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FOREIGN TRIP REPORT

ORNL/FTR-3600

DATE: May 4, 1990

SUBJECT: Report of Foreign Travel of Richard Leggett of the Health and Safety Research Division

TO: Alvin W. Trivelpiece

FROM: Richard W. Leggett

PURPOSE: To participate in a meeting of the International Commission on Radiological Protection (ICRP) Task Group on Age-Dependent Doses to Members of the Public from Intakes of Radionuclides, held April 23-27, 1990, in Cadarache, France.

SITES VISITED:	4/22-27/90	Chateau de Cadarache, Cadarache, France	Henri Metivier
	4/26/90	Centre d'Etudes Nucleaires de Cadarache, Cadarache, France	Henri Metivier

ABSTRACT: The traveler participated in a meeting of the International Commission on Radiological Protection (ICRP) Task Group on Age-Dependent Doses to Members of the Public from Intakes of Radionuclides, held April 23-27, 1990, in Cadarache, France. The purpose of the meeting was to work on a second draft of Part 2 of ICRP Publication 56 on doses from intakes of selected radioisotopes of S, Co, Ni, Zn, Mo, Tc, Ag, Te, Ba, Ra, Pb, and Po. The traveler is a corresponding member of the Task Group but was asked by the chairman, Alexander Kaul, to attend this meeting because the Task Group is using several biokinetic models developed by the traveler. During the week the Task Group was able to complete a second draft of Part 2 of ICRP Publication 56. It is anticipated that a final draft version of this report can be presented to Committee 2 of the ICRP at their meeting in Oak Ridge in October 1990. On Thursday, April 26, the traveler and other members of the Group were taken on a brief tour of the nearby Centre d'Etudes Nucleaires de Cadarache and attended a presentation of the Severe Fuel Damage Program for experimental study of reactor core accidents.

INTRODUCTION

The traveler participated in a meeting of the International Commission on Radiological Protection (ICRP) Task Group on Age-Dependent Doses to Members of the Public from Intakes of Radionuclides (Task Group AGDOS). The meeting was held April 23-27, 1990, at the Chateau de Cadarache in Cadarache, France. The purpose of this meeting was to work on a draft version of Part 2 of ICRP Publication 56 on doses to members of the public from intakes of selected radioisotopes of S, Co, Ni, Zn, Mo, Tc, Ag, Te, Ba, Ra, Pb, and Po.

Until the last few years, the work of the ICRP has been directed primarily toward development of guidelines for protection of radiation workers. The need for internationally accepted dose conversion factors for intakes of radionuclides by children and other subgroups of the population has been recognized by the ICRP for several years but became particularly evident after the Chernobyl reactor accident. The ICRP Task Group AGDOS was formed in 1987 to develop such dose factors for potentially harmful radionuclides that might be released to the environment due to various human activities such as mining and milling, conversion, enrichment, fabrication, power station operations, fuel reprocessing, waste storage, and waste disposal. Part 1 of ICRP Publication 56, dealing primarily with radionuclides posing the greatest threat to humans as a result of reactor accidents, was completed by this Task Group in December 1989.

The traveler is a corresponding member of this Task Group. He was asked by the Chairman, Dr. A. Kaul, to attend this meeting to ensure that ICRP Publication 56 accurately describes some biokinetic models of the traveler that are being used in this document. Also, the Chairman felt it was important to ensure that the formulation of these models are consistent with formulations of other models of the traveler that were used in Part 1 of ICRP Publication 56.

MEETING OF THE TASK GROUP AGDOS

In addition to the traveler, participants in the meeting were Dr. A. Kaul (Chairman) from West Germany, Dr. H. Metivier from France, Dr. J. W. Stather from Great Britain, Dr. J. Inaba from Japan, Dr. J. C. Barton from the United States, Drs. D. Nosske and D. Taylor from West Germany. The affiliations and addresses of the participants are listed in Attachment 1. Another Task Group member, Dr. K. F. Eckerman of ORNL, was unable to attend.

The agenda for the meeting is given in Attachment 2. Although this agenda proposed several items of discussion regarding future work, the primary task before the Group was to complete a second draft of Part 2 of ICRP Publication 56 on doses to members of the public from intakes of selected isotopes of S, Co, Ni, Zn, Mo, Tc, Ag, Te, Ba, Ra, Pb, and Po. This task can be divided into two main subtasks:

(1) Agree on a gastrointestinal (GI) absorption fraction (or fractions in some cases, for different chemical forms) and a biokinetic model for each element for use in calculations of dose from internal exposures.

(2) Revise previously prepared manuscripts on each element to include or to substitute the new information on GI absorption fractions and biokinetic models.

Once the biokinetic models have been chosen, calculations of dose from a unit intake of each radioisotope considered can be made over the next few months, preferably before the next gathering of the group in Oak Ridge in October 1990.

Each of the participants brought drafts of chapters or parts of chapters that had been assigned by the Chairman more than a year ago. Some of these draft documents had been discussed briefly at the Task Group meeting in Chiba, Japan, in May 1989. The traveler had been assigned chapters describing age-specific information on GI absorption and biokinetics of Ra and Ba and an appendix to the report describing in some detail the traveler's biokinetic models for Ba and Ra. In addition to the assigned material, the traveler took a preliminary description of a biokinetic model for Pb now under construction, a description of a model framework for Po, and information on Po, S, and Zn that was not included in first drafts of chapters for those elements but which might be used to improve the ICRP document.

The Group had detailed (and sometimes spirited) discussions on each chapter of the document. It was particularly difficult to reach agreement on GI absorption fractions for some of the elements, as might be expected from the diverse backgrounds and interests of the participants. Three of the participants, Drs. Metivier, Barton, and Taylor, had been members of an "expert group" that had recently prepared a report on age-specific GI absorption for the Nuclear Energy Agency (NEA) of the (European) Organization for Economic Co-operation and Development (OECD). Numerous arguments in favor of adopting NEA values for use in ICRP Publication 56 were heard during the course of this meeting. Dr. Stather of the National Radiological Protection Board (NRPB) of Great Britain generally argued for values which were recently suggested in an NRPB report and which differ occasionally from those adopted by the NEA Group. The participants who had conducted experiments on the uptake and/or distribution of radionuclides in rats (Drs. Barton, Taylor, Stather, Metivier, and Inaba) generally seemed to hold the rat in higher regard as a quantitative model for man than does the traveler.

The difficulties encountered in reaching an agreement on GI absorption fractions are illustrated by the selection process that evolved for Po. The chapter on Po prepared by Dr. Barton proposed adoption of the age-specific GI absorption fractions suggested by the NEA Group, namely, 0.6 for the first year of life and 0.3 thereafter. The latter value is three times higher than the value adopted in ICRP Publication 30, which deals with occupational exposures. Dr. Stather presented arguments given in a recent NRPB document for using a value of 0.2 for the first year of life and 0.1 thereafter. Thus, the value suggested by the NRPB is consistent with ICRP Publication 30 with regard to adults and is consistent with the general approach of the NEA Group in that twice the value for adults is assigned to the first year of life and the value for adults is used for all subsequent ages. The arguments of both Dr. Barton and Dr. Stather were based on limited data for humans and more plentiful data for laboratory animals -- particularly rats -- but Dr. Stather's proposal appeared to depend quite heavily on a recent experiment with rats conducted by Dr. J. Harrison of the NRPB. Dr. Stather argued that the only useful data for humans are for an experiment of Fink, conducted around 1950, on a subject who absorbed about 10% of ingested Po, based on urinary excretion data. The traveler pointed out results of a recent study conducted at the New York University which indicate that urinary excretion of Po had probably been underestimated in the earlier study of Fink because of differences in recovery of metabolized and tracer Po from urine by Fink's methods. The traveler also noted that the estimated GI absorption fraction for the subject of Fink would be considerably higher if one relied on the measured fecal recovery of Po rather than urinary recovery, even if endogenous secretion

into the GI tract during the study period were not considered. Dr. Stather eventually agreed to use the values proposed by Dr. Barton for the present draft version of the report but indicated that the Group's final decision should await the outcome of a current Po absorption experiment on rats being conducted by his group at the NRPB.

Although there were also some differing opinions regarding biokinetic data and models, the various participants were more willing to compromise on these than on GI absorption fractions. The Group was very receptive to the traveler's suggestions for changes in the description of biokinetic data for S, Zn, Po, and Pb, and in the formulations of biokinetic models for those elements. The traveler pointed out, however, that the development and testing of new biokinetic models incorporating the suggested changes would take many months and, for some of these elements, may be impossible to complete new models in time for the October meeting in Oak Ridge. The Chairman felt that the traveler should proceed with development of these models, since they would be useful in an upcoming ICRP revision of its Annual Limits on Intake, even if some of the models were not available in time for use in ICRP Publication 56. The consensus of opinion appeared to be that the traveler should give priority to completion of a model for Pb.

The Group spent considerable time discussing the traveler's chapters on Ba and Ra and the traveler's biokinetic models for these elements. The participants were generally in agreement with the formulation of the models and the parameter values that had been selected. Dr. Stather suggested that the models may be optimal with regard to compartments that should be used in consideration of the age-specific biokinetics of Ba and Ra. Drs. Stather and Taylor expressed concern, however, that the Ra model predicts a greater portion of total-body Ra in soft tissues of fully mature adults than is indicated by data for laboratory animals, particularly beagles. The traveler pointed out that parameter values in the model are based on data for humans, the model deals with changes with age in the behavior of Ra even during adulthood, the fraction of the total-body Ra retained in soft tissue apparently increases with age at exposure even after age 20 y, and the data for beagles are for young adult beagles and are reasonably consistent with model predictions for humans for injection age 20 y. This did not fully allay the concerns of Drs. Stather and Taylor, since they are suspect of much of the data on Ra in soft tissues of humans, particularly that derived in the 1930s. They believe that the data for Ra in soft tissues of beagles may be superior in some respects ~~to~~ available data for humans. The traveler understood their concerns but reiterated the point that comparison of Ra in young adult beagles and old adult humans may be misleading. For use of the Ra and Ba models in ICRP Publication 56, it was agreed that the adult, who is always assigned age-independent parameter values in this report, would be assigned parameter values consistent with those for a 20-year-old person rather than a fully mature adult. This satisfied the concerns of Drs. Stather and Taylor, since it yields soft-tissue retention curves fairly consistent with those for young adult beagles and also results in cautious estimates of dose to bone tissues.

The chapter on Ba prepared by the traveler presented arguments for using a GI absorption fraction of 0.2 for adults and values for children that depend on age-specific needs for Ca; for example, an absorption fraction of 0.6 was proposed for infants. These proposals differed from the value of 0.1 for adults suggested in Publication 30 of the ICRP, the recent report of the NEA, and the recent document of the NRPB, and for children they differed from the NEA and NRPB recommendations of a value of 0.2 for the first year of life and 0.1 thereafter. The Group readily accepted the traveler's proposal of assuming that age-specific absorption of Ba is proportional to that of Ca. A precedent for this had been set in Part 1 of Publication 56, in which the traveler's

model for the alkaline earth element Sr had incorporated an analogous scheme for age-specific GI absorption. The problem was then one of agreeing on a reference point (that is, a value for adults) with which to begin the age-specific scaling, since it was evident that the Group would not readily depart from the GI absorption fraction of 0.1 for adults previously suggested by the ICRP, NEA, and NRPB. The traveler pointed out that previous estimates based on data for humans generally underestimated GI absorption of Ba since they relied on measurements of ingested Ba in urine and feces and did not take into account the relatively low urinary excretion and high GI secretion of Ba by humans (compared with rats and beagles) during the first few days after intake. He noted that his biokinetic model for Ba explicitly considers endogenous secretion of Ba into the GI tract, and use of only a net GI absorption over the first few days, as had been done in the past, would result in underestimates of dose to most tissues. The traveler noted, however, that he had been unable to obtain the doctoral dissertation of Bligh, published in 1960 and referred to in the NEA document, that indicated an average absorption fraction for Ba of about 0.1 in five cancer patients, and he therefore did not know whether that study had taken into account the early endogenous secretion of Ba. Dr. Taylor said that Bligh had been his student at the University of London, that the experiment was done under Dr. Taylor's direction, and that the experimental methods probably would have allowed for early endogenous secretion of Ba. The Group then seemed to view the study of Bligh as providing the best available information. It soon became evident to the traveler that his proposed value of 0.2 for adults was not supported by the Group, and he agreed to adopt the ICRP, NEA, and NRPB value of 0.1. The next day, the Group surprisingly reversed its decision at the insistence of Drs. Stather and Taylor, who had decided that the results of Bligh should not be given more weight than results of several other studies. Also, they had reconsidered arguments given the day before that Ba should be assigned the same absorption fraction as Ra, for which a value of 0.2 for adults had been adopted earlier in the meeting.

There was relatively little debate regarding the chapters on Co, Ni, Mo, Tc, Ag, and Te. This probably was attributable to the paucity of relevant data, particularly age-specific data, on GI absorption and biokinetics of these elements. For these elements, the biokinetic models for adults as recommended in Publication 30 of the ICRP generally were adopted for all age groups, although changes suggested by some participants on the basis of data for rats were sometimes incorporated. The traveler is opposed to this piecemeal approach to biokinetic modeling as well as to such indiscriminate use of data for rats, but he did not argue these points.

VISIT TO THE CENTRE D'ETUDES NUCLEAIRES DE CADARACHE

On Thursday afternoon, April 26, the participants were taken on a brief tour of the nearby Centre d'Etudes Nucleaires de Cadarache. This installation is a part of the Environmental Studies and Research Service (SERE) of the French Institute for Nuclear Protection and Safety (IPSN). The IPSN conducts research activities assigned by the various French ministries and government agencies. The SERE is specifically responsible for radioecology investigations and site studies. Most of the SERE facilities and personnel are located at the Cadarache installation. This installation appears to cover several times the area covered by the main ORNL site, but, unlike ORNL, buildings are widely separated by large open areas.

Most of our two-hour visit at the Centre d'Etudes Nucleaires de Cadarache was spent at a presentation of the Severe Fuel Damage Program (called PHEBUS, probably a French acronym)

for experimental study of reactor core accidents. The agenda of the PHEBUS Plant visit is given in Attachment 3. The objective of this program is to study the physical phenomena occurring in actual controlled fuel damage and to study ways in which the core might be cooled during various stages of an accident by use of an emergency cooling circuit. The members of the Task Group were particularly interested in the chemical forms of radionuclides that might be released during an accident. Drs. R. Del Negro and Ch Gonnier, who gave the presentation, described various compounds of U and Zr that might be released. They pointed out that the PHEBUS tests are carried out with fresh fuel and cannot provide information about the phenomena governing the release of fission products within the reactor containment. This problem will be studied in a subsequent program.

SUMMARY

The meeting of the Task Group AGDOS was largely successful, since the Group met its goal by completing a second draft of Part 2 of ICRP Publication 56. There is a clear need, however, to replace some biokinetic models in the report with models that more fully reflect current information on the behavior of radioelements in immature humans and laboratory animals. The traveler is continuing development of an age-specific biokinetic model for Pb that will be included in the report if it can be completed by October 1990. Also, as time allows, the traveler will work toward completion of less complicated age-specific models for some or all of the elements Po, S, and Zn for possible inclusion in Part 2 of ICRP Publication 56. This document should be extremely valuable to DOE, since it will provide dose conversion factors that can be used to set guidelines for exposures to the general public.

ATTACHMENT 1

Itinerary

April 21-22, 1990	Travel from Knoxville, Tennessee, to Cadarache, France
April 23-27, 1990	Chateau de Cadarache, Cadarache, France
April 27, 1990	Travel from Cadarache, France, to Knoxville, Tennessee

Persons Contacted

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ATTACHMENT 2
AGENDA OF THE MEETING

1. Age-dependent biokinetic data of part 2: elements and revision of data for the worker.

   1.1 Compilation of biokinetic data for those elements not yet discussed in the Task Group: Mo, Tc, Pb, Po

   1.2 Discussion of models for Ra and Ba

   1.3 Biokinetic data for Ra and Ba

   1.4 Final discussion of biokinetic data for S, Co, Ni, Zn, Ag, Te

   1.5 Draft of preface

2. Procedure and time schedule for future activities.

   2.1 Cooperation of ICRP Committee 2 Task Group AGDOS and IAEA

   2.2 Dose to embryo and fetus

   2.3 Uncertainties of dose coefficients

   2.4 Biokinetic data of part 3 elements

   2.5 Revision of part 1

      2.5.1. New weighting factors, and estimation of dose conversion values and biokinetic data for a new GI-Tract model

      2.5.2. Estimation of new dose coefficients based on the new ICRP lung model

3. Miscellaneous

ATTACHMENT 3
PHEBUS PLANT VISIT, April 26, 1990

Agenda

2:30 - 3:00	-Welcome -PHEBUS programmes -Plant presentation -PHEBUS PF Programme	R. DEL NEGRO
3:00 - 4:00	-LOCA and Severe Fuel Damage Programmes -SFD results -Plant visit	Ch GONNIER