Pathways Assessment Working Group, we were involved in various ways with the Terrestrial, Urban, and Aquatic Working Groups. Dr. B. Gordon Blaylock, who recently joined the staff of SENES Oak Ridge, has been involved in the Aquatic Working Group for several years.

2.2.1. Terrestrial Working Group

A review paper on interception and retention of radionuclides on vegetation was completed during 1994 and has been submitted for publication by the IAEA. Dr. F. Owen Hoffman is a co-editor of this paper.

2.2.2. Urban Working Group

A draft report has been prepared for the Urban Working Group of IAEA/VAMP. This paper summarizes the results from a modeling problem dealing with resuspension of contaminated soil in an urban area in Goiania, Brazil. One set of model predictions for this problem was submitted by SENES Oak Ridge; we are also assisting with preparation of the report. On completion, this paper will be submitted to the IAEA for publication.

2.2.3. Aquatic Working Group

The final report of the Rivers and Reservoirs Scenarios of the IAEA/VAMP Aquatic Working Group is in progress; SENES Oak Ridge is assisting in completion of the report, which will be published by the IAEA. Two scenarios were examined, the release of radionuclides from the Chernobyl accident to the Dnieper River and the release of radionuclides from the Oak Ridge National Laboratory to the Clinch and Tennessee Rivers. The scenarios called for prediction of accumulated radionuclides in various compartments and the potential dose to individuals using the river systems.

2.3. Post Chernobyl Data Working Group of BIOMOVs II

Three scenarios have been developed by the Post Chernobyl Data Working Group of BIOMOVs II. These scenarios are designed for testing of process-level models, using data from Chernobyl fallout.

The objective of Scenario W (Wash-off) is to test models concerned with the movement of trace contaminants from terrestrial sources to water bodies. Particular emphasis is placed on chemical speciation and on the geochemical and geophysical processes affecting transfer of contaminants from soil to water. Scenario CP (Cooling Pond) is designed to test models for radioactive contamination of aquatic ecosystems, based on data from the Chernobyl NPP cooling pond. Scenario R (Resuspension) has been developed to test models for resuspension of contaminated soils. Resuspension can be a secondary source of contamination after a release has stopped, as well as a source of contamination for people and areas not exposed to the original release.

Initial comparison and evaluation of model predictions for the BIOMOVs II Post Chernobyl scenarios has been carried out. Model predictions have been received for all three scenarios; SENES Oak Ridge submitted predictions for Scenarios W and R. Selected examples of model predictions for these scenarios are shown in Figures 22-25. The differences in predictions between modelers result from differences in the approaches used. The model predictions have been compared with the test data (observations), but in anticipation of submissions by additional modelers, the test data have been released only to modelers who have submitted predictions. *Therefore comparisons of model predictions to test data are not included in this report.*

BIOMOVs II technical reports describing each model testing exercise and its results will be prepared before BIOMOVs II ends in 1996. The scenarios have been submitted as a set to *Health Physics*; the results from the modeling exercise will be submitted to *Health Physics* at a later date. A description of our modeling approach for Scenario W is in preparation for submission to the open literature.

Two new scenarios, extensions of the W and CP scenarios, have been proposed in the BIOMOVs II Post Chernobyl Data Working Group. Scenario FP (Flood Plain) has been distributed in draft form. This scenario describes the wash-off of contaminated soil into the Pripyat River (Ukraine) during a flood in 1991. The proposed extension of Scenario CP will provide an opportunity to compare dose and risk assessments for three possible remediation plans (no remediation; filling of the cooling pond with dirt; and drainage of the cooling pond) and for a possible accident (breaking of the dam).

3.0. Recommendations for further work

The appropriate next steps in these projects are (1) to complete the final reports on the VAMP exercises, (2) to complete the BIOMOVs II exercises and prepare final reports on them, and (3) to carry out the new test exercises as their development is completed. The new scenarios are designed to address specific situations not addressed in previous test exercises (e.g., the effects of post-contamination countermeasures, surface water contamination, and additional radionuclides).

Renewed funding will be necessary to see the present projects through to completion and to ensure that additional test exercises both meet the Government's anticipated needs for appropriate model testing opportunities and make use of properly validated, high-quality data sets. In addition, for the Government to achieve the best possible use from model testing activities, it is highly desirable for the data sets (input data and test or output data, together with complete documentation) to be properly archived. This will enable present and future researchers and modelers to have access to suitable data sets for testing a wide variety of models. Additional funding is also necessary if archival of the data sets is to occur in a timely fashion and while the data sets are still complete.

4.0. Reports and papers

Several manuscripts have been submitted to journals for publication or are being prepared for submission. These are listed in Section 4.1. Section 4.2. contains a list of the technical reports put out by either the International Atomic Energy Agency or BIOMOVs II in which we or our working groups have been involved during the course of this subcontract. These reports include a review paper, several scenario descriptions, and final reports from model testing exercises. Section 4.3. contains a list of newsletters and progress reports put out by the organizers of the model testing studies, as well as LLNL progress reports describing our work under this subcontract.

4.1. Manuscripts

Apostolaei, A. I., Hoffman, F. O., and Thiessen, K. M. The use of Chernobyl data to test predictions and uncertainty estimates from exposure assessment models. (To be submitted to *Health Physics*)

Apostolaei, A. I., Hoffman, F. O., and Thiessen, K. M. Comparison of Cs-137 concentrations resulting from Chernobyl fallout for milk, beef, pork, and humans in two European regions. (In preparation)

Garger, E. K., Hoffman, F. O., and Miller, C. W. III. Atmospheric resuspension of radionuclides in Ukrainian regions impacted by Chernobyl fallout. (submitted to *Health Physics*)

Hoffman, F. O., Thiessen, K. M., and Watkins, B. Opportunities for the testing of environmental transport models using data obtained following the Chernobyl accident. Descriptions of three test scenarios developed by the Post Chernobyl Data Working Group of BIOMOVs II. *Health Physics* (in press)

Konoplev, A. V., Bulgakov, A. A., Popov, V. E., Popov, O. F., Scherbak, A. V., and Shveikin, Yu. V. I. Wash-Off of ^{90}Sr and ^{137}Cs from two experimental plots established in the vicinity of the Chernobyl reactor. (submitted to *Health Physics*)

Kryshev, I. I., Sazykina, T. G., Ryabov, I. N., Chumak, V. K., and Zarubin, O. L. II. Assessment of the consequences of the radioactive contamination of the Chernobyl NPP cooling pond. (submitted to *Health Physics*)

Nair, S. K., Thiessen, K. M., and Konoplev, A. Modeling the wash-off of ^{90}Sr and ^{137}Cs from an experimental plot established in the vicinity of the Chernobyl reactor. (In preparation)

4.2. Technical Reports

BIOMOVs II Glossary, developed for the participants in the BIOMOVs II study, August 1993.

Garger, E. K., Hoffman, F. O., and Miller, C. W. (1994) Atmospheric resuspension of radionuclides in Ukrainian regions impacted by Chernobyl fallout. Description of Scenario R (Version 1.02). BIOMOVs II.

International Atomic Energy Agency. (in press) Validation of models using Chernobyl fallout data from the Central Bohemia region of the Czech Republic--Scenario CB. First Report of the VAMP Multiple Pathways Assessment Working Group.

International Atomic Energy Agency. (in press) The interception, initial and post deposition retention by vegetation of dry- and wet-deposited radionuclides. Review Paper of the IAEA Terrestrial Working Group. Pröhl, G., and Hoffman, F. O., eds.

International Atomic Energy Agency. (in preparation) Validation of models using Chernobyl fallout data from southern Finland--Scenario S. Second Report of the VAMP Multiple Pathways Assessment Working Group.

Konoplev, A. V., and Hoffman, F. O. (1994) Wash-Off of ^{90}Sr and ^{137}Cs from two experimental plots established in the vicinity of the Chernobyl reactor. Description of Scenario W (Version 1.03). BIOMOVs II.

Kryshev, I. I., Sazykina, T. G., Drogolyubova, I. V., Borisova, N. T., Ryabov, I. N., Nasvit, O. I., Chumak, V. K., Zarubin, O. L., Hoffman, F. O., and Thiessen, K. M. (1994) Assessment of the consequences of the radioactive contamination of the Chernobyl NPP cooling pond. Description of the Scenario CP (Version 1.04). BIOMOVs II.

Kryshev, I. I., Sazykina, T. G., Dragolybova, I. V., Nikitin, A. I., Alexakhin, R. M., Fesenko, S. V., Sanzharova, N. I., Balonov, M. I., Barishkov, N. K., Golikov,

V. Yu., and Hoffman, F. O. (1994) Estimation of consequences of radioactive contamination with Cs-137 in the Iput River Catchment Area. Description of test scenario I (Version 1.05). IAEA/VAMP.

Kryshev, I. I., Sazykina, T. G., Ryabov, I. N., Chumak, V. K., Zarubin, O. L., Hoffman, F. O., and Thiessen, K. M. (1994) Assessment of the consequences of the radioactive contamination of the Chernobyl NPP cooling pond. Description of the Scenario CP (Version 2.02). BIOMOVs II.

Kryshev, I. I., Sazykina, T. G., Chumichev, V. B., Hoffman, F. O., and Thiessen, K. M. (1994) Multiple model testing using environmental contamination data of ^{90}Sr , ^{137}Cs , ^{239}Pu , and ^{240}Pu for the Techa River (Settlement Muslumovo, Ural Region, Russia) Description of the Scenario T, Stage I, "Model testing for ^{90}Sr " (Version 1.0) IAEA/VAMP.

Napier, B. A., and Kennedy, W. E., Jr. (1993) Description of Test Scenario H. Draft. IAEA/VAMP.

4.3. Newsletters and progress reports

BIOMOVs II Newsletter: No. 8, October, 1993.

BIOMOVs II Newsletter: No. 10, April, 1994.

BIOMOVs II Newsletter: No. 12, September, 1994.

BIOMOVs II Progress Report No. 4, November 1993.

BIOMOVs II Progress Report No. 5, November 1994.

VAMP (VAlidation of Model Predictions) Progress Report No. 5, October 1993.

VAMP-MP Newsletter, May 1994.

VAMP-MP Newsletter, July 1994.

VAMP-MP Newsletter, November 1994.

Progress Report. August 1993-January 1994. Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and ..

Dose Reconstruction at DOE Facilities. Lawrence Livermore National Laboratory, UCRL-CR-116511-94-1.

Progress Report. February 1994. Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities. Lawrence Livermore National Laboratory, UCRL-CR-116511-94-2.

Progress Report. March-May 1994. Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities. Lawrence Livermore National Laboratory, UCRL-CR-116511-94-3.

Progress Report. June-September 1994. Use of International Data Sets to Evaluate and Validate Pathway Assessment Models Applicable to Exposure and Dose Reconstruction at DOE Facilities. Lawrence Livermore National Laboratory, UCRL-CR-116511-94-4.

5.0. Meeting participation

During the period of this subcontract, we participated in several working group and general meetings of the model testing studies. In addition, we have had or expect to have several opportunities to present this work at other scientific meetings.

27 June - 10 July, 1993. Dr. F. Owen Hoffman and Dr. Stanley I. Auerbach attended a meeting of the Post Chernobyl Data Working Group Meeting of BIOMOVs II and the 5th Research Coordination Meeting of the VAMP program. Both meetings were held at the headquarters of the International Atomic Energy Agency (IAEA) in Vienna, Austria. A trip report was submitted in July 1993.

14 July, 1993. Dr. F. Owen Hoffman gave an invited presentation to the Health Physics Society at their annual meeting in Atlanta, Georgia. His talk was entitled "Introduction to Uncertainty Analysis for Radiological Dose and risk Assessment."

24 September - 9 October, 1993. Dr. F. Owen Hoffman and Dr. Kathleen M. Thiessen attended the BIOMOVs II 4th Workshop in Vienna and a meeting of the VAMP Multiple Pathways Assessment Working Group of VAMP in Helsinki, Finland. Participation in these meetings by several scientists from Russia and Ukraine was also supported by this contract. A trip report was submitted in October 1993.

8 October, 1993. Dr. F. Owen Hoffman gave a special seminar at the Finnish Centre for Radiation and Nuclear Safety (STUK) in Helsinki, Finland. His talk was entitled "A Risk-Based Approach to the Evaluation of Multiple Contaminants in Various Environmental Media."

28 October, 1993. Dr. F. Owen Hoffman gave a talk to the Science Advisory Board of the U.S. Environmental Protection Agency in Washington, D.C. The talk was entitled "International Biospheric Model Validation: Implications for Environmental Risk Assessment."

21-31 March, 1994. SENES Oak Ridge, Inc., hosted meetings of the Post Chernobyl Data Working Group of BIOMOVs II and the Multiple Pathways Assessment Working Group of VAMP. The meetings took place in Oak Ridge, Tennessee. Participation in these meetings by several scientists from Russia and Ukraine was supported by this contract. A public meeting was held on March 29 with presentations by Russian and Ukrainian scientists on the subject of the Chernobyl

accident and its aftermath. This meeting was described in the monthly report submitted in April 1994.

20-24 June, 1994. Dr. F. Owen Hoffman and Dr. Kathleen M. Thiessen attended a meeting of the VAMP Multiple Pathways Assessment Working Group of VAMP in Helsinki, Finland. A trip report was submitted in July 1994.

28 June, 1994. Dr. F. Owen Hoffman gave an invited presentation to the American Statistical Society in Nantucket, Massachusetts. The presentation was entitled "Use of Chernobyl Fallout Data for Testing Exposure and Dose Assessment Models."

19 August, 1994. Dr. F. Owen Hoffman gave an invited lecture at the University of Tennessee in Knoxville. The lecture, entitled "International Biospheric Model Validation: Implications for Environmental Risk Assessment," was part of a short course in Quantitative Uncertainty Analysis offered by the Nuclear Engineering Department.

17 October - 4 November 1994. Dr. F. Owen Hoffman, Dr. Kathleen M. Thiessen, and Dr. Shyam K. Nair attended a meeting of the Fifth Workshop of BIOMOVs II and the Sixth and Final Research Coordination Meeting of VAMP, both of which were held in Vienna. Prior to those meetings, Dr. Hoffman also chaired a meeting for the revision of IAEA Safety Series 57. A trip report was submitted in November 1994.

4-7 December 1994. Dr. F. Owen Hoffman gave an invited presentation at the Annual Conference and Exposition of the Society for Risk Analysis. Dr. Hoffman's talk was entitled "The Use of Chernobyl Data to Test Predictions and Uncertainty Estimates from Exposure Assessment Models."

May 1995. Dr. F. Owen Hoffman will present a paper on the use of Chernobyl data for model testing at the IAEA's meeting, "International Symposium on environmental Impact of Radioactive Releases." An abstract was submitted in July of 1994. The paper is entitled "The Use of Chernobyl Data to Test Predictions and Uncertainty Estimates from Exposure Assessment Models."

July 1995. Dr. Shyam K. Nair and Mr. A. Iulian Apostoaei are submitting abstracts for presentation at the Health Physics Society Annual Meeting, to be held July 23-27 in Boston. Abstracts include "Modeling the Resuspension of Radionuclides in Ukrainian Regions Impacted by Chernobyl Fallout," by S. K. Nair, C. W. Miller, K. M. Thiessen, and E. K. Garger, and "The Use of Chernobyl Data to Test Predictions and Uncertainty Estimates from Exposure Assessment Models," by A. I. Apostoaei, F. O. Hoffman, and K. M. Thiessen.

6.0. Summary of scenarios developed by the Multiple Pathways Assessment Working Group of VAMP and the Post Chernobyl Data Working Group of BIOMOVs II

The major scenarios developed by these groups are briefly described below. The status of the test exercises and discussions of our involvement are given in Section 2.0 of this report.

6.1. Scenario CB (Central Bohemia, Czech Republic). IAEA/VAMP.

Starting point

Concentrations of Cs-137 in air and soil in 1986

Midpoint

Time-dependent quantities of Cs-137 in various types of food and fodder (1986-1989)

Endpoints

Time-dependent concentrations of Cs-137 in the whole body for adult humans
(1986-1989)

Estimates of doses to adult humans from external and internal radiation exposure
(1986-1989)

6.2. Scenario S (southern Finland). IAEA/VAMP.

Starting point

Concentrations of Cs-137 in air and soil in 1986

Midpoint

Time-dependent quantities of Cs-137 in various types of food and fodder (1986-1990)

Endpoints

Time-dependent concentrations of Cs-137 in the whole body for humans (men, women, and children; 1986-1990)

Estimates of doses to humans from external and internal radiation exposure
(1986-1990)

6.3. Scenario H (Hanford, Washington). IAEA/VAMP.

Starting points

Atmospheric source term information
Measured air concentrations
Measured deposition on vegetation

Endpoints

Total deposition and total inventory of I-131
Concentrations of I-131 in milk and vegetation
Human intake of I-131
Thyroid burdens of I-131
Doses of I-131 to humans
Dispersion contours (deposition rates) across the region

6.4. Scenario I (Ipup River catchment basin, southern Russia). IAEA/VAMP.

Starting points

Concentrations of Cs-137 in air, soil, and water in 1986
Information on protective measures applied in the region

Midpoint

Time-dependent quantities of radionuclides in various types of food and fodder
(1986-1991)

Endpoints

Time-dependent concentrations of Cs-137 in the whole body for adult humans
(men and women; 1986-1991)
Estimates of doses to humans from external and internal radiation exposure from
Cs-137 (1986-1991)
Note: An expected expansion of Scenario I will add calculations for children and for
several additional radionuclides, including short-lived ones.

6.5. Techa River (Ural region, Russia). IAEA/VAMP.

Starting point

Radioactive discharges in the Techa River (1949-1956 and current)

Midpoints

Radionuclide concentrations in water (Sr-90, Cs-137, Pu-239+240; 1949-1994)

Radionuclide concentrations in the flood plain (1991-1993)

Radionuclide concentrations in the food chains and biota (1991-1993)

Endpoints

Concentration of Sr-90 in the whole body for humans of different ages (1949-1956; 1991-1993)

Estimates of doses to humans from external and internal radiation exposure (1949-1956; 1949-1993; 1949-lifetime)

Assessment of risk to humans from exposure to radionuclides in the Techa River and its flood plain

6.6. Scenario W (Wash-off). BIOMOVs II.

Objective: to test models concerned with the movement of trace contaminants from terrestrial sources to water bodies. Particular emphasis is placed on chemical speciation and on the geochemical and geophysical processes affecting transfer of contaminants from soil to water.

Stage 1: Wash-off of Cs-137 and Sr-90 from two experimental plots (HR, heavy rain; SM, snow melt)

Stages 2 and 3: Watersheds of the Kiev reservoir and the Dneiper River basin

Starting points

Characteristics of the initial aerial deposition of the radionuclides

Data on topography, soil type and characteristics, and time-varying precipitation

Midpoint

Vertical distribution of concentrations of exchangeable and nonexchangeable forms of Cs-137 and Sr-90 in the soil of the experimental plots

Endpoints

Concentrations of Cs-137 and Sr-90 in runoff water from the experimental plots

Total amounts of Cs-137 and Sr-90 removed by runoff from the experimental plots

6.7. Scenario CP (Cooling Pond). BIOMOVs II.

Objective: to test models for radioactive contamination of aquatic ecosystems, based on data from the Chernobyl NPP cooling pond.

Starting points

Characteristics of the cooling pond ecosystem (hydrological, hydrochemical, and hydrobiological conditions)

Stage 1: Estimated amounts of Cs-137 in the Chernobyl cooling pond in 1986

Stage 2: Estimated amounts of radionuclides in the Chernobyl cooling pond, sediment, and biota

Endpoints

Stage 1: Concentrations of Cs-137 in the cooling pond water, the sediment layers, and fish (total, nonpredators vs. predators, and by age class; 1986-1995)

Stage 2:

Concentrations of other radionuclides in the cooling pond water, the sediment layers, and fish (1986-2000)

Estimates of dose and risk to humans from hypothetical consumption of contaminated fish from the cooling pond (1986-1988)

6.8. Scenario R (Resuspension). BIOMOVs II.

Objective: to test models for resuspension of contaminated soils. Resuspension can be a secondary source of contamination after a release has stopped, as well as a source of contamination for people and areas not exposed to the original release.

Exposure situations

- (1) Locations within the highly contaminated 30-km zone (exposures to resuspended material are probably dominated by local processes)
- (2) Urban area (Kiev) outside the 30-km zone (local processes include extensive vehicular traffic)
- (3) Location 40-60 km west of the Chernobyl reactor (upwind sources of contamination are important)

Starting points

Characteristics of the Cs-137 ground contamination around specific sites

Climatological data for the sites

Characteristics of the terrain and topography

Locations of sampling sites

Endpoints

Calculation of average air concentrations due to resuspension
of Cs-137 initially released from the Chernobyl reactor, for the specified
locations

Calculation of specified resuspension factors and rates

Figure 1. Initial predictions for average Cs-137 concentrations in humans: A comparison of selected model predictions with observations for region CB. Dark circles indicate the mean and horizontal bars the 95% confidence intervals of the mean of observations; dashed lines indicate the 95% subjective confidence interval about the mean prediction (solid line with triangles).

Figure 2. Revised predictions for average Cs-137 concentrations in humans: A comparison of selected model predictions with observations for region CB. Dark circles indicate the mean and horizontal bars the 95% confidence intervals of the mean of observations; dashed lines indicate the 95% subjective confidence interval about the mean prediction (solid line with triangles).

Figure 3. A comparison of selected model predictions with observations for mean concentrations of Cs-137 in freshwater fish in southern Finland. Vertical bars indicate 95% confidence intervals on the mean value of observations (dark circles); dashed lines indicate the 95% subjective confidence interval about the mean prediction (solid line).

Figure 4. A comparison of selected model predictions with observations for mean concentrations of Cs-137 in mushrooms in southern Finland. Vertical bars indicate 95% confidence intervals on the mean value of observations (dark circles); dashed lines indicate the 95% subjective confidence interval about the mean prediction (solid line).

Figure 5. A comparison of model predictions with observations for mean concentrations of Cs-137 in adult males in southern Finland. Vertical bars indicate 95% confidence intervals on the mean value of observations (dark circles); dashed lines indicate the 95% subjective confidence interval about the mean prediction (solid line). (continued on next page)

Figure 5 (continued)

Figure 6. Comparison of Cs-137 concentrations in milk for Central Bohemia (CB) and southern Finland (S). Shown are (A) the observations normalized for total deposition and (B) the cumulative time-integrated concentrations normalized for total deposition (shown for 1, 2, 3, 4, and 5 years post-accident). The 95% confidence limits are indicated as lines (A) or bars (B).

Figure 7. Comparison of Cs-137 concentrations in beef for Central Bohemia (CB) and southern Finland (S). Shown are (A) the observations normalized for total deposition and (B) the cumulative time-integrated concentrations normalized for total deposition (shown for 1, 2, 3, 4, and 5 years post-accident). The 95% confidence limits are indicated as lines (A) or bars (B).

Figure 8. Comparison of Cs-137 concentrations in pork for Central Bohemia (CB) and southern Finland (S). Shown are (A) the observations normalized for total deposition and (B) the cumulative time-integrated concentrations normalized for total deposition (shown for 1, 2, 3, 4, and 5 years post-accident). The 95% confidence limits are indicated as lines (A) or bars (B).

Figure 9. Comparison of whole body concentrations of Cs-137 in adult humans for Central Bohemia (CB) and southern Finland (S). Shown are (A) the observations normalized for total deposition and (B) the cumulative time-integrated concentrations normalized for total deposition (shown for 1, 2, 3, 4, and 5 years post-accident). The 95% confidence limits are indicated as lines (A) or bars (B).

Figure 10. Comparison of distributions of whole body concentrations for adults (males and females) in Central Bohemia (CB) and southern Finland (S) for 1987. Shown are (A) the observations and (B) the observations normalized for total deposition. Confidence limits on the normalized observations represent only the uncertainty in the total deposition. Observations for CB are for the second quarter of 1987; observations for S are for December 31, 1987.

Figure 11. Comparison of distributions of whole body concentrations for adults (males and females) in Central Bohemia (CB) and southern Finland (S) for 1990. Shown are (A) the observations and (B) the observations normalized for total deposition. Confidence limits on the normalized observations represent only the uncertainty in the total deposition. Observations for CB are for the fourth quarter of 1990; observations for S are for December 31, 1990.

Figure 12. Comparison of model predictions to observations for time-integrated concentrations of Cs-137 in milk in Central Bohemia. In the lower graph, the time-integrated concentrations have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario CB exercise.

Figure 13. Comparison of model predictions to observations for time-integrated concentrations of Cs-137 in milk in southern Finland. In the lower graph, the time-integrated concentrations have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario S exercise.

Figure 14. Comparison of model predictions to observations for time-integrated concentrations of Cs-137 in beef in Central Bohemia. In the lower graph, the time-integrated concentrations have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario CB exercise.

Figure 15. Comparison of model predictions to observations for time-integrated concentrations of Cs-137 in beef in southern Finland. In the lower graph, the time-integrated concentrations have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario S exercise.

Figure 16. Comparison of model predictions to observations for time-integrated concentrations of Cs-137 in pork in Central Bohemia. In the lower graph, the time-integrated concentrations have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario CB exercise.

Figure 17. Comparison of model predictions to observations for time-integrated concentrations of Cs-137 in pork in southern Finland. In the lower graph, the time-integrated concentrations have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario S exercise.

Figure 18. Comparison of model predictions to estimated values for the ingestion dose due to Cs-137 in Central Bohemia. In the lower graph, the calculated doses have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario CB exercise.

Figure 19. Comparison of model predictions to estimated values for the ingestion dose due to Cs-137 in southern Finland. In the lower graph, the calculated doses have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario S exercise.

Figure 20. Comparison of model predictions to estimated values for the total dose due to Cs-137 in Central Bohemia. In the lower graph, the calculated doses have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario CB exercise.

Figure 21. Comparison of model predictions to estimated values for the total dose due to Cs-137 in southern Finland. In the lower graph, the calculated doses have been normalized to the predicted total deposition. Model names in boldface indicate calculations made during the present project; other calculations were made by participants in the Scenario S exercise.

Figure 22. Scenario W: Estimates of the vertical distribution of Cs-137 (top) and Sr-90 (bottom) concentrations in the soil of experimental plot HR.

Figure 23. Scenario W: Estimates of the total amounts of Cs-137 (top) and Sr-90 (bottom) removed by runoff from experimental plot HR. The bars represent 95% confidence limits on the estimates.

Figure 24. Scenario CP: Estimates of Cs-137 activity in muscle tissue of fish in the Chernobyl cooling pond. Shown are estimates for nonpredators (top) and predators (bottom).

Figure 25. Scenario R: Estimated annual average concentrations of Cs-137 in air for the cities of Pripjat (top left), Kiev (top right), and the region of Poleskoe (bottom left). Estimated quarterly average concentrations for Poleskoe are also shown (bottom right). Seasonal effects were considered in the approach of Nair but not that of Miller (bottom right).