BRIEF TRIP REPORT

Chelyabinsk (URCRM) and Ozersk (FIB-1 and Mayak)
June 22, 1997, through July 7, 1997

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July 15, 1997

INTRODUCTION

According to a recent agreement between DOE and NRC, I am providing a brief trip report to members of the teams for Projects 2.2 and 2.3. In addition, I am providing the same information to other interested parties, including those working on Project 1.2. The main reason for undertaking this form of communication is concern expressed by the NRC about Project 2.4 meeting the needs for Project 2.3 in a timely manner.

There were several purposes for the recently completed trip to the Ural Research Centre for Radiation Medicine (URCRM), the First Branch of the Institute of Biophysics (FIB-1), and the Mayak Production Association (MPA). The visit to the URCRM was to work jointly with Dr. Marina Degteva and her staff in furthering the work on Project 1.1. The main purpose of the visit to FIB-1 and MPA was to complete a revised proposal for Project 2.4. An earlier proposal, which had not benefited from the usual one-year feasibility study and which was based on limited contact with scientists at MPA and FIB-1, was judged by the American Scientific Review Group as lacking detail sufficient for a complete evaluation. A strong secondary interest for the trip was to undertake discussions with MPA staff on Project 1.3. This new project was recommended to be undertaken by the American Scientific Review Group. The main purpose is to develop further the source term for the releases of radionuclides to the Techa River.

VISIT TO THE URCRM, CHELYABINSK

Dr. Lynn Anspaugh (University of Utah), Dr. Bruce Napier (Pacific Northwest National Laboratory), and Ms. Larisa Anspaugh composed the dosimetry group that worked during the week of June 21 with Dr. Degteva and staff. Scientifically, this visit went very well. The work on improving the Techa River Dosimetry System is going well, and there are no disagreements among the American and Russian scientists. Two documents were completed during this visit. The first (eight pages) is a progress report entitled "Update on Project 1.1 Tasks and Milestones." This document describes what changes have been made in the project in response to the recommendations of the joint meeting of the American and Russian Scientific Review Groups in February 1997. The list of tasks has been modified, and the list of deliverables has been reworked to include actual dates (rather than projections of number of months into the future from the start date) for the deliverables, as the project was formally begun in February 1997.

The second report (10 pages) was essentially complete upon our arrival, and the American team members assisted only in editing the report for better understanding in English. This report is entitled "Feasibility Analysis of the Development of a Special System for Obtaining Tooth Samples from the Techa River Residents." This report is in direct response to a request from the American and Russian Scientific Review Groups to give special attention to the members of the Techa River Cohort who lived in the upper part of the Techa and who were exposed to much higher levels of external dose. The report describes a feasibility study of capturing teeth of opportunity for the analysis of dose by electron paramagnetic resonance (EPR) spectroscopy. This feasibility study has worked extremely well in capturing teeth from the target population, and plans have been developed for full implementation. In order to make use of the teeth it is recommended strongly that an EPR spectrometer be purchased for use by Dr. Alex Romanyukha at the Institute of Metal Physics in Ekaterinburg.

Copies of these two reports have been provided electronically to other Principal Investigators of Project 1.1: Drs. Bruce Napier, André Bouville, and Charles Miller. Paper copies were mailed on July 15, 1997, to Drs. Dan Hoffman, Ethel Gilbert, Ruth Neta, Elaine Ron, and Terry Thomas and to Ms. Elizabeth White. Copies will be made available to other interested parties by note to Lynn Anspaugh.

One of the key features of the Techa River Dosimetry System, and our efforts to improve it jointly with our Russian colleagues, is the URCRM Whole Body Counter, which has been used to document the ^{90}Sr content of over half of the entire Techa River Cohort. This equipment is now obsolete. We believe that we will receive funds shortly to upgrade the detector and associated electronic systems. It is also essential that a new anthropomorphic phantom be manufactured that will be seeded appropriately with ^{90}Sr. The design and preliminary work have been underway for many months with the work being led by Dr. Alexander Kovtun of the Institute of Marine Transport Hygiene (IMTH) in St. Petersburg. The members of the American team were very disappointed to learn that the administrative unit of the URCRM had not yet signed the contract for the phantom construction. This matter was discussed with Dr. Akleev, Director of the URCRM, and we subsequently learned that the contract had been signed during our visit. However, we are again disappointed to learn that money has not yet been provided to the IMTH for the implementation of this contract. [It seems that the usual practice in Russia is to pay for contracts up front.] This delay is not understandable to us (or to Dr. Degteva), as the DOE has already provided the funds for this purpose.

Our summary of the visit to the URCRM is that the scientific work is going very well. Dr. Degteva is one of the world's best dosimetrists, and she has assembled a very capable team. However, we are disappointed in the administrative support being provided to the project at the URCRM. So far, the project has not been impacted beyond the point that we cannot meet our milestones, but this administrative logjam must be broken.

VISIT TO FIB-1 AND MPA, OZERSK

The Anspaughs and Dr. Napier were joined in Ozersk by Drs. David Hickman (Lawrence

Livermore National Laboratory) and Dr. Bruce Boecker (Lovelace Respiratory Research Institute). Dr. Hickman was recently added to the dosimetry team in response to the request of the American Scientific Review Group that we add to our team a member "...with specific expertise in occupational radiation dosimetry." Dr. Hickman is a working health physicist currently at Livermore and with experience at Rocky Flats, Hanford, and Mound. His expertise encompasses whole body counting, anthropomorphic phantom design and construction, computer phantom design and construction, and the interpretation of bioassay data. Within his group he also has access to experts on neutron dosimetry. Dr. Boecker has worked for many years on problems associated with the inhalation of Pu; he is a member of the Project 2.3 team, and his future role will likely be primarily as a liaison between Projects 2.3 and 2.4.

INTERNAL DOSE FOR THE MAYAK WORKERS

The internal dosimetry part of the Mayak worker cohort dosimetry-improvement project has always been straightforward to the American team, largely because Dr. Khokhryakov, Head of the Biophysics Laboratory, has interacted with American scientists extensively over the last several years, and he has published several papers in English. He probably has more experience than does anyone else in the field concerning the dosimetry in humans of inhaled Pu. He has assay data on thousands of workers and autopsy data on hundreds of workers.

Our discussions with Dr. Khokhryakov centered mainly on getting more detailed information from him on his methods of interpreting bioassay data, his lung model, and in extensive negotiations and discussions about tasks and milestones. At some times we despaired about ever reaching closure on tasks and milestones, and we did not have complete closure when we left. However, we have since reached closure via e-mail, and we are proceeding to prepare the revised proposal. Our goals for internal dosimetry in the preparation of the revised proposal are to explain clearly the methods to be used, to propose a course of detailed interactions with the epidemiologists and clinicians, to develop a list of tasks that make the project execution logical, and to provide a list of deliverables with a schedule that is workable within the needs of Projects 2.2 and 2.3. We believe that we have achieved these goals.

One of our significant concerns relates to the methods of calculation used by Dr. Khokhryakov and his team. The details of his methods have not yet been published in English, and his methods differ from those used by the ICRP. In light of Dr. Khokhryakov's extensive experience, we strongly suspect that his methods are more firmly based on experimental evidence than are those of the ICRP. Nevertheless, we recognize that this means nothing until these methods are published and documented in the peer-reviewed literature. Thus, a primary goal is the publication of such methods and a full comparison of his methods with those of the ICRP, the NCRP, and others. Agreement on this goal tended to be elusive, but was achieved. One concern stated by Dr. Khokhryakov was that this was Russian work performed years before, and he did not want American co-authors. We assured him that we did not need to be co-authors, but that we would assist wherever and however we could in getting his material published. Dr. Khokhryakov and Dr. Romanov, the new Director of FIB-1 (and former pupil of Dr. Khokhryakov) agreed to the publication of the material. Dr. Romanov was intimately involved in

improvements to the model of metabolism and dosimetry; part of Dr. Khokhryakov's reluctance may stem from his realization that Dr. Romanov's time to work on such publications is now very limited.

Dr. Khokhryakov also agreed to meet the needs of Project 2.3 concerning delivery at 18 months of interim doses for several organs for about 600 persons enrolled in the Project 2.3 cohort. There will also be an extensive effort to describe the uncertainties in the calculations of internal dose.

Dr. Hickman also had extensive discussions with Dr. Khokhryakov and others about possible improvements in the FIB-1 whole body (lung) counting system. While the investigators at FIB-1 have extensive data, these data have not been used for dosimetry purposes, but only for screening. One task is to examine the usefulness of these data for dosimetry purposes, but we believe that it would be necessary to calibrate thoroughly the existing FIB-1 system and then to upgrade the counting system. The possibility is being actively pursued of rescuing the Pu lung counters being offered for surplus from the Rocky Flats Plant. Dr. Khokhryakov was initially negative about this, but after the details were explained fully, he became very interested and now wants to receive this equipment. One confusing detail regarding this was Dr. Khokhryakov's prior acceptance of a large Ge detector being offered by the Italians as part of a "non-proliferation" agreement. Such a detector would only work for high energy gammas and would not be suitable for the detection of Pu (or Am) in lungs. We encouraged Dr. Khokhryakov to accept both offers to upgrade his capabilities.

We believe that the internal dosimetry team at FIB-1 is very talented and capable of performing the work required to support Projects 2.2 and 2.3. Some of Dr. Khokhryakov's reluctance to add tasks and milestones for Project 2.4 appeared to be due to his concept that, regardless of the number of tasks and deliverables, he would not receive any more money. Thus, he seemed quite resistant for some time to commit to publications. We did, however, receive a strong commitment from Dr. Romanov that such publications would be forthcoming, and our proposed draft tasks and milestones have now been accepted by Dr. Khokhryakov.

EXTERNAL DOSE FOR THE MAYAK WORKERS

This part of the trip was most valuable, as the American team had never before been able to achieve extensive discussions with the external dosimetrists from Mayak. It was also very helpful that we were able to visit (albeit only for two hours) the MPA itself. We examined the dosimetry records and witnessed the ongoing activity to enter dosimetry data into a computer-based data base. We also visited the laboratories where various dosimetry methods are being practiced, such as the construction and processing of neutron dosimeters. This part of the trip was hosted by Dr. Evgenii Vasilenko, Chief of the Radiation Protection Service at Mayak. We also visited a laboratory at Mayak where urine samples are analyzed for Pu. This was a bit of a surprise, as we thought all of this work was done at FIB-1. It was explained that Mayak only processes urine samples for Pu under emergency or screening conditions. Samples analyzed at FIB-1 are only collected at the end of the worker's vacation period; in this way they are assured

that there is no external contamination of the urine samples with Pu. However, we do wish to discuss further the possible usefulness of the Mayak data on Pu content in urine in terms of learning more about the time course of the accumulation of Pu-body burdens.

During the main part of our visit with Dr. Vasilenko, which took place at FIB-1, we discussed extensively the existing data on external dosimetry. As noted in our original proposal, four different types of individual external dosimeters have been used at Mayak. But, more importantly, some type of external gamma dosimeter was used from the very first days of the facility. We now have data on the energy response of the external gamma detectors. We also discussed plans on how the energy spectra of the work locations can be reconstructed and calculated using known times of fuel irradiation, cooling times, known fission energy spectra, and Monte Carlo simulation methods to calculate spectra degraded by scattering and absorption through interactions with known geometries of shielding and scattering objects. Once these details are available, the work-location spectra can be combined with the energy response of the detector systems to derive a corrected "film badge" dose for an individual work location.

As with the internal dose part of our project, our goals for external dosimetry in developing the revised proposal are to explain clearly the methods to be used, to propose a course of detailed interactions with the epidemiologists and clinicians, to develop a list of tasks that make the project execution logical, and to provide a list of deliverables with a schedule that is workable within the needs of Projects 2.2 and 2.3. We believe that we have achieved these goals for external dosimetry as well.

One point of more significant discussion was the calculation of organ doses. Dr. Vasilenko at first indicated that they would not do this. However, the members of the American team offered to take the lead in performing several activities to facilitate this process: First, to perform some sensitivity calculations with several spectra of gamma-energy distributions to see how sensitive the derivation of organ dose is from work-location "film badge" dose, and second, to actually perform the major work in developing algorithms to calculate organ dose on the basis of work-location "film badge" doses. The exact form of the to be provided results is not yet decided and will depend on the outcome of the sensitivity calculations. Results may be in the form of a generic set of conversion factors, or they may be in the form of very individualized organ doses. In any event agreement was reached that organ doses will be calculated and provided in a timely manner to support the needs of Project 2.3.

Neutron dosimetry was also discussed extensively. Neutron dosimeters have been used at Mayak, but the data are probably not useable for dose reconstruction in the sense that the dosimeters either were not sensitive to intermediate or fast neutrons or, for those dosimeters sensitive to intermediate or fast neutrons, the dosimeters were intended more for use in criticality accidents. In fact, it was stated that the existing individual neutron-dosimetry data are "zeros" with not very useable (for dose reconstruction) minimum detection levels.

However, a lot of neutron-survey data has been taken (although later in time) and these data were taken with devices that could record the energy spectra of neutrons or that could provide an effective energy; thus, meaningful doses could be calculated on the basis of these data.

The process for the reconstruction of neutron doses will be to match the historical data on neutron-energy-dependent fluxes within individual work locations with records from the workplace registry on work locations for a particular individual. Doses will be calculated on the basis of the work-location specific neutron-energy-dependent fluxes and the time spent in particular locations. Neutron doses are stated to be significant only for those persons working in the reactor buildings. As the neutron doses must be reconstructed and are not likely to be verifiable by individual dosimeters, the calculations of neutron dose will be relatively more uncertain than those for external gamma exposure.

An agreed task is to calculate expressions of uncertainty in all doses, both external gamma and neutron, calculated for the project.

Dr. Vasilenko also agreed to the provision of interim doses at 18 months to meet the needs of Project 2.3.

There was also agreement to publish all of the methods and summary results in the peer-reviewed literature.

As with the internal dosimetry team, we were quite impressed with the capabilities of the Mayak external dosimetry team and with the work that has already done. After our extensive discussions we now understand clearly how the improvements in the external dosimetry data base system can be and will be done.

A major effort to enter the external gamma dosimetry information into a computer-based data base is being sponsored by Dr. Tajima from Japan. The data base will be subjected to a total quality-assurance audit by the process of completely entering all data twice.

PROJECT 1.3

Our initial expectation was that negotiations for Project 1.3 would be very difficult in the sense that we feared what the American side wanted and what the Russian side proposed to do were very different. These discussions were carried out by Dr. Napier for the American side and Dr. Yuri Mokrov for the Russian side. Surprisingly, the goals of the two sides were not as different as we had feared, and agreement was quickly reached on the structure and content of a one-year feasibility study, and development is nearing closure on this proposal.

Thus, we are cautiously optimistic that more information on the rate of release of radionuclides from the MPA into the Techa River will be forthcoming. This was one of the strongly and consistently stated wishes of the American Scientific Review Group, although the Russian Group has disagreed. We also note that the existing dosimetry system is adequate to perform the dosimetry tasks without the additional information.

Nevertheless, it is valuable to have two approaches. The approach in the existing dosimetry system utilizes heavily the tail end of the information stream, that is, the measurements of body burdens in people and the validation of predicted external doses by EPR spectroscopy of teeth samples. The new approach is oriented toward a better definition of the source term in terms of what was released into the river during what time periods. Such information, to be useful, would have to be coupled with models of ecological transport of radionuclides to man and is bound to be more uncertain than the approach based upon direct measurements in people. The problem with the measurements-in-people-approach is that it is difficult to prove in a definitive sense that what was measured was, in reality, fully representative of the activities that produced the significant dose. Both approaches can be useful and complement each other. Our opinion is that we should proceed with the one-year feasibility study.