UR

UNITED STATES
URANIUM REGISTRY

ANNUAL REPORT

October 1, 1988 through September 30, 1989

HANFORD ENVIRONMENTAL
HEALTH FOUNDATION

HEHF-54-89

BD-8800-446 (3-83)

ANNUAL REPORT OF THE

UNITED STATES TRANSURANIUM AND URANIUM REGISTRIES

OCTOBER 1, 1988 THROUGH SEPTEMBER 30, 1989

HEHF--54-89

DE90 011619

Ronald L. Kathren

Margery J. Swint

Scott E. Dietert

April 1990

Hanford Environmental Health Foundation
Richland, WA 99352

Prepared for the U.S. Department of Energy under Contract DE-AC06-76RL01837

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report summarizes the primary scientific activities of the United States Transuranium and Uranium Registries for the period October 1, 1988 through September 30, 1989. The Registries are parallel human tissue research programs devoted to the study of the actinide elements in man. In addition to their own scientific research activities, the Registries have active collaborations with 13 other laboratories, including one in the United Kingdom. The Transuranium Registry has received a total of 258 postmortem donations, including seven whole bodies, and currently has 509 living registrants of whom 25 are whole body donors. The Uranium Registry has 31 living registrants, including two whole body donors, and has received eight postmortem donations, including one whole body.

The emphasis of the Transuranium Registry was directed towards evaluation of six whole body donations. In the five cases whose exposure was through inhalation, approximately half of the total body content of Pu-239+240 and a third of the Am-241 was found in the respiratory tract, suggesting that these nuclides are more avidly retained than predicted by the current model of the International Commission on Radiological Protection. A significant fraction of these nuclides is found in soft tissues other than liver, and an uptake fraction of 0.2 is proposed for muscle, with a residence half-time of 10 years. Studies of these and routine autopsy cases indicate that more than 90 per cent of the total respiratory tract plutonium or americium is in the lungs, with the remainder in the lymph nodes, and that a greater fraction is found in the lungs of smokers relative to the lymph nodes.

Primary activities of the Uranium Registry centered around the acquisition of a whole body donation from a woman who had received an injection of colloidal thorium dioxide some 38 years prior to death.

INTRODUCTION

The U. S. Transuranium Registry (USTR) and United States Uranium Registry (USUR) are parallel but separate human tissue research programs devoted to the study of the actinide elements in man. The Registries are funded through the Office of Health and Environmental Research (OHER) of the United States Department of Energy (DOE), and operated under contract by the Hanford Environmental Health Foundation (HEHF), a private non-profit organization incorporated within the state of Washington to provide occupational health services, including research, to governmental agencies and private industry.

The basic mission of the Registries is to ensure the adequacy and validity of radiation protection standards for the actinide elements through study of actual human experience. The actinides are a series of chemically similar elements with atomic numbers (Z) greater than 88. All known isotopes of the actinide elements are radioactive. Members of the series with atomic numbers between 89 (actinium) and 92 (uranium) occur in nature and the study of these elements falls within the province of the USUR. The higher actinides, beginning with element number 93 (neptunium) are so-called man-made or artificially created elements, being produced primarily in nuclear reactors or as a result of nuclear detonations.

The actinide elements uranium, plutonium and americium are produced and used in large quantities for various purposes. These radioelements and their significant daughters are principally alpha emitters, and as such have the potential for hazard when taken into the body. The Registries thus focus on evaluating the movement and fate of these materials within the body, with a goal of determining in what tissues the various alpha emitting radioelements concentrate and how long they remain; the ultimate objective is evaluating the dose to various tissues and organs and verifying or improving various mathematical models. Information of this nature is the basis of radiation protection standards for specific radionuclides developed by such organizations as the International Commission on Radiological Protection and

the National Council on Radiation Protection and Measurements as well as the various regulatory agencies.

THE UNITED STATES TRANSURANIUM REGISTRY

The Transuranium Registry was established in August 1968 by the Hanford Environmental Health Foundation under contract to the U. S. Atomic Energy Commission. Originally it was known as the National Plutonium Registry but the name was changed in 1970 to reflect better the broader interest of the Registry with all transuranium elements. The USTR is concerned with elements with atomic numbers greater than 92, primarily plutonium (Z = 94) and americium (Z = 95), which are the two most common higher actinides. The primary objective of the USTR -- to improve understanding of the biokinetics and dosimetry of the actinide elements and their decay products in humans and thus provide scientific data for verification and refinement of existing radiation protection standards for the higher actinides -- is accomplished by:

(1) determining the distribution and concentrations of transuranium elements through radiochemical analysis of donated tissues from occupationally exposed individuals;
(2) evaluating estimates of body, lung and other organ burdens made during life on the exposed worker by comparison with those from postmortem tissue analysis;
(3) verifying, or modifying as appropriate, existing biokinetic models or developing new models for plutonium and the higher actinides in man.
(4) comparing animal experiments with human tissue data to assess the validity of interspecies extrapolation;
(5) acting as a repository for information on internal depositions of transuranics;
(6) obtaining histopathologic autopsy slides for later evaluation of toxic changes possibly attributable to the transuranium elements.

The Registry seeks organ or whole body donation from occupationally exposed personnel based on the level of internal deposition recorded during

employment. Medical, radiation exposure and bioassay data are reviewed for incorporation into the final interpretation. The Registry thus serves as a repository and information center for in-vivo and postmortem health physics data on human exposures to the transuranium elements. In addition, the data collected by the Registry may be used to provide information for assessment of: (1) the adequacy of operational radiological controls for transuranic elements at various facilities; (2) the accuracy of the health physics models and bioassay efforts to characterize the exposures; (3) the dose level at which tissue damage may be incurred; and (4) the degree of correlation between animal experiments and human experience.

Since the transuranium elements are not found in nature, these elements represent a new dimension with respect to radiotoxicity and potential hazards. Human experience with these elements has of necessity been limited and come about as a result of operations associated with nuclear reactors and weapons. Concentration, distribution and retention of transuranic elements in the human need to be measured and interpreted to validate or alter, when appropriate, current health protection standards and work site practices. In addition, it is important to evaluate laboratory studies with animals to assess their applicability to humans. Extrapolation of the findings from animal experiments to man is complex and must be supplemented by human data. To reduce the latent period between exposure and toxic effects, such as malignant neoplasms, studies with laboratory animals have been made at high radionuclide doses. Considerably smaller doses, however, are present at the work site as reflected by the actual depositions measured in occupationally exposed registrants. This limitation needs to be considered, along with species differences and other factors, during the assessment of human applicability of animal experimental data.

The USTR relies upon voluntary donation of tissues by exposed individuals. The usual procedure is to obtain premortem autopsy or whole body donation agreements, although success has been achieved in reaching postmortem agreements with the next-of-kin. To minimize data distortion, the pathologist's contributions are, where possible, augmented by the services of a prosector who helps assure proper tissue identification and weight as well as prepare samp-

les for processing by the analytical laboratories. In situations with a known, documented internal deposition exceeding 4 nCi (150 Bq), whole body donations are sought; whole body donations may also be sought in cases of incorporation of selected elements or other unusual circumstances. Specimens of tissue removed surgically for diagnosis or therapy may also be obtained occasionally. The resulting laboratory data are used to:

(1) evaluate the distribution and concentration of transuranics in man by radiochemical and autoradiographic analysis of autopsy tissues from occupationally exposed workers, so that reliability of mathematical models used to predict the burden from internally deposited transuranic elements can be assessed;
(2) determine the total amount of a radionuclide in an organ;
(3) evaluate, verify or revise, as indicated, existing biokinetic models for the transuranic elements in man;
(4) verify or develop improved methods for estimating systemic burdens of plutonium during life;
(5) examine microscope slides obtained at autopsy for histopathologic changes that might be attributed to the toxic effects of the transuranics;
(6) compare findings in humans after exposure to transuranics with findings observed by other investigators in experimental animals in an effort to identify the species that most closely correlates with human experience;
(7) conduct studies of the comparability and consistency of data provided to the Registry from multiple sources including: (a) estimates of systemic burden based on urinary excretion data, (b) radiochemical analysis of human tissue samples by laboratories providing these services for the Registry and (c) external detector surveillance data.

THE UNITED STATES URANIUM REGISTRY

The Uranium Registry was established in 1978 as a separate but parallel program to the USTR. At its formation, the USUR had three primary objectives:

(1) to evaluate the occupational and radiological exposures and regulations applicable to the front end of the uranium fuel cycle;

(2) assess the feasibility of creating a registry of American uranium workers;

(3) develop a voluntary human tissue donor program patterned after the successful U. S. Transuranium Registry.

The last of the three initial objectives serves as the basis for ongoing studies related to the biokinetics, dosimetry and general occupational health aspects of uranium in man.

The first two objectives were achieved through on-site visits and review of the relevant literature. On the basis of that effort, the Registry concluded that a centralized registry of uranium workers was not feasible because of the diverse ownership and regulation of the American uranium industry, but that a program of recruitment of suitable postmortem tissue donors was both indicated and attainable. The present effort of the U. S. Uranium Registry is largely directed toward the third objective with emphasis on the study of uranium biokinetics in humans.

Since biokinetic models are fundamental to the development of radiation protection standards for internal radioactivity, the ultimate objective of the USUR research is to ensure the adequacy and applicability of such standards for the uranium decay chain. The long-standing need for improvement in this knowledge has been repeatedly identified and in fact was an important basis for establishment of the USUR. Measurement of uranium and other members of the uranium decay chain in human tissue obtained through a program of informed voluntary donation will contribute new information on the intake, translocation and distribution of uranium in the human body as a result of occupational exposure, serve as the basis for new or improved biokinetic

models, provide more accurate dose and risk calculations, and permit evaluation of the suitability of existing regulations. These data will also be of value in evaluating and improving the effectiveness of operational programs for the control of uranium. Studies will also be made of the distribution, biokinetics and dose from other elements in the uranium decay chain, including thorium and lead, to establish more accurately their contribution to the risk from exposure to the uranium series. In addition, histologic slides prepared from selected autopsy tissues will be used in later studies to evaluate potential toxic changes. Information will also be developed on environmentally incorporated uranium and other elements in the uranium decay chain. An ongoing review of occupational donor populations is carried out with the aim of producing the most information at the least programmatic cost.

As is the case with the USTR, data obtained from postmortem analyses of tissue are evaluated along with bioassay and medical data obtained during life. The results of the tissue analyses give important information on uranium biokinetics in man and contribute to the accuracy of mathematical modeling and dose calculations on which the radiation protection standards for uranium are based.

More recently, interest has focused on various members of the uranium decay chain and their contribution to personnel exposure and radiation risk. Th-230, a daughter of U-234 and a member of the U-238 decay chain, has been identified as the leading contributor to the dose incurred from inhalation of natural uranium. The biokinetics and relationship of Th-230 to its uranium progenitors are not clearly understood. Increasing public concern regarding potential environmental radon exposures in homes and other buildings has further emphasized the need for improved understanding of the biokinetics of the various members of the uranium decay chain. In particular, a better understanding of the biokinetics and role of the long-lived uranium and radon daughter Pb-210 is necessary to assess the long-term hazard of both environmental and occupational exposure to radon daughters.

RELATIONSHIPS AND COLLABORATION WITH OTHER LABORATORIES

The USTR and USUR actively collaborate in areas of common interest despite differences in radionuclides and exposed human populations. The Registries have a combined staff and a six member Scientific Advisory Committee with specific expertise in areas pertinent to the work of the Registries (Appendix A). In 1987, a three member Technical Subcommittee was established to provide additional support in scientific matters.

Both the USTR and USUR are intimately linked to the Los Alamos National Laboratory (LANL) tissue analytical laboratory, a separately funded DOE program that provides the Registries with radiochemistry support and analyses of tissue. The data generated by LANL are fundamental to the objectives and work of the Registry; the overall evaluation and scientific interpretation of the radioanalytical work are carried on with LANL in a collaborative and collegial fashion.

The Registries have also developed important collaborative relationships with other research laboratories, and currently have active collaborations with 13 individual laboratories (Appendix B). Collaborative efforts of the USTR include study of the depth distribution of actinide on bone surfaces, bone microdosimetry, and oncogene studies with Argonne National Laboratory; autoradiography and scanning electron microscopy studies of soft tissues have been initiated with Lawrence Berkeley National Laboratory, Inhalation Toxicology Research Institute, and the Pacific Northwest Laboratory. An autoradiographic study of the distribution of Am-241 in bone is also being carried out in conjunction with the National Radiological Protection Board of Great Britain.

Collaborative studies of the USUR have been developed with the National Cancer Institute, National Naval Medical Center, Argonne National Laboratory, Pacific Northwest Laboratory and others for specific studies relating to the evaluation of a whole body donation from an individual who had received an injection of Thorotrast for medical diagnosis 38 years prior to death. In addition, the USUR has developed collaborative arrangements with St. Mary's

Hospital, Grand Junction, CO, to facilitate computerization of data in the Uranium Miner Lung Cancer Study. Research collaboration and eventual transfer of the automated database along with selected tissue, slides, and hard copy files and records to the USUR is projected.

Service to and collaborative research with the academic community is an important byproduct of Registry activities, benefiting the academic community and the Registries. The Registries have developed an important link with the newly established Tri-Cities branch campus of Washington State University Richland. One Registries staff member currently holds a courtesy appointment in Biological Sciences at WSU/Tri-Cities and actively teaches both regular academic and continuing education courses at this institution in addition to serving as Affiliate Associate Professor of Radiological Sciences at the University of Washington.

The Registries also maintain close ties with the Northwest College and University Association for Science (NORCUS) program. In a special pilot program, Professor Daniel Strom, a NORCUS Faculty Fellow from the University of Pittsburgh, spent two months at HEHF collaborating on a study of the distribution of actinides in lung.

Professional and scientific society activities are interpreted as a normal part of Registry operation. The former Director of Health Physics Research at HEHF, and now Director of the Registries, completed his term as President-Elect of the Health Physics Society and assumed the Presidency during 1989; he also was named a Diplomate of the American Board of Medical Physics.

REGISTRY STATISTICS

The USTR has a total of 509 living registrants, including 25 whole body donors, distributed by industrial site as shown:

Site Participation Registrants

Hanford	156
Rocky Flats	135
Savannah River	129
Los Alamos	66
Mound	21
Miscellaneous sites	2
Total	509

Distribution of analyzed autopsy and surgical specimens by participating industrial site for the USTR is:

Autopsies and Surgical Specimens

Hanford	69
Rocky Flats	85
Savannah River	8
Los Alamos	51
British	35
Miscellaneous	9
Case not used	1
Total	258

The USUR currently has 31 registrants, including 15 mill workers and 14 general uranium industry workers. Of this number, two are whole body donors.

CURRENT RESEARCH PROJECTS OF THE USTR

Evaluation of Whole Body Cases

Evaluation of the first six whole body contributions to the USTR has been completed and a summary of results published in the open peer reviewed literature. In the five cases whose exposure was through inhalation, nearly half of the total body deposition of Pu-239 and about a third of the Am-241 were found in the lungs, even though exposure took place many years prior to death. In the single case in which inhalation was via a wound, only 0.4% of the total body burden was found in the lungs. These results support tentative observations in accidental exposure cases in-vivo, and provide clear evidence of a long-term retention component in the lung. Furthermore, this finding

suggests that retention fractions and half-times for both Am-241 and Pu-239 in the respiratory tract are greater than proposed by the current lung model of the International Commission on Radiological Protection.

Another important observation was that initial fractionation of Pu-239 between liver and skeleton is approximately equal, and consistent with the values specified in ICRP Publication 30. On the other hand, initial fractionation of Am-241 between liver and skeleton is consistent with the 50:30 ratio cited in ICRP Publication 48, and with a clearance half-time from the liver of about 2 years. This confirms what had previously been observed in postmortem studies of the USTR using tissues obtained at autopsy.

In all six cases, a significant fraction of the systemic Pu-239 and Am-241 was found in the muscle and other soft tissues, suggesting that these tissues represent a long term depot for these nuclides. Preliminary evaluation of the data suggest that the fractional uptake by the muscle from the transfer compartment are 0.2, and the residence half-time in the muscle is about 10 years. These observations have clear implications for modelling and dose distribution studies on which the protection standards for plutonium and americium are based.

More than a dozen biokinetic models were used to obtain estimates of systemic deposition of Pu-239 using radiourinalysis data obtained during life. In general, estimates made with the earlier models were several fold greater than the actual deposition measured in the tissues of the whole body after death. Estimates made with later models provided much more realistic values, and in the case of the ICRP 30 model, were actually lower than the radiochemical results. Thus, models used for operational control of exposure to plutonium and americium are conservative, but in need of refinement to better describe the exposure and risk incurred from internal depositions.

A comprehensive evaluation of the first whole body plutonium donor, USTR Case 193, was completed and submitted for internal peer review prior to submission for publication in a peer reviewed journal. The evaluation of this case in general supported the older ICRP model for plutonium, but at the same time

underscored the necessity for refinements to the model, including consideration of muscle as an important compartment for plutonium deposition.

Americium Accident Case (USTR Case 246)

USTR Case 246 was a 76 year old caucasian male who received a massive internal deposition of Am-241 approximately 11 years prior to death as a result of a glove box explosion. Because of the enormity of the exposure, this case received considerable attention in the media as well as the technical literature. The formal autopsy findings for this case were finally forwarded by the independent pathologist performing the autopsy and revealed no identifiable radiation induced abnormalities except possibly for some minor skin effects associated with the contamination and acid burns.

Radiochemical analysis was performed on more than 20 individual tissues collected at autopsy. From these results, the systemic deposition at the time of death has been estimated as 491 kBq, of which 89% was in the skeleton, 5.7% in the liver, and 4.0% in the muscle and fat. About five per cent of the total skeletal activity was in the marrow. Soft tissue concentrations were highest in the liver, which was about twenty times greater than the mean soft tissue concentration. Cartilagineous tissues and bone marrow also showed higher than average concentrations. Concentration in muscle was approximately the average of all soft tissues, but because of the large muscle mass an appreciable fraction of the systemic Am-241 was found in this tissue. Activity concentrations in pancreas, hilar lymph node and fat were below the average. The distribution of activity in this case was similar to that reported observed in USTR Case 102, a whole body donor exposed percutaneously via a wound 25 years prior to death.

Laboratory work and related data analysis are in progress on four special collaborative studies being carried out with other DOE laboratories and the UKAEA. The initial laboratory measurements of the microdistribution of Am-241 on bone surfaces, being carried out in conjunction with RA Schlenker, Argonne National Laboratory revealed a surface deposition of Am-241 more typical of

what would be expected from a recent exposure, and is suggestive of active remodelling at the sites examined.

The laboratory portion of the scanning electron microscopy-autoradiography of selected soft tissues [lung, hilar lymph node, thyroid and liver (in conjunction with CL Sanders, PNL)] has been completed. Radioactivity concentrations in the tissues examined agreed well with those determined in similar tissues by radiochemical means. However, in some samples, such as thyroid where the bulk of the activity was found to be associated with the connective tissue, it was possible to gain additional information regarding the distribution of the activity within the tissues. The laboratory portion of the autoradiographic studies of Am-241 distribution in bone (in conjunction with Nicholas Priest, UKAEA, Harwell) has also been completed and data analysis well under way.

A contract was signed with PW Durbin, Lawrence Berkeley Laboratory to perform conventional soft tissue autoradiography; no results have been reported to date. Other autoradiographic determinations are being carried out by RA Guilmette on the distribution of Am-241 in lung and associated lymph nodes. Preliminary laboratory findings revealed no identifiable radiation related abnormalities.

Am-241 In-vivo Counting Phantoms

USTR Case 102 was an individual who had incurred an intake of Am-241 via a wound some 25 years prior to death. The unanalyzed half skeleton of this case was used to construct four separate phantoms (head, arm, torso, and leg) for use as Am-241 calibration phantoms. Announcements were made in scientific and technical journals regarding the availability of these phantoms for loan to in-vivo counting facilities. To date, counting has been carried out at New York University and Pacific Northwest Laboratory, which developed the phantoms, and at Aldermaston and British Nuclear Fuels, Ltd. in Britain.

Actinide Concentration and Distribution in Bone

Statistical and mathematical expansion and refinement of the ash fraction-concentration relationships for individual bones and for the skeleton as a whole has been performed and data from the fifth whole body entered into the data base. The results indicate that the ash fraction-concentration relationship can be fit equally well by a linear or a log-linear relationship, although the latter seems to provide a slightly better fit. Collectively, the relationship between ash fraction and plutonium concentration per gram of ash for all five cases can be described by a single equation normalized to unit activity in the skeleton. Similarly, a single equation can be fit to the data for Am-241 for all six cases. These results are highly encouraging, and suggest that prediction of the total skeletal burden from analysis of a single sample of bone can be made with an uncertainty of less than $\pm$ 30% provided that the ratio of ash weight to wet weight (i.e. the ash fraction) is within the range of about 0.15 to 0.40.

Studies of the surface distribution of actinides in bone are being carried out in conjunction with Argonne National Laboratory. Bone from two USTR high exposure cases (both Am-241 wound cases) has been examined to date. Results indicate that while some remodelling has occurred, burial appears to be less than predicted by models that are largely based on animal studies or human data from volume seekers such as radium.

Long-Term Excretion Studies

The study of the long-term urinary excretion of plutonium in four retired USTR registrants was continued. All four cases are known to excrete detectable levels of Pu in their urine, with exposure occurring decades previously. During FY 1989, the second biennial Pu urinalyses and fecal analyses were performed along with in-vivo counts and physical examinations.

To determine if there is long-term clearance of particulate radioactivity from the respiratory tract via the mucociliary pathway and the gastrointestinal

tract, fecal samples from these four cases were split and shared with Pacific Northwest Laboratory. One half was analyzed for total plutonium by the standard USTR technique. The corresponding half samples are being analyzed by PNL using a special technique designed to separate particulate activity and evaluate the presence of plutonium with autoradiographic methods. The ICRP Task Group on Lung Dynamics has expressed considerable interest in the results of this study. A preliminary model developed by the ICRP includes a long-term depot for insoluble particulates of plutonium, with slow clearance over a period of many years. Results of this study could verify the existence of such a compartment and might even provide information on the clearance halftime and other constants.

Distribution of Actinides in Lung and Lymph Nodes

A rigorous study of the distribution of actinides in lung and lymph nodes of USTR routine autopsy donors was undertaken with the assistance of a NORCUS faculty appointee, Professor DJ Strom, University of Pittsburgh. This new effort will expand and consolidate the pilot work previously done. Preliminary results confirm the earlier finding that the ratio of actinide concentration in the lymph nodes relative to that in the lungs is log normally distributed. Concentrations in the lymph nodes were about an order of magnitude greater than those in the lungs, indicating that 90 per cent or more of the actinide activity in the respiratory tract resides in the lungs. No significant differences were observed between plutonium isotopes, but the ratio was somewhat greater for Am-241.

In most of these cases, exposure occurred many years prior to death. Thus, the ratios observed are inconsistent with the current lung model of the ICRP, which would predict a considerably larger fraction of the activity in the respiratory tract to be in the lymph nodes.

Pu-238 Whole Body Donation

USTR Case 258 was a whole body donation of an individual who died in June 1989. This case received an acute inhalation exposure to Pu-238 in the Los

Alamos Wing 9 accident 28 years prior to death. The takedown has been completed and the tissues sent to Los Alamos for radiochemical analysis.

RESEARCH PROJECTS OF THE USUR

Evaluation of Case SP32-0007

USUR Case SP32-0007 was a 50-year old male with a history of more than two decades of work with uranium who suffered a fatal cardiac event while at work. At autopsy, both lungs and samples of kidney, liver and bone (vertebrae) were obtained and subjected to radiochemical analysis. Levels of uranium in these tissues were clearly in excess of that expected solely from environmental exposure, providing strong confirmatory evidence of past occupational exposure. The ratio of systemic uranium in skeleton:liver:kidney was 65:3:1; this finding was in consonance with the pattern of human tissue levels observed in some recent studies in non-occupationally exposed New York City residents, but differed significantly from the pattern reported for Reference Man. These results suggest that the liver has greater importance as a depot for uranium, and that the current ICRP biokinetic models may be in need of revision.

Evaluation of the tissue uranium concentrations and enrichments in conjunction with in-vivo bioassay and other health physics data indicated an important long-term storage compartment for uranium in the skeleton and possibly the kidney. These findings tend to confirm a recently proposed pharmacodynamic model put forth by ME Wrenn and coworkers, and indicate that the uptake fractions specified by the current ICRP 30 model may be too small. If so, the dose to these organs as well as the liver from a given intake of uranium may be greater than indicated by current biokinetic models for uranium, implying that the Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) for uranium enrichments above 5-8% may be too low.

In-vivo chest counts in this registrant made over a period of years prior to death were strongly suggestive of a long-term uranium lung deposition, and

indicated approximately twice as much uranium in the lungs and twice the U-235 enrichment as measured by postmortem radioassay.

Uranium Distribution in the Tissues of a Whole Body

This project involves the measurement of uranium in two whole body donations to the Transuranium Registry from individuals without known occupational exposure to uranium. Analysis of these tissues is being carried out at Los Alamos National Laboratory using kinetic phosphorescence analysis. This relatively new technique provides a degree of sensitivity for total uranium unattainable by conventional methods, but, unlike radiochemical analysis, does not provide quantitative information on specific isotopes. Preliminary results have been encouraging; the method clearly is able to detect uranium in the tissues at environmental levels. Distribution of uranium was observed to be nonuniform in the skeleton, which was an unexpected observation in view of the biodynamics of uranium in bone. No particular distribution pattern or biological basis for the observed nonuniformity has been identified, and this aspect is being investigated further.

The uranium content and distribution in the various tissues was also determined. Preliminary examination of these results revealed the relative uranium content of liver and kidney to be similar to that observed in USUR Case SP32-0007 and therefore different from that of Reference Man. No tissues were found to have extraordinary levels, or concentrations of uranium.

Uranium in Lung and Lymph Nodes

Following successful results of a pilot study of uranium concentration in the lung and associated lymph nodes of routine autopsy cases from the U.S. Transuranium Registry, a more rigorous study was undertaken. Data on all routine USTR autopsy cases were reviewed. It should be noted that these cases are not known and indeed unlikely to have incurred occupational exposure to uranium. Hence, levels of uranium in these individuals are at environmental levels, which in some cases are below the radiochemical detection limit for uranium. Furthermore, since uranium measurements were only done by the Rocky

Flats Facility, which ceased performing radioanalyses three years ago, only a relatively small number of cases were found. In the nine cases for which reliable data are available, the ratio of the uranium concentration in the lymph node to the concentration in lung was log normally distributed, with a geometric mean of 5.2 and geometric standard deviation of 4.3. These results were somewhat greater but not statistically different from values reported previously in a study of six occupationally exposed workers.

USUR Case TH01 0001 (Whole Body Donation of Thorotrast Case)

In November 1988, a potential registrant was identified to the USUR by the late CL Mays, then a member of the Scientific Advisory Committee. This individual had received a single injection of Thorotrast radiology contrast medium in 1951 as part of an unsuccessful diagnostic procedure; she was interested in donating her body to the USUR for scientific study.

Thorotrast is a colloidal suspension of natural thorium dioxide. While thorium is of interest to the Registry in as much as Th-230 is an important member of the U-238 decay chain, the primary significance of this case is its potential value to the long-term studies of Thorotrast by the National Cancer Institute and other agencies that are directed at determining risk coefficients for alpha irradiation of human tissue. Because of the overwhelming potential value of this singular donation, which affords the unique opportunity to evaluate the concentration, distribution, biokinetics, and dose from thorium, efforts were immediately begun to enroll this voluntary donor.

To maximize the scientific yield from the donation, extensive planning was carried out, including development of collaborative arrangements with other investigators. Because of the unusual nature of this case, some departure from the normal autopsy procedures was required to ensure that certain time constrained data were not lost. Arrangements were made with the National Naval Medical Center, where Case TH01 0001 was hospitalized, for an immediate autopsy following death; this included removal of selected tissues and organs for external counting at the nearby National Institutes of Health and the

National Institute for Standards and Technology. Because of the short half-life of certain thorium daughters, it was essential that this counting be carried out as soon after death as possible. In addition, arrangements were made to have a Registry prosector at the autopsy, and to obtain special tissue samples for collaborative bone and oncogene studies at other laboratories.

The donor died in June 1989, some 38 years after the original injection of Thorotrast. External counting of specific tissues and organs was carried out within hours after death. These data are currently being analyzed; preliminary results indicated that activity in the soft tissue was concentrated in liver, as expected, and that levels in the remaining soft tissues were not uniform. Similarly, differences in radioactive equilibria were observed in some tissues. Previous studies suggested that the eye and breast might be particularly at excessive risk because of high thorium concentration at these sites, but the counting results to date indicate that at least for the eye this is not the case. External counting of the eviscerated body was performed at PNL, and was consistent with deposition of thorium in the large bone masses.

The body takedown was completed and the tissues sent to Los Alamos for radiochemical analysis using methods for the analysis of thorium and its daughters that were standardized in anticipation of this case. Preliminary results revealed an unexpectedly large amount of tissue Th-230. The 230 isotope is not a member of the Th-232 decay chain, but could have been present in significant amounts if the parent thorium oxide (used to manufacture the Thorotrast) had been derived from an ore containing significant amounts of uranium. Accordingly, samples of Thorotrast produced at the approximate time of the case injection were sought so that the isotopic content could be compared with that in Case TH01 0001. A single bottle of suitable Thorotrast has been found, and will be subjected to radiochemical analysis.

In addition to Los Alamos National Laboratory, collaborative research on this case is being carried out with seven other institutions. The overall evaluation of this case is being conducted with the National Cancer Institute (NCI). The NCI and the Registry will also collaborate on the development of

biological risk estimates. Other collaborating institutions include the National Naval Medical Center (medical aspects of the case, including pathology); Argonne National Laboratory (bone dosimetry and oncogene studies); National Radiological Protection Board (bone dosimetry and autoradiography); and Pacific Northwest Laboratory, Georgetown University and the National Institute of Standards and Technology (external counting). The USUR is coordinating the activities of these collaborating institutions and planning for the publication of all manuscripts in a single issue or supplement of the peer reviewed journal Health Physics.

Evaluation of Uranium Exposure Incident

As a result of an accident in January 1986, 31 workers at the Sequoyah Nuclear Fuels Plant in Gore, OK were acutely exposed to uranium hexafluoride and its decomposition products. A medical and health physics evaluation of these cases was undertaken in conjunction with PNL as part of their review of the accident under contract to the Nuclear Regulatory Commission (NRC). A draft report was prepared and submitted to the NRC. No health effects attributable to uranium exposure were found in the exposed workers. Uranium clearance from the lung was more rapid than would be predicted by the ICRP model. Urinary excretion data from the affected workers were used to develop a four exponential compartment model. Committed effective dose equivalents for each of the exposed workers ranged from 10 to 48 uSv (1-4.8 mrem). Maximum kidney concentrations of uranium ranged from 0.05 to 2.5 ug U/g kidney.

SCIENTIFIC ADVISORY COMMITTEE MEETING

The 16th Annual Meeting of the Scientific Advisory Committee to the U.S. Transuranium and Uranium Registries was held November 16-17, 1989, in Richland, Washington. Committee members present were: George L. Voelz, (Chairman), Patricia W. Durbin (Chairman, Technical Subcommittee), Kenneth G. W. Inn, J. Newell Stannard, and Langan W. Swent. Prospective committee members Roy C. Thompson and Paul L. Ziemer were also present.

Other attendants were William L. Meader, President, HEHF; Scott E. Dietert, Manager, Research, HEHF; Ronald L. Kathren, Director, Health Physics, HEHF; Margery J. Swint, Director, USTR and USUR, HEHF; James F. McInroy (LANL); Robert W. Bistline (RFF); Paul W. Kruger (DOE/RL) and Daniel J. Strom (University of Pittsburgh).

The meeting was largely devoted to a review of technical progress during the previous year (FY 1989) and to scientific questions relating to specific Registry projects; some emphasis was placed on administrative aspects of the two programs. The Advisory Committee made several general and specific recommendations. Development of stronger alliances with the radiobiological scientific community, possibly including the services of a prominent radiation biologist as a consultant, and continued development of the comprehensive Registry data base were the priority recommendations. The Committee again noted the DOE-OHER budgetary constraints with respect to the analytical laboratory support provided by LANL. The report of the Committee is included as Appendix C.

APPENDIX A

UNITED STATES TRANSURANIUM AND URANIUM REGISTRIES MANAGEMENT (April 1990)

ADMINISTRATION

Ronald L. Kathren, C.H.P., D.E.E.	Director, U.S. Transuranium and Uranium Registries
Scott E. Dietert, M.D.	Manager, Research
Willard L. Meader, M.D.	President, Hanford Environmental Health Foundation
Becky Savage, C.P.S.	Secretary
Jackie Richelieu	Secretary

PROSECTORS

Robert W. Bistline, Ph.D.	Rocky Flats Plant
Gerald R. Dagle, D.V.M., Ph.D.	Pacific Northwest Laboratory
James F. McInroy, Ph.D.	Los Alamos National Laboratory

SCIENTIFIC ADVISORY COMMITTEE

G. L. Voelz, M.D., Chairman	Epidemiology Program Manager Los Alamos National Laboratory
P. W. Durbin, Ph.D., Chairman, Technical Subcommittee	Senior Scientist, Lawrence Berkeley National Laboratory
K. G. W. Inn, Ph.D.	National Institute of Standards and Technology
J. N. Stannard, Ph.D.	Professor Emeritus, University of Rochester and Adjunct Professor, University of California, San Diego
L. W. Swent	Vice President (Retired) Homestake Mining Company
R. C. Thompson, Ph.D.	Senior Staff Scientist (Retired) Pacific Northwest Laboratory
P. L. Ziemer, Ph.D., C.H.P.	Professor of Bionucleonics, Purdue University

APPENDIX B

COLLABORATING INSTITUTIONS AND PRINCIPAL INVESTIGATORS, USTR

Argonne National Laboratory
- Surface Deposition of Actinide in Human Bone (RA Schlenker)

Inhalation Toxicology Research Institute
- Autoradiography and Microscopic Examination of Respiratory Tract Tissues, USTR Case 246 (RA Guilmette)

Lawrence Berkeley Laboratory
- Soft Tissue Autoradiography, USTR Case 246 (PW Durbin)

Los Alamos National Laboratory
- Radiochemical Analysis of Tissues (JF McInroy)

National Radiological Protection Board
- Autoradiography of Bone, USTR Case 246 (NJ Priest)

National Institute of Standards and Technology
- Intercomparison Studies and Development of SRM -- Human Bone (KGW Inn)

Pacific Northwest Laboratory
- Scanning Electron Microscopy and Autoradiography of Selected Soft Tissues, USTR Case 246 (CL Sanders)
- Distribution of Actinide in the Human Skeleton (TP Lynch)
- In-vivo Counting Studies (HE Palmer, TP Lynch)
- Long-Term Fecal Excretion of Particulates (GR Dagle)
- Comparison of Skeletal Actinides in Humans and Animals (GR Dagle, TP Lynch)

University of Pittsburgh
- Distribution of Actinide in the Respiratory Tract (DJ Strom)

University of Washington
- Distribution of Actinide in the Human Skeleton (AH Nevissi)

COLLABORATING INSTITUTIONS AND PRINCIPAL INVESTIGATORS, USUR

[USUR CASE TH01 0007]

Argonne National Laboratory
  Oncogene Studies (RA Schlenker)

Georgetown University
  Postmortem External Counting (KL Mossman)

Los Alamos National Laboratory
  Radiochemical Analysis of Tissues (JF McInroy)

National Cancer Institute
  Case Overview and Relevance (JD Boice, Jr.)
  Risk Estimates and Epidemiology (JD Boice, Jr; LB Travis)

National Naval Medical Center
  Medical Aspects (W Tauber)
  Autopsy Findings (J Cotelingam)

National Institute of Standards and Technology
  Postmortem External Counting (KGW Inn)

National Radiological Protection Board
  Bone autoradiography (ND Priest)

Pacific Northwest Laboratory
  Soft tissue autoradiographic studies (GR Dagle, AC James)

OTHER

Saint Mary's Hospital
  Data Base Automation, Uranium Miner Lung Cancer Study (G. Saccomanno)

APPENDIX C

1989 REPORT OF THE ADVISORY COMMITTEE TO THE U. S. TRANSURANIUM AND U. S. URANIUM REGISTRIES

Meeting Held On November 16-17, 1989
Richland, WA

All members of the Advisory Committee, including two prospective new members, were present. The members are George L. Voelz (Chairman), Patricia W. Durbin, Kenneth G. W. Inn, J. Newell Stannard, and Langan W. Swent. The prospective new members are Roy C. Thompson and Paul L. Ziemer. The meeting was conducted as an informal working session of the Committee and the staff of the combined Registries in order to encourage an unrestricted exchange of information and ideas. A list of all attendees and the agenda are appended as Appendices I and II. At the end of the meeting, the Advisory Committee recommendations were discussed with key staff members of the Registries.

Dr. Willard L. Meader was introduced as the new Chief Operating Officer of Hanford Environmental Health Foundation (HEHF). Dan Strom, a NORCUS (Northwest College and University Association for Science) Visiting Professor from the University of Pittsburgh, was introduced. He has been collaborating on a study of Am and Pu distribution in the respiratory tract (lung vs. lymph node) using routine autopsy data.

Since the last meeting of the Advisory Committee, several unusual circumstances have taxed the available time of the staff. Dr. Margery Swent was called upon by HEHF to be the interim Medical Director for the Occupational Medicine activities during a period of staff changes, and Ron Kathren carried out the responsibilities of President Elect/President of the Health Physics Society during the past year. Despite these temporary extra duties, the Committee believes the Registry programs have continued to make good progress. HEHF is recruiting for an additional staff person with a radiological health and mathematics background to help complete the archived database and accelerate data analysis and interpretation.

Dr. Dietert reviewed the status of the 1988 Advisory Committee recommendations. He noted that in the "Guidelines for the Scientific Advisory Committee", issued July 1989, HEHF encourages Registry authors to use individual members of the Committee for peer review prior to submission for publication, but does not require review by all members of the Committee. During 1989 work has been done on 3 manuscripts. Funding for FY 1990 is anticipated to be about $355K vs. $321K for FY 1989. The next year's activities should be at approximately at the same level as in the past.

Current registrants total about 530 plutonium exposed cases in the USTR and 30 uranium workers in the USUR. Eight whole body cases have been procured for the USTR and one Thorotrast case for the USUR. Of these cases, analyses of one ^{241}Am case and five ^{239}Pu cases (analyzed for both Am and Pu) have been completed.

Based on the presentations and discussions of the agenda items, which are not summarized here, the Committee makes the following recommendations.

General Recommendations:

1. Priority Setting for 1990.

The Committee suggests that the Registry management consider the following areas as particularly important to work on during the next year. They are listed approximately in the order of priority:

a) Development of strong alliances with the radiobiological scientific community is an important objective and could be a major help in strengthening the work of the Registries. HEHF should try to arrange for a prominent biology consultant to help them with data evaluation and biokinetic modeling. Good starts in this direction can be made with needed work on Case 246 and the Thorotrast case. It is also considered helpful for the staff to maintain an awareness of the interests and activities of the NCRP and ICRP in developing the technical questions and studies for the Registry.

b) Continued development of a comprehensive database to handle Registry information is essential. The Committee was pleased to hear that some work on this project was begun during the past year. The data should include all tissue information available from earlier measurements on Los Alamos and Rocky Flats workers. Data on plutonium measured in tissues from the general population by the Los Alamos laboratory should be included, if possible. The database should be developed as a comprehensive archive of actinide exposure cases, including non-Registry cases to the extent possible. A carefully recorded exposure history should be an important component of the database. The need for quality assurance procedures in developing the database is emphasized.

c) Recruitment of volunteers among uranium workers should be pursued vigorously. More on this later.

d) Criteria for selection of volunteers with potential transuranium exposures should be publicized and clarified for the various employers who recruit for the Registry. See additional recommendations in Sections 2 and 3 below.

2. CRITERIA FOR REGISTRANT SELECTION

The Committee makes the following recommendations with regard to the "Criteria for Registrant Selection", dated 11/89,

in the handout booklet. Robert Bistline, Rocky Flats, brought up the point that there was some confusion as to the amount of plutonium deposition required to be a Registrant. He thought the criteria included an estimated deposition of 4 nCi or more for transuranics. The criteria for whole body donations includes a 150 Bq (4 nCi) deposition requirement, but this requirement is not placed on partial body cases. The difference between partial and whole body donations is not identified in the 11/89 "Criteria for Registrant Selection" paper in the handouts to the Committee and should be specified.

In Criterion 1, for both USTR and USUR Registrants, it is suggested that the word "current" be dropped. It is likely that most registrants would not have current verification of their internal depositions and important cases could be eliminated if this technicality is taken seriously. Past documentation of exposure should be adequate.

In Criterion 3 for the USTR it is suggested that the statement read: **Occupational history of work with transuranium elements (i.e., chronic exposure potential) plus confirmed positive bioassay results.** The remainder of the phrase requiring the case to be of "unique value" to the Registry is dropped because some redundancy between similarly exposed cases is needed. Not all cases need to have unique features to be useful.

A new Criterion 4 is suggested for USTR Registrants which would read: **Reasonable expectation that information gained from the analysis of tissues from the registrant will further the scientific objectives of the Registry.** This addition should help clarify the intent of selections and might also assist in eliminating some cases that are primarily medicolegal cases (See Recommendation 3 below).

In Criterion 3 for the USUR it is suggested that the last phrase, "and of unique value to the Registry", be dropped for the same reasons mentioned above for the USTR.

A new Criterion 5 is suggested for USUR registrants that is the same as the new Criterion 4 for the USTR above.

3. REGISTRY CASES AND LITIGATION.

The basis for acceptance of cases for the Registry should be on their potential scientific value. Cases that have scientific merit should neither be dropped nor accepted because of potential litigation claims against the employer, the DOE, or others. The Registry should <u>not</u>, however, be required to expend its limited resources to obtain measurements on cases where the interest in the case is primarily potential litigation, and the case does <u>not</u> meet the normal selection criteria.

Addition of the new Criteria for Registrants on the expectation of a case to "further the scientific objectives of the Registry" should be helpful in setting aside purely medicolegal requests of dubious scientific interest.

4. DEVELOPMENT OF REGISTRY DATABASE SYSTEM

The need for a database management system for the Registry ranks high on the Committee's priority listing (See 1b above). It was also noted that currently a DOE working group is studying means of making databases from the DOE epidemiology studies available to independent investigators. The purpose is to establish a Comprehensive Epidemiologic Data Resource (CEDR). The epidemiologic studies have been faulted by some for not being open to outside investigators. Two Committees appointed by and reporting to the Secretary of Energy are now studying DOE epidemiology programs, including means for making their data available to outside investigators. Issues of confidentiality, privacy, and rights of the scientists gathering the data are significant. The Registry database will probably have to address the same issues in the future. The CEDR planners are already discussing inclusion of other health effects data, such as from the USTR and USUR. The Advisory Committee recommends that in developing the uses and format for the Registry database careful attention be paid to the problems of openness of records, data access by outside investigators (friendly and hostile), and means to maintain and strengthen the credibility of these studies, while at the same time retaining privacy.

5. USE OF THE TECHNICAL SUBCOMMITTEE

The Registry staff has available for its use an Ad Hoc Technical Subcommittee of the Advisory Committee for special studies or problems. Patricia Durbin chairs the Subcommittee. An example of a special activity is to consider special questions associated with Thorotrast that should be considered during analyses of the present whole body case. In addition, it is suggested that the Registry may wish to communicate with or gather a meeting of other experts knowledgeable in the metabolism of thorium. The Subcommittee should also be used to examine ways to acquire other special cases of interest to the Registry.

6. EXPOSURE HISTORIES OF REGISTRANTS

The advantage of obtaining good exposure histories on Registrants while still alive is emphasized. The Registries should devise better means of obtaining such histories.

7. ANNUAL LIST OF PRIORITIES FOR REGISTRY WORK

The Committee recommends that the staff of the Registries prepare a list of their own work priorities for the coming year prior to the Advisory Committee meeting. The Advisory Committee shall review and comment on the priorities at its annual meeting.

* * * * *

Recommendations for the
U. S. Transuranium Registry

The following recommendations pertain to work in the USTR specifically.

8. PRIORITIES IN CASE SELECTION OF USTR REGISTRANTS

Certain types of transuranium exposure cases are of special value to the Registry and should be given priority for registration. Current situations to be given such priority are:

a) Whole body cases.

b) Cases in which the time between exposure and time of death is short (months to a few years).

c) Special known exposure groups being followed, such as Manhattan District Pu workers (Los Alamos), 1965 Rocky Flats fire exposures, and ^{238}Pu exposures from 1971 Los Alamos Wing 9 hot cell accident.

d) Documented incidents with unusual exposure characteristics.

The Registry should continue to be alert to these priority cases and evaluate its success in enrolling a reasonable percentage of such cases for future work.

9. RECRUITMENT OF CASES FROM ROCKY FLATS

Special efforts to promote recruitment of cases at Rocky Flats seem useful during the next year. This recommendation is particularly important because a majority of potentially important exposure cases exist at this facility. Criteria for case selection should be clarified with the RF medical staff. A visit to Rocky Flats would be useful to meet the new EG&G and DOE officials and introduce them to the Registry programs and goals. Support for validating past laboratory analyses for actinides done at RF for the Registry should also be solicited from their management.

10. VALIDATION OF ROCKY FLATS ANALYSES

A large number of radiochemical tissue analyses in the Registry program were done at Rocky Flats. It is recommended that a vigorous effort be made to validate the procedures and results and to corroborate the results with Los Alamos calibrations to the extent possible. The RF technician involved in these analyses is reported to be retiring in about six months. The suggestion is to try to arrange for him to work with the Los Alamos staff using RF procedures and tracer solutions to validate that the RF tissue measurements correlate satisfactorily with measurements of Los Alamos and the National Institute of Standards and Technology (formerly National Bureau of Standards). In addition, the technician should analyze the NIST SRM 4351 and 4352 materials as part of the validation studies.

11. QUALITY ASSURANCE AT THE LOS ALAMOS LABORATORY

All Registry samples are now being analyzed by the Los Alamos HSE-9 radiochemistry laboratory. This dependence on one laboratory makes the QA procedures critical to the work and output of the Registries. Thus it is recommended that the QA procedures for Los Alamos done as carefully as possible, and, ideally, be beyond reproach. This recommendation does not imply that the present QA procedures at Los Alamos are being questioned: No review was done by the Committee. The importance of this topic is simply being emphasized. The QA procedures must include both internal and external methods. For example:

a) Internal QA procedures should assure that the Laboratory is using robust methods and that multiple methods can reproduce the results. The sensitivities required for the work must be satisfied. The results of internal QA procedures must be routinely recorded.

b) External comparisons should be performed regularly. There are a number of laboratories that may be appropriate for such intercomparisons. The Committee does not wish to recommend specific procedures for such comparison studies, but some candidate laboratories identified at the meeting include other DOE laboratories (e.g., Brookhaven, Univ. of Utah), competent commercial laboratories, or internationally recognized foreign laboratories (e.g., NRPB).

12. FUNDING FOR LOS ALAMOS RADIOCHEMICAL TISSUE LABORATORY

A subject, which is related to the recommendation on QA work, is the DOE budgetary support for laboratory analyses. There is a perennial funding problem for the analytical laboratory operation at Los Alamos. The laboratory has been level-funded, and even reduced in some years, since 1984. The workload has not decreased during this time, and it is expected to increase in the future, because the average age of Registrants

is advancing with the years. Increasing QA work, such as, interlaboratory comparisons and any work involved with legal claims, also involve extra costs. In each of the last several years, the Advisory Committee has articulated its concerns about the status of the essential analytical chemical support for the Registries (limited budgets, loss of the Rocky Flats Laboratory, etc.). These efforts by the Committee to mobilize support apparently have failed to improve the situation. Once again it is reiterated that the Registry and the Los Alamos staff work together to impress DOE sponsors of the importance of providing adequate funds for this essential service.

* * * * *

Recommendations for the U. S. Uranium Registry

The following recommendations pertain to the work of the USUR specifically.

12. RECRUITMENT OF REGISTRANTS

The Committee encourages continued recruitment of uranium workers. The work done during the past year to get approval to recruit former and present uranium workers at the Oak Ridge Y-12 plant is commendable. This effort should be continued, even though a difficult and tortuous pathway for approvals has developed . Another plant mentioned for possible recruitment is the Apollo plant near Pittsburgh run by Babcock & Wilcox, which is reputed to have some special exposure data such as fecal measurements. More information is needed on the available exposure data and potential access to this information.

13. URANIUM MEASUREMENTS ON USTR WHOLE BODY CASES

Jim McInroy described the laboratory work during the past year in which uranium measurements were made on solutions prepared from tissues obtained from whole body donations to the USTR. See recommendation 2 for the USUR in the 1988 Advisory Committee report, which recommends this type of study. The Committee again agrees that this is a worthwhile effort to provide a better understanding of distribution of uranium in the body and the effort should be continued. We note once again that there has been work with uranium at Los Alamos and Rocky Flats and certain registrants for the USTR could be of considerable interest for uranium content as well as the transuranics.

14. MEASUREMENT OF AC-228 IN THOROTRAST WHOLE BODY CASE

The results of direct counts performed on organs from the Thorotrast whole body case and a few preliminary tissue

radiochemical analyses of tissues were presented. Ken Inn wishes to cross calibrate the results of direct counting techniques with Jim McInroy's laboratory results. Pat Durbin also offered to recount samples with a sensitive sodium iodide detector system available at her laboratory. A question for the committee concerned technical problems of getting adequate sensitivity for ^{228}Ac measurements, which raises the question as to whether the effort to do such measurements is worthwhile.

The consensus of staff and Committee was that measurements of ^{232}Th and ^{228}Th should be given priority. If it is feasible to also obtain useful ^{228}Ac results, it was concluded that the additional effort to obtain such data should be made.

APPENDIX I

LIST OF ATTENDEES
USTR-USUR ADVISORY COMMITTEE MEETING

November 16-17, 1989

Advisory Committee:

Patricia W. Durbin
Kenneth G. W. Inn
J. Newell Stannard
Langan W. Swent
Roy C. Thompson *
George L. Voelz
Paul L. Ziemer *

* = Prospective New Members

Registries:

Scott E. Dietert
Ronald L. Kathren
James F. McInroy
Willard L. Meader
Margery J. Swint

Invited Guests:

Robert W. Bistline (Rockwell-Rocky Flats)
Paul Krueger (US DOE/Richland Op. Office)
Dan Strom (NORCUS Visiting Scientist, Univ. of Pittsburgh)

APPENDIX II

USTR/USUR ADVISORY COMMITTEE AGENDA

Thursday, November 16, 1989

0830 - 0835 Welcome: Introduction of new Committee Chairman, Committee member designates and DOE Representatives (Scott Dietert)

0835 - 0845 Call to Order (George Voelz)
Opening Remarks

0845 - 0915 Management Report (Scott Dietert)

1. Introduction of new HEHF President, Dr. Willard Meader
2. Review of 1988 Advisory Committee recommendations
3. Registries' Funding -- FY 1989 and prospective

0915 - 1000 Director's Report and Administrative Items (Marge Swint)

1. Recruitment of New Registrants
2. Current Registrant Enrollment
3. Case Selection Criteria
4. Integrated Registry data base
5. Staffing

1000 - 1030 Break

1030 - 1100 Rocky Flats Facility report (Bob Bistline)

1100 - 1140 Los Alamos National Laboratory: Radiochemistry report (Jim McInroy)

1140 - 1200 NCRP activities (Newell Stannard)

1200 - 1300 Lunch

1300 - 1430 US Transuranium Registry (Ron Kathren)

1. Case 246 collaboration studies
2. Excretion study of long term exposure cases
3. Comparison of postmortem data with excretion models
4. Pu-238 whole body case
5. Macrodistribution of Pu in skeleton
6. Lung-lymph node study (Dan Strom, NORCUS Visiting Professor)

1430 - 1500 Break

1500 - 1700 US Uranium Registry (Ron Kathren)

1. Whole body uranium data
2. Thorotrast whole body case

##########

1730 - 1830 Social Hour

1830 - 1930 Dinner

2000 - 2200 Mid Columbia Symphony, "The Art of the Fugue"

##########

Friday, November 17, 1989

0830 - 1000 Executive Session

1000 - 1030 Break

1030 - 1200 Debriefing with Registry Staff

11/89

APPENDIX D

PUBLICATIONS AND PRESENTATIONS

1. Brodsky, A. and R. L. Kathren. 1989. "Historical Development of Radiation Protection Practices in Radiology:, Radiographics 9:1267-75.

2. Denham, D. H. and R. L. Kathren. 1989. Recommended Protocol for Standardization in Collecting and Interpreting Radiological Environmental Data, Radiation Protection -- Theory and Practice, Fourth International Symposium of the Society for Radiological Protection, Malvern, England, June, 1989, pp. 385-388.

3. Fisher, D. R. and R. L. Kathren. 1989. "Presentation of Distinguished Scientific Achievement Award to Charles W. Mays", Health Physics 56:807-9.

4. Kathren, R. L. 1988. "Health Physics Instruments Yesterday: Some Notes on the Evolution of Health Physics Instruments", in Proceedings of the 22nd Midyear Topical Meeting on Instrumentation, December 4-8, 1988, Health Physics Society, San Antonio, pp. 1-9.

5. Kathren, R. L. 1989. "The United States Transuranium and Uranium Registries: Overview and Recent Scientific Progress", Presented at the Workshop on Biological Assessment of Exposure to Actinides, Versailles, France, May 30-June 2, 1988, Radiation Protection Dosimetry 26:323-330.

6. Kathren, R. L. 1989. Book Review: Something About X-Rays for Everybody. Medical Physics 16:922.

7. Kathren, R. L., "Instrumentation for Monitoring and Field Use", Chapter 18 in Stannard, J. N., Radioactivity and Health: A History, Office of Scientific and Technical Information, pp. 1541-1573, October 1988.

8. Kathren, R. L. and J. F. McInroy. 1990. Plutonium Content in Marrow and Mineralized Bone in an Occupationally Exposed Person. Submitted to Radiation Protection Dosimetry.

9. Kathren R.L., McInroy J.F., Moore R.H. and Dietert S.E. 1989. "Uranium in the Tissues of an Occupationally Exposed Individual," Health Physics

10. Kathren, R. L. and G. R. Peterson. 1989. "Units and Terminology of Radiation Measurement: A Primer for the Epidemiologist", American Journal of Epidemiology 130:1076-1087.

11. Lynch, T. P., R. L. Kathren, G. E. Dagle and J. F. McInroy. 1989. "Comparative Skeletal Distribution of Americium and Plutonium in Man, Monkey and Baboon", Presented at the 26th Annual Hanford Life Sciences Symposium, Richland, WA, October 20-23, 1987, Health Physics 57 (Suppl. 1): 81-88.

12. McInroy, J. F., R. L. Kathren and M. J. Swint. 1989. "Distribution of Plutonium and Americium in Six Whole Bodies Donated to the United States Transuranium Registry", Presented at the Workshop on Biological Assessment of Exposure to Actinides, Versailles, France, May 30-June 2, 1988, Radiation Protection Dosimetry 26:151-156.

13. McInroy, J. F., R. L. Kathren and M. J. Swint. 1989. "Distribution of $^{Pu-239}$ In Occupationally Exposed Workers, Based on Radiochemical Analysis of Three Whole Bodies", (Abstract), Health Physics 57 (Suppl. 1):89.

14. Schlenker, R. A., B. G. Oltman and R. L. Kathren. 1989. "Bone Surface Deposition of $^{Am-241}$ In a Person with Occupational Exposure", Radiation Protection Dosimetry 26:195-200.