The Registries are a human tissue research program studying the deposition, biokinetics and dosimetry of the actinide elements in humans with the primary goals of providing data fundamental to the verification, refinement, or future development of radiation protection standards for these and other radionuclides, and of determining possible bioeffects on both a macro and subcellular level attributable to exposure to the actinides.

UNITED STATES TRANSURANIUM AND URANIUM REGISTRIES:

A HUMAN TISSUE RESEARCH PROGRAM

PHARMACEUTICAL SCIENCES
COLLEGE OF PHARMACY
WASHINGTON STATE UNIVERSITY

COMPILED AND EDITED

SUSAN M. EHRHART and RONALD E. FILIPY

CONTRIBUTORS

S. BAO, S.M. EHRHART, R.E. FILIPY, S.E. GLOVER, C.L. LOVE, M.V. PHAM, J.J. RUSSELL, R.G. THOMAS

2710 UNIVERSITY DRIVE
RICHLAND, WA 99352
PHONE: (800)375-9317
FAX: (509)375-1817
FAX: (509)372-7160
www.ustur.wsu.edu

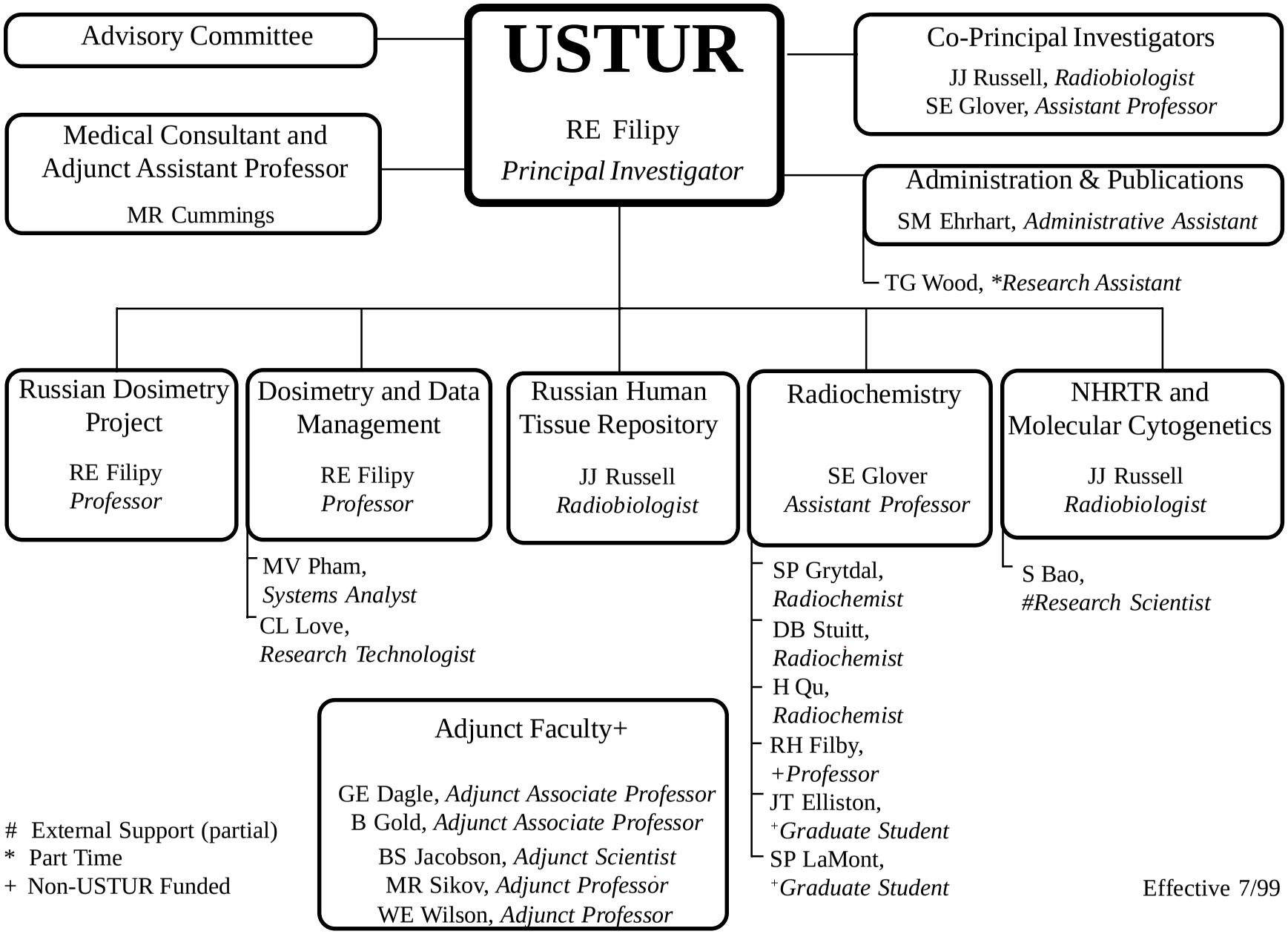
INSIDE THIS REPORT

FOREWORD

Regular recipients of the USTUR annual reports will note that the format of the report has changed from that of previous reports. This report contains summaries of the many activities in which the Registries are involved and virtually no Registries data are included. The change arose during the September 1998 meeting of the USTUR Advisory Committee who suggested a much-abbreviated annual report (Page 34). They also recommended continued inclusion of updated Registries data in the World Wide Web pages of the Registries and this will be a high priority for the coming year. This report also covers the period October 1, 1997 through January 31, 1999; therefore, future annual reports will coincide with the grant year (February 1 through January 31).

A change in USTUR administration occurred in July 1999 with the retirement of Ronald L. Kathren, director of the USTUR for over 10 years. The new Registries leadership consists of Dr. Ronald E. Filipy, principal investigator, with John J. Russell and Dr. Samuel E. Glover as co-principal investigators. The Registries will continue to provide service to tissue donors and their families and to the sponsors. It is hoped that the Registries will maintain and expand contacts with other scientists throughout the world.

BY RONALD E. FILIPY, DIRECTOR


Advisory Committee
USTUR
RE Filipy
Principal Investigator
Co-Principal Investigators
JJ Russell, Radiobiologist
SE Glover, Assistant Professor
Medical Consultant and Adjunct Assistant Professor
MR Cummings
Administration & Publications
SM Ehrhart, Administrative Assistant
TG Wood, *Research Assistant
Russian Dosimetry Project
RE Filipy
Professor
Dosimetry and Data Management
RE Filipy
Professor
Russian Human Tissue Repository
JJ Russell
Radiobiologist
Radiochemistry
SE Glover
Assistant Professor
NHRTR and Molecular Cytogenetics
JJ Russell
Radiobiologist
MV Pham,
Systems Analyst
CL Love,
Research Technologist
SP Grytdal,
Radiochemist
DB Stuitt,
Radiochemist
H Qu,
Radiochemist
RH Filby,
+Professor
JT Elliston,
+Graduate Student
SP LaMont,
+Graduate Student
S Bao,
#Research Scientist
Adjunct Faculty+
GE Dagle, Adjunct Associate Professor
B Gold, Adjunct Associate Professor
BS Jacobson, Adjunct Scientist
MR Sikov, Adjunct Professor
WE Wilson, Adjunct Professor
External Support (partial)
* Part Time
+ Non-USTUR Funded
Effective 7/99

EXECUTIVE SUMMARY

BY RONALD E. FILIPY, DIRECTOR

The United States Transuranium and Uranium Registries (USTUR) have been in a very productive mode during this reporting period as reflected in the number of publications in the open scientific literature. In addition to those publications, the USTUR has made great forward strides in compilation of data, establishment of collaborative research programs, and improvement of the quality of radiochemical analytical methods.

The number of active USTUR registrants has declined over this reporting period. The death rate among registrants was close to that expected in the U. S. population of the same age groups; however a relatively large number (34) failed to renew their consents for autopsy. While this was unfortunate for the USTUR, that choice for the registrants is precisely the reason for the USTUR policy of renewal at five-year intervals. It is noteworthy that, although the number of active registrants decreased, the overall number of registrants increased slightly. New registrants are mainly from two sources; previous workers from various sites who have become involved in follow-up studies and personnel recently involved in exposure incidents.

Upon examination, it was discovered that the USTUR database, in use since 1990, would have Y2K compliance problems, beginning in the year 2000. Although only a few USTUR registrants were born before the year 1900, there are many registrants who will very likely live into the next millennium. A change in the commercial software basis of the USTUR database will be completed in time and will prevent any disruption.

The USTUR website on the World Wide Web continues to be very popular with scientists of the world. This page is linked to the Comprehensive Epidemiologic Data Resource (CEDR) in which a large amount of USTUR data is listed. This method of dissemination of data was selected over publication of those data in voluminous USTUR annual reports. A high priority activity during the next reporting period will include making those data more useful to other scientists by inclusion of summary information in addition to the individual analytical results and by inclusion of some exposure information for each case.

Two collaborative research programs between the USTUR and colleagues from the Russian Federation are in progress. One of them involves the combination of USTUR tissue analytical data with that of a Russian tissue analysis registry which has been operating nearly as long as the USTUR. It was found that the data of the two Registries were quite compatible even though tissues of Russian workers contained far more plutonium and americium than did those of U. S. workers. A beneficial effect of this collaboration has been the intense effort to organize the USTUR analytical data into a format that was suitable for comparison with the Russian data and this format will be the foundation of the revision of the USTUR database on CEDR, discussed above. The other collaborative project involves the establishment of a Russian tissue repository modeled after the National Human Radiobiology Tissue Repository (NHRTR) operated by the USTUR. USTUR staff members serve primarily as advisors to that program, because of their experience with operation of the NHRTR.

The USTUR radiochemistry personnel, located on the Pullman, WA campus of WSU, have established themselves as a world-class actinide analysis laboratory. During this reporting period, they have been very productive in terms of the number of tissue and bioassay samples processed, the number of published scientific reports, and their improvements of actinide separation and analytical methods. They have supported a number of graduate students who have been instrumental in methods improvement and who have been awarded advanced degrees. They continue to achieve high standards of quality assurance/quality control and they have become recognized authorities in the analysis for actinide elements.

WHOLE BODY DONATIONS TO THE USTUR

BY RONALD E. FILIPY, DIRECTOR, SAMUEL E. GLOVER, ASSISTANT PROFESSOR,
CHERYL L. LOVE, RESEARCH TECHNOLOGIST

During the past 15 years, the USTUR has received 23 whole body donations and the radiochemical analyses of tissue samples from those bodies has always been a high priority activity. The first case (0102) was the subject of a special issue of the journal Health Physics, vol. 49, 1985. Five cases (0193, 0208, 0212, 0213, and 0242) were presented in the USTUR annual report for the period April, 1992 - September, 1993 (USTUR-0015-94) and they have been the subjects of a number of open literature publications. Analysis of another, case 0205, had not been completed at that time. Case 1001 was the first USTUR whole body donor that involved the medical administration of Thorotrast and this case was also presented in a special issue of Health Physics, vol. 63, 1992. Analysis of three other whole body donors (0259, 0262, and 0769) were largely completed at Los Alamos Scientific Laboratories and data were included in the USTUR annual report for the period, October 1, 1995 - September 30, 1996, although radiochemical analyses of some of the tissues were not yet complete. Since that time, the analyses have been completed and verified and these three cases with five others for which tissue analyses have recently been completed and are the subjects of this report. This report contains brief sketches of the exposure and medical histories of those cases.

Case 0259 is unique among USTUR whole body donors received thus far in that his primary exposure was to ^{238}Pu. He was exposed at Los Alamos National Laboratory, by inhalation, to high-fired $^{238}PuO_2$ 18 years before his death from cardiovascular disease. Urinary bioassays confirmed the intake after the incident and they remained positive for the remainder of his life. This case has been the subject of reports in two previous USTUR annual reports (October 1, 1994 - September 30, 1995 and October 1, 1995 - September 30, 1996) and it was the subject of a report in Health Physics, vol. 68, 1995. The former report contains exposure information and urinary plutonium excretion information and the latter report contains actinide content data for individual tissue samples; the Health Physics report is a summary presented at an annual meeting. Temporal urinary excretion patterns indicated different biokinetics than would be expected from $^{239+240}Pu$; however, differences in body distribution were not in-

dicated by initial evaluations.

Case 0262 was a Hanford worker whose primary intake of $^{239+240}$Pu appeared to be through a hand wound 33 years before his death from metastatic hepatocellular carcinoma. Estimates of the amount of deposition, based on urinary excretion data, were approximately 84 Bq. He also had a lifetime whole body dose of 0.11 Sv from external sources. An exposure history, along with the actinide contents of individual tissue samples, were reported in the USTUR annual report for the period October 1, 1995 - September 30, 1996.

Case 0269 was a Hanford worker who worked with plutonium between 1949 and 1956. In 1956, he inhaled an acidic solution of plutonium nitrate and was removed from work with plutonium until he retired in 1980. Initial estimates of plutonium intake were 0.42 μCi of $^{239+240}$Pu and 3.3 μCi of ^{241}Pu; this was later amended to 0.23 μCi of $^{239+240}$Pu and 1.8 μCu of ^{241}Pu. He received Ca-EDTA first for several months and, after it became available, Ca-DTPA therapy. The total plutonium output ascribed to chelation therapy was 0.03 μCi. He was a participant in a special follow-up study conducted by the USTUR that included periodic bioassays and *in-vivo* counts. He died in 1994 at age 79 as a result of extensive carcinomatosis secondary to adenocarcinoma of the prostate.

Case 0769 was Subject 20 in the long-term follow-up study of Manhattan Project workers performed at Los Alamos National Laboratory. He was likely exposed to $^{239+240}$Pu, by inhalation in 1945 and 1946, and in addition, he suffered a contaminated wound in 1945. He died as a result of an osteoblastic osteosarcoma in 1990, some 45 years after his primary exposures. Plutonium deposition at death was estimated, by bioassay, at 580 Bq. This case is also reported in the USTUR annual report for the period October 1, 1995 - September 30,1996, which includes his exposure history and tissue content of actinides. It was also reported in Health Physics vol. 61 1991, and Health Physics vol. 73 1997.

Case 1002 was a Hanford worker between 1944 and 1972. Based on urinary bioassays performed during that time, his primary exposure was to uranium. His work history contains few documented incidents involving intakes of radionuclides although bioassays during 1949 and 1950 were consistently above background levels of uranium. He died in 1991 of cardiovascular disease.

Case 1007 was a chemical operator at the Fernald Feed Materials plant from 1953 to 1968. Urinary bioassays performed during that time indicated higher-than-background levels of uranium; however, only a few potential inhalation incidents were recorded and they did not result in high intakes. Bioassays continued after he retired in 1968 with the last recorded in 1984. He died from an acute myocardial infarct in 1991.

Case 1028 was the first female whole body donor to the USTUR whose exposure was primarily to uranium. She was a chemical operator at an Oak Ridge facility from 1944 to 1971. She worked with uranium from 1944 until 1962 when she was removed from the uranium processing areas because of an "abnormal pattern" or urinary excretion of uranium and because *in vivo* measurements indicated that she had exceeded the maximum permissible lung burden of uranium. She died in 1993 as a result of a cerebro-vascular accident. Autopsy showed that she had a bronchogenic carcinoma of the right lung and a carcinoma of the right breast, both with no signs of metastases. Radiochemical analyses of tissue samples revealed a very high ^{234}U/^{238}U ratio.

Case 1054 was the second USTUR whole body donation involving the medical administration of Thorotrast. This was a female who died at the age of 59 from an adenocarcinoma of the liver. She had been injected with Thorotrast for a cerebral angiogram some 45 years earlier and she was later a participant in the German Thorotrast Study in Heidleberg, Germany. She moved to the United States where she lived for seven years before death. This case was the subject of a report in Health Effects of Internally Deposited Radionclides: Empahasis on Radium and Thorium, World Scientific, NewJersey, 1995.

There are seven more whole body donations whose tissues are awaiting analysis, they are:

Case 0425 - a plutonium inhalation exposure case from Rocky Flats;

Case 0503 - a plutonium inhalation exposure case from Rocky Flats who received chelation therapy;

Case 0680 - a plutonuim case with estimated deposition of 3180 Bq from Los Alamos. This was Subject 7 of the follow-up study of Manhattan Project workers;

Case 0682 - a ^{238}Pu inhalation exposure case from Mound Laboratories;

Case 0706 - a plutonium wound case from Rocky Flats who received chelation therapy;

Case 0744 - a plutonium inhalation case with additional intake via wounds from Rocky Flats;

Case 1053 - a male who was administered Thorotrast some 47 years before death.

Whole body donations have been very important to the USTUR in that they permit a very thorough evaluation of actinide element partitioning in the body, information that is invaluable for comparison with existing biokinetic models. These comparisons were extensive with the first six whole body donations. Data from the additional whole body donations, described above, will add many dimensions to the modeling effort by providing increased numbers for greater validity of conclusions. For example, the distribution of Thorotrast in the body was evaluated on the basis of a single whole body donation; with the two additional whole body donations described above, the data are expected to become more definitive. Analytical data from whole bodies are also very useful in the evaluation of data of those cases from which a limited number of samples are analyzed (routine autopsy cases). Assumptions required for estimations of actinide distributions in the autopsy cases, as in the skeletal distribution, are based on data from whole body donations.

Another advantage resulting from the number of whole body donations is the wide range of exposure histories that are encompassed. The USTUR now has uranium concentration data from three whole body donors whose primary occupational exposures were to uranium compounds. There were two donors whose exposures were primarily to ^{238}Pu and at least two of the whole body donors incorporated plutonium into their systems by intake through wounds rather than by inhalation. Three of the recent wholebody donors had chelation therapy following their intakes of plutonium into the body and, prior to these recent donors, only one case (0212) had received such therapy. It is anticipated that sufficient data will now be available to discern the effects, if any, of chelation therapy on the distribution of plutonium in the body.

Many of the whole body donors have participated in follow-up studies so that detailed exposure and medical information are available. This provides the USTUR with bioassay and *in vivo* counting data as well as body burden estimations made shortly before death. For the majority of USTUR cases such information was not obtained during the times between cessation of work with actinides and death, frequently 15 - 20 years or more.

Compilation and analysis of the data resulting from these whole body donations is a high-priority activity within the USTUR. Manuscripts will be prepared for publication in the scientific literature and the data will be included in the USTUR web site for use by other interested scientists.

RADIOCHEMISTRY OPERATIONS

BY SAMUEL E. GLOVER, ASSISTANT PROFESSOR

The Radiochemistry Program for the USTUR was transferred to Washington State University from Los Alamos National Laboratory in 1994. In these five years the laboratory has had great sucess in developing a quality laboratory, reducing the backlog of samples, developing new separation methods, publishing, and participating in the graduate and undergraduate educational process at Washington State University.

Sam Glover at the Alpha Spectrometry System

ANALYSIS OF USTUR REGISTRANT TISSUES AND EXCRETA

Prioritization of USTUR Cases

During the final quarter of 1997, based on recommendations of the USTUR Advisory Committee, a program was initiated to prioritize, for future analyses, routine and whole body cases awaiting analysis by analyzing selected tissues from all the cases.

The protocol usually involves analyses of 4-5 samples of each case for the suspected radionuclide suspected to be predominant in the samples. Samples typically include the lungs, pulmonary lymph nodes, liver, and 1-2 bone samples. Estimates of the total actinide content are shown in Figure 1. Eleven of the 26 donors evaluated to date had estimated body burdens less than 100 dpm (1.7 Bq) which means that a number of the smaller samples from these cases will have actinide contents at or below the minimum detectable amount. The information in Figure 1 may be used to make that decision unless other characteristics of individual cases indicate that the analyses should be performed regardless of the low content.

Whole Body Cases Completed/Currently Analyzing

Reduction in the backlog of whole body cases continues to be one of the primary goals of the USTUR Radiochemistry Program. In keeping with this, several whole body cases

were completed or were in the process of analysis during this period. These included:

Case 0269: This Hanford registrant was analyzed for plutonium and americium. This was the first whole body case completed totally by the WSU Radiochemistry Program;

Case 1028: A female registrant from Oak Ridge was analyzed for isotopic uranium by alpha spectrometry;

Case 0744: This case was in various stages of dissolution during this period;

Case 0212: This Hanford registrant was previously analyzed for plutonium and americium by LANL and has been further analyzed for natural thorium distribution using a combined alpha spectrometry - neutron activation analysis method. Results have been published in a PhD dissertation and are being prepared for publication in the open literature.

Additionally, the calcium in the bone samples from all of these cases has or will be determined in order to compare the use of calcium and bone ash weight as a normalizing factor for actinide concentration. Six additional whole body cases await analysis (0425, 0503, 0680, 0682, 0706, 1053). Descriptions of these cases are contained in this report.

Routine Analyis of USTUR Cases

Analysis of routine cases during this period consisted entirely of expedited analyses. A prioritization list of these cases is being prepared and cases will be analyzed concurrently with whole body cases. To date, 26 cases have been analyzed using the expedited analysis protocol.

Several cases have joined the USTUR after recent accidental exposures. These cases have agreed to whole body counting at the PNNL facilities and to submit periodic urinalysis samples for long-term follow-up studies.

IMPLEMENTATION OF NEW METHODS

At the time the Radiochemistry Program was transferred to WSU from LANL in 1994, the need for improved methods of sample decomposition and separation for the determination of actinides in the tissues and excreta of deceased registrants was recognized. A series of research projects was initiated using staff, graduate students and undergraduate students to develop improved methods that would replace those that had been adopted from LANL. The following areas have been dramatically improved and/or capabilities added as a result of this research:

- Electrodeposition
- Pre-concentration of actinides
- Separation methods
- Determination of Ca/P in bone samples
- Ultra-sensitive methods for the determination of ^{239}Pu
- Methods for determining $^{239}Pu/^{240}Pu$ ratios

NATIONAL/INTERNATIONAL RECOGNITION

The USTUR Radiochemistry Program has published 10 peer reviewed publications during the period with an additional 9 papers being accepted for publication. Additionally, the radiochemistry program presented 11 papers at various national/international conferences including the 1997 and 1998 Bioassay and Environmental Radiochemistry Conferences, Methods and Applications of Radioanalytical Chemistry (MARC IV), 1998 Health Physics Society annual meeting, 1997 and 1998 Winter Conferences of the American Nuclear Society, Seventh International Conference on Low Level Measurement of

Actinides and Long-Lived Radionuclides in Biological and Environmental Samples, as well as numerous departmental seminars.

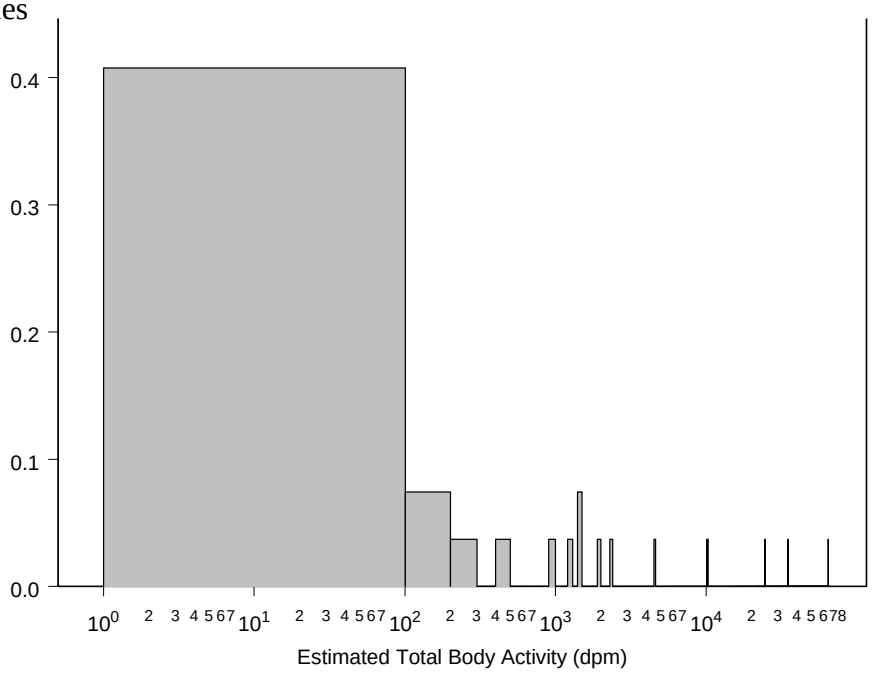
The USTUR Radiochemistry Program participated in the National Institute for Standards and Technology Bone Ash Standard Intercomparison. This program seeks to develop a reference material for the determination of actinides in human bone ash and is determining the radionuclide concentrations and uncertainty from the analyses of the proposed SRM by laboratories of high caliber. It is also worth noting that the source material for this proposed SRM was derived from a USTUR case.

GRADUATE/UNDERGRADUATE STUDENT INVOLVEMENT

Hongguo Qu in the radiochemistry laboratory

The USTUR Radiochemistry Program has been actively involved in the education of undergraduate and graduate students at Washington State University. This is evident in the number of students associated with the program, degrees granted, and student publications, thesis, and presentations at national and international meetings. A complete list of publications and thesis titles are contained in the Publications and Presentations portion of this report.

Figure 1. Frequency Histogram of the Total Body Activity Based on Expedited Analysis of Only a Few Samples



NATIONAL HUMAN RADIOBIOLOGY TISSUE REPOSITORY

BY JOHN J. RUSSELL, ASSOCIATE DIRECTOR

Following the transfer of the United States Transuranium and Uranium Registries (USTUR) program from the Hanford Environmental Health Foundation to WSU in 1992, the tissue materials of the National Human Radiobiology Tissue Repository (NHRTR) were housed in laboratory space leased from Sacred Heart Medical Center in Spokane. The responsibility for the National Radiobiology Archives (NRA) materials was assumed by WSU in 1997 and they were physically housed in the same Spokane facility. In April 1998, following expiration of the USTUR lease with Sacred Heart Medical Center, the NHRTR and NRA materials were moved to leased facilities located at the Richland Airport close to the WSU Tri-Cities branch campus and to the offices of the USTUR. The building is newly constructed and the USTUR half of the building has been remodeled into wet biochemistry labs, photographic dark room, autopsy room, ultra-cold freezer room and separate storage rooms for the NHRTR and NRA archived materials. The new five thousand square foot facility also has its own heating and air conditioning systems. The university has signed a five-year lease agreement contingent upon grant renewal at an initial lease rate of $8 per square foot, approximately half of the rate paid for the Spokane facility.

Active Collaborations

1. A Memorandum of Understanding (MOU) between the USTUR and the Human Monitoring Laboratory, Health Protection Bureau, Ottawa, Ontario has been agreed on. The USTUR has agreed in principle to lend a nearly complete skeleton of a former radium painter to Dr. Gary Kramer at the Health Protection Bureau for use as a calibration phantom. This dial painter, a female, was born in 1900 and was first exposed to radium at the age of 18; she died in 1957.

2. Drs. Ray Lloyd and Scott C. Miller at the University of Utah are working to develop a tumor predictor model that will be based on experimentally derived biokinetic, biological, dosimetric and clinical data. The model will predict the risk of Pu induced skeletal tumors, their latency period, anatomical sites and frequencies as functions of radiation dose or dose rate at specific skeletal sites. To aid in these studies, the Registries are supplying selected bone samples from 2 to 15 previously radiochemically analyzed registry cases to compare with the existing Utah dog data.

3. The Registries were contacted by Dr. Tom Johnson from the United States Air Force and asked to consider including in ongoing studies any of the Air Force personnel who participated in the clean-up actions at Palomares, Spain in the 1960's. After some discussion, the Air Force agreed to contact the "High 26", those individuals who had a positive urine bioassay measured shortly after the cessation of clean-up activities, and encourage them to contact the USTUR directly. The Registries agreed to discuss, advise and/or enroll any Palomares clean-up worker who had a documented intake of plutonium

who directly contacted the USTUR. To date, two of the "High 26" Palomares clean-up workers have contacted and subsequently joined the USTUR.

4. A Memorandum of Understanding between the USTUR and the Rocky Flats Environmental Technology Site Former Worker Health Monitoring Program is in place. This memorandum outlines the potential benefits (autopsy results, radiochemical analysis of selected tissues) that might arise as a result of the health check follow-up activities of selected former site radiation workers whom also are USTUR registrants.

5. The NHRTR was contacted by a graduate student, Mr. Don Halter at Texas A&M University who is doing research on the microdistribution and microdosimetry of Pu in bone. Mr. Halter's project is to evaluate the microdistribution, microdosimetry and retention characteristics of plutonium in compact or cortical vs. cancellous or trabecular bone. Accordingly, he was provided with samples of each bone type obtained from two separate previously autopsied and radiochemically analyzed USTUR cases.

6. The Registries received an inquiry from Dr. Andrew C. Todd at Mount Sinai Medical Center regarding the possible use of USTUR bone samples to perform X-ray fluorescence bone lead measurements.

7. Dr. Patricia W. Durbin, Lawrence Berkeley National Laboratory, has agreed to donate a unique collection of homogenized skeletal ash samples from human adults who died between 1955 and 1959. They were collected for an U.S. Atomic Energy Commission sponsored program that assessed the levels of fallout ^{90}Sr in the human skeleton. The collection also includes the original records, the Los Alamos laboratory record of the individual sample ash weights and the three volume final project report (NYO-9934, 1961).

8. In a collaboration with Dr. James Hardwick at the Medical College of Ohio entitled Molecular Studies of Thorotrast Patient Blood Sample, preliminary results from analysis of a blood sample from USTUR Thorotrast case #1053 were negative for alterations/deletions in the tumor suppressor Rb gene or in the c-fms proto-oncogene. The latter gene has been shown to have a high degree of association with leukemia. Although the autopsy and slide examination performed at the light microscopic level failed to identify any signs of leukemia or lymphoma (which also effects the alpha risk coefficient calculation), other cytogenetic tests, i.e. micronuclei induction, suggests that an abnormal (preleukemic?) blood picture existed before the patient's demise. Moreover, in addition to liver cancer, blood dyscrasias, including leukemia, are a major cause of death in thorotrast treated patients. Thus, molecular probing of this patient's blood and tissue samples will continue.

Public Inquiries

The Registries received several calls from Mr. Scott Peterson, of the Christian Science Monitor Newspaper, Amman, Jordan seeking additional information on depleted uranium (DU). Mr. Peterson was referred to the USTUR by Col. Eric Daxson at the Pentagon, and asked about the deleterious effects of DU on humans (soldiers). Mr. Peterson is writing a news story on DU, the supposed medical effects both real and imagined, suffered by former military personnel who served in the Gulf War conflict. The news story "Trail of

A Bullet" is scheduled to run at the end of April 1999.

Registrant Deaths

During the reporting period, eleven USTUR registrants have died. Table 1 displays the calculated number of expected deaths per five-year date of birth period based on the conditional probabilities of death statistics for the U.S. in 1990. In addition, the five-year date of birth data also highlights the fact that the vast majority of the remaining living USTUR registrants is greater than sixty-five years of age.

Table 1. Predicted and Actual Number of Registrant Deaths in the Living USTUR Cohort

Date of Birth Range	No. Living	[qx]*	Expected Deaths in 5y Period	Actual Deaths 10/1/95-9/30/96	Actual Deaths 10/1/96-10/30/97	Actual Deaths 11/1/97-1/31/99
1906 - 1910	5	0.41080	2.05	-	1	4
1911 - 1915	22	0.28270	6.22	1	1	1
1916 - 1920	32	0.19190	6.15	2	1	3
1921 - 1925	63	0.12780	8.05	4	3	2
1926 - 1930	52	0.08750	4.55	1	-	1
1931 - 1935	24	0.05600	1.34	-	-	-
1936 - 1940	19	0.03380	0.64	-	-	-
1941 - 1945	6	0.02160	0.13	-	-	-
1946 - 1950	3	0.01470	0.04	-	-	-
1951 - 1955	2	0.01150	0.02	-	-	-
1956 - 1960	2	0.00930	0.02	-	-	-
1961- 1965	1	-	-	-	-	-
Unknown	3					
Total As of 1/31/99	**234**			8	6	11

* Conditional Probabilities of Deaths in the United States in 1990.

NATIONAL RADIOBIOLOBY ARCHIVES

BY JOHN J. RUSSELL, ASSOCIATE DIRECTOR

In April 1998, following expiration of the USTUR lease with the Sacred Heart Medical Center in Spokane, the National Radiobiology Archives (NRA) and NHRTR materials were moved to new leased facilities located at the Richland airport close to the WSU Tri-Cities branch campus and also the USTUR offices.

The NRA is an archival program that was started in 1989 and whose original mission was to collect, organize, catalog data, lab notebooks, and animal tissue specimens from government (DOE and its predecessor agencies) sponsored radiobiology life-span studies using beagle dogs and rats in experiments performed at various national labs and university facilities since the 1940's. Now, these valuable archived records, histopathology slides and paraffin embedded tissue blocks are stored and maintained in a centralized

facility and are available for additional future research and/or analyses if and when needed. Although these studies were performed over many years and at different laboratories with differing data managing systems, the NRA has translated them into a more convenient set of relational database tables, which can be distributed following a formal written request.

Since transfer of the NRA to WSU, the USTUR has actively promoted and publicized the use of these materials by outside investigators in addition to utilizing NRA data and materials to facilitate its long standing stated goal of validating animal data for use with human biokinetic models and safety standards development. In addition, the USTUR developed an NRA brochure that describes the program and it is also featured on the USTUR World Wide Web site as well as having its own Pacific Northwest National Laboratory (PNNL) developed web site with links to the USTUR. A number of inquiries and formal requests for NRA materials and or data have been received from outside investigators and since the last annual report, several manuscripts using data from the NRA have been published in the open peer-reviewed literature:

1. Park, J. F., et. al. G. E. Dagle. Biological effects of inhaled ^{238}PuO in beagles. Radiat. Res. 148(4):365-381; 1997.

2. Dagle, G. E., F. T. Cross. Analysis of lung tumor risk in rats exposed to radon. Radiat. Res. 148(3):350-360; 1997.

3. G. E. Dagle gave a presentation entitled "The use of animal studies to predict the health effects of inhaled Pu" at the University of Washington's Hanford Projects 1st annual conference, December 3-4,1997 in Richland, WA.

4. Another manuscript using NRA data entitled "A comparison of the distribution of actinide elements in selected tissues and organs of humans and beagle dogs" is in preparation by R.E. Filipy and others.

In addition to the above-mentioned studies, the following individuals seeking NRA data and/or information have contacted the Registries during the past year. Three of the more significant requests are described briefly below:

1. Gail Cordes from INEL requested data on the beagle dog studies. As an introduction to the dog studies, a copy of "Lifespan effects of ionizing radiation in the beagle dog" by Dr. Roy Thompson was sent. We also provided them with a description of the combined International Radiobiology Archives along with suggestions for developing an appropriate subset of data for use.

2. The USTUR received an inquiry from Dr. Philippe Duport of the International Center for Low Dose Radiation Research, at the University of Ottawa. They are evaluating animal data from published papers for testing the linear-no-threshold (LNT) theory. Their request for dose, dose rate, pathology, and age at death for individual animals from a wide variety of animal studies was somewhat unrealistic. Dr. Charles R. Watson, former director of the NRA, is assisting the USTUR in developing ideas that will provide a more targeted approach to their data search and analysis scheme.

3. Request for a copy of DOE/RL-96-72 "International Radiobiology Archives of long-term animal studies" from Dr. Eleanor Blakely at Lawrence Berkeley

National Laboratory.

During the past year, the NRA has acquired the books, technical reports, and other reference materials used by Professor J. Newell Stannard in preparing his book "Radiation and Health". The WSU Library is currently cataloging this important collection of materials.

In the near future, a reorganization of the data base files into a more user-friendlier format is planned and they will be placed on the Internet with existing Registries radiochemical data. This Internet site will also complement the CD-ROM version of the DOE/RL-96-72 "International Radiobiology Archives of long-term animal studies" being developed by Dr. Charles R. Watson of PNNL for distribution later this year.

*This work was supported by the Office of Biological and Environmental Programs/Department of Energy via grant number DE-FC03-96ER62213 to Washington State University.

RUSSIAN COLLABORATION: JOINT COORDINATING COMMITTEE FOR RADIATION EFFECTS RESEARCH PROJECT 2.1: METABOLISM AND DOSIMETRY OF PLUTONIUM INDUSTRIAL COMPOUNDS

BY RONALD E. FILIPY, DIRECTOR

A three-year collaborative research project between the United States Transuranium and Uranium Registries (USTUR), operated by Washington State University, and the Dosimetry Registry of the Mayak Industrial Association (DRMIA), operated by Branch No. 1 of the Russian Institute of Biophysics, officially began on April 1, 1997. The DRMIA operates very similarly to the USTUR by performing radiochemical analyses on tissue samples collected at autopsy of personnel who worked with actinide elements.

Because radioanalytical methods used by the two Registries in the past were quite different, the first task of Project 2.1 involved a comparison of radioanalytical methods. Aliquots of processed tissue samples were exchanged and analyzed by the two laboratories and the analytical results were statistically compared. Figure 2 illustrates the comparison of results obtained by chemical separation of total plutonium from exchanged dehydrated, acid-dissolved tissue samples and bone ash followed by measurements with the respective instrumentation of the USTUR and the DRMIA. There were no statistically significant differences between the analytical results obtained by the laboratories of the two Registries among four groups of exchanged samples. This has allowed us to combine and jointly analyze the data collected by the Registries in the past for the investigation of plutonium and americium biokinetics in the human body.

As a result of Project 2.1, the DRMIA laboratories were transformed and have adapted many of the methods of the USTUR for their use. This includes the same radioactive tracers, anion exchange resins, organic americium extractant, and alpha spectrometry used by the USTUR. The DRMIA has also obtained a modern *in-vivo* counter formerly used by the Rocky Flats Facility in the U.S. The shield

was shipped to the DRMIA and installed and the electronic equipment was completely refurbished before shipment and installation. USTUR personnel will assist the DRMIA in the calibration of equipment during the final year of the project.

The DRMIA has collected workplace aerosol samples from uranium and plutonium processing facilities since 1974. The samples, on filter paper, were analyzed for transportability (*in vitro* solubility) by a method called the dialysis method. They have noted a relationship between transportability of the aerosols and the substrate processed at specific Mayak workplaces and the aerosols can be classified as soluble, intermediate, and slightly soluble. They have also noted a relationship between respiratory tract:systemic plutonium concentration ratios and the transportability coefficient determined by the dialysis method. This leads to the conclusion that knowledge of the work histories of their workers is important to calculation of lung radiation doses and they have designed a lung dosimetry model that accommodates the three transportability classes found in Mayak workplaces. In general, there is very little information in USTUR files regarding the solubility of aerosols to which U.S. workers were exposed although the lung:systemic plutonium concentration ratios indicate that U.S. workers were exposed to the same range of aerosol solubility as the Mayak workers.

Another aspect of Project 2.1 is an investigation of the effect of health status of individuals at death and the distribution of plutonium in body at death as determined by analysis of tissues collected at autopsy. DRMIA and USTUR cases were divided into three categories according to their state of health at death. Briefly, the health groups were: 1) relatively healthy individuals, 2) individuals with disease conditions that did not involve the liver, and 3) individuals with marked liver impairment. Mean skeleton:systemic and liver:systemic plutonium concentration ratios of the three groups were compared and they indicated that liver impairment does cause a redistribution of plutonium in the body. The primary effect appears to be a loss of plutonium from a diseased liver with possible redistribution to the skeleton when compared to relatively healthy individuals. Data of both Registries indicated the same trends.

Liver diseases also tends to increase the fraction of systemic plutonium that is excreted each day when compared to relatively healthy individuals. Daily plutonium excretion, as a fraction of systemic content, was nearly two-fold greater for individuals with liver disease than for healthy individuals. Plutonium excretion rates of individuals with serious diseases not affecting the liver were midway between group 1 and group 3 values.

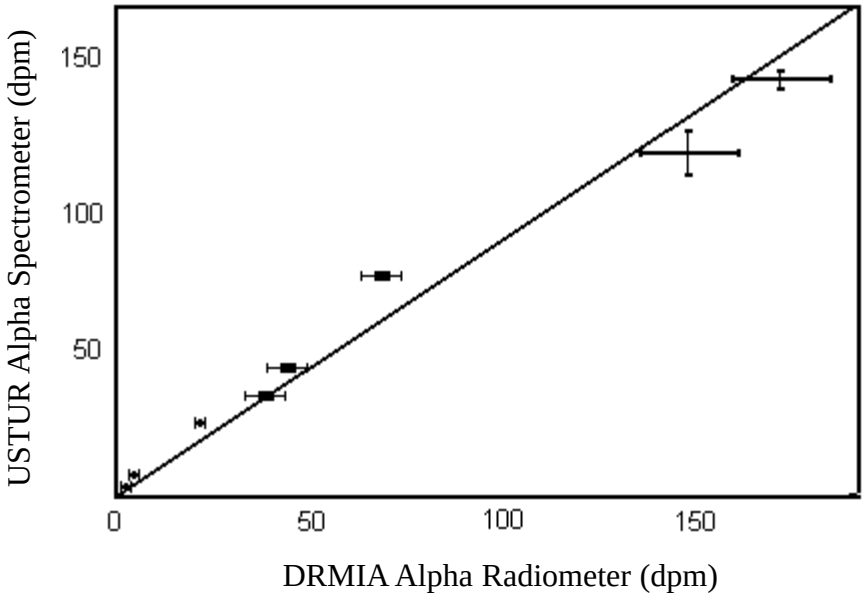
Another task of this project involves translation of Russian manuscripts into English. Thus far, five publications in the open scientific literature have resulted from this collaborative project.

---

*This work was supported by the Office of International Health Programs/Department of Energy via grant number DE-FG06-92EH89181 to Washington State University.

Valentin Khokhryakov and Ronald Filipy at the Occupational Medical Clinic, Ozyorsk, Russia

Figure 2. A Comparison of Analytical Results of the USTUR and the DRMIA Laboratories



RUSSIAN TISSUE REPOSITORY: ESTABLISHMENT OF A REPOSITORY CONTAINING TISSUES AND ORGANS OF DECEASED WORKERS OF MAYAK WHO WERE EXPOSED TO ACTINIDE ELEMENTS

BY JOHN J. RUSSELL, ASSOCIATE DIRECTOR

The main purpose of this U.S. - Russian collaborative research project is the establishment of a Russian Human Radiobiology Tissue Repository (RHRTR) at the First Branch of the Russian Institute of Biophysics-1 (FIB-1). The Repository will collect and maintain organ and tissue samples from deceased MAYAK facility workers who were exposed to known or suspected elevated levels of occupational irradiation that occurred during the early formative years at the plant.

The first Milestone task of the work (August 15, 1998 - December 15, 1998) was to establish the Repository office or program, develop protocols of work procedures including how to safely handle preserved materials, develop a detailed inventory of tissue and organ samples (fixed in formalin and ethyl alcohol), their weights, the number of paraffin blocks and slides, and to obtain detailed occupational, radiochemical, dosimetric and medical information of every repository registrant.

During the first year of study, a detailed inventory list of tissue samples etc. obtained from approximately 150 deceased MAYAK workers, identified by a common identifier and by name, is being established.

An inventory of autopsy tissue material from the first group of 50 registrants was carried out (44-men, 6-women) during the first quar-

terly report period (August 15, 1998 through December 15, 1998). The inventory consisted of the following:

- the identification of long-term formalin-fixed tissue material;
- the estimation of formalin-fixed tissue/organ sample weight;
- the enumeration of paraffin embedded tissue samples and histopathology slides.

Detailed information about the occupational route of actinide intake that occurred in each registrant during their years of employment at the MAYAK facility and data on individual external gamma-irradiation doses were received from the facility Radiation Safety Service Office. The radiochemical analyses of Pu body burden and level of Pu deposition in various body organs were performed at the FIB-1 Internal Dosimetry Laboratory.

A thorough examination of medical charts and disease histories was performed in order to produce a detailed medical information file about every tissue donor. The causes of death were verified by examination of autopsy results, histopathology, disease histories and medical chart information.

A number of registrants whose tissue materials were inventoried during this period were exposed to occupational irradiation during work conditions at a plutonium manufacturing facility and/or a plutonium radiochemical separation plant (38 cases out of 50; 76%). The remainder (12 registrants or 24%) were former workers at the first productive Mayak reactors. Eighty-eight percent of the registrants began work at the Mayak PA facility during a known period of high external irradiation 1948-1953; the remaining registrants of the inventoried group began work in the following 6 years.

The radiochemical determination of plutonium body burden and plutonium content in the major organs of deposition was performed for all 50 registrants, however at present DRMIA has information on only 38 cases. In 18 cases, plutonium body burden estimates ranged from 0 (1 case) to 40 nCi; 20 registrants out of 38 had Pu body burden estimates over 40 nCi, including 13 cases with body burden estimates over 400 nCi.

The external gamma-irradiation summary doses of registrants whose tissue materials were processed in the period covered had levels ranging from 2 cGy to 611 cGy, including 33 registrants with doses from 100 to 400 cGy.

The inventory has demonstrated that there are formalin-fixed tissue samples of all internal organs, and also paraffin blocks and histology slides for all 50 cases. Moreover, there are specimens of different bone samples stored in alcohol for 48 cases. Histopathology slides of bones have been found so far for 26 cases. Information on occupational route of actinide intake, bioassay data, radiation doses, medical information and tissue material inventory data have been entered into the Common Information Chart of the Dead (donor of tissue and organs).

The cause of death for 50% of this registrant group was malignant neoplasm (25 out of 50 cases), 12 individuals had lung cancer, and 7 had digestive organ tumors.

---

*This work was supported by the Office of International Health Programs/Department of Energy via grant number DE-FC03-98EH98029/A000 to Washington State University.

HIGH LET ^{56}FE PARTICLES INDUCED CHROMOSOME DAMAGE AND GENOMIC INSTABILITY*

BY SHIPING BAO, SCIENTIST, AND ANTONE L. BROOKS, SCIENTIST+

One of the major goals of the USTUR is to evaluate biological effects of occupational exposure to high-LET radiation, such as plutonium and americium. Chromosome aberration, genomic instability and cancer induction are the leading biological effects of concern. In this study, high-LET ^{56}Fe particles were used to expose rats. Rapidly dividing bone marrow cells and slowly dividing epithelial cells from lung and trachea were cultured to define the relationship between initial chromosome aberration and longer-term genomic instability in these three tissues. Lung epithelial cells are much more sensitive to cancer induction by radiation than tracheal epithelial cells. It is thus important to compare the frequency of initial chromosome aberration to the induction of genomic instability and cancer.

Dr. Antonne Brooks and Shiping Bao evaluating tissue cultures

Wistar rats were exposed to graded doses of ^{56}Fe particles (1000 Mev/AMU) at 0.0, 0.2, 0.5, 1.0 and 2.0 Gy using a dose rate of 0.2 Gy/min. Cells from the bone marrow and respiratory tract epithelium were isolated immediately and grown in culture. The frequency and distribution of chromosome damage were evaluated. Epithelial cells from respiratory tract were also maintained in culture for multiple passages. Chromosomes were prepared at different times after exposure for the evaluation of genomic instability. Some exposed rats were maintained for more than a month to determine the *in vivo* repair of genomic instability

Data demonstrated that exposure to ^{56}Fe particles caused a mitotic delay in bone marrow cells. There was an increase in the mitotic in- dex as a function of time after the end of the exposure. The frequency of chromosome aberrations increased as a linear function of dose, with the slope of 0.17 aberrations/cell/Gy. Most of aberrations were of the chromatid type, since the bone marrow cells were rapidly dividing at the time of the radiation exposure. In the high exposure group (2.0 Gy), it was observed that some cells had multiple aberrations on individual chromosomes, suggesting a "direct hit" of the ^{56}Fe particles on the chromosome. The frequency of micronuclei in both lung and tracheal epithelial cells also increased as a linear function of dose. The slopes in dose-response equations were 1.2×10^{-2} and 1.1×10^{-2} micronuclei/binucleated cell/Gy for lung and tracheal epithelial cells respectively. Genomic instability *in vitro* at multiple passage cultures and *in vivo* are still under investigation.

Initial genetic damages have been characterized in three different tissues following exposure to ^{56}Fe particles. There was no significant difference in the initial radiation sensitivity be-

tween lung and tracheal epithelial cells. The response of the respiratory tract epithelial cells to ^{56}Fe particles was compared to the results from low-LET gamma rays and high-LET radon alpha particle exposure. It was determined that ^{56}Fe particles were 1.3 and 3.3 times more effective than ^{60}Co gamma rays in the induction of micronuclei in lung and tracheal epithelial cells, respectively. The ^{56}Fe particles were only 14% and 25% as effective as radon alpha particles in the lung and tracheal epithelial cells, respectively. Such results help to place ^{56}Fe particles in proper prospective for the induction of initial chromosome damage. Studies are continuing to relate the repair of initial damage by ^{56}Fe particles to the repair of damage by other radiation types. The repair of the initial cytogenetic damage may play an important role in the induction of genomic instability and cancer.

+ Department of Environmental Science, Washington State University, Richland, WA 99352
*This work was supported by the National Institute of Health (NIH)/National Aeronautics and Space Administration (NASA) via grant number CA74053-01 to Washington State University.

DATABASE /WWW

BY MINH V. PHAM, SYSTEMS ANALYST

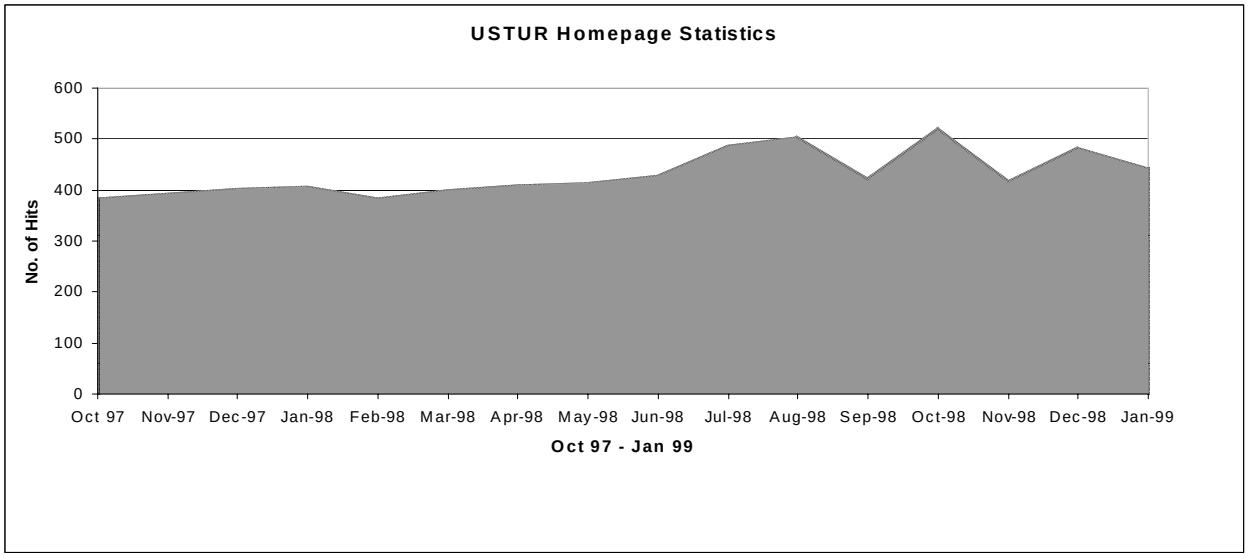
During an examination of the current USTUR computer hardware, software and database, it was discovered that the database, based on Paradox software, was not Y2K compliant. Paradox ignores the first two digits of the year and this would cause the database to malfunction when the year 2000 is reached. After a thorough evaluation of this problem, the Registries decided to convert the database system to Microsoft Access. This resulted in another problem, inadequate capacity of many USTUR computers. Microsoft Access has been programmed to accept the USTUR database and USTUR computers will be upgraded so that the transition will be completed in time for the new millenium.

The USTUR home page on the World Wide Web is accessible via the web address: www.ustur.wsu.edu. The web pages are updated bimonthly and they receive over 4000 hits per year. Figure 3 indicates the number of "hits" per month on the USTUR home page between October 1, 1997 and January 31, 1999. Publication requests and direct contact with USTUR faculty and staff can also be obtained via the e-mail linkages proved in the web pages.

Our current World Wide Web address is:

www.ustur.wsu.edu

Figure 3. Number of monthly visitors to the USTUR web pages



REGISTRANT STATISTICS

BY SUSAN M. EHRHART, ADMINISTRATIVE ASSISTANT

Since the 1992 transfer to Washington State University, the Registries renew registrants at five-year intervals. This provides registrants with an opportunity to reconsider their agreement with the Registries and withdraw from the program if circumstances have changed since the last agreement was signed and to provide the registries with updated medical and radiation exposure information for those registrants who choose to renew. In January of 1999, 270 registrant renewals were processed and 234 registrants were renewed.

As of January 31, 1999, the Registries had a total of 900 registrants in all categories. Of that number, 234 were active registrants (those whose authorizations were all current and complete) and 364 registrants were deceased. There were 302 registrants in an “inactive” category which includes those who were lost to follow-up, those whose agreements were terminated, and those who passed away without notification to the Registries. Figure 4 shows the types of tissue donations for deceased registrants. There were 24 whole body donors, 333 routine donors (routine autopsy) and 7 classified as "other" donors. Figure 5 shows the types of tissue donations agreed upon by living registrants. There are 20 whole body donors, 208 routine donors and 6 "other". Figure 6 shows the registrant status (active, deceased, or inactive) by worksite.

The Registries have made much progress obtaining medical and health physics records on registrants. Currently, all sites are working closely with the USTUR to provide these records. This has been a very difficult task because of legal barriers, administrative barriers, and the costs associated with duplication and shipping of the records. The USTUR now has medical records for 70% of the active registrants and 54% of the deceased registrants. Health physics records have increased to 85%

for active registrants and 71% for deceased registrants. Obtaining these records from the various sites is imperative in carrying out the Registries research.

Figure 4. Types of Tissue Donations by USTUR Deceased Registrants

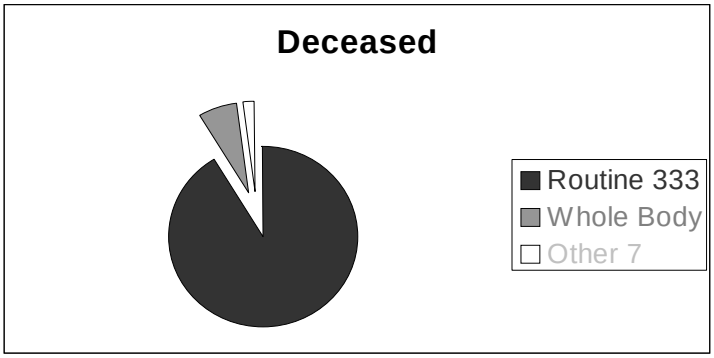


Figure 5. Types of Tissue Donations Agreed Upon by Living USTUR Registrants

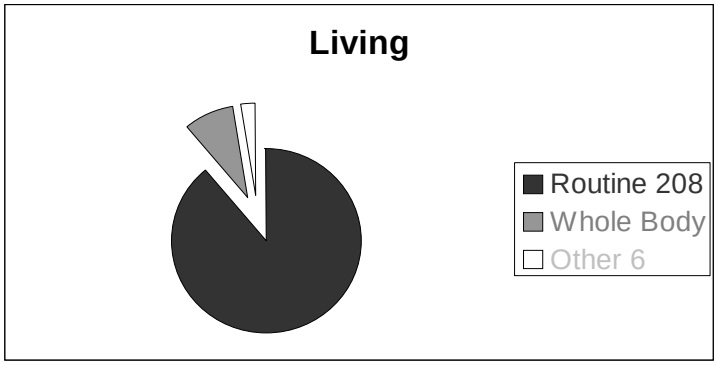
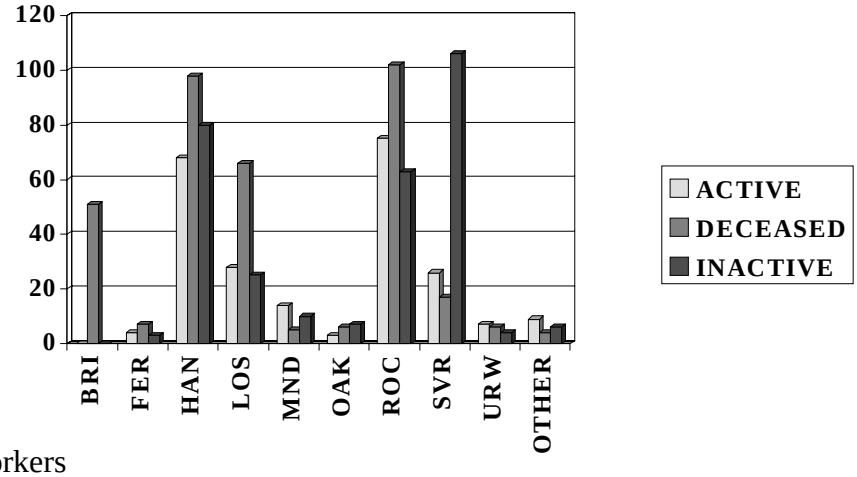


Figure 6. Status of Tissue Donors by Worksite



BRI - British
FER - Fernald
HAN - Hanford
LOS - Los Alamos
MND - Mound
OAK - Oak Ridge
SVR - Savannah River
URW - Uranium Mine Workers

PUBLICATIONS AND PRESENTATIONS

BY SUSAN M. EHRHART, ADMINISTRATIVE ASSISTANT

PUBLICATIONS

Bao, S., B. D. Thrall, R. A. Gies, and D. L. Miller. *In vivo* transfection of melanoma cells by lithotripter shockwaves. Cancer Research 58:219-221; 1998.

Brooks, A. L., and S. Bao. Induction of micronuclei in respiratory tract following radon inhalation. Int. J. of Radiat. Biol. 72:485-495; 1997.

Elliston, J. T., S. E. Glover, and R. H. Filby. Determination of isotopic uranium in human tissues by combined alpha spectrometry and neutron activation analysis. Trans. American Nucl. Society 77:14-15; 1997.

Filipy, R. E., V. F. Khokhryakov, K. G. Suslova, S. A. Romanov, D. B. Stuit, and R. L. Kathren. Analysis for actinides in tissue samples from plutonium workers of two countries. J. Radioanal. Nucl. Chem. 234(1-2):171-174; 1998.

Gehrke, R. J., R. H. Filby, S. P. LaMont, and S. E. Glover. Measurement of the ^{226}Ra alpha branching ratio. ICRM Newsletter 12:91; 1998.

Gilbert, E. S., W. C. Griffith, B. B. Boecker, G. E. Dagle, R. A. Guilmette, F. F. Hahn, B. A. Muggenburg, J. F. Park, and C. R. Watson. Statistical modeling of carcinogenic risks in dogs exposed to inhaled $^{238}PuO_2$. Radiat. Res. 150:66-82; 1998.

Glover, S. E., C. A. Grimm, and R. H. Filby. Determination of thorium and other select trace elements in human tissue by neutron activation analysis. Trans. American Nucl. Society 77:13-14; 1997.

Glover, S. E. Distribution of thorium and other trace elements in human tissues. (Ph.D. Dissertation) USTUR-0093-97; 1997. Washington State University, Pullman, WA.

Glover, S. E., R. H. Filby, S. B. Clark, and S. P. Grytdal. Optimization and characterization of a sulfate based electrodeposition method for alpha-spectroscopy of actinide elements using chemometric analysis. J. Radioanal. Nucl. Chem. 234(1-2):213-218; 1998.

Glover, S. E., R. H. Filby and S. B. Clark. Determination of ^{232}Th in human tissue by preconcentration neutron activation analysis with yield determination using ^{227}Th. J. Radioanal. Nucl. Chem. 234(1-2):65-70; 1998.

Glover, S. E., R. H. Filby, and S. B. Clark. Determination of isotopic thorium in biological samples by combined alpha spectrometry and neutron activation analysis. J. Radioanal. Nucl. Chem. 234(1-2):201-208; 1998.

Kathren, R. L. NORM sources and their origins: applied radiation and isotopes. Appl. Radiat. and Radio. 49(3):149-168; 1997.

Kathren, R. L., and S. M. Ehrhart. United States Transuranium and Uranium Registries Annual Report: October 1, 1996 to September 30, 1997. USTUR-0094-97; 1997. College of Pharmacy, Washington State University, Richland, WA.

Kathren, R. L., and S. M. Ehrhart. Facts about the United States Transuranium and Uranium Registries. (brochure) USTUR-0096-97;

1997. College of Pharmacy, Washington State Univeristy, Richland, WA.

Kathren, R. L., and S. M. Ehrhart. The National Human Radiobiology Tissue Repository and the National Radiobiology Archives. (brochure) USTUR-0101-98; 1998. College of Pharmacy, Washington State University, Richland, WA.

Kathren, R. L., and S. M. Ehrhart. Publications of the United States Transuranium and Uranium Registries: 1968-1998. USTUR-0095-97; 1998. College of Pharmacy, Washington State University, Richland, WA.

Kathren, R. L., and B. Gold. Causes of death in a USTUR cohort of 260 plutonium workers. Health Phys. 75(3);236-240; 1998.

Khokhryakov, V. F., K. G. Suslova, E. E. Aladova, I. A. Orlova, V. I. Chernikov, R. E. Filipy, D. B. Stuit, S. E. Glover, R. H. Filby, and R. L. Kathren. Progress report number 4, project 2.1: metabolism and dosimetry of plutonium industrial compounds. Richland, WA: College of Pharmacy, Washington State University. USTUR-0105-98; 1998.

Khokhryakov, V. F., T. I. Kudravtsva, V. I. Chernikov, K. G. Suslova, L. A. Orlova, and R. E. Filipy. A scintillation method for determination of actinide alpha activity in samples. J. Radioanal. Nucl. Chem. 234(1-2):293-295; 1998.

Khokhryakov, V. F., K. G. Suslova, I. A. Tseveloyova, E. E. Aladova, and R. E. Filipy. Classification of alpha-active work place aerosols based on coefficient of transportability as measured by the dialysis method. J. Radioanal. Nucl. Chem. 234(1-2):209-212; 1998.

Khokhryakov, V. F. , K. G. Suslova, E. E. Aladova, I. A. Orlova, V. I. Chernikov, R. E. Filipy, D. B. Stuit, S. E. Glover, R. H. Filby, and R. L. Kathren. Progress report number 5, project 2.1: metabolism and dosimetry of plutonium industrial compounds. Richland, WA: College of Pharmacy, Washington State University. USTUR-0126-98; 1998.

LaMont, S. P., S. E. Glover, and R. H. Filby. Determination of plutonium $^{240/239}$ratios in low activity samples using high resolution alpha spectrometry. J. Radioanal. Nucl. Chem. 234(1-2):195-199; 1998.

Love, S. F., R. H. Filby, S. E. Glover, R. L. Kathren, and D. B. Stuit. Use of combined alpha spectrometry and fission track analysis for the determination of ^{240}Pu/^{239}Pu ratios in human tissue. J. Radioanal. Nucl. Chem. 234(1-2):189-193; 1998.

Miller, D. L., and S. Bao. The relationship of scattered subharmonic, 3.3 MHz fundamental and second harmonic signals to damage of monolayer cells by ultrasonically activated albunex. The J. of The Acoustical Society of America 103(2):1183-1189; 1998.

Miller, D. L., R. A. Gies, B. D. Thrall, and S. Bao. The potential of lithotripter shockwaves for gene therapy of tumors. In: proceedings from the 16th International Congress on Acoustics and 135th meeting Acoustical Society of America, Seattle, Washington, June 20-26, 1998. (Abstract) 4:2489-2490; 1998.

Miller, D. L., S. Bao, and J. E. Morris. Sonoporation of cultured cells in the rotating tube exposure system. Ultrasound in Med. & Biol. 25(1):143-149; 1999.

Moody, C. A., S. E. Glover, D. B. Stuit, and R. H. Filby. Preconcentration and separation of thorium, uranium, plutonium and americium in human soft tissues by extraction chro-

matography. J. Radioanal. Nucl. Chem. 234(1-2)183-189; 1998.

Morris, J. E., L. B. Sasser, D. L. Miller, G. E. Dagle, C. N. Rafferty, K. L. Ebi, and L. E. Anderson. Clinical progression of transplanted large granular lymphocytic Leukemia in Fischer 344 rates Exposed to 60Hz magnetic fields. Bioelectromagnetics 20:48-56; 1999.

Muksinova, K. N., R. L. Kathren and J. J. Russell. Progress report number 1: Establishment of a repository containing tissues and organs of deceased workers of the MAYAK Industrial Association exposed to actinide elements. Richland, WA: College of Pharmacy, Washington State University. USTUR-0134-99; 1998.

Nikjoo, H., S. Uehara, W. E. Wilson, M. Hoshi, and D. T. Goodhead. Track structure in radiation biology: theory and application. Int. J. Radiat. Biol. 73(4):355-364; 1998.

Park, J. F., R. L. Buschom, G. E. Dagle, A. C. James, C. R. Watson, and R. E. Weller. Biological effects of inhaled $^{238}PuO_2$ in beagles. Radiat. Research 148(4):365-381; 1997.

Qu, H., D. B. Stuit, S. E. Glover, S. F. Love, and R. H. Filby. Preconcentration of plutonium and americium using the actinide-CU resin for human tissue analysis. J. Radioanal. Nucl. Chem. 234(1-2):175-181; 1998.

PRESENTATIONS

November 1997

J. T. Elliston presented "Determination of isotopic uranium in human tissues by combined alpha spectrometry and neutron activation analysis" at the American Nuclear Society meeting in Albuquerque, New Mexico.

S. E. Glover presented "Determination of thorium and other select trace elements in human tissue by neutron activation analysis" at the American Nuclear Society meeting in Albuquerque, New Mexico.

B. Gold presented "Brain tumors in the USTUR cohort" at the 2nd International Mediteranean IRPA Congress in Tel Aviv, Israel.

R. L. Kathren presented "Human tissue analysis: the ultimate bioassay" as the Keynote Address at the Bioassay and Environmental Radiochemistry conference in Charleston, South Carolina.

D. B. Stuit presented "Radiochemical comparison between the Dosimetry Registry of the Mayak Industrial Association (DRMIA) and the USTUR" at the Bioassay and Environmental Radiochemistry conference in Charleston, South Carolina.

February 1998

J. J. Russell presented "Plutonium content of human fetal and placental tissue" at the Health Physics Society midyear meeting in Mobile, Alabama.

April 1998

A. L. Brooks and S. Bao presented "Induction of Cytogenetic damage by HZE ^{56}Fe particles *in vivo* in both dividing and nondividing tissues" at the 46th Annual Radiation Research Society meeting in Louisville, Kentucky.

July 1998

S. P. LaMont presented "Determination of plutonium 240/239 ratios in USTUR cases using high resolution alpha spectrometry" at the Health Physics Society meeting in Minneapolis, Minnesota.

September 1998

J. T. Elliston presented "Determination of the isotopic distribution of uranium in a whole body case from the USTUR by combined alpha spectrometry and neutron" at the 7th International Conference on Low-level Measurements of Actinides and Long-lived Radionuclides in Biological and Environmental Samples in Salt Lake City, Utah.

S. E. Glover presented "The use of Ca in evaluating the skeletal distribution of actinides in a whole body donor to the USTUR" at the 7th International Conference on Low-level Measurements of Actinides and Long-lived Radionuclides in Biological and Environmental Samples in Salt Lake City, Utah.

R. H. Filby presented "The status and current research projects of the radiochemical division of the USTUR program" at the 7th International Conference on Low-level Measurements of Actinides and Long-lived Radionuclides in Biological and Environmental Samples in Salt Lake City, Utah.

R. H. Filby presented "An investigation of possible differences in the behavior of ^{238}Pu and $^{239/240}$Pu in soil" at the 7th International Conference on Low-level Measurements of Actinides and Long-lived Radionuclides in Biological and Environmental Samples in Salt Lake City, Utah.

S. E. Glover presented "Preconcentration and determination of uranium from human tissue using the actinide resin" at the 7th International Conference on Low-level Measurements of Actinides and Long-lived Radionuclides in Biological and Environmental Samples in Salt Lake City, Utah.

W. E. Wilson presented "A monte carlo for positive ion track simulation" at the 9th annual L. H. Gray Workshop in Oxford, England.

November 1998

R. H. Filby presented "Activation analysis facilities at W.S.U." at the American Nuclear Society meeting in Washington, D.C.

S. E. Glover presented "Quality assurance in true elemental analysis: a historical perspective" at the American Nuclear Society meeting in Washington, D.C.

D. B. Stuit presented "Status of the USTUR analytical methods for the determination of plutonium and americium in biological samples" at the Bioassay and Environmental Radiochemistry conference in Albuquerque, New Mexico.

ADVISORY COMMITTEE RECOMMENDATIONS

BY ROBERT G. THOMAS, ADVISORY COMMITTEE CHAIR

1997 ADVISORY COMMITTEE MEETING
WSU TRI-CITIES CAMPUS
RICHLAND, WA
OCTOBER 17-18

Radiochemistry
When the transfer of all radiochemical analytical functions from Los Alamos National Laboratory to Washington State University was first proposed in 1993, the Advisory Committee expressed serious reservations. At that time, WSU was not equipped for, and had minimal experience with, the required analyses, and the Committee was concerned with the potential loss of time, data and funding. Each year since then, the Committee has closely scrutinized the progress of the radiochemistry project and has made recommendations to ensure the development of competence, quality and efficiency. Each of these recommendations has been systematically addressed and satisfactorily resolved by the USTUR staff.

Communication
Most aspects of the USTUR program are aimed at solving existing or potential problems for the sponsoring agency, the DOE, through an effort to gather applicable information. During the presentations to the Committee, there was little reference to where the results from a given research project were headed and to the specific problems for which DOE was seeking answers. More emphasis should be placed upon the use of the USTUR results as related to the public's problems or perceived problems, as related to them by the media and other sources. In addition to presentations, a recommendation is that the USTUR home page on the Internet should be well maintained and updated.

Medical and Dosimetry Records
It was recommended this year as in the past that contact has to be made with the medical directors at exposure sites and not with health physics personnel. How one approaches the medical directors and obtains cooperation is a factor that needs investigation by the USTUR staff. Many approaches have been tried but now needed is an approach that will work.

Molecular Biology
Involvement of the USTUR in research aimed at studying the molecular biology of the effects of uranium and transuranium elements should emphasize collaborations with other institutions and should not utilize funds allocated for normal operations of the USTUR. Resources to support molecular biological research using materials at the USTUR should come from grants and contracts with outside agencies. The goals of such collaborative research must be clearly specified in order to ensure that the USTUR can make significant contributions that are consistent with the main USTUR missions.

Academic Relationships
The USTUR and related laboratories should expand present efforts to develop internships, visitations and similar programs for students who may enter careers related to radiation and health.

Occupational Health
The USTUR needs to develop a document that identifies specific scientific questions about

worker health that can be addressed with available materials. This document should include a detailed discussion regarding the significance of each scientific question, and how it may contribute to protecting worker health and safety. Then develop a document that identifies specific scientific questions about worker health that may be addressed with materials that will become available in the future. Again, this document needs to include a detailed discussion regarding the significance of each scientific question, and how it may contribute to protecting worker health and safety.

The radiochemistry group's research efforts need to be justified in terms of its contributions to worker health and safety, as well as environmental protection activities. Specific potential contributions need to be documented.

Involvement of worker health and safety stakeholders needs to be increased to ensure that the data generated by the USTUR is believable to scientists, administrators, regulators, workers, and other organized groups, such as unions. A specific plan needs to be rapidly developed and implemented. A number of DOE laboratories have such plans that could form the basis for the USTUR effort.

Foreign Collaborations
To be certain that procedures in the Dosimetry Registry of the Mayak Industrial Association (DRMIA) yield the same results as in the USTUR, parts of the same tissue have to be analyzed through the entire procedure to compare the two laboratories. Only counting foils and disks will not accomplish this as much error normally is attributed to the digestion process. The biggest problem which must be overcome, is obtaining tissue samples as they are derived at autopsy and not from some step along the radiochemical analysis procedure. Better coordination with other government-supported organizations with common interests is to be sought, although it is a difficult task.

As an overall comment, the Committee strongly suggested that a coherent set of goals and objectives (that can be audited or measured) needs to be developed for the next year of work. These should be distributed widely, including the Department of Energy Program Manager, to the Advisory Committee members, and to the staff of the Registries.

1998 ADVISORY COMMITTEE MEETING
DOUBLE TREE HOTEL
PASCO, WA
OCTOBER 23-24

Radiochemistry
This applies to the tissue collections of the USTUR and NHRTR (and possibly the JCCRER). An electronic bar coding system should be used for sample tracking and the record should include all relevant information, including the analyst of record, whether for chemical or biological analysis. If not already done, the reagent banks and quality control samples should be identified with each group of samples. This is particularly important if analyses are performed on a sample at some later date.

Documented QA/QC procedures and results are fundamental to credible data. It is recognized there are essentially no certified reference materials available for the USTUR radioanalytical program. Therefore, it is strongly suggested that an internal QA/QC program is established in which reagent blanks, blind duplicates (split samples) and previously analyzed samples make-up at least 15% of the analytical effort. The results of the QA/QC analyses should be published and form a database to look for trends including performance of an analyst.

The QA/QC procedures must also include the performance of the instrumentation used to obtain the measurement. For alpha spectrometry: background in the regions of interest, detector efficiency and energy resolution determined with a standard source in the same configuration as the sample are minimal requirements. Limits of acceptability should be established for sample resolution and radiometric tracer yield. The detection limit for an analytical procedure and how the limit is calculated should be documented in the procedure manual.

Some samples previously analyzed for the actinides are now being analyzed for stable elements, such as calcium. This retrospective work causes some concern. Presumably the samples are stored in an acid solution, but the actual acid and concentration are important. The storage bottles are of "soft" glass, not borosilicate, with paper/metal screw caps and at various sizes, perhaps from 0.1 to 1 L. Whether reagent blanks associated with the original sample suite are available is important but as important is the possibility of leaching from the walls of the storage container. There are some elements, beryllium for example, which are particularly sensitive to contamination. These concerns should be allayed before resources are allocated to stable element analyses.

Communication
In a similar approach, there needs to be a dissemination of information related to the purpose, scope, magnitude, and results obtained so far, to the public, using the media in all forms.

A recommendation is that the USTUR home page on the Internet should be well maintained and updated. All listed "links" should work and it should be kept user friendly. Since this is the only contact with the public that the USTUR may have the home page should be made maintained as attractive as feasible.

Establish the cross-link between CEDR and USTUR for verification of epidemiological dose rates.

Molecular Biology
Involvement of the USTUR in research aimed at studying the molecular biology of radiation effects should continue to emphasize collaborations with other research groups. Efforts to attract resources from external funding agencies for these studies should continue. Whenever possible, molecular biological research should take advantage of the noteworthy research group in analytical radiochemistry. External support for the radiochemistry program and for research utilizing this singular expertise should be aggressively pursued.

Medical and Dosimetry Records
It was recommended that a committee of about three people be set up to look into the medical histories of persons already in the Registries, so that well-founded decisions could be made as to what autopsy material should be analyzed with priority. Perhaps written guidelines should be established so that the selection of tissues and bodies for analysis will be accepted in an established prioritization scheme, and used for the next few years.

Occupational Health and Safety
There needs to be a recognizable effort made, such as through a widely distributed report, in which specific results obtained in the 30 years of USTUR investigation are shown to have importantly influenced radiation protection guidelines recommended by organizations such as the National Council on Radiation Protection and Measurements (NCRP), the International Committee on Radiological Protection (ICRP), the U.S. Environmental Protection Agency (EPA), the Nuclear Regulatory Commission

(NRC), the Department of Energy (DOE), Department of Defense (DOD), and Health and Human Services (HHS), and the many other organizations and institutions which have some responsibility to establish, suggest, or influence such working guidelines.

One suggestion made during the executive session involved the elimination of so many pages (174) of data on individuals in the Registries. This suggestion was counter to last year's recommendation, but it is on the web site and having been published once as part of last years annual report it may not be necessary to repeat this process for another few years.